How primary schools really work:
Architecture, use, and perspectives

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Abstract

Schools are an important class of architecture. This is for many reasons, not least because primary schools are the first public buildings that most children inhabit for a significant amount of their waking hours and are, thus, their first experience of what should be quality built environment design. To ensure this quality, occupied building evaluation should be an important endeavour in architectural practice.

Recent school building performance evaluations have been undertaken from the perspective of facilities management, or building-science, using 'expert' judgement to assess the used built environment. This presents two concerns. First, these techno-economic positions assume that behaviour of users is predictable and logical over the life of the school building, and omits the variety of users, activities, and experience of the 'Architecture'. Second, by using so-called professional 'experts', building performance often omits the voice of users (staff and students) who are expert in their own environment.

The primary objective of this inquiry was to, first, establish architectural research methods suitable for including primary school users in building performance evaluation and, second, apply it to investigate the context and user perspective of their school built environment.

Five primary schools, located in the Adelaide, South Australia, were selected for recognised heritage, architectural, and educational facility values, and recruited to participate in a mixed-method case study inquiry, as critical cases.

Because school architecture and school occupants form a building-occupant system, this inquiry needed a range of data collection methods to capture the system. Architectural assessment, physical (environmental monitoring) and social science (surveys, visual ethnography) data collection methods were integrated to create rich case study interpretations of the schools, at school and classroom units of analysis.

It was observed that the building fabric, regardless of age or design intentions, was modified to introduce contemporary permanent technological and sustainability innovations, and also for transitory occupational needs.

Data triangulation found that user perspectives of the primary school architecture differed between staff and students, and this difference was aligned with each cohort's active use of different school facilities. Exploratory Principal Axis Factoring using student participant responses resulted in five factors loaded on variables grouped around wellbeing, smell, acoustics, vision, and satisfaction, in order of their contribution to variance. This suggests that their environment quality is particularly important to primary school students. This finding was confirmed when triangulated against the qualitative data collected. Given this, and the emergent findings from the triangulated staff perspectives with other methods, it was deduced that user perspectives could be grouped into four themes: Place/Architecture, Functionality, Wellbeing, and Environment. These are proposed as a new quality framework and used to as a lens to review the success of recent school technological and sustainability innovations.

This research suggests that omitting user voices from building performance evaluation omits important sources of knowledge and design learning since, even with the best intentions, non-occupants, expert or not, cannot speak on behalf of primary school users. This flexible, techno-socio paradigm also offers a framework for interdisciplinary research that integrates the knowledge of other disciplines into future architectural inquiries.

Declarations

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Preface

This research was designed by the author to be a stand-alone PhD research project. The School of Architecture and Built Environment at The University of Adelaide provided loan equipment and $1200 towards the project. The PhD candidate was supported with a living allowance via an Australian Postgraduate Award scholarship from 2011 to 2014, and the top up Gowrie scholarship of $4000 in 2012. The candidate also self-funded some equipment and living costs. No other government or corporate sponsorship funding was used in this research.

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Keywords

school architecture; school buildings; post occupancy evaluation; building performance evaluation; school architecture - Adelaide; primary schools; architecture for vulnerable populations; mixed methods research; school case study; school architecture quality; school design; school built environment.

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The School of Art, Architecture and Design at the University of South Australia who employed me and endured my completion stage: Mads Gaardboe, Jane Lawrence, Andrew Wallace, and Christine Garnaut. Thank you. I've finished.

Forward

I am a registered architect in South Australia, who is active in the Adelaide architect professional services market and in the local chapter of the Australian Institute of Architects. This inquiry is intended to be an exercise in reflexivity of professional design and research with the intention of contributing to local professional knowledge in addition to a contribution to scholarly knowledge. It is one exercise in research and, under the principles of pragmatist philosophy it is, by definition, fallible. It is hoped that any findings that could be considered negative are not taken as direct criticism of local practitioners. The findings are presented as an opening to a conversation about how do we all, scholars and practitioners, work together to improve school design in a complex sector, and our opportunity to ethically contribute to our future generations.

This thesis is written in the third person so as to focus attention on the subject of the thesis rather than the writer. It is written from the perspective of my role as an academic researcher but, where pertinent (or I just can't hold my tongue), I include footnotes from my perspective as a registered architect. These are included as an aid to keep me firmly in the academic thought space during this exercise, but the footnotes might also be interesting in highlighting the professional-academic divide.

The original title to this inquiry was " An investigation of the ‘sustainability’ expectations and outcomes of the architecture of school buildings from design to occupancy", and it was planned to collect a wider range of data from occupants and buildings, along the lines of contemporary post occupancy evaluations (e.g. Cohen et al. 2001; Williamson et al. 2010). Inevitably real life got in the way, in the form of temporary, yet significant, health challenges, so the system boundary was drawn a little smaller. This provided the opportunity for a deeper analysis of the data that was collected. I believe that the result provides a small, yet more fundamental, contribution to knowledge. I was certainly delighted when the factor analysis threw out some logical, yet unexpected, factor loadings (which re-checked it 20 times). However, this is a book about children, so let's just say I didn't shout 'eureka'.

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List of abbreviations and terminology

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
AFL	Above floor level
AIA	American Institute of Architects
Air conditioning	Local colloquial for either combined heating and cooling plant OR cooling only plant. If it is ducted it may also include mechanical ventilation
AISSA	The Association of Independent Schools of South Australia
AuSSI	Australian Sustainable Schools Initiative
BCA	Building Code of Australia, part of the ABCB NCC
BER	Building the Education Revolution economic stimulus package 2009-2012, Australian Government
Blackboard	Black slate or equivalent board written on with chalk. Used before white boards and appropriate pens became available
BOM	The Australian Bureau of Meteorology (www.bom.gov.au)
BREEAM	Building Research Establishment Environmental Assessment Method (UK)
CEFPI	Council of Education Facility Planners International
CEO	Catholic Education Office, South Australia
DECD	Department for Education and Child Development, South Australian Government, formally DECS (name change early 2011)
DECS	Department of Education and Children’s Services, South Australian Government
DEEWR	Department of Education, Employment and Workplace Relations, Australian Government
EAL/D	English as additional language or dialect
Early years	Birth to pre-school
Education Authority	The South Australian bodies responsible for administering collective school functions, e.g., DECS, CEO or AISSA
EE	Environmental Education
EfS	Education for Sustainability
ELC	Early learning centres – Birth to pre-school
ESD	Environmental / Ecological Sustainable Development
ESD(Ed)	Education for Sustainable Development is abbreviated to ESD in educational literature. This document differentiates it from Environmental / Ecological Sustainable Development by adding the suffix (Ed).
EXIF	Exchangeable image file format - in this context refers to metadata captured in digital photographs
FA	Factor Analysis
FM	Facilities management / maintenance
GBCA	Green Building Council of Australia (administrator of Green Star)
GPO	General power outlets, colloquially known as 'power points'
ICT	Information and Communications Technology
IPTC	International Press Telecommunications Council - refers to metadata standard for press photographs (see www.iptc.org)
IWB	Interactive white board. Colloquially known as 'Smart boards', which is a brand name
Junior Primary, JP	Years R – 2
LEED	Leadership in Energy and Environmental Design, US Green Building Council
Middle Primary	Years 3 - 4
N/A	Not available – item may exist but was not available, or not confirmed as not existing
NAPLAN	The National Assessment Program – Literacy and Numeracy: annual assessment of Australian students in years 3, 5, 7, and 9.

NCC	National Construction Code Series published by the ABCB
NEP	Negotiated education plan
NEP	Negotiated education plan
Nil	Item does not exist or considered not observed
OECD	Organisation for Economic Cooperation and Development
OSHC	Out of school hours care – paid child care provided after school hours at the school
PAF	Principal Axis Factoring
PB	Pin board, i.e., large wall fixture for pinning up display. Typically soft particle board or cork equivalent, covered with fabric.
PCA	Principal components analysis
Photovoltaic panels	In Australia these are commonly called 'solar panels', but photovoltaic panels or PV will be used to distinguish them from solar hot water heating systems
PMV	Predicted mean vote of self-reported perception of thermal comfort
Primary School	Reception - year 7 (note that this is specific to South Australia - other Australian states stop primary at year 6)
Private schools	CEO or AISSA run schools, i.e., funded by a combination of private and public money
Public schools	DECS run schools, i.e., funded by public money.
R-2	Reception – year 2
RAIA	Australian Institute of Architects (formally Royal Australian Institute of Architects – R kept in the abbreviation to distinguish from AIA)
RIBA	Royal Institute of British Architects
SA	South Australia
Senior Primary, SP	Year 5 - year 7
Solar panels	This is the term for photovoltaic panels by participants. Where referring to a participant response it will be shown as 'solar' panels.
Student Diversity	Recognition of the diversity and individuality of Australian students, such as students with a disability, gifted students, students with EAL/D, Aboriginal and Torres Strait Islander students, etc. http://www.acara.edu.au/curriculum/student_diversity/student_diversity.html
Term 1	Summer term: 30 January 2012 – 5 April 2012
Term 2	Autumn term: 23 April 2012 – 29 June 2012
Term 3	Winter term: 16 July 2012 – 21 September 2012
Term 4	Spring term: 8 October 2012 – 14 December 2012
Toilets	'Toilets' is used by the public for both the pans and the room where sanitary fixtures are located. Since design professionals refer specifically to pans this word will be used to distinguish between the room and fixture even though responses may use the word 'toilet' when referring specifically to the 'pan'.
Transportables	Transportable buildings used as temporary infrastructure to cater to increased school demand. Variation occurs when demographics of school catchment areas changes.
WB	White board, i.e., large white melamine board written on with water based pens

Research specific abbreviations

Orange, Yellow, Red, White, Purple	Code names given to five case study schools
Orange.1, Orange.2	Classrooms within each case study school
O.a	Sources of paraphrased incidental conversations during site visits with staff members. Capital letter is the school (O for Orange), and lower case letter is the staff member
O.Stu100	Orange student, student number 100 out of 147 participants across all schools
O.Sta10	Orange staff, staff number 10 out of 44 participants across all schools

1 Introduction

School buildings are long lasting (e.g., over 120 years in some cases in South Australia, Chinner 1978) and are significant places within local communities (Higgins et al. 2005); however, when reading architectural history and theory literature it is rare to find examples of school architecture. When you think 'school architecture', you do not think iconic architecture[1]. Published collections and commentary of Frank Gehry's work include some educational facilities, but only at tertiary education level: three out of 24 projects (Friedman 2002) and six out of 58 projects (Lemonier & Migayrou 2015). Of his 472 projects, Alvar Aalto is credited with two primary schools, only one of which stands today (Alvar Aalto Foundation 2005). The Frank Lloyd Wright Foundation includes only one school out of 87 listed projects (The Frank Lloyd Wright Foundation 2015). Charles Rennie Macintosh's Scotland Street School is not mentioned in critical architecture history (Frampton 1992, pp. 74-77), however schools are used to illustrate New Brutalism (Alison and Peter Smithson's Hunstanton School, England, Frampton 1992, p. 263), and structuralism (Hertzberger's Apolloschool, Amsterdam, Frampton 1992, p. 30). In reality, this latter school comprises of two schools, using two different pedagogies, in two school buildings, each designed to be similar and of the same order of form of adjacent detached houses (Architectuurstudio HH 2015). Considering that two different pedagogies operate in similar spaces, it is difficult to reconcile these activities with the structuralist labelling of the architecture. And here lies the challenge of researching school architecture. Within discipline literature, it seems to be invisible.

This thesis had its beginnings in architectural practice in which an architect, the author, provided professional services for a client, schools or education authorities, while working for an architectural practice. Though the work below is written as an academic doctoral thesis, it is grounded in a background of real-world consulting where schools are far from invisible. Rather, as the first public buildings that most[2] children use, school buildings are considered extremely important. The point of departure for this inquiry is the intention to contribute to better school design, specifically primary school design.

1.1 Background to the project

Schools are an integral part of the Australian community. In 2010, over 3.5 million students were attending school throughout Australia, with approximately 7%, or 246,000, of the total attendance

[1] Personally, I don't remember school architecture being mentioned during my professional design degrees.
[2] Some children are educated at home (Government of South Australia 2015); however, reliable percentage not available at time of writing.

at South Australian schools (ABS 2011b).

Schools play a significant part in the Australian economy. In 2012 public expenditure on schools accounted for 4.9% of the Australian GDP and 13.2% of total Australian Government expenditure, excluding construction costs (UNESCO 2015). Across Australia, the education and training sector directly employed approximately 7.5% of all 'employed persons' in 2008-2009, as compared to 1.5% of in the mining sector (ABS 2010). By adding in other stakeholders such as facilities contractors, parents, volunteers and state administration staff, not to mention the schools used after hours for life-long education, community activities and elections, the number of people associated with schools increases significantly. Thus, schools that are significant to our communities, which means that their buildings are a worthy topic of investigation. With the expected doubling of population in the next 40 years (ABS 2011a; Davis Langdon 2011, p. 57) the importance of schools will not diminish.

Schools are complex built environments that function for many years. They require a wide range of functional spaces (e.g. DECS 2001), and they must meet various education regulations in addition to building rules (e.g. DECS Capital Programs & Asset Services 2010). They are expected to facilitate a desired pedagogy, but also be flexible enough to allow for changes to teaching and learning styles, now and in the future (e.g. Nair & Fielding 2005). Furthermore, the school buildings, themselves, are also expected to be spatial and sustainability teaching tools (e.g. Ford 2007, p. 11; Newton et al. 2009).

Schools are designed in the context of a complex range of stakeholders (staff, government, parents, local community, and politics) (Clark 2002) and must provide a duty of care on behalf of their key, often unvoiced, stakeholder, students (e.g. DECS Asset Policy & Capital Programs 2008). The school community is also seen as a major contributor to their local community through extra-curricula activities 'beyond the classroom' and community involvement (Higgins et al. 2005). There is an underlying premise that education, as human capital, will increase productivity, which, in turn, increases economic growth and benefits the economy (Begg et al. 1997, p. 505). What schools teach today influences our society's direction tomorrow (see the Melbourne Declaration in Marsh et al. 2014, p. 78).

The procurement of school buildings requires its own complex system of stakeholders. Unlike a commercial building where economic productivity, of both occupants and the capital asset itself, is a key target, the design of a school building is informed by far wider implied social key performance indicators. As implied by the existence of education authority design guidelines (e.g., DECS Capital Programs & Asset Services 2010) and other design advice to design professionals (e.g., CEFPI 2015), school procurement agencies rely on the professionalism of the professional service consultants to provide appropriate teaching spaces and sustainable development. Thus, designers need good quality evidence-based knowledge to underpin their advice.

Methodical assessment of the success, or otherwise, of school built environments is not well established and problematic. It is noted that the there is little rigorous research available on what makes an effective learning environment (Higgins et al. 2005). Design advice is observed to be most readily available in the form of case studies from international organisations (e.g. CEFPI 2015; OECD 2006), and governments (e.g. National Clearinghouse for Educational Facilities 2015) and is not necessarily underpinned by empirical evidence of effectiveness.

Putting aside the effects of the occupants and their activities, pre-design commercial tools do exist for rating the intended environmental performance of school buildings (Green Building Council of Australia 2011b, 2011c). These are referenced in design guidelines relevant to this inquiry (DECS Asset Services 2009), however scholarly concerns have been raised about the validity and reliability of so called environment tools, such as lack of correlation between assigned rating and actual energy use (Williamson & Radford 2000). Regardless, this approach does not address the users' activity needs.

User needs might be incorporated through stakeholder consultation (e.g., Day & Parnell 2003), yet the school procurement process, at individual school level, has been observed to omit critical information from intended users due to the power structure of decision-making (Parnell et al. 2008). Without this information, it is difficult to undertake an informed life cycle analysis (Ding & Langston 2004), particularly during the 'value engineering' post-design pre-construction phase of building procurement at which market prices are available (Ford 2007, p. 12). Thus, any innovations or local individualisation in educational facilities are not necessarily cohesive and may not include input from all stakeholders.

Given the above, building performance evaluation may be extremely useful in its ability to provide learning from past 'innovations', but is also potentially a nebulous undertaking. Good performance is difficult to define from the perspective of empirically established best design practice, appropriate environmental impact, or local needs unfiltered by the procurement team. It can seem that an architect, while wanting to design a suitable, robust, and beautiful school building for its intended occupants (using the architect's specialist knowledge about design for people and multidimensional problem solving skills), may be constrained by lack of rich *and tested* exemplars to draw on. Thus, this raises the question: what knowledge must an architect have to make the most informed decisions during the design and construction process that will maximise the quality of schools for their users? What would be the risks if a school were not robust to the challenges of time? Do architects really know what school occupants want and need?

1.2 Research questions

In the context of educational building regulations and pedagogies, both of which change over time, school building performance evaluation should be an important task, particularly when public expenditure is involved. Where performed, professional 'experts'[3] are often used to evaluate school buildings and architecture for design success and building performance.

But what of the users? Children can spend up to half of their waking hours at school[4]. Given that schools are public buildings, both economically and as architectural typology, children are immersed in significant architecture very early in their lives, through their primary schools. This significant architecture also acts as a workplace for considerable number of Australians. Using only non-occupant ‘experts’ in building evaluation removes the possibility of learning from the users, the true experts of their daily environments.

In order to provide future inclusive and equitable building performance evaluation, this inquiry questions how can school occupants (staff and students), located in selected South Australian primary schools, be included in evaluation, what perspectives do they have about their built environment and its use, and how can these perspectives improve school building evaluation? Specifically:

Research Question 1
How can architectural researchers investigate occupied primary school architecture and the users’ perspectives of the architecture?

Research Question 2
What is publically expected of primary school buildings in South Australia?

Research Question 3
How are selected South Australian primary school buildings observed to be used?

Research Question 4
Within the selected South Australian schools, what are users’ perspectives of the architecture of their primary schools?

[3]The notion of experts and professional expertise is considered here to be an imperfect hierarchical construction with various moral conflics (Coady 1996) that require informed and deliberate reflection-in-practice (Schön 1983). The Australian author, with her history of management consuting and educational facility design, tends towards a more egalitarian view such as the pragmatic approach of Metcalfe (2008) in general, and, more specifically, is drawn to Till’s discussion of the architect’s ‘double punch’ of art and science expertise and its implied professional hegemony (Till 2009, pp. 159-160), thus experts are, for this exercise, indicated as ‘experts’ so as to raise gentle skepticism towards their claims (and the author’s professional claim) on the basis that, though they are professional, their perspectives are not necessarily complete and require user voices. This is a personal bias grounded in many years of experience, and being a self-deprecating Australian, and, on reflection, could put this inquiry into the realm of transformative research (Mertens 2003) or critical theory (Alvesson & Sköldberg 2009, p. 162), but this inquiry deliberately stops before overlaying these interpretations on this endeavour due to the selected scope of the questions and available time.

[4] In South Australia a typical school day starts around 8am and finishes at 3pm. With travelling and assuming children sleep at least eight hours a night (admittedly a contestable claim), and excluding children who are homeschooled, children spend roughly a third of their day at school during term time.

Research Question 5

Based on these findings, what can design professionals learn from formally collecting school building user perspectives, and how and why this should be used in future school design?

1.3 Objectives and scope of the project

1.3.1 Objectives

The primary objective of this research is to undertake building performance evaluations on selected architecturally recognised and occupied primary schools in South Australia, specifically to:

- identify and interpret the effects occupancy and usage have on a school building's fabric over time;
- identify significant themes of fabric and facility needs from user perspectives;
- synthesise the case study results into a built environment quality framework specific to primary school architecture.

1.3.2 Scope & Assumptions

This research focuses on the built environment of a school (building envelope, landscape and services) in the context of the required educational building regulations and pedagogies in South Australia. Since the researcher is an architect in South Australia, South Australian schools have been studied for pragmatic, professional, geographic, and resource reasons. Regardless of location, any school is regarded as a complex system with individual influences, so South Australian schools should be considered as having, both, the possibility of providing rich site-specific knowledge about a building-occupant system, and as representatives of the other schools albeit in the context of a small sample size and specific culture.

This inquiry did not test the validity of the current educational building regulations. However, outcomes of the research may point to the need to review current educational building regulations and guidelines.

This inquiry was undertaken by an architect registered in South Australia, however, no architectural services were provided to participants other than statutory workplace, health and safety notification (Appendix B).

1.3.3 Terminology

A full list of all terms and abbreviations used in this thesis are found on page xxix. Some terms have different meaning depending on discipline and personal background. These are identified here to provide specific context to this inquiry.

This research will use the term 'school' to mean the system that includes students (and parents to a lesser extent), teachers, support and management staff, and the physical location and infrastructure, i.e., the system of occupants and built environment. This is further developed in Section 2.2.2.1. In South Australia, at the time of writing, the term 'primary school' referred to school years one to seven, which covers student ages from five to thirteen years old.

The term 'school built environment' designates the fixed physical infrastructure, and includes ovals and playing fields. 'School buildings' refers specifically to all buildings that are habitable spaces, either air conditioned and naturally ventilated. The term 'classroom' refers to an interior learning space. Schools also use the term 'learning space' to imply an area, generally indoors, which is set up for group or individual activities. This research acknowledges the preference by some[5] for 'learning space', however will use the term 'classroom' since (rightly or wrongly) it is of common use in current built environment academic literature. Similarly, this research acknowledges the contemporary education term 'learners' yet will use the term 'students'[6]. It will also use the term 'students' rather than 'children' as an occupational complement to 'staff', and to acknowledge that children have an additional and specific role within the boundaries of school.

The meaning of the term 'environment' also depends on its context. Within this inquiry, the focus is on the physical environment, so 'environment' refers to aspects of the 'built environment'. This differs to its use within educational literature, where it implicitly refers to the 'psycho-social classroom' environment (e.g. Moos 1980). Additionally, the natural environment is differentiated from the built environment using the terms 'ecological environment' or 'natural environment'.

The term 'architecture' is notoriously difficult to define. In this context it will be used to indicate buildings and is used interchangeably with 'buildings' since, in South Australia, architects must be involved in the procurement of permanent school buildings.

1.4 Organisation of the thesis

Having presented the research questions and terms in this section, the next section, Chapter 2, presents the literature reviewed and identifies the opening in knowledge this inquiry intends to address. Chapter 3 discusses the mixed-method research methodology and methods used, together with research considerations that originated due to the use of human ethics protocols.

Chapters 4 to 6 present the data collected together with a case-by-case analysis. The

[5] Some of my previous education clients.

[6] Some of my previous education clients, and the Teaching for Effective Learning framework (Department of Education and Children's Services 2010)

architectural context of the case study schools is presented in Chapter 4, followed by the measured environment in chapter 5. Both of these act as context for interpretation of the case study user perspectives presented at school and classroom level of analysis in chapter 6.

Mixed-methods research using case studies requires ‘triangulation’ or integrated meta-inference. This is presented as inductive emergent themes and their application to building performance evaluation and architecture practice in chapter 7. The thesis ends with responses to the research questions and final observations in chapter 8, followed by sources and supporting appendices.

2 Literature review

2.1 Introduction

Judging architecture is potentially binary where buildings are either landmarks or 'everyday architecture' depending on the political power of the building and the presence of a high profile architect (Jones 2011, pp. 3-4). Landmark buildings are much studied and taught, yet it is the 'everyday architecture' that people use. This inquiry assumes that schools are one of the first public buildings with which children become familiar. In their world schools are both landmarks and everyday architecture, making the school built environment an important class to investigate.

The research questions ask about how the primary school built environment is used and perceived, which is beyond pure evaluation as built environment fabric. If it is accepted that schools may be considered as systems (Higgins et al. 2005) then, to provide a wider picture of school buildings and their context, a range of discipline paradigms need to be explored. The use of systems thinking, in particular drawing on soft systems methodology as a 'process of inquiry' into a system (Checkland & Haynes 1994), allows the inquiry to follow new and unusual connections with the intention of providing a more complete understanding of the system, particularly a system that includes a social, natural, and material elements. However, it must also be noted that system boundaries are arbitrary and imposed (Williamson et al. 2003, p. 82).

As an organising principle this literature review draws on a systemic view of buildings in their context, which proposes that buildings are located within an interconnected environment, social and economic sub-systems (see Figure 2.1)(Williamson et al. 2003). In this inquiry these headings are explored further in areas considered relevant to the research questions, and relevant strategic interconnections and omissions are identified where obvious and appropriate.

This chapter does not restrict the review to literature that addresses only primary schools. Following the generalist approach of pivotal educational appraisal advice (Sanoff 2001a), appraisal and design primary and secondary schools are not considered as separate building classes. As such, to restrict this review to literature about primary schools, risks overlooking important and useful findings.

The context of school buildings is first reviewed in Section 2.2, commencing with the 'society' subsystem. This subsystem in represents the wider social context that adapts to current conditions and transmits knowledge of adaptation to new generations, thus framing the context for occupants. For school buildings, we can interpret this as the wider local and national context for the building and its performance (Section 2.2.1). The system of Figure 2.1 does not overtly address the political aspects of school buildings. Political systems can be considered as a macro-sociological component within large social systems (Giddens 2006, p. 25), so political influences are also considered within the society subsystem.

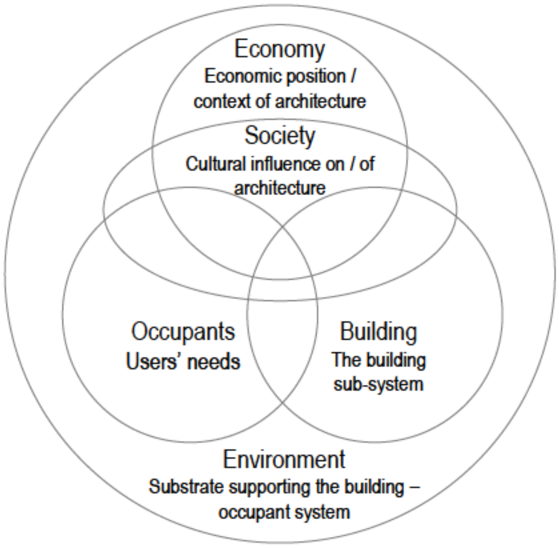


Figure 2.1: A model of the building system / subsystems view, after Williamson (2003, p. 85)

The occupant subsystem has been interpreted as that part of the building with acts on the people using the building and focuses on health, safety, satisfaction and comfort (Williamson et al. 2003, p. 91). This is also the correct place to review the activity and needs of specified occupants, in this case, the activity and needs of students, and how they act on the building, and, so, inverting the building fabric as subject. Thus, occupants provide only context for this research about buildings, in particular, schools as organisation, schools as service delivery of teaching and learning, and schools as sustainable development demonstration. The associated literature about occupants and their relationship to their school built environment are discussed in Section 2.2.2.

The economy subsystem highlights the financial restrictions of school buildings (Section 2.2.3), while the environment subsystem discusses the trend towards sustainable development, both as a design imperative and as a social trend within youth culture (Section 2.2.4).

The previous subsystems present the necessary context for the investigation of the architecture of school buildings. Literature relating to the school built environment is presented in Section 2.3 and includes both literary sources and reflections on the input from design professionals into shaping learning space.

Since this inquiry tests the research questions with data from occupied school built environments, process and precedents of building performance evaluation are discussed in Section 2.4.

Finally, in the context of this review, Section 2.5 presents the omissions in knowledge that this thesis intends to address and the significance of this inquiry.

2.2 The context of the school built environment

Before addressing the literature on the school built environment, this section discusses relevant contextual literature. The Sociocultural context is discussed first followed by the literature about school occupants. These, in turn, provide context for discussions about the economic and wider environment influences on and by schools.

2.2.1 Socio-cultural context of school buildings

In Australia, school buildings are classed as ‘a building of a public nature’, specifically an ‘assembly building’ (Australian Building Codes Board 2014). From the infrastructure perspective, this public nature implies a socio-cultural context in which the infrastructure is created predominantly for public use. Logically, this must incorporate that public context into the evaluation. This section draws on macro-sociological perspectives that include large-scale social systems, such as politics (Giddens 2006, p. 25), which are particularly important given that Australian education is historically influenced by state and federal government policy (Van Krieken et al. 2010, pp. 164-168).

The intention of this section is to explore the covert socio-cultural potential of ‘everyday architecture’ to its wider public context. In the case of school infrastructure, that context is Australian education and its interaction with the wider community.

2.2.1.1 Education in Australia

Education in Australia is a contested history as might be summarised by the quote below:

> We do not subscribe to the view that the story of Australian schooling is one of perpetual progress, nor that it is one of descent from a golden age (whenever that might have been). The educational past was neither an entirely dark place from which we have now emerged, nor a better place in which every child was well behaved and new their spelling and grammar (for example). It is undeniable, however, that the story of Australian schooling is one of extraordinary growth. Schools have sometimes been overlooked in broad histories of Australia, yet they have played an important part in the national story - culturally, socially, economically and even politically. There is no civic institution that has had a greater impact on social and family life. (Campbell & Proctor 2014, p. 248)

Politically, education is important, with government intervention starting in 1850s in Australia and continuing to the present (Churchill et al. 2011, pp. 35-37). Given that public funding for schools is significant (see 2.2.3) and that schools and school systems are representative of the political ideologies (Bowler et al. 2007, p. 396) the government power structure that controls and manages those finances will influence the way that funding is spent. Governments use positivistic approaches in their decision-making for infrastructure projects (Flyvbjerg 2004b, p. 286), suggesting an easily calculated return on investment is implicitly expected, if not expounded. If school infrastructure is, indeed, seen as ‘everyday architecture’ (Jones 2011, pp. 3-4) within the public consciousness, then minimal sophistication of cost-benefit analysis might be the appropriate government measure of success for school buildings; however, popular commentary emerging about the education system suggest that the required infrastructure and delivery needs to be more nuanced (Bonner & Caro 2012; Gillespie 2014).

Historically, Australian education has been influenced by trends from the UK, Europe, and North America (Campbell & Proctor 2014, p. xiv). This is evident architecturally in the early focus on natural light and ventilation for health and hygiene imported from the UK (Orr 2011), the open plan classrooms of the 1970s imported from the United States (Angus et al. 1979, p. xi), and recent implementations of schools informed by Reggio Emilia principles from Italy (Designshare.com 2007). Because of this international borrowing, this inquiry also looks to international sources and assumes, to a certain extent, a common experience of education and educational architecture.

2.2.1.2 **Schools as community asset**

Schools can be considered as community assets in that they are human, social and physical capital that contributes to the development of a specific community as ‘communities of place’ (Green & Haines 2012, pp. 2, 14). From a sociological perspective, the material form of a school creates a specific geographical location, a foci, that is ‘invested with meaning and value’, with consequent loss of place being felt with a community (Gieryn 2000).

Schools are also seen as a source of social justice (Mahony & Hextall 2013), with the UK ‘Schools for the Future’, the restructuring and rebuilding of dilapidated government funded schools, justified on the grounds that schools

> …should be inclusive, so that no child is left out and all can achieve their full potential, and be open to wider use, binding schools into their local communities. (DfES 2004)

New schools have also been seen as a means of ‘raising the aspirations of a community’, suggesting a functionalist premise behind the infrastructure intentions (Araújo 2009), often based on dubious evidence and unmet expectations (Mahony & Hextall 2013). More recent British school projects have been justified based on community centric arguments, but with variable outcomes (Bagley & Hillyard 2014).

In Australia, there is less discussion about schools acting as community assets. Rather, community involvement is implied by policy documents (Gonski et al. 2011, p. 220), and contribution to improving social inclusion underpins teaching expectations (Churchill et al. 2013, p. 146); however, at state level, evidence exists that use of South Australian schools 'after hours' for community education dates back to at least 1882 (Chinner 1978, p. 21), and the current national Australian school performance database 'My School' is scheduled to include a community connection measure (Hurst 2015).

2.2.1.3 Rankings and performance

Internationally, Australian education is regularly ranked by the OECD through their Programme for Internal Student Assessment (PISA) (Program for International Student Assessment 2014), with Australia ranking high for physical infrastructure quality (von Ahlefeld 2007, p. 37).

In parallel to international testing, the National Assessment Plan-Literacy and Numeracy (NAPLAN) programme was established in 2008 to test school effectiveness (Campbell & Proctor 2014, p. 255). In addition to monitoring school performance for educational benefit, rankings have been assumed to influence school selection, yet little correlation has been found, suggesting other factors drive the 'school market' (Jensen et al. 2013) (Section 2.2.2.6).

2.2.2 Occupants of School Buildings

Having provided a brief social context of school, this section reviews school occupants and their occupational objectives to identify later systemic interconnections and actions between occupants and school buildings.

At a perfunctory level, school occupants consist of three cohorts identified according to the legal relationship they have with the school. Staff are employees. Students are members of the public that receive a service (education) from the school. The immediate school community are other people who are not employed, or receiving the education service, but have an immediate relationship with the school, and include parents, guardians and volunteers. This inquiry tends to focus on the first two cohorts, staff and students, but acknowledges the importance of the immediate school community.

This section commences by reviewing the service provided in schools, and is followed by selected trends in education that have an obvious systemic connection with the school built environments. Finally, this section reviews the school community from an organisational management approach.

2.2.2.1 Pedagogy

Primary and secondary education is comprised of three components – pedagogy, curriculum, and behaviour (or classroom) management (Churchill et al. 2011, p. 51). Curriculum has a history of being influenced by external forces, yet remains constant in its tendency to return to literacy and numeracy (Churchill et al. 2011, pp. 54-55). Classroom management approaches have also varied over time from scientific rationalism to 'engagement' approaches (Churchill et al. 2011, pp. 55-56).

Discussions about the interaction of the built environment with education tend to highlight pedagogy as the driver of education spatial considerations (Barrett & Zhang 2009; Designshare.com 2007; Newton 2007). In the educational domain, pedagogy is a fluid term that describes teaching and learning strategies to transfer knowledge to students using appropriate instructional modes and communication techniques (Marsh et al. 2014, pp. 181-182), in other words:

> Pedagogy captures not only what teachers do, in the form of teachers' action, but also their role in making judgements and decisions that take into account a *wide range* of understandings of students and their needs. [emphasis added] (Brady 2003 and Foley 2007 cited in Churchill et al. 2011, p. 51)

The theoretical basis underpinning teaching and learning in South Australian DECD schools is constructivism; it is assumed that students are active in the learning process and bring their individual history to learning and teachers facilitate learning with tasks and support within 'low threat environments' (Department of Education and Children's Services 2001). The objective is to create student 'expert learners' through personalised co-construction of knowledge using dialogue and collaboration, such as, but not limited to, students working in groups on 'focused learning conversations' (Department of Education and Children's Services 2010, p. 59), or learning about their 'own thinking processes (the metacognitive work of learning)' using tools such as digital cameras to reflect learning (Department of Education and Children's Services 2010, p. 73). Furthermore, in contemporary teacher education literature, there are many instruction modes listed that rely on group work (nine out of twelve listed, Marsh et al. 2014, p. 191). The South Australian model also makes the point that this co-construction is intended to be underpinned by staff continuous professional development to improve their 'teaching for effective learning' (Department of Education and Children's Services 2010), thus demonstrating the workplace nature of schools

South Australia education also offers access to alternative[7] 'progressive' (Churchill et al. 2011, p. 50). Montessori education has a history of use in South Australia dating back to at least 1912 (Nesdale 1988, p. 10). It uses 'self-directed, play-like' activities where students are simultaneously occupied in different activities within a learning space (Churchill et al. 2011, p. 50) in a 'prepared environment' (Widger & Schofield 2012) where students participate in different activities simultaneously (Al et al. 2012). Reggio Emilia education also uses self-directed learning, with a

[7] 'Traditional', 'main-stream', 'alternative', and 'progressive' are all potentially derogatory terms of 'otherness' in this sphere of interest. Where I use these terms I do so with the greatest respect for their practitioners and their right to offer different professional approaches. I will use the term 'alternative' to refer to the minority of schools that offer approaches other than the DECD constructivist approach.

focus on group work on longer-term projects. Emphasis is places on visual arts (Ardzejewska & Coutts 2004). In contrast, Steiner (Waldorf) philosophy aims to develop the uniqueness and independence of students through interaction with a wide range of 'natural materials' (Widger & Schofield 2012). Table 2.1 lists examples of these pedagogies in South Australian Schools.

The aim to give opportunity to individual students to create, or construct, their own knowledge is similar between some of these 'alternative' approaches and constructivism, (Churchill et al. 2011, p. 11). It is also reminiscent of 'open education' from the 1970s where

> …children learn best when they can actively explore an environment rich in materials, when they are given the responsibility to make meaningful choices about what is to be learned, and when they interact informally with their teachers and with one another. (Weinstein 1979)

The logic follows that students need locations prepared for different topics and to enable group work. Within the 'alternative' education philosophies, it is the way interaction is initiated, rather than the physical environment itself, that differentiates the approaches (Widger & Schofield 2012), although there is some evidence that the philosophies are not necessarily strictly delineated in education practice. For example, some working within the Reggio Emilia pedagogy also identified Steiner philosophies as being part of their pedagogy (Ardzejewska & Coutts 2004).

Table 2.1: Alternative pedagogies in South Australia

Pedagogy	Pedagogy / influence	Examples of Schools in SA
Reggio Emilia approach	Student directed. Focus on pre-school. Opportunity to explore environment (Ceppi & Zini 1998)	CEO - St Ignatius College (2011) DECS – Parkside Primary School (2011) AISSA – St Andrews Early Learning Centre (St Andrew's School)
Steiner / Waldorf	Whole child approach 'spiritual, physical, moral and academic' through creative, independent exercises (Steiner Education Australia 2015)	DECS - Trinity Park Primary School (2008) AISSA – Mt Barker Waldorf School (2005)
Montessori	Holistic approach with four planes of development by age range 'absorbent mind' 0-6 'reasoning mind' 6-12 'humanistic mind'12-18 'specialist mind' 18-24 (Montessori Australia)	DECS – Para Hills West Primary School (2008) AISSA – The Hills Montessori School (2011)

Contemporary curriculum has seen attempts to return to a more traditional focus on literacy and numeracy, and educational productivity (Churchill et al. 2011, pp. 54-55). The implied logic of these changes is that pedagogy and curriculum innovations in the late 20th century led to a decline in standards, prompting changes in approach in the 21st century, yet this logical causality should not be assumed. On one hand, it has been suggested that only 10% of education initiatives evaluated for efficacy (OECD 2015). On the other, there is a plethora of education research, but it is not written to be applied to policy or made available to the practice of teaching (Hattie 2009, p. 2). Either way, despite various changes in pedagogy and curriculum, there has been little profound change in school educational structure over the last century (Hattie 2009, pp. 5-6).

In addition to learning productivity, school also provides other roles such as affective and physical outcomes (Marsh et al. 2014, pp. 156-157) and cultural socialisation (Brint et al. 2001). Thus, pedagogy, productivity, and other outcomes, are not necessarily well defined and are subject to competing narratives and outside influences. For architects this may make programming a pedagogy into the built environment (e.g., OECD 2006) a risky design strategy.

2.2.2.2 Schools as systems

Another approach that connects these together, and to the classroom level, is to represent schools as systems. A model often quoted in built environment literature (e.g. Higgins et al. 2005; Newton 2007; Newton et al. 2009) is a systemic 'conceptual model' of classroom climate (Moos 1980). This model, developed in the context of open plan classroom evaluation, proposed interconnections, albeit one way, between a range of organisational, student, and teacher factors that contribute to the classroom social environment, and a modified version is shown in Figure 2.2. Of note is the effect of architectural features was not tested, rather it was induced through the comparison of classroom climate in traditional and open plan spaces (Moos 1980, p. 245). This model, though logical and likely applicable to all pedagogies, is, therefore, not underpinned by evidence for the inclusion of architectural features. The omission of the physical environment is a consistent problem in social science approaches learning environments (Moore 1986). Despite this, it promotes the view of school as system, and acknowledges the possibility of interaction of the school community with the physical environment. This might be viewed as a 'soft system' (Checkland & Haynes 1994) due to the interaction between humans and their physical environment.

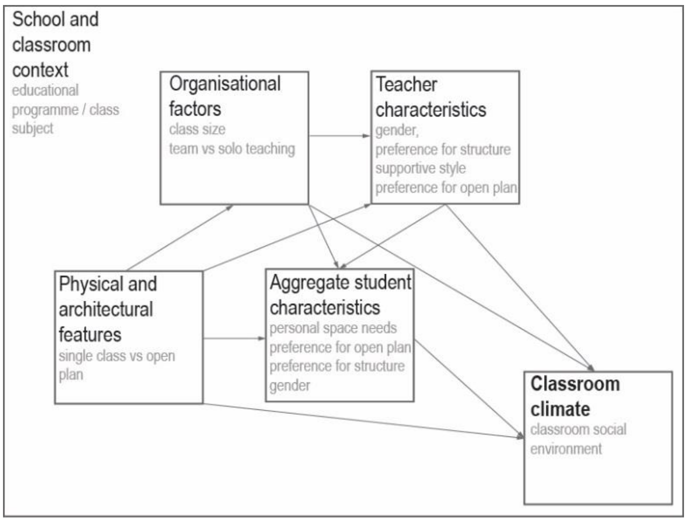


Figure 2.2 A Model of the Determinants of Classroom Climate (after Moos 1980, p. 245)

An alternative approach is step back from 'architectural features' and review the general activeness of the learner-environment relationship, where active is '…to be moving and effective, to have a causal role', and passive is submission or not active (Bowler et al. 2007). In this matrix, based on a systemic ecological approach to child development (Dent-Read & Zukow-Goldring 1997), four quadrants of environment and learner activeness are possible (Figure 2.3). Quadrant 2 and 4 (numbering taken from Bowler et al. 2007) consider the learner as passive. Where the environment is assumed passive, learning capacity is considered to be due to pre-determined factors such as genetics, whereas an active environment describes a traditional didactic delivery.

Quadrants 1 and 3 present the theory of an active learner. If the environment is assumed passive, then the learner is assumed purely self-directed in their learning so that they can 'discover' selected aspects of their environment. This is consistent with constructivist.

Quadrant 1 assumes an active learner interactive with their environment, and the nested ecological system of Bronfenbrenner is proposed as an example of this quadrant (Bowler et al. 2007). Two possibilities arise within this quadrant. First, taking this proposed ecological system of student and learner, it raises the possibility of mapping the alternative education philosophies onto this quadrant (Lippman 2010). Reggio Emilia literature presents the education philosophy within its physical context and specifically refers to the system of school (Ceppi & Zini 1998, p. 114). Montessori learning uses a 'prepared environment' (Montessori Australia), suggesting the physical environment is manipulated to stimulate an active interaction (Berris & Miller 2011). Steiner education focuses on individual development, yet there is an emphasis on an appropriate physical environment and a substrate for learning particularly in early years (Steiner Education Australia 2015). These examples of integration of the physical environment into active learning suggests that they sit in quadrant 1 of the model below.

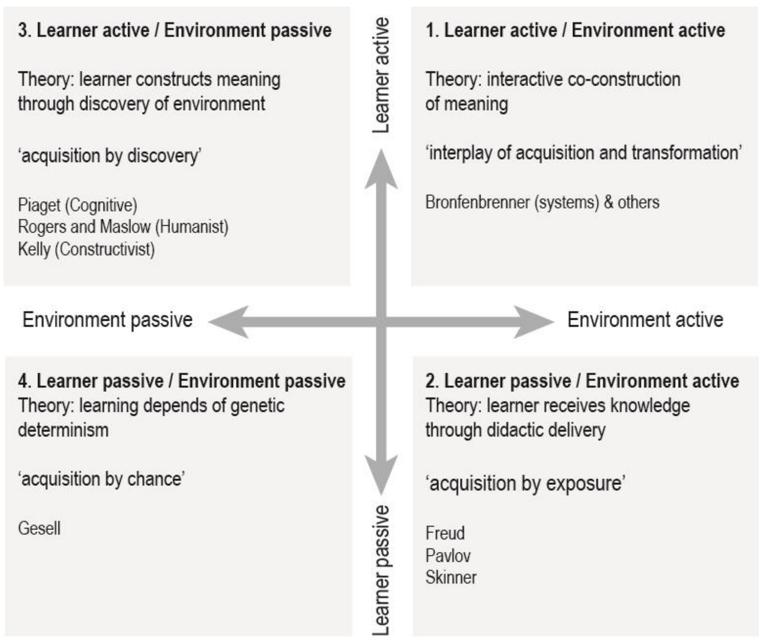


Figure 2.3: Conceptual relationship between learner and environment (after Bowler et al. 2007)

The second possibility is the implied positioning of South Australian constructivist approaches in quadrant 1 rather than quadrant 3. At face value, the espoused pedagogy is constructivist (Department of Education and Children's Services 2010), yet the existence of facilities guidelines (DECS Capital Programs & Asset Services 2010) suggests that there is an action by the environment on the learners, if only at a minimum level of removing hazards. For now, South Australian ‘constructivism’ is left tentatively in quadrant 3.

2.2.2.3 **ICT and 21C schools**

Information and communications technology changed rapidly in the last fifteen years and these changes are seen as significantly influencing school teaching and learning and classroom layout (Clark 2002, pp. 30-32; Newton, Backhouse, et al. 2012, p. 9) (Nair & Fielding 2005).

Use of contemporary information and communications technology and remote teaching delivery is not new. Remote secondary school teaching via the internet has been available since 1998 (e.g., Heppell 2007; Heppell 2009). Remote South Australia has been receiving primary school education via radio since the 1958 commencement of ‘School of the Air’ (Nesdale 1988, p. 108).

For students who are able to attend school, traditional classrooms remain to date and technology such as portable devices and interactive white boards have been added to the existing fabric to enable ‘technology-enhanced learning’. While ICT is seen as integral, or ubiquitous, to 21st century learning, there is evidence that recent students want other space free of technology, suggesting that older school design typologies are not necessarily redundant (Burke 2014). The enthusiasm for technology can also overlook the social effects of change due to technology. There is some evidence that interactive white boards to provide the advocated benefits with evidence of less group work within classrooms with IWBs installed (Smith et al. 2006), and that gender effects appeared, with boys dominating interactions (Smith et al. 2007). Yet, in science teaching, there is evidence that IWBs increase multi-modal learning, i.e., there is more interactivity at the board (Murcia 2014). Thus, the theoretical possibilities of 21st century learning using ICT need good quality evidence of their efficacy and equity, and this evidence could only benefit future school design.

2.2.2.4 **Education about sustainability**

The history of Australian education for sustainable development is detailed and complex in both its negotiation between the values and curriculum necessary for education for sustainable development, and its implementation (de Leo 2012). Currently in Australia, primary school level education includes sustainability in the national curriculum as a ‘cross curriculum priority’ (ACARA 2011a, 2015), and is prefaced by a range of curricula to educate students about their environment.

Prior to the 1992 'environmental education' (EE) was taught. This changed to a more critical approach known as 'education for sustainability' (EfS) after the 1992 Earth Summit (Lewis et al. 2009). The 'Australian Sustainable Schools Initiative' (AuSSI) was piloted in 2002 in Vic and NSW then rolled out to all states by 2007. At 2009, one quarter of all schools were part of the programme, which focused on creating a 'culture of sustainability' that reduced use of resources and creation of waste, while conserving biodiversity (Davis & Ferreira 2009). In other words, the scope of sustainability education was originally limited to waste, water, energy and biodiversity. In contemporary education, the cross-curriculum sustainability priority introduces social and economic sustainability considerations (ACARA 2011a, 2015), thus returning sustainability interpretation back to the Brundtland systemic approach.

The development of Australian curricula 'education for sustainability' (EfS) is approximately contemporary with the UK and US. In the UK, Education for Sustainable Development (ESD) curriculum was introduced in 1999, in which the three themes of 'social equity, environmental quality and economic prosperity' are taught (Walshe 2008, p. 538). In the US, Sustainability Education (SE) is seen as education in the three 'e's – equity, environment and economy (Higgs & McMillan 2006). With these similar approaches, these countries were drawn on for examples of integration of the built environment into sustainability curricula.

In applying the curricular, one example of AuSSI was found to be resource intensive since it required a fully integrated environmental vision and curriculum rather than their previous periodic and intensive environmental lessons. This required additional staff to implement and maintain (Lewis et al. 2009). New Zealand uses trained 'enviroschool facilitators' to deliver curricular (Robertson 2012, p. 95).

The success of sustainability education depends on the level of integration of sustainability and whole school congruence. Schools that integrate sustainability into teaching, behaviour, buildings and governance are more successful than those approaching only some aspects, and a culture of sustainability that is reinforced by modelled behaviour is more effective that teaching alone (Higgs & McMillan 2006). In particular, extending student involvement to facilities management increases environmental awareness through transparency of operations and decreases the need to 'preach':

> Involving students in the operations of the school makes the waste, consumption, inequities, governance, and economics of the school more visible and tangible. …'There is a natural tendency to become aware of how your life impacts the place that you live and the land that you're on since we are the ones who mow the lawn and clean out the septic system.' (Higgs & McMillan 2006, p. 45)

It has been reported that students overwhelmingly preferred lessons in biodiversity to other AuSSI themes (waterwise, energysmart, wastewise and wellbeing) (Lewis et al. 2009). In one UK qualitative study the theme ‘Nature: Environmental’ received the most mentions in coded data and the only example of the built environment presented is an example of how buildings are seen as negative due to poor location (hotels) or visually intrusive (‘land turned into buildings and estates’) (Walshe 2008). Buildings as a source of carbon pollution, or beneficial through their social and economic functions, such as providing shelter were not considered. If the intention of the education for sustainable development is to not only educate but also socialise students about sustainable development values (Sund & Wickman 2011a), although political, focusing only on ‘natural’ biodiversity omits important contributions to sustainable development.

At the time of the data collection in this inquiry, publicly funded schools remained focussed on the AuSSI program (DECS 2007) and the solar schools programme (Department of Climate Change and Energy Efficiency 2011) while the Catholic ‘Earth care’ programme focuses on ‘ESD’ (CEA 2010). These programmes omit both focus on school buildings and wider interpretations of the Brundtland sustainable development system.

2.2.2.5 **School as organisation**

A class or lecture is a service (Desmet et al. 1998, p. 3) and, as a ‘collective social arrangement’, a school can be considered to be an organisation (Wilson & Rosenfeld 1990, p. 6), as acknowledged by the educational conceptual framework in Figure 2.2. Schools provide a service in the form of education and development of young people. To do this they require infrastructure in the form of teaching equipment and accommodation. They also need to provide an appropriate and safe workplace for staff (DECS Executive Director Human Resource & Workplace Development 2010). They must maintain their operational finances so that they are both liquid and solvent. Moreover, they employ, manage and develop staff. Given this, it is valid to draw on organisational behaviour writing to find richness about the building occupants.

In 2012, the Government of South Australia employed 28,401 people, 54% in a full time role, with a mean age of 46 years, and 75% females (Department for Education and Child Development 2012). The government education workforce can be described as feminised, yet, given the history of employment in the education sector, this is not unusual (Basten 1997; Drudy 2008).

Each school has a culture (Sanoff 2001a). A school’s culture “… is manifested through the school’s rituals, traditions, buildings, programs, instructional methods, and extracurricular activities” (Higgs & McMillan, p. 48), or is ‘the sum of values, cultures, safety practices and organisational structures...that inform the policy and function of a school’ (Churchill et al. 2011, p. 162). Others argue that notion of culture is nebulous, but that buildings and grounds can act as ‘visual manifestations’ of school culture (Marsh et al. 2014, p. 355).

These can be viewed in terms of generic organisational culture writings, where organisational culture is defined as:

> '…the pattern of basic assumptions that a given group has invented, discovered or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and therefore, to be taught to new members as the correct way to perceive, think and feel in relation to these problems' (Schein 1985 quoted in Legge 1995, p. 188)

These artefacts and values are manifestations of basic assumptions that have been integrated into a culture, often through a process of sharing and solving of problems (or not), to the point that they 'drop from conscious recognition' (Legge 1995, p. 189).

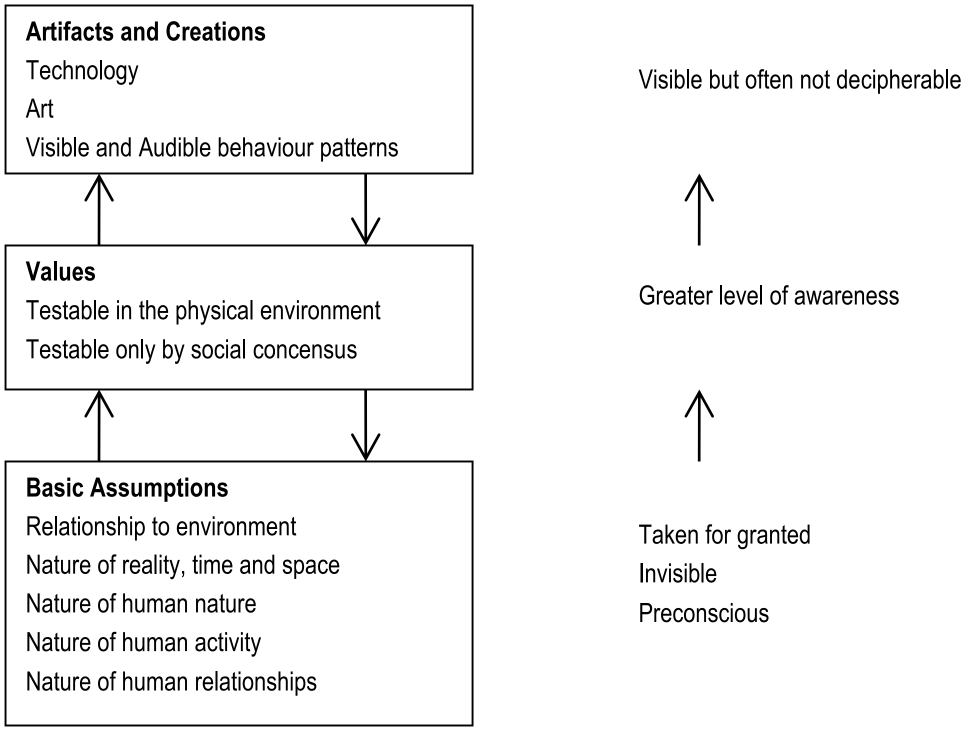


Figure 2.4 Schein's model of levels of culture and their interaction (Schein in Legge 1995, modified)

If a school is an organisation, then any major change within a school, to any part of its operation, can be viewed as organisational change. For some time it has been observed that organisational change can be planned or emergent, simple or transformational, driven by technology, wider environmental factors or the life cycle of the organisation (Wilson 1992, pp. 25-47). Organisations can be irrational, political, have significant gender based divisions, have conservative organisational cultures or (and) national cultures that make change difficult (Wilson 1992, pp. 48-91). Intended strategies can lead to unintended consequences often as a result of the informal process of sense-making (Balogun & Johnson 2005; Weick et al. 2005).

For example, the success of one school's implementation of sustainability education over another may be due to culture and the successful of integration of sustainability behaviours. A school that does not both fully integrate and model appropriate sustainability behaviours does not meet the goal of school-wide sustainability (Higgs & McMillan 2006, p. 49).

In other, more general changes to improve the school physical environment, successful integration may be influenced by the level staff engagement (Higgins et al. 2005). Assuming buildings act as cultural artefacts, the group's attitude towards changes in the fabric could be considered as an expression of that group's culture. This potentially explains any integration, or lack of, school building into modelling and teaching behaviours. Where a change in school built environment is too quick or without a common language or vision there is disappointment by users (Parnell et al. 2008). Where building controls are not explained or are unresponsive then they will not be used (Bordass, Leaman, et al. 2001; Leaman & Bordass 2001). Yet, where the technological artefact is accepted and integrated within a culture then their performance may be better (see the Kingsmead school in DfES 2006).

In change management literature, introducing technology into an organisation has long been seen as a social process, which may result in acceptance or rejection of technological items (Scarbrough & Corbett 1992; Wilson 1992, p. 129). Of analogical interest here is the manner in which new technology is introduced. Management consultants have been seen as facilitating in leading the technological 'pre-packaged change project' in commercial organisations (Morgan & Spicer 2009/2011, p. 255), with populist management gurus providing further influence: '…it is vital to understand the role that [management] gurus play in convincing people of the enormities of change. …They are extremists, the enthusiasts, the proselytizers.' (Morgan & Spicer 2009/2011, p. 256). Designers might reflect on any tendency towards 'guru' role as spatial change managers and any promises of positive deterministic effects, given the variety of actors involved. We should be wary about assuming that new buildings and technology, such as technology associated with sustainability, will be embraced whole heartedly, and without question, as best practice and fully integrated into curriculum.

The schools as organisation lens also opens up the consideration of staff as networkers. It has been proposed that, historically, Australian female educators have been responsible for transnational interaction and distribution of educational ideas (Whitehead 2014).

2.2.2.6 **The school market**

In the context of economic rationalist trends of current education (Churchill et al. 2011, p. 55), there is a perception that school choice exists in Australia and that choice is a market place (Campbell et al. 2009). The notion of a school market is not new and examples existed in Australia in the mid-19th century prior to the introduction of government-assisted education (Campbell & Proctor 2014, p. 35). During the first half of the 20th century, government-assisted education was tightly zoned, so the market was isolated to non-government funded schools.

Federal government funding changed in the late 20th century, together with active recruitment by non-government funding schools and lifting of zoning restrictions. These changes intended to increase competition and create a school market (Campbell & Proctor 2014, p. 211).

If the school market exists and if school buildings represent the 'visible culture' then architecture potentially becomes a marketing exercise; however, there is disagreement about the existence of a school market in Australia (Jensen et al. 2013), particularly the drawcard of 'facilities and resources' of a school (Campbell et al. 2009, pp. 76-77). While there might not logically be a school market, there may be a consumer perspective of market. This perspective of a market may inform strategic decisions about school operation, such as the procurement of architecture. At the time of writing there is little evidence to support or refute this idea.

2.2.3 Economic context of school buildings

Publically funded education is a merit good, i.e., it is provided by the government for the benefit of a society rather than an individual. The return to society can be a range of effects such as productivity. Government will spend money on public goods when there is market failure and when it is perceived that the public will not engage appropriately, such as leaving school early will reduce wider benefits to society (Begg et al. 1997, pp. 264-265). Regardless of the economic paradigms of the political party in power, there are limits on tax collection which requires decisions on how equitably and efficiently (not necessarily at once) distribute taxable income (Begg et al. 1997, pp. 270-271).

Thus, school buildings are dependent on restricted finance, yet the resources available to schools have a clear impact on school performance (von Ahlefeld 2007). In the case of public schools this funding is public funding, whereas private schools are funded by a combination of public funding, parent organisations and school fees (Australian Government 2008; Campbell et al. 2009, p. 1; Gurd 2013). Funding arrangements are complex and possibly inequitable (Gonski et al. 2011), and tend to be in a state of flux depending on the government in power. This if further complicated by the distribution of funding from the Australian federal government to the state governments, who are responsible for the provision of public education (Gonski et al. 2011, p. 43), or direct to the private education authorities at a national level such as the Catholic Education Office.

Despite this restricted financing, Australia has a history of attempting innovation in school infrastructure, such as buildings supporting difference pedagogy (Section 2.3.3.4) and 'green' schools (Section 2.3.6), the latter also seen as reducing operating costs.

2.2.4 Wider environmental context of architecture

According to the organising system used here, education occupants and school architecture exists in the context of the wider natural environment and, furthermore, this wider environment is explicitly addressed in school curriculum through education for sustainability (Section 2.2.2.4). This section briefly addresses the wider environmental context of architecture, in particular the drivers of sustainable development, which is intended to provide a context for sustainability expectations of the school built environment discussed further in Section 2.3.6.

2.2.4.1 Sustainable development

Concern about the need to protect the environment from effect of human development is certainly not new (McHarg & American Museum of Natural History 1969). The notion of sustainability development was formalised internationally with the 1987 World Commission on Environment and Development and the 'Brundtland report', which placed the interconnected need of development and growth, together with the need to use resources wisely and equitably for current and future generations (Brundtland & United Nations World Commision on Enviornment and Development 1987).

Market mechanisms have been proposed as drivers that will change the sustainability of infrastructure. These include such as the 'triple bottom line' which acts as a 'condition of entry into a market through the supply chain' (Elkington 1998, p. 211), or demand 'pull factors', such as sustainability requirements from insurance, changes in the materials supply, and energy supply (Davis Langdon 2011, p. 64). Other opinions suggest that the reliance on pure market economy to trigger sustainable development so as to slow down any anthropogenic triggered climate change is possibly hopeful at best, and, at worst, unlikely without government intervention to transform markets (Roaf et al. 2010).

Codification through international standards (ISO 2006a, 2006b, 2007, 2008) and, to a lesser extent, Australian standards and codes (Australian Building Codes Board 1999-2011), exist. Non-government assessment tools are also available. These range from checklists for environmental sustainability performance (Green Building Council of Australia 2011a) to computer aided guidance such as post occupancy building energy use evaluation by NABERS (NSW Government 2016; Watson 2004b, pp. 43-44). However concerns about these tool include, but are not limited to, a lack of grounding in environmental theory (Watson 2004b, p. 79) to poor reliability of software (Thomas 2010 quoting T. Williamson) to lack of correlation between ratings and energy use (Williamson et al. 2001; Williamson et al. 2010).

So, while sustainability, or sustainable development, is seen internationally as a tripartite aim, in Australia the lack of single legislative framework or reliable performance assessment tool means sustainable development of buildings, let alone sustainable occupation of buildings, is fragmented at best. The result is architects and building designers look to professionally developed knowledge and advice to meet their design intentions.

Designing for local conditions predates sustainable development principles. Architects have long used architectural science principles in their designs (Cowan 1977; Olgyay & Olgyay 1963), and drawn on vernacular responses to climate in their designs (Frampton 1992, p. 327).

Architects now design for the ‘green’ market, i.e., the building procurers or regulators that use the terms ‘green’, ‘sustainable’, ‘sustainable development’, ‘low energy’, ‘energy efficient’ and ‘zero carbon’ to indicate that a construction exercise is an ethical or moral process in some way (Davis Langdon 2011). Williamson and Radford note the lack of appropriate emission targets, the emergence of design advice that does not necessarily lead to the reduced emissions and the possible financial cost of attempting to meet inappropriate targets using poor design advice (Williamson & Radford 2000). Guy and Farmer note the complexity of interpreting “green” buildings

> …the debate around green buildings can be visualised as a landscape of often fragmented, contradictory and competing values and interests. It has become a site of conflicting continuous process of defining and redefining the meaning of the environmental problem itself (Guy & Farmer 2000, p. 73)

An alternative approach to designing for sustainability is to use a risk management approach in which buildings are designed to be robust or resilient to changing environmental conditions (Lisø 2006) using strategic forecasting techniques to test built environment response to alternative possible futures (Nordvik & Lisø 2004; Pearce 2006b). This presupposes fixed fabric, whereas the integration of technology to create responsive ‘intelligent buildings’ has also been proposed and attempted. However, concerns about poor understanding of building technology due to socio-technical interaction limitations to date (Chiu et al. 2014), and concerns about technology as the ‘new modernism’ (Till 2009, p. 102), have implications for solution through technology strategies, particularly in the context of rapid change of technology (Mack 2011).

2.2.4.2 Public concern and the next generation as change agents

Public concern for sustainability issues in Australia was demonstrated to be growing in the late 20th century, but with focus on environmental ‘green’ issues (McAllister & Studlar 1999), not social and economic sustainability. This parallels the built environment sustainability influences outlined above that centre around reducing resource use, energy use, and waste generation.

Of relevance to this inquiry is that Brundtland singled out a number of key stakeholders, such as young people and implores teachers to include the findings of the report in the curriculum (Brundtland & United Nations World Commision on Enviornment and Development 1987, p. xiv). This was later reinforced by The UN Division for Sustainable Development, who were tasked with the implementation of ‘Agenda 21’ goals of social, economic, and environmental sustainable development (United Nations 1992a), where young people are positioned as stakeholders with limited decision making power in sustainable development (principle 21 in United Nations 1992b).

In light of this, education about sustainability (Section 2.2.2.4) could be interpreted as a form of ‘bridge’ social sustainability (actively changing the relationship between humans and their natural and built environment), and ‘maintenance’ social sustainability (maintaining good quality exemplar natural and built environments) (Vallance et al. 2011). Thus, any assumptions about the teaching power of school buildings aiming to contribute to education for sustainability (DECS Asset Services 2009) need to be viewed in this historical context as a source for their pedagogical intentions.

2.2.5 **Summary**

This section has outlined briefly the context in which school operate in Australia. Education in Australia is compulsory and delivered by a public education system and a number of private independent education authorities. The use of a significant amount of public money in both systems adds consistency across the different education authorities, yet also opens them up to consequences of politics. Schools are seen as a community asset, yet the community also wants (or is told it wants) information about school performance, leading to attempts at transparency through performance rankings systems.

School occupants consist of different cohorts – employed service delivery, education service consumer, and other local stakeholders and users. These different users have different legal relationships with the school, and different needs. The delivered service is education. It has the same curricula objectives across Australia, but it is delivered according to different pedagogies, or teaching and learning. The predominant pedagogy is ‘constructivism’, which privileges the learner as active over its passive environment. It is argued here that, in the context of built environment research, the passiveness of the ‘passive’ environment needs reviewing.

School instructional modes are also changing due to change in information and communication technology. In parallel with this, and of interest to built environment research, education for sustainable development continues to grow in importance.

Returning to the different cohorts, being a service provider means employing staff to deliver the service. This opens up a new paradigm with which to view schools. The applied sociological approach of organisational studies allows schools to be seen as groups with cultures. These cultures are expressed in artefacts, including buildings. This is a useful context for built environment research. Along this business vein, the concept of a school market is reviewed, together with the economic context of schools.

Finally, the wider environmental context of schools is reviewed to introduce current understandings and conflicts of sustainable development, to provide context for education for sustainable development, as discussed earlier, and sustainability expectations of the school built environment, which is presented in the next section.

2.3 The school built environment

Having reviewed the school context, this section discusses contemporary literature on the school building environment and its relationship to its users.

Literature about school buildings tends to focus on whether the built environment functions well and comfortable (e.g. Barrett & Zhang 2012); however, school is more than a place to learn. From the perspective of environmental psychology, it also provides a place for socialisation and psychological development (Rivlin & Weinstein 1984) and it must be safe (DECS Capital Programs & Asset Services 2010). These environmental interactions that are invisible or implicit to the user, yet, in the case of creating a safe workplace, required significant design input on the part of designers, to make them actively absent of danger.

This section reflects on this active or passive role in the context of contemporary literature, in light of the professionalism expected of built environment practitioners (Hughes & Hughes 2013) and the role of government clients to act as change agents for development practices in the wider built environment (Bonham 2013).

2.3.1 The 'learning environment'

It has been assumed that the physical environment affects teaching and learning, and this interaction can be modelled using ecological systems (Section 2.2.2.1), which is contemporaneous with attitudes about the impact of design as a positive contributor to life in general, and children specifically (Kinchin & O'Connor 2012).

Design advice is based on this deterministic presumption: better quality 'learning environment' leads to better quality learning (OECD 2006) due to systemic effects (Moore 1979) on cognitive development (Moore 1985). Learning environments are also intended to add value in various ways to many stakeholders, as demonstrated in selection criteria for school facilities awards:

> The jury was keen that the winner in this category [new construction: entire school] would add new knowledge to the community, to educators and to architects. We looked for evidence of the links between research and educating the community on the impact of the built learning environment on learning. Above all we wanted to be sure that the mission of the process was to create a built learning environment that added value to the experiences of the learners, whoever they may be. (Education Today 2011, p. 31)

Evidence of this is provided through jury comments, where presumably the jury is drawn from facilities experts, with some reference to feedback from staff to the jury; however, the appraisal process is not transparent. Comfort, in reference to students' overall feeling, not thermal comfort, is mentioned twice, and indoor temperature and thermal comfort is not mentioned as a quality criterion. Light and ventilation is mentioned in the context of 'ESD features' (Education Today 2011, p. 31). Light is also attributed to promoting 'independent learning through a series of stimulating learning environments' (Education Today 2011, p. 32). Acoustics is mentioned in the context of 'soft acoustic quality … allows spaces to retain their openness while maintaining group focus and individual comfort' (Education Today 2011, p. 36), and acoustic isolation 'with respect to adjoining properties' (Education Today 2011, p. 37). Identity is mentioned once, as is air quality. Jury comments focus on space planning, functionality, consultation, and facilities for saving energy and water, thus implying that a good 'learning environment' is determined by broad brush design decisions, rather than detail and complex interactions of fabric and service elements and quality.

Reviewing literature about the learning environment is difficult because of the range of disciplines involved, subjective interpretations, and omissions of aspects of the built environment (Higgins et al. 2005). Unlike the systemic presumptions in Section 2.2.2.1, research is limited to specific areas or elements without consideration of the area's relation to the wider system or context, e.g., the noise issues associated with temperature control through HVAC systems (Higgins et al. 2005, p. 6) or unit of analysis such as school, building or classroom (Simon et al. 2007). Similarly, the practicalities of researching schools means that samples may be small and participant selection biased (Simon et al. 2007). Ultimately, student achievement is influenced by a myriad of external factors (Hattie 2009; Moos 1980), so linking achievement to the learning environment is difficult. Furthermore, the 'learning environment' is often interpreted as independent of the physical environment (Hattie 2009, p. 13), and issues with negative behaviour such as bullying (Swearer et al. 2010), omit the physical environment as potential enabler of such behaviour.

An additional challenge is that evaluators tend to be from non-architectural backgrounds and group variables together into topics that cross professional procurement boundaries. For example variables such as ‘classroom design and furniture’, ‘density and crowding’, and ‘noise’ (Weinstein 1979), depend on, but are not limited to, decisions about the budget available for construction, educational authority regulations and guidelines, architectural design, use patterns during teaching and learning activities. Other more recent reviews do attempt to break these down into variables closer to the limits of professional scope (Higgins et al. 2005), while others attempt to extend the scope of the physical environment design to include cognitive psychology and neuroscience (Barrett & Zhang 2009; Forward by Eberhard in Ford 2007, pp. 8-9).

Where there have been past expectations of significant influence of the physical environment on learning (Weinstein 1979), others note that, while the literature is clear that physical environment extremes can have negative effects (e.g. poor air quality), they are hesitant to conclude that there is gain to be had beyond a basic level of adequate facility (Higgins et al. 2005). Regardless, it has also been asserted that schools should have an ‘appropriate’ ‘level of stimulation’ through the use ‘complexity’, ‘colour’, and ‘texture’ (Barrett & Zhang 2009, p. 25); however, design subtleties, such as the hue, saturation and brightness of ‘appropriate’ colour tend not be made explicit, referring only to the generic colour description ‘red’ as a preference.

Warning against architectural determinism such as this, other influences, such as how staff are engaged in changes in the physical environment, are likely to impact on the effects on student learning and behaviour (Higgins et al. 2005, p. 6). This suggests that the physical environment plays a supporting role in facilitating education delivery, such as ‘effective learning provision’ as an alternative functional approach to ‘effective learning environments’ (Hes 2012).

Ultimately, the ‘learning environment’ is neither single parameter, nor universally agreed group of built environment elements. The next sections review literature pertaining to school identity as place.

2.3.2 School identity, place, and landscape

Due to funding constraints, there is a perception that the aesthetic is of lower importance in school buildings (Dudek 2000, p. 101), yet it is also argued that the architecture of school buildings should be more than functional because architecture as a visual encounter contributes to the student ‘learning experience’ and local community (Dudek 2000, pp. 72-73). This section reviews these two scales of schools as an architectural typology, and a contributor to urban context.

2.3.2.1 School buildings as Architecture

Education design advice, education guidelines, and literature break school architecture down into the components that are thought to contribute to teaching and learning effectiveness, and affect learning, i.e., functional space, fabric quality, and comfort, all of which are discussed later in Section 2.3. These are all part of architecture, yet, since these involve people, they are unlikely to be seen as part of Architecture in contemporary architectural theory (Till 2009, pp. 19-20). Schools are ‘everyday’ (Jones 2011, p. 3), so cannot be iconic in the sense of iconic Architecture (Jencks 2005). Visual quality can also be judged from the perspective of architectonic reductionism (Frampton 1992, p. 10), or visual experience (Tveit et al. 2013), or as official architecture with a capital 'A' (Till 2009, p. 19).

These adult interpretations of Architecture deal with the whole, yet understanding the production and product of school architecture requires the dissection of components, thus reinforcing the technology of school buildings (Churchill et al. 2011). However, this overlooks the wholeness of the experience of architecture for the sake of Architecture, which, assuming this is important (at least in the minds of architects), should not be denied to staff and students, particularly considering the social and economic importance of schools (Section 2.2). Certainly, the visual quality of schools is seen by some as a required part of evaluation (Sanoff 2001a).

So, it is worth asking, what is iconic in student scale? Perception is modelled as three dependent stages: direct perception; perceptual awareness; and planning (Baird 1982). Direct perception is the ability to sense the environment. Perceptual awareness is the ability to ‘…recall the memory-coded aspects of direct perception over long time periods (hours, days, weeks), and under conditions where the original perceptual stimulus is not available’ (Baird 1982, p. 90). Planning is the ability to use direct perception and perceptual awareness for strategic inferences. Children develop these abilities over time, so that they are not fully developed until adulthood (Baird 1982, p. 91), thus children must see architecture differently to adults (and, presumably, to adults with additional spatial skill development such as architecture).

It could be asked whether students are actually aware of their physical environment. In education and design literature opinions differ from the assertion that students have poor spatial literacy (Fisher 2002), to students considered as ‘experts’ in their environment (Moos 1980, p. 240), while others have found students to be aware of their surroundings others (Edgerton et al. 2010; Parnell et al. 2008; Simon et al. 2007)

Breaking down the iconic, children like balance and symmetry (Baird 1982). There is some evidence that internal wall colour and light is important to students (Barrett et al. 2011; Higgins et al. 2005). Similarly, there is some evidence of student preferences for external landscapes (playgrounds, sports grounds, and grounds in general) (Baird 1982; Barrett et al. 2011; Higgins et al. 2005), yet the exterior architecture, the outside of the classrooms, seems to be omitted from these inquiries, at least at the scale of within the school grounds.

2.3.2.2 School as place

In the urban fabric, a designer should consider the capacity of any building to be landmark (Lynch 1994) or focal point (Cullen 1961). School as a place, separate from other urban attributes, such as church or town hall or home or other building typology, has existed from the middle ages (Seaborne 1971a).

As places (‘site, area, land, landscape, building or other work, group of buildings or other works…’), schools may have value for people due to their cultural significance (Australia ICOMOS 2000, p. 2). However, as a representative artefact of organisational culture (Section 2.2.2.5) and wider social culture (Section 2.2.1), school buildings may be unreliable, since alternative cultures may easily co-exist with official visual narratives of ‘real utopias’ in the same educational architectural context (Burke & Grosvenor 2013). Similarly, places viewed in person, ‘…mediated by bodily mobility; in particular the walking practices specific to a particular built environment’, create strong individual memories, which are notable in their personal ordinariness (Degen & Rose 2012), thus school as place is potentially both individual, ordinary, as well as a collective construction.

From the perspective of environmental psychology, place attachment is an ‘emotional connection to a place’ which develops over time, whereas place identity ‘…develops when individuals experience similarities between self and place and incorporate cognitions about the physical environment (memories, thoughts, values, preferences and categorizations) into their self-definitions’ (Gifford 2014). This connection to place needs more than physical experience of the environment. Rather, it depends on the individual and their social and physical interaction between and within a physical environment (Proshansky & Fabian 1987, p. 25). Given the mandatory socialisation in schools, schools as place and associated place-identity are significant for children (Proshansky & Fabian 1987, pp. 33-36).

In making sense of space and place it is assumed that people, and children in particular, rely on cognitive maps of their local space that consist of both spatial and social knowledge (Higgins et al. 2005; Proshansky & Fabian 1987, pp. 30-31). The interaction with the environment has been modelled as an ordered interaction with nested systems based on concentrically distant physical and social systems (Bronfenbrenner in Heft 2013), and applied in the model of active and passive environment interactions with active and passive learning (Bowler et al. 2007) discussed in Section 2.2.2.1. Others have argued that the interaction is far more complex and individuals should be thought of transacting equally with the environment, rather than independently immersed into an environment (Heft 2013). This suggests that the environment is always active, thus all learning must occur in the active environment side of Figure 2.3. This is consistent with the perspective of design.

2.3.2.3 School buildings as communication tool

School aesthetic appearance is a marketing artefact of the school culture. For example one school's 'culture of simple living is manifest in their humble buildings and rustic grounds…[as opposed to another school where] …immaculate, state-of-the-art facilities are an important part of their identity' (Higgs & McMillan 2006, p. 49). Like other marketing strategies, this communication can be either reinforcing a choice, or acting as a branding tool (Doyle 1998 477).

In Australia, existence of a school market is not well establish (Section 2.2.2.6). If it does exist in some form, schools might be expected to leverage their buildings for marketing, particularly given the possibilities of iconic buildings as brand (Jencks 2005, p. 203). Evidence suggests that 'facilities and resources' form only a small part of the decision about school selection (Campbell et al. 2009, pp. 76-77), but it is not clear whether that is due to other higher priorities or whether the school architecture in the study is not remarkable to study participants, i.e., parents.

It might be expected that children, themselves, had some input into school selection based on their own perceptions of schools, however no literature was found to confirm or reject this possibility. There is some evidence that older students select tertiary education institutions based on building facility quality in conjunction with other decision criteria (Price et al. 2003); however, neither building quality nor communication is illustrated.

In Australia, the role of school buildings in school marketing materials is discussed as promoting 'elitism' through 'iconic' school architecture and grounds (Drew 2013), where images of buildings promote 'idealised masculine space' to older male students, and 'softer' landscape images are used to promote 'nurturing' junior schools (Gottschall et al. 2010). The possibility of using school infrastructure to attract girls is unknown.

Aside from commercial communications, Australian schools demonstrated their use as a government communication channel during the 2009 economic stimulus package 'Building the Education Revolution' when all schools receiving government funding display information signs under government instruction (Commonwealth of Australia 2009).

2.3.3 School infrastructure typology

Within the education discipline, it has been argued that the 'learning environment' referred solely to the classroom social environment until the late 1960s and that classroom 'minimum standards for size, acoustics, lighting and heating' were only 'basic requirements' (Weinstein 1979). This infers, first, that the physical environment does, indeed, contribute to teaching and learning; second, that no concern about the effect of the physical environment on teaching and learning existed prior to this time; and third, the provision of these 'basic requirements' was a simple endeavour, easily dismissed as background. Given the explicit design and construction thought displayed to create this infrastructure, and how educational built environment design has evolved and innovations attempted, this view of the basic learning environment needs consideration.

2.3.3.1 Nineteenth and early Twentieth century influences

School buildings are public buildings, making it likely that these are first, and possibly the last, public buildings that students experience as users. In recent history, public input to Australian school design goes back to the mid-19th century with British[8] influences imported into Australia (e.g., Orr 2009, 2011). These early designs were considered 'technology' due to the spatial design which controlled movement such as to separate male and female students. 'Schoolrooms' were arranged in tiers, suggesting the spatial arrangement provided an active influence on students for the purpose of control (Churchill et al. 2011, p. 47).

Referring to the United Kingdom, the change from communal 'schoolroom' to 'individual' classroom occurred in the late 19th century to early 20th century. Where previously schools had been taught by uncertified teachers under the direction of a certified head teacher, as the numbers of certified teachers increased, communal school rooms were no longer necessary (Seaborne 1971b, pp. 25-26). In New South Wales, Australia, partitioning of the schoolroom started earlier with the introduction of glass partitions in the late 19th century (Orr 2009).

Charles Rennie Mackintosh' Scotland Street School, Glasgow (1903-1906) (Crawford 2002, pp. 114-119), provides a conserved example of the separation of genders and the tiered classroom seating (Photograph 2.1).

Photograph 2.1: Example of gender specific entrances and tiered classroom, Scotland Street School, Glasgow, Scotland, UK. Architect: Charles Rennie Mackintosh. Photo: L. Pearce 2009

[8] It must also be noted that there was a significant wave of German immigration into South Australia in the 19th century. These colonists, fleeing religious persecution, brough their form of Lutheranism and set up their own schools, teaching in German language. Some of these schools were later incorporated into the government state school system (Whitehead 2001). The influence of this group on school building design is not known, but acknowledge as part of the South Australian history.

2.3.3.2 Open plan, open space, open area, and transformative school design

Teaching a large number of students in a single space simultaneously can be traced back to the late Middle Ages in English schools such as Winchester, Eton and Harrow, which consisted of a single schoolroom to house the entire school (Seaborne 1971a, p. 1; 1971b, p. 13). This single schoolroom model was introduced at the beginning of the 19th century to cater to the sudden increase in demand due to the introduction compulsory schooling. Space per student was restricted to six square feet (0.56m2), and students were grouped under 'monitors' for lessons, all overseen by a 'master' or 'mistress' (Seaborne 1971b, p. 13). This model made its way to Victoria, Australia, in the form of four-class 'long rooms' in the 1870s, and designed to facilitate team teaching to high demand. These were then replaced by the 'traditional' or 'linear' school in the 1920s (Angus et al. 1979, pp. 1-2).

In the 1950s, British educational facilities design changed in line with contemporary architectural philosophies of functionalism and architectural determinism (Burke 2010) and changing attitudes towards education:

> Self sufficiency, practical engagement and appreciation of beauty were essential characteristics of an education and educational environment that was considered to enhance humanity and democracy.
> (Burke 2010, p. 72)

This was initiated as government-led change, but was also informed designers, so that schools become more open and more to child scale with multipurpose areas and spaces for withdrawal (Burke 2010). The intention was seen as driving social transformation after the Second World War (Burke 2010) or as propaganda and social engineering (Cooper 1981) depending on political perspective. These schools were both informed by Scandinavian design (Burke 2010) and Montessori education (de Coninck-Smith 2010), and informed Danish school design in return (de Coninck-Smith 2010).

At the time it was noted that there was little study into teaching and learning outcomes in open plan schools, and observational studies demonstrated that the architecture did not change teaching since walls were replaced by other obstructions to create single class spaces (Bennett & Hyland 1979). Furthermore, the actual use differed from the 'government endorsed advice' (Cooper 1982). Function was not changed by form. This influence continued until political and social changes in the early 1970s (Burke 2010).

Simultaneously, North American 'open education', referring to teaching practices, was felt to be better implemented in conjunction with 'open space' schools, which were intended to provide the flexibility required through omission of internal partitions (Weinstein 1979).

These modernist concepts of open area teaching environments were adapted for Australian conditions from British and North American designs by local architects. The first ‘open area’ or ‘open plan’ school module was constructed in 1969 in South Australia and included spaces designated as ‘general learning area’, ‘practical area’, ‘withdrawal’, ‘covered area’ (outdoor), and girls and boys toilets. (Angus et al. 1979, pp. 8-11). Interior design for children also flourished (e.g., Mary Featherstone in Victoria, Frith & Whitehouse 2009).

By the late 1970s, evidence was mounting that open plan designs provided little advantage over ‘traditional’ classrooms (single room with single class). In Australia, ‘conventional schools’ were found to do better than ‘open area schools’ in mathematics and reading and open area schools did not catch up by the end of the year, but affective outcomes were better in open plan (Angus et al. 1979). It was observed that they were introduced without consultation or opportunity to develop pedagogy to match them, i.e., ‘open education’ was not well defined. These were also seen as being overcrowded, thus reducing not increasing flexibility as intended (Beck 1980).

In North America open plan schools were being modified by the 1970s, with evidence that installing partitions reduced interruptions, either through reducing ‘extraneous auditory and visual information’, or though creating defined classroom boundaries (Evans & Lovell 1979). Meta-analysis of other 1970s and 1980s studies (Hattie 2009, pp. 88-89) suggest that there is a small decrease in learning achievement, although some evidence of improved self-concept (e.g., Giaconia & Hedges 1982), which is consistent with the Australian experience.

This short background of open area education is presented as context for current design trends. The notion of openness is still present in design. Space flexibility is seen as a major criterion in contemporary design exemplars, where schools with open spaces feature prominently (OECD 2006, p. 8; Robinson & Robinson 2009). Operable walls and screens are suggested to increase flexibility of open spaces (Nair & Fielding 2005, pp. 21-22). Issues with noise are acknowledged where interior glazing is proposed to retain appropriate acoustic separation while retaining ‘openness’ through transparency (Nair & Fielding 2005, p. 47), which could either be seen as providing flexibility as intended, or setting up spaces for returning to traditional teaching and learning groups, as experienced in the 1970s experience of open plan.

Evaluation of such spaces is starting to echo research from the last wave of open areas in finding deficiencies in the learning environment. In the UK, the strong vision of a new type of school environment was found to be compromised, particularly the acoustics, during the procurement stage due to inter-organisation issues, leading to the construction of buildings with known speech intelligibility problems (Tse et al. 2014). Although only one example, this suggests that technical design knowledge and specification of open spaces in education have improved, but risks during procurement process, particularly cost management, also contribute to the building success.

It is noted that in both waves instructional modes did not automatically change to match the new architecture. Given that schools can also be seen as workplaces (Section 2.2.2.5), organisational behaviour theory suggest that this may be due to a change management issue. Change in organisations, and 'change management' is a contested topic in itself. It has been proposed that the change depends on whether the change is planned or emergent, and how it is implemented (Wilson 1992), within the context of an evolving organisational culture (Bryson 2008) and leadership (van der Voet 2014). These school architecture changes were planned, in the sense that they were explicitly implemented as top-down changes. While there exist many frameworks for making sense of organisational change from the later 20th century (Dunphy & Stace 1988) through to contemporary models (Al-Haddad & Kotnour 2015; Jacobs et al. 2013), using a simple change management framework (Wilson 1992, p. 10), they were not successful either through the lack of developed 'commitment and shared vision models' or there were no attempts to reduce the resistance to change from staff. Or, very likely, both. If education is truly a system, then all aspects of the system have to change for the system to change.

2.3.3.3 **Flexibility, Pattern language and L-shaped classrooms**

Following on from the open space trend, educational design advice (Sanoff 1977, p. 148) turned to pattern language (Alexander et al. 1977) to develop '…a program that is objectively correct and that yields the actual physical geometry of a building' (Sanoff 1977, p. 98).

Design advice also suggested pattern language as a precedent for children's centres, with patterns such as 'village plan', 'home base', 'protected openness' to integrate constructivist principles into the building fabric (Moore et al. 1989). Patterns from Italian town urban environments were also proposed for Italian children's centres. These seen as creating new built environment typologies where early learning facilities were neither traditional school nor replication of home, but more village with central piazza (Ceppi & Zini 1998, pp. 36-43).

By the early 20th century, patterns were proposed for all educational levels (Nair & Fielding 2005), and included the L-shape classroom. Although proposed as design solution earlier to reduce the perception of crowding (Dyck 1994), these have been argued to act as 'learning studios' where the shape facilitate different simultaneous activities (Lippman 2006; Nair & Fielding 2005, p. 20). Qualitative evidence of stakeholder consultation suggests that teachers may select this format, but concerns about adaption of teaching to the shape remained (Sanoff 2007). The L-shaped classroom is not necessarily different from earlier Montessori built environments, which, in turn, rely on context to be successful (Dudek 2000, pp. 56-57).

Like the case of open plan, there is little evidence of the advantages or disadvantages of these approaches. Referring back to the original pattern language text, a single space may have overlapping patterns. This makes it compressed and dense in patterns, and provides economy within the space. It is suggested that this compression 'make[s] buildings which are poems' (Alexander et al. 1977, pp. xli-xliiv). Thus, the original source of these ideas is not necessarily promoting space with unique purposes, such as implied by L-shaped rooms. This opens the possibility that 'traditional' rectilinear classrooms are just as innovative, if not more, than hard-coded space, given the right fabric design.

Recent Australian schools have been investigated for their provision of flexible space using large sliding walls that allowed classrooms to be opened into a communal space. After a month's occupation it was noted that the classrooms 'were not configured very differently to the classrooms that they had come from in terms of layout of student tables' (Newton, Wilks, et al. 2012), but this is not related back to their observation of the restrictions of a fixed IWB, such as the table arranged was best for all to see the board. While principals were apparently aware that teachers would need to move towards team-teaching rather than independently, no discussion is offered about if they will, and how to, manage this transition.

Recent design advice suggests that technologies will facilitate 'stage, not age' learning, where the teaching model and diverse learning space '…allows students to work in groups and engage in different topics based on their unique learning styles' (*Learning better and teaching smarter: aglimpse into the design of the school for the future* 2015). This is reminiscent of 'alternative' pedagogies (Section 2.2.2.1) such as the Montessori practice of mixing ages in classes and working in small groups in classrooms designed for such work (Al et al. 2012), however there is no critical comparisons or appraisal available to date.

2.3.3.4 **School infrastructure in South Australia**

In South Australian schools, while the aim of change is not always strictly defined, it might be assumed that the taken-for-granted aim is to improve education. Reviewing the available changes in school buildings in South Australia since the beginning of public education, there is physical evidence that innovation processes are at work.

In South Australia, the 1875 Education Act made education subsidised and compulsory for (white) children between the ages of seven to 13 years (Miller 1986, pp. 1, 69). The colony[9] governance body, The South Australian Company, providing funds for construction of a number of schools. One example is the LeFevre's Peninsula Model School (a teacher training school) which opened in 1878 and had 414 children attending in five classes (Chinner 1978, pp. 10-13), approximating to just over 80 students on average per class. Throughout the colony, class sizes ranged from up to

[9] South Australia commenced as British colony with the 1836 arrival of Europeans onto the land occupied by indigenous people. It became a state within the Commonwealth of Australia at the enactment of the Federation of Australia on 1 January 1901.

90 in the urban areas, down to six in some country schools, with mixed ages typical in each class (Miller 1986, p. 69).

In the inter-war years, State education focused on vocational training (Miller 1986, p. 188). Separation of genders was operating in the 1920s with examples of construction of separate classroom blocks for girls (Crouch 1979, p. 9) and operating as separate vocational education for girls until 1965 (Crouch 1979, p. 9). Class sizes were recommended to be reduced to twenty-five in the 1940s (Miller 1986, p. 218).

Other school building innovation attempts include the earliest noted open space units in Australia in 1969 (Angus et al. 1979, pp. 8-11). In 1991, a school opened with buildings designed to be re-sold as housing at the end of the anticipated 15 year life of the school (Hallet Cove East Primary School 2015). Notably, this school not only continues to operate, it describes this building innovation clearly in its online presence.

The South Australian public education sector has also attempted innovation in modular school construction techniques. In the 1970s, a modular 'industrialised building systems' for schools was introduced due to concerns about future local availability of skilled construction labour, noting that there was little evidence for economy of scales (Public Buildings Department 1976). This contrasts to the 'parametric design' of the Californian 'schools construction system development', where significant savings were claimed (Jencks 1985, pp. 75-76) (and current Spanish trends for prefabrication for sustainability (Pons & Aguado 2012; Pons & Wadel 2011)). No formal evaluation was found of the South Australian modular classrooms, now forty years old, but it is noted that prefabrication is still seen as future opportunity for school infrastructure innovation but challenged by structural and political restraining forces rather than technology (Newton, Backhouse, et al. 2012).

While the education authorities themselves provide facilities design standards (DECS Capital Programs & Asset Services 2010), developed through years of facilities management, it is the practising architects as lead professional service contractors in the design process[10] that provide much of the agency (Lawson 2004) for visual, spatial, safety, durability and sustainable design aspects of school buildings.

As established in Section 2.2.2.1, a range of alternative pedagogies are offered in South Australia, and these are predicated on the explicit interaction of the built environment with teaching and learning. For example, in the context of Reggio Emilia design advice, spatial design for young

[10] Pre-qualification is managemed by the Department of Transport, Enery and Infrastructure. Professional service contractors are graded by project size. Refer to http://www.dtei.sa.gov.au/BuildingManagement/information_for_contractors/prequalification (19/6/11) for pre-qualification process

children includes examples of spaces for resting, visually permeable walls and tactile floors that are required for learning and growth (Vecchi 1998). A summary of space requirements for alternative pedagogies is given in Table 2.2.

Table 2.2: Alternative pedagogies and space requirements

Pedagogy	Pedagogy / influence	Space requirements
Reggio Emilia approach	Student directed. Focus on pre-school. Opportunity to explore environment (Ceppi & Zini 1998)	Central Piazza with studios. Large windows and lots of natural light. Good sight lines between spaces. Soft colours. Many pin boards for students to decorate space. Architecture in background. (Vecchi 1998)
Steiner / Waldorf	Whole child approach through creative, independent exercises (Steiner Education Australia 2015)	Colour, natural materials, homelike, spaces for art and music, collaborative work, access to tools and resources.
Montessori	Holistic approach with four planes of development by age range (Montessori Australia) (Al et al. 2012)	Classroom as prepared environment with access to materials for project work. Learning spaces extend outdoors.

Designers also draw on a 'personal library of design solutions' developed through experience of solving similar problems from incomplete briefs under various restrictions (Lawson 2004, p. 118). For current South Australian school design, it should be assumed that designers draw on design advice through diffusion and networking knowledge processes (Hislop et al. 1997), from professional organisations such as the Council for Education Facilities Planners International (CEFPI) which includes representatives from DECS (CEFPI Australasia 2011), suggesting this design is appropriate. Other examples of design advice sources are shown in Table 2.3.

Table 2.3: Examples of CEFPI directed school design advice

Author	Book title or Website	Comment	Design reference from CEFPI accessed 26/8/11)
OECD (2006)	Programme on Educational Building: Compendium of exemplary educational facilities	Gives school exemplars selected for flexibility, community needs, sustainability, safety and security and alternative financing. Each school receives a 2-3 pages to show pictures and outline.	http://www.cefpi.org/i4a/pages/index.cfm?pageid=4168
The Sorrell Foundation (2005)	Joinedupdesignforschools, Young Designers Program	UK non-profit foundation experience of student consultation during design phase of school built environment and other initiatives (e.g. redesign of uniforms)	http://www.cefpi.org/i4a/pages/index.cfm?pageid=4439
Ceppi et al.(1998)	Children, Spaces, Relations: Metaproject for an Environment for Young Children	Describes a "relational space" model for the Reggio Emilia pedagogy	Galilee Catholic School, Aldinga, as exemplar http://www.cefpi.org.au/awards/galilee-catholic-learning-community-stage-1-aldinga-beach-sa/46/http://www.cefpi.org.au/awards/galilee-catholic-learning-community-stage-1-aldinga-beach-sa/46/
Nair & Fielding(2005)	The Language of School Design: Design Patterns for 21st Century Schools www.designshare.com	Draws on Alexander's pattern language to create new school patterns, e.g. L shape room for variable learning sub-spaces	http://www.cefpi.org.au/news/56/2011-sydney-conference-wrap/
Heppell(2009)	www.heppell.net/notschool/	Parallel website for the book 'The language of School Design.' Gives awards for school design	http://www.cefpi.org/i4a/pages/index.cfm?pageid=4168

Given the above, it is likely that school design in South Australia will continue to change due to design advice from a range of international sources. These changes will attempt to provide innovation of facilities to education, however, it must be noted that formal evaluation, such as post occupancy evaluations, of these built environment innovations in South Australia, have not been found to date.

2.3.4 School functionality

In Australia architects are not legally required to design buildings that are 'fit for purpose'[11] (Australian Institute of Architects 2014), yet a market exists where clients engage architects to design buildings that can be used for client needs. Having discussed the expectations and ambiguities of the 'learning environment', and briefly outlined architectural attempts at school spatial innovation, this section reviews the regulation frameworks and design advice that contribute to the functionality of the schools for teaching and learning, together with evidence from literature.

Learning spaces vary across the world (Higgins et al. 2005; Knapp & Noschis 2010). Within Australia, each state government and each private education authority delivers education services in the context of federal government initiatives, thus, within the Australian education system, variation should be expected as normal. On a smaller, classroom scale, variation should be expected from classroom to classroom and from year to year:

> "It is the case that we reinvent schooling every year. Despite any successes we may have had with this year's cohort of students, teachers have to start again next year with a brand new cohort. The greatest change that most students experience is the level of competence of the teacher … It is required of teachers, however, that they re-invent their passion in their teaching; they must identify and accommodate the differences brought with each new cohort of students, react to the learning as it occurs (every moment of learning is different), and treat the current cohort of students as if it is the first time that the teacher has taught a class - as it is for the students with this teacher and this curricula." (Hattie 2009, p. 1)

This suggests that the timeframe for spatial flexibility is very short, requiring immediate responses to learning challenges. While acknowledging the imperative for positive achievement and affective student outcomes, the functionality of schools addressed below discusses the functional components required by an educational client in terms of prescribed space and flexible possibilities.

2.3.4.1 Functional spaces for teaching and learning

Based on the South Australian curriculum (DECS 2001; SACE), Table 2.4 lists the wide range of required school functional spaces. Typically, this might form the starting point for space programming (Sanoff 1977). It is not exhaustive and assumes that many subjects and activities do

[11] Though Australian architects are deemed able to judge 'fitness for purpose' during post occupancy evaluation (Australian Institute of Architects 2012a, 2012b, 2012c).

not require specific infrastructure[12]. It also omits adapted education spaces for students with disabilities or other learning challenges.

All of these spaces require different design, e.g., reverberation times in classrooms differ from Music spaces (DECS Asset Policy & Capital Programs 2008). Home Economics can be either a domestic kitchen or commercial kitchen, or both. Technology could be woodwork, metalwork or robotics, which require different area allowances and waste treatment for the technology specific machinery. The school designer must be knowledgeable in all areas.

Table 2.4: Typical school spaces requiring individuation

Administration	Home economics & catering
Foyer / waiting	Agriculture
Board room / meeting rooms	Science (laboratories, hazardous chemical storage)
Teacher offices	Visual Arts & design
Teacher preparation	Technical studies (Design, materials, fabrication & control systems)
Resources / Library	Language studies
Hall / assembly	Music
General learning spaces	Drama
Wet area learning spaces	Year 12 personal study
Cooking demonstrations	IT studies
Teacher toilets	Dance
Student toilets	Physical education
Sick room	Aboriginal studies
Change rooms and showers	Child studies (child care and early learning)
Student lockers & storage	Circulation, indoors & outdoors

Spaces need to be safe and appropriate for a range of ages from very young children to not-quite-adults, and need to cater to different learning abilities and styles. The need for natural surveillance for safety and security is a significant concern of school administrators (Fram 2010). Overlaid on this is the school's pedagogy and the cultural appropriateness of the wider community, such as the design of toilets to reduce a potential bullying space yet retain privacy appropriate to a multicultural society (DfES 2007).

We know that school fabric needs to be tough:

> Compared to most other types of buildings, schools are extreme environments. They have high and sporadic occupancy levels, often boisterous use of circulation space, and are subject to the ultimate human agents of erosion and accelerated wear: school children. (DfES 2006, p. 7)

South Australian schools need to be designed to expect unexpected behaviour (DECS Capital Programs & Asset Services 2010, pp. 5,10,11,15,25,27,29,34). Finally schools are workplaces and must be designed to be appropriate for a very wide range of employment activities, and to keep staff (teaching and support) safe, sane and energised with their focus on students' learning (DECS Executive Director Human Resource & Workplace Development 2010).

[12] e.g., in professional practice, out of school hours care (OSHC) has been observed to use classrooms or halls.

2.3.4.2 School architecture and functionalities beyond pedagogy

The integration of school buildings into the education process is often overlooked in pedagogical research (Burke 2005). Logically, this might be due to the positioning of educational research away from building design, and the taken for granted nature of infrastructure. Looking towards design literature, two perspectives exist for viewing school built environment infrastructure and its explicit role in teaching and learning.

Various spatial typologies have been attempted to meet various pedagogies since the beginning of publically funded schooling (Section 2.3.3). This suggests an expected interaction between functional space and education. This interaction may or may not be explicitly acknowledged within the pedagogy, itself (Section 2.2.2.1); however, taking the view that school infrastructure is implicitly active in education, it logically follows that schools may be actively integrated into the education process. While alternative pedagogies are premised on the expectation of a significant interaction between student and built environment (Table 2.2), South Australian DECD constructivist pedagogy refers to the built environment only minimally as a source of 'unconscious messages…e.g. (sic) displays, signage, access' (Department of Education and Children's Services 2010, p. 23), and for spatial needs for flexible learning (Department of Education and Children's Services 2010, p. 77). Thus, the expectations of the integration of school buildings into pedagogy is not explicit and only implied.

From the perspective of environmental psychology, the physical setting is actually important:

> Environmental psychologists believe that educational settings can and should make education both more efficient and more enjoyable. The physical setting may not make or break education on its own – to believe that would be a naïve form of architectural determinism – but it can interact with non-environmental factors either to promote or to hinder the learning process (Gifford 1997, p. 243).

In addition to specific learning activities, children also learn to perceive and orientate within a physical environment, express preferences, develop the environmental design capabilities (Baird & Lutkus 1982). Cognition is not necessarily instant, nor is it mediated by an educator. Furthermore, preferences and cognition change with age (Baird 1982). Thus, the notion of passive environment in constructivist learning is true if interaction is only seen as full cognition. However, perceptions without cognition do occur, suggesting a form of interaction. From this perspective, constructivist learning is not isolated from the environment, as has been suggested (Bowler et al. 2007), and must include a component of active environment interaction, if only at a sensory perceptual level. Even this latter interaction provides opportunities for development, such as developing personal identity and trust in one's exterior world (David & Weinstein 1987). Thus, the value of active integration of buildings into the learning experience should not stop at pedagogy. Like any other architecture (de Botton 2006), it is potentially a more complex and holistic experience.

Design advice and theory asserts that all interactions with the environment are both explicit and important. These assumed interactions assert that the school built environment may be used as an integrated teaching tool, i.e., as a '3D text book' fully embedded in the curriculum (Newton 2007; Newton et al. 2009). Similarly, in the UK, it has been assumed that the building may be integrated into the curriculum through meter reading, Perspex rainwater pipes, or visibility of building insulation (DfES 2006). In justifying the use of buildings explicitly, it was expected that

> *Students can interact with buildings and develop better appreciation of issues such as seasonal changes, energy costs, comfort levels, wind dynamics, heat flow and water conservation. The building can also help students understand cultural, spatial and economic issues. To fully utilise the potential of buildings as 3D textbooks, teachers need to be more aware of the importance of the built environment within their educational discourse and to be active partners alongside designers at the conceptual school design stage.* (Newton 2007, p. 97)

This might be possible, but the extent of mediated cognition, and teaching skills and knowledge, required for this to be successful is unknown. Furthermore, the place buildings take within national curriculum is unclear. The built environment has been considered under science (ACARA 2009) and geography (ACARA 2011b) suggesting physical aspects of a building will be the focus while generic design will be offered under arts (ACARA 2011c). Without more clarification of the vision for buildings within the curriculum, it is difficult to create a sustainable solution.

Architects also assert that school buildings contribute to 'spatial intelligence' (van Schaik 2008). The existence of spatial intelligence specifically is contested (Newcombe & Frick 2010; White 2008), yet the possibility remains that architecture does contribute to child development. Certainly, the introduction of spaces for learning other than didactic instruction, such as 'withdrawal' rooms in the 1960s (Burke 2014), provides the opportunity for varying environmental interactions, as might be required by different students. Other reviews note that flexibility is associated with 'playful' and 'games-based' learning, which engenders learning such as independence, respectful relationships, and creativity, this latter capability, being a specific topic in the Scottish curriculum (Davies et al. 2013).

New projects offer another source of architecture integration into curriculum through student participation in school building design (Sorrell 2005; The Lighthouse 2005). Children (year 5/6) are able to imagine different school buildings according to fantasy (unrestricted imaginings), empathic (what helps others), creative (ideas more grounded), and critical (ideas that change the social power structures) imagination (Bland & Sharma-Brymer 2012), suggesting they have the capability to think of alternatives to their current school infrastructure. Excluding school users from the design process can be due to fears about cost and time constraints (Sanoff 2001b; Woolner et al. 2007), yet it provides an opportunity for stakeholders to learn how to maximise and optimise their buildings (Clark 2002), and engagement improves student behaviour (Sanoff 2001b). Engagement is also beneficial through allowing users to 'have a voice', learn new design languages, gives designers a broader understanding of required functionality (Parnell et al. 2008), and provides better briefing development (DfES 2006). It also provides an opportunity for students to learn new skills and creativity through participation in an 'adult' design process (Parnell et al. 2008; Sorrell 2005), for teachers to learn new skills and knowledge (Sanoff 1989), and parents to be involved (Sanoff 1986). Support and administration staff were not mentioned in the literature reviewed.

History of previous consultations during the open plan development era suggest that limited consultation led to inappropriate designs. Although user participation provides an opportunity for users to define spatial problems according to their own lived experience (Luck 2012b), contemporary large scale consultation do not necessarily lead to appropriately resolved design resolutions due to the conflicting voices of the very large group of stakeholders (Woolner et al. 2007; Woolner et al. 2012). Like other skills, architects need to learn participatory design facilitation (Day & Parnell 2003; Luck 2007; Sanoff & Barbour 1974).

The long-term effects of design participation are not clear. Where some report a lack of literature to date (Higgins et al. 2005, p. 10) others have shown some evidence of intergenerational ownership of participative school design (Parnell et al. 2008). Ultimately, there are many ways that the school built environment can be integrated into teaching and learning; however, beyond basic perceptions, this integration requires time and effort on the part of a range of facilitators. Through their enthusiasm for the built environment, architects and design professionals might expect others to willingly engage explicitly with the built environment and share the knowledge it offers. This might be an unfair expectation since passive approaches towards the built environment are normal in the otherwise complex day of teaching and learning.

2.3.4.3 **Building adaption – transient and permanent**

Buildings change during their lifetime (Brand 1994) and despite architects' desires, once built, begin their decay towards '…the inexorable slide to the status of rubbish' (Till 2009, p. 71). Economically, school buildings need to remain useable for a certain period, and this requires maintenance and adaption, the latter being either temporary flexibility to meet daily teaching and learning needs, or permanent adjustment to meet new pedagogies and social norms. History shows that architectural adaptation is a reflection of the social and educational context dating back to (at least) the Middle Ages:

> From the purely educational point of view, we have seen that the alteration or rebuilding of a school is invariably a sign of its success, or at any rate of important internal change. We have also seen how at certain turning-points in the history of English education, new educational ideas were expressed, not only in theoretical treatises, but also in bricks and mortar. (Seaborne 1971a)

Thus, we should *expect* to see evidence of change in the building fabric, particularly in older buildings that still operate as schools.

Transient building adaption falls within functional space usability and integration of the building into lessons. This is building as technology (Churchill et al. 2011), and use is dependent on the teacher and his or her style (Sztejnberg & Finch 2006). However, design to promote flexibility has a troubled past. A large open space offers a blank canvas for configuration; however, this type of building has a poor record fulfilling its promise due to quality issues and staff preferences (Section 2.3.3.2). Non-rectilinear spaces, and spaces with moveable walls, also have a questionable history available flexibility as opposed to designed flexibility (Section 2.3.3.3).

Transient flexibility in daily classroom use includes changing display and loose furniture arrangement (DECS Capital Programs & Asset Services 2010). Teachers are advised to 'use a room arrangement that facilitates your teaching and learning style and doesn't impede it', with suggestions about classroom components, including, but not restricted to, high traffic areas, floor space, desk arrangements and other furniture, learning stations, and pinboards (Marsh et al. 2014, pp. 56-60). The assumption is that teacher have ownership and control over their space, and have the potential to create a dynamic space.

On the other hand, adapting buildings permanently is a major project. Adaption and renovation, and the time between initial construction and consequent adaption, gives an indicator of the initial design quality and the force of change from new pedagogy. In the UK, there is evidence that attempts at creative forms in the early 1960s either needed significant renovation or were demolished quickly due to poor construction and lack of appropriate funding (Saint 2010), thus demonstrating a risk associated with new construction techniques and the sensitivity to public economic conditions, to the point where ongoing maintenance becomes unviable. Minor interventions in circulation and entrance design have been shown opened up these areas to improve interaction between students and support staff (Frelin & Grannäs 2014), thus adapting to new service delivery.

Even 'exemplar' schools are not immune to rapid change. Recent Scandinavian exemplars designed using stakeholder participation were found to need adaptation due to unforeseen issues with acoustics and rooms too small for economic student to teacher ratios (Leiringer & Cardellino 2011).

2.3.4.4 **ICT and space**

As late as 2004, ICT was not recommended by some to be integrated into the curriculum due to issues with glare, ergonomics, lack of teacher 'ownership' and the concern that ICT may supersede interpersonal interactions (Higgins et al. 2005, p. 28). Alternatively, architectural design advice, suggested that ICT can create new learning opportunities (Nair & Fielding 2005) and other educational authorities recognised the potential in 'intelligent classrooms' and wireless networking (Tibúrcio & Finch 2005), but it was acknowledge that the effect on traditional classrooms was difficult to predict (Clark 2002, pp. 30-32).

Large scale introduction of laptops into classrooms found that inappropriate space and power restrictions, and incompatible lighting design, reduced successful integration of technology into learning, but also noted human factors, such as teacher reluctance, as playing a role (Cardellino & Leiringer 2014). In contrast, small mobile 'laptop desks' have been found to increase flexibility in both digital and non-digital interactions since these smaller desks free up space and are easier for students to move (Burke 2014).

Structural factors, such as lighting design, will no doubt continue to be challenged as teaching and learning potentially moves towards mixed reality and embodied learning (Lindgren & Johnson-Glenberg 2013). The conflict between technological innovation and built environment fabric, no doubt, will continue.

2.3.4.5 **Fixtures, fittings and furniture**

Students and staff do not walk into empty schools at the start of each school day. In addition to ICT, each room is furnished with fixtures, fittings[13], and furniture. Excluding carpet, splash backs, and other fittings to linings, Table 2.5 collates the fixed and flexible additions to the building fabric required for local educational facilities (DECD Capital Programs & Asset Services 2013; DECS Capital Programs & Asset Services 2010).

Treatment of furniture in literature is mixed. Furniture is seen in educational design policy as a 'cosmetic factor' (Clark 2002), or as integral but with little research underpinning its effects, other than recommendations for ergonomic furniture (Higgins et al. 2005). Ergonomically appropriate and adjustable furniture could be made available to prevent discomfort, yet contemporary classroom desks and chairs and often mismatched, and chairs lack cushioning (Oyewole et al. 2010), possibly due to furniture selection based on factors other than ergonomic concern (Castellucci et al. 2010).

[13] I note the various debates about the difference between 'fixtures' and 'fittings'. In this context I use them refer to the items added to the building envelope to improve the classroom environment. I also note that 'chattels' is a more legally correct word than 'fittings', but 'fittings' is used here due to its vernacular use in local architectural professional practice.

Furniture such as desks needs to be selected for its usability, and coordinated with the intended space. Some evidence suggests that rows of desks are not optimal since this arrangement reduces teacher interaction with the far corners (Ramli et al. 2013). Alternatively, if arranged in groups of desks, the size of the desk groups tends to drive the size of student work groups (Higgins et al. 2005).

Table 2.5: Furniture, fixtures, and fittings in South Australian primary schools

Category	Detail items	Notes
Curtains and Blinds		Assumed not needed due to external solar control
Sinks and Troughs	Sinks and Troughs	For general learning and science
	Drinking troughs/fountains	Heights to suit students
Toilet fittings	Partitions	
	Toilet pans and urinals	
	Basins	
	Hand driers	
	Mirrors	
Showers	Student and staff showers	
	Emergency shower / eyewash	Science laboratory
Joinery[14]	Fixed joinery and benches	Reception, staff areas, kitchen, classrooms, wet areas, library, canteen
	Cupboards	
Fixtures	Bag storage / lockers and coat hooks	
	Display boards (pinboards)	
	Whiteboards	
	Wall stripping	For shelves
	Compactus units	Large central storage
	Key cabinet, safe	
	Pigeon holes, staff	
	Signage – internal	
Loose furniture and equipment	Clocks	
	Shelving	
	Whiteboards	
Student and staff furniture	Desks – student and staff	
	Chairs – student and staff	
	Filing cabinet	
	Storage	
	Shelving	

2.3.4.6 **School landscape and play**

Exterior school spaces (outside, but within the school boundaries) are also seen as learning spaces. Design advice suggests that these can be used as an extension to classroom activities (Ceppi & Zini 1998; Nair & Fielding 2005; OECD 2006). Literature tends to focus on the exterior school for education about the environment (Spalie et al. 2011), and risk and adventure (Dyment & Potter 2014) or both (Preston 2013), and depends on national educational curriculum and outdoor culture (Bentsen et al. 2012; Mygind 2007). Formal outdoor activity is also seen as important for reducing obesity (Mygind 2007).

In addition to formal outdoor learning, informal outdoor activities allow for self-selected play during breaks. These times typically have less interaction with teachers and are important for learning

[14] 'Casework' in North America

social behaviour and developing cohesion (Waite 2010; Waite et al. 2013). The site layout of the school affects play because it dictates the play space available (Armitage 2005). Older students prefer outdoor play with risk and without adults (Baird & Lutkus 1982, pp. 13-14), with a sense of place and variety of spaces to allow daily choice (Shaw 1987). However, some evidence suggests students tend to gravitate towards large green areas, with boys dominating courts, and girls in smaller areas and on play equipment (Lucas & Dyment 2010). Thus, the outdoor domain offers the potential for student ownership.

2.3.4.7 School infrastructure for out of school hours use

It is observed anecdotally, that Australian school ovals and playing fields are well used by the local community on the weekends; however, little discussion was found about the provision of infrastructure for community activities. Schools are seen as providing an interactive contribution to the UK community (Higgins et al. 2005, p. 7), however design advice varies in its definition of ‘community’. Communities are defined concentrically, as ‘small learning communities’ (Nair & Fielding 2005, p. 24), consisting of children, teachers (and it is assumed support staff), and parents (Ceppi & Zini 1998, p. 20), or the wider circle that includes local stakeholders (Sanoff 2001b) as implied by South Australian guidelines (DECS Capital Programs & Asset Services 2010, p. 24).

In the UK, in addition to recreation, school programs, such as those to improve diet and general service outreach, extend the contribution of schools to the community (Higgins et al. 2005, pp. 29-32). On the other hand, extending the use of school beyond school hours changes the typical education occupant profiles used in design, thus increasing energy use (DfES, pp. 13-19), and operating costs and associated economic risk.

US design advice suggests that schools should use local community facilities where they are not available within a school (Nair & Fielding 2005, p. 19), however added circulation times in dispersed suburbs, such as those in Adelaide, are not addressed. The duty of care responsibilities added to schools when students leave school boundaries was also not found to be addressed.

2.3.5 Fabric quality and indoor comfort

Indoor environment quality, or IEQ, is included in environmental ratings tools as an important design consideration (Green Building Council of Australia 2011a), yet the factors covered by IEQ, and their measurement, varies between investigations of effect of indoor environment on occupants (Bluyssen et al. 2011), making comparison difficult.

Researcher approaches also propose a range of indoor quality and comfort variables. These range from a combination of parameters based on building design (‘classroom design’, ‘noise’, 'presence or absence of windows') to user choices ('seating position', 'density', 'privacy') (Weinstein 1979), thus including some factors that are beyond the typical scope of the design team. Other early learning research anticipated good quality spaces as '…space fostering exploration, independence and development (a child's sense of self and willingness to play), spatial quality (through space, colour, light, noise, and materials), and integration of the outdoors and indoors environments' (Berris & Miller 2011), but again using terms that are open to design interpretation in practice.

The importance of the physical environment according to age is not consistent (Higgins et al. 2005, p. 10). In secondary school students this has been attributed to either age related cognitive changes, or impact of changes associated with student progression from primary to secondary school (Edgerton et al. 2010). Furthermore, it is theorised that children judge their environment in the context of their experience of their own homes (Simon et al. 2007), but it is also theorised that aesthetic perceptual abilities develop as children get older (Baird 1982). Regardless of student perspective capabilities, it should not be overlooked that two cohorts experience indoor quality, students and staff, potentially adding complexity to indoor quality expectations.

To discuss indoor quality, this section separates IEQ elements into interior architectural design quality, thermal comfort and control, light, sound and noise, and indoor air quality.

2.3.5.1 **Interior architectural design quality**

Design quality is addressed here as the quality of the building fabric for which architects, or other spatial design professionals, are responsible. This is the interior building fabric without structural, mechanical, electrical, hydraulic, or other engineering services, but must coordinate and integrate all these elements.

Sensory design of buildings is implicitly part of architectural design (Kerr 2013) and has been integral to school design for some time (Department of Education and Science 1969). Colour and stimulation are asserted to be important for learning (Barrett & Barrett 2010; Zhang & Barrett 2010). It is also asserted that 'warm' and 'cool' colours are associated with different levels of concentration and extroversion (Barrett et al. 2011) and that, based on colour theorists (Mahnke 1996; Mahnke & Mahnke 1987), white and grey do not provide enough stimulation in educational settings (Read 2003). Some educationalists are sceptical that the evidence exists for colour as either providing benefit or otherwise (Marsh et al. 2014, p. 61), as is environmental psychology, where there is conflicting evidence for belief that reds and oranges more arousing than blue and greens (Gifford 1997, pp. 254,256). Colour theorists, themselves, also acknowledge the complexity in individual perceptions and reactions to colour (Mahnke & Mahnke 1987, pp. 8,9). Neither ranges of child response to colour hue, saturation, and brightness, nor the effect on educational staff were found in the literature reviewed. The inseparability of colour, lighting design, and user vision perception, was acknowledged in school specific design advice last century (Department of Education and Science 1969, p. 9), yet the study of colour seems to have been abstracted into coarse components.

Of more practical use for architectural specifiers[15] is the effect of hue, saturation, and/or brightness. These have all been found to be important variables in environmental psychology (Gifford 1997, p. 205). In a controlled laboratory study, university students returned higher reading scores with vivid versions of primary hues, and their heart rates were lower in lighter versions of primary hues as well as the vivid version of blue, while, qualitatively, the lighter versions were reported as preferred (Al-Ayash et al. 2015). In another controlled study, high school and university students were tested in grey, 'colourful', primary red, and primary blue rooms. The 'colourful' room used a range[16] of large patterns and colours to provide a 'complex' physical environment. More arousal (EEG) was found in colourful room as compared to grey, and more in the red room when compared to blue. Heart rates (EKG) were expected to be lower in the grey room as compared to the colourful room, and lower in the blue room as compared to the red room. The reverse findings were explained by physiological responses of introverts where arousal is accompanied by a drop in heart rate (Küller et al. 2009). Thus, there exists the possibility that colour does change physiological responses; however, the evidence to date is limited. It also raises two questions for designers. Should schoolrooms be 'hard-coded' to 'stimulate' students with colour, and should the colours be selected for a normative response within a student cohort? Apart from lack of data about the range of hues available, the range of student characteristics (and teacher characteristics) might preclude 'optimising' classroom colour.

Spatial definition may also be important. In child care centres, it has been reported that well defined spaces of 5 to 10m^2, as opposed to open spaces, promote more exploration and cooperative behaviour, but is reduced in over- or under-differentiated, but it was noted that this might be due to differences in teacher behaviour (Moore 1986). Moderate spatial differentiation, such as mild ceiling rake or a wall coloured in a saturated red, also promotes cooperation, but the combination of both did not increase cooperation (Read et al. 1999), suggesting there is a fine line between simple and complex design in the minds of students.

From an environmental psychology perspective, the perception of building attractiveness emerges

[15] Australian paint companies, such as Wattyl, Taubmans, and Dulux, offer a wide range of paint. My 2012 Dulux specifier's fan deck offers 1854 colours. Taubman's online colour range offers a light reflectance value, RGB and HEX value with each colour (http://www.taubmans.com.au/ColourCentre/Explore#wall accessed 2/4/15). These latter numbers can be converted to and from HSB (hue, saturation, and brightness) values. Specifying a value makes it easier to identify what 'red' or 'blue' is intended in the discussion.

[16] From a designer's perspective the room shown in the publication was very poorly designed. It would be unlikely that any designer engaged for work in a school would recommend that strategy, let alone get paid for it. However, the experiment design is acknowledged as creating an extreme effect.

as important to students (Edgerton et al. 2010, p. 48) but absence of poor maintenance quality seems to be more important (Simon et al. 2007). A connection between socio-emotional development and perceived building fabric quality was identified in nine year olds in New York (Simon et al. 2007). Similarly, a positive correlation was found between building quality and increased student self-esteem and reduced negative behaviour, particularly in early years of high school (Edgerton et al. 2010). In both studies, the detail of building quality assessment method was unavailable, so it is again difficult to apply specific learnings to design practice. Furthermore, the latter study omitted items such as cleanliness, condition, maintenance and usability of ICT (glare) due to concerns including, 'their [lack of] relevance to the physical design of the school building' and 'their relative lack of importance to students' (Edgerton et al. 2010). This is puzzling since other studies identify that students prefer a clean environment (Stewart 1981) and the finishes of schools are critical design selection decisions for both the education authorities and architects who attempt to embed these qualities in the building fabric, in South Australia at least (DECS Capital Programs & Asset Services 2010). Thus, design process required to make the environment benign are either implicit or overlooked as important where, in practice, it takes a significant effort to make the built environment actively passive.

Teaching staff aim to create a 'safe' environment for learners. Within education texts this is discussed in the psychosocial sense of 'safe' (Churchill et al. 2011, p. 51), suggesting that physical environment is taken implicitly to be safe. The physical safety of the built environment, together with design for maintenance, is made explicit through regulation and guidelines (Architects Professional Risk Services 2013; DECS Capital Programs & Asset Services 2010; Department for Education and Child Development 2013; Safe Work Australia 2012) and good spatial design. This latter is best demonstrated by design advice for toilets (DfES 2007).

2.3.5.2 Thermal comfort and control

Thermal comfort is 'that condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation' (ASHRAE 2013b/23). Thermal comfort is said to depend on personal factors (metabolism, clothing, food and water consumption, migration), measurable environmental factors (air temperature, radiant temperature, air motion, humidity), and psychological factors (colour, sound, light, aroma), the latter being not well understood (Grondzik et al. 2010, p. 92).

It has been assumed that people have control over personal factors (Grondzik et al. 2010, p. 92), however this may not be the case for children in schools. Students are not able to leave classrooms during teaching time, nor are they able to boil the kettle for a hot drink. Students may also be restricted in their clothing choices and primary school children have been observed not to adjust their clothing either because they '…did not think to change, and perhaps because some combinations of clothing did not permit adjustment without a complete change' (Humphreys 1977, p. 238). Since the differences between the metabolism of adults and children, and the latter's adaptive capabilities, are not well understood (ASHRAE 2013b, p. 19), the effect of limited control over personal factors on children's thermal comfort is unknown.

Environmental control is 'the means by which the thermal environment can be controlled: these may require energy-use, e.g. heating or cooling systems, fans, etc., or may be 'passive', e.g. openable windows, blinds etc. [sic]' (Nicol et al. 2012, p. 160). In the case of schools, these, too, may not be available to students directly. Rather, control is likely mediated via the staff.

People do adapt to their environments and there exists a large body of work on an adaptive thermal comfort model (e.g., Cena & de Dear 2001; de Dear 2004; Deuble & de Dear 2012; Nicol et al. 2012; Roaf et al. 2010), however these studies tend to involve adults in sedentary workplaces or residential buildings with HVAC controlled environments. Using only these locations omits people with other lived experiences. For example, it omits people who work in places other than offices, such as employees in hospitals or schools, who are likely to be more active than office workers are. There are limited studies on people whose metabolism might be compromised due to illness (Verheyen et al. 2011) or older age (Walker et al. 2015). We know that children are more vulnerable to cold-related illness and dehydration during heat (Roaf et al. 2009, pp. 147-148), so anticipate that adaptation is not always possible.

It is noted that in recent standards (e.g., ISO 7730(2006) and EN15251 cited in Roaf et al. 2010) people with different thermal comfort needs are acknowledged, and, in practice, at least in richer countries, indoor school temperatures are tightly controlled (Clements-Croome et al. 2008; DECS Asset Services 2008), as are some indoor workplace temperatures (Hellwig & Bux 2013), and becoming stricter (Montazami & Nicol 2013).

Thermal comfort studies in children have been attempted with responses found to vary more than for adults (Humphreys 1977). In naturally ventilated classrooms, results have varied by age and location. For pre-school students during mid-season, using pictorial scales, predicted mean vote (PMV) of thermal has been found to be both higher in northern Italy (Fabbri 2013) and lower in Korea (Yun et al. 2014) than adult accepted PMV.

In primary school students, PMV has found to be higher during the Taiwanese heating season (Liang et al. 2012) and throughout the year in the Netherlands (ter Mors et al. 2011), and lower during the English non-heating season (Teli et al. 2013; Teli et al. 2012) than adult PMV.

In secondary schools, variation also exists between seasons. During mid-season testing the PMV has been found to be higher in Portugal (Dias Pereira et al. 2014) and neutral in northern Italy (Corgnati et al. 2009), lower in summer Australian naturally ventilated and air conditioned subtropical locations (de Dear et al. 2015), and higher during the heating period in some cases in northern Italy (Corgnati et al. 2007) than adult PMV.

Since staff have the responsibility to control the environment, the environmental controls in schools should be simple and 'obvious' (Dudek 2000, pp. 104-107). Drawing on other workplaces, such as office buildings, 'most occupiers want to take their buildings for granted so that they can get on with their lives and businesses' (Bordass, Leaman, et al., p. 145), making a strong argument for simplification of systems and ensuring occupants can operate any form of technology in the building.

Heating and cooling controls that are complicated, together with a low understanding of and commitment to their use, presents a risk to building energy performance in offices (Bordass, Leaman, et al. 2001) and residential buildings (Chiu et al. 2014). The perceived amount of control of workplace temperature, noise, and ventilation is see by users as important, specifically in office workplaces (Baird & Lechat 2009; Boerstra et al. 2013). Concerns about the lack of socio-technical approaches to control design have been raised (Chiu et al. 2014), and it has been observed that high levels of technical skill are sometimes needed to operate controls as designed (Healey & Webster-Mannison 2012). Since schools are also workplaces, the risk of complicated control is equally applicable and anticipated.

So are the users not performing, or is it the building not performing? From one perspective, it is the users. Where users' behaviour in summer is '…not supporting the building concept due to windows being opened while the outdoor temperature is higher than the indoor air temperature', re-education was suggested as a remedy (Schakib-Ekbatan et al. 2015). This may be a challenge given the complexity of motivation and capability to open a window, as found in offices (Fabi et al. 2012). Re-education of school occupants to adjust behaviour to building design operation is likely to be a challenge.

Rather than aiming to create a building that can be 'taken for granted', it has been proposed that primary schools should have fully automated building management systems installed to ensure good indoor environmental quality since teachers' actions are seen as inadequate (De Giuli et al. 2012). This suggests that the users are incapable of performing to meet the building's terms and control should be removed from users.

Another perspective is that behaviour is not uniform or predictable, but is logical. Human factors, particularly those around human interaction with technology, are poorly understood in office workplaces (Roussac et al. 2011). Office occupants use logical (to them) and creative approaches in their attempts to control their environment, which may be the easiest method available to them and not necessarily the designed method (O'Brien & Gunay 2014). The assumption that users understand the relationship between engineering-derived control numbers and the feeling of comfort is flawed. Non-engineers do not necessarily relate the settings on controls back to their perception of comfort (Gunn & Clausen 2013). Again, given that schools are also workplaces, if alternative control methods are found, it should not be unexpected.

All of these concerns are applicable to education facilities, but control of temperature and ventilation in classrooms has received little investigation to date.

2.3.5.3 **Light and views**

Lighting design is a combination of illumination through daylight and artificial light to create appropriate lighting effects and meet user task needs, in the context of responsible energy consumption (Grondzik et al. 2010, p. 467). In studies in offices, occupants prefer a lower illuminance where offered (Uttley et al. 2013), and it has been observed that occupants make significant attempts to reduce glare (Byrd 2012). In school infrastructure, ‘natural’ lighting is seen as required to promote good learning (Ceppi & Zini 1998, p. 45; Ford 2007; Nair & Fielding 2005, p. 74; OECD 2006), however the effects of lighting on students has been found to be inconsistent (Higgins et al. 2005, p. 20).

In industry studies, the level of daylight, as judged by experts, in primary schools has been found to be predictive of student performance. It is noted by the study that this could be due to ‘better’ teachers securing classrooms with better daylight (Heschong Mahone Group 1999), yet the influence of daylighting on teaching performance as, say workplace health and safety requirement, was not addressed. In children, evidence suggests that lack of windows in a classroom changes ‘the basic hormone pattern, and this in turn may influence the children’s ability to concentrate or co-operate…’ (Küller & Lindsten 1992), suggesting that for students, at least, daylight is a health and safety concern, with complex effects on physiology.

Lighting design is also integral to energy use. In the late 20th century, attempts to design schools solely using passive energy techniques resulted in large variations in lighting levels and glare, which changed over time due to deterioration of finishes (McKennan 1985). Notably this design problem with glare occurred prior to the integration of ICT into teaching pedagogy (Winterbottom & Wilkins 2009). Despite the glare, students were found to prefer to be near windows, but this was ‘to see what is going on’ rather than look at the view (Stewart 1981). This suggests that the hypothesised need to ‘connect to nature’ (Gelfand & Corey Freed 2010, p. 85) needs refining to ‘connect to what is happening in nature’. Students also report low satisfaction with low daylight and that this contributed to their perceptions of quality of environment (Kim et al. 2014), thus potentially complicating glare control in new ICT facilitated learning.

2.3.5.4 **Sound and noise**

Good acoustic quality in classrooms is important so that all children can hear what is being said during the teaching and learning process and for equity of access to children with temporary (e.g., illness) or permanent hearing impairment. Good acoustic quality is achieved by controlling internal background classroom noise, reducing external noise ingress, and designing for appropriate reverberation times (DECS Asset Policy & Capital Programs 2008).

Design advice for the L-shape classroom is based on the perception that square classrooms increase noise due to proximity of students and that, logically, rectangular classrooms increases distance, thus decreasing noise (Dyck 1994). Acoustics does not necessarily support this conclusion. In addition to building fabric and finishes, sound quality depends on other factors, including, but not limited to, room volume, shape and wall curvature (Egan 2007, pp. 113-115). Furthermore, the activity within a room changes the sound quality. Modelling shows that speech transmission depends on the source directivity, even in small rooms with well controlled reverberation (Stewart & Cabrera 2009), thus a teacher talking while writing on a board fixed to the wall will have reduced speech intelligibility. Directivity affects high frequencies more than lower frequencies so, consonants are lost with the teacher's back to the class (Egan 2007, p. 83). Additionally, female speech is naturally quieter than male speech by 2-5dB (Egan 2007, p. 325), which is a significant design concern in a workforce that is predominantly female (Section 2.2.2.5).

Excessive noise impacts students and teachers through annoyance, lost teaching time due to teachers waiting for class noise levels to subside, and personal intolerance for noise (Higgins et al. 2005). Teachers identify main noise sources as coming from inside schools and suggest mitigation with better design (Barrett & Zhang 2012), with open plan multi-class rooms measured with higher noise levels and reverberation times (Chiang & Lai 2008; Shield et al. 2010). Attempts to divide open classrooms into zones with open partitions, i.e., not enclosed classrooms, failed to reduce noise levels (Evans & Lovell 1979), which is consistent with acoustic physics.

There is some evidence that constant external noise, such as traffic, interferes with learning effectiveness (Higgins et al. 2005). Mitigation of exterior noise raises a conflict with air quality. Teachers prefer to close windows, which leads to overheating and poor air quality, rather than enduring aircraft noise through open windows (Montazami et al. 2012).

Student focus groups identify noise as a concern (Edgerton et al. 2010), and students desire noise privacy (Simon et al. 2007), together with 'peace' and 'serenity' (Barrett et al. 2011), which might be interpreted as requiring good quality sound. Staff in schools for children with special needs indicate that in addition to reverberation and noise level, students are observed to be sensitive to frequency and suddenness of sound (Shabha 2006). Students in regular classrooms also identified high-pitched sudden sounds, such as ‘creaking windows’, as annoying (Barrett et al. 2011). Attempts to provide peaceful places are evident from the mid-20th century where small rooms were designed for withdrawal from noise (Burke 2014).

Temperature ranges require strict control (Section 2.3.5.2); however, the use of mechanical ventilation or climate control increases background noise, which affects speech intelligibility. Recommendations to include soft furnishings as sound absorption introduces cleaning and air quality issues (Higgins et al. 2005). This is discussed in the next section.

2.3.5.5 **Indoor air quality**

Good indoor air quality is ‘”air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80%) or more of the people exposed do not express dissatisfaction”’ (ASHRAE Standard 62.1, 2007 quoted in Grondzik et al. 2010, p. 116). It has been assumed that air quality relies on the building design team (appropriate material selection, isolating pollution sources, providing adequate fresh air), and the facilities management team (keeping the building, and its services, maintained and clean) (Grondzik et al. 2010, p. 116). The purpose of this is to reduce health hazards due to poor air quality. In schools, air pollutants have the potential to increase illness, such as asthma, associated with volatile organic compounds and microbiological irritants (Chatzidiakou et al. 2012). Other maintenance and building rectification issues risk indoor air quality, such as water ingress leads, and consequent fungal growth, particularly in tropical climates (Tsao & Hwang 2013).

In parallel to this approach is perception of air quality by users. In office buildings, this perception is linked proportionally to overall satisfaction with buildings, so that when a building is perceived as having poor air quality, the building is perceived poorly (Kim & de Dear 2012).

There is concern that 'fresh' air may itself introduce pollutants (Clements-Croome et al. 2008) regardless of careful selection of materials to meet air quality guidelines and codes (DECS Capital Programs & Asset Services 2010); however, indoor activities, not fresh air ventilation, were found to increase particle density in French schools (Tran et al. 2014), suggesting internal sources are more likely to degrade air quality.

Similarly, acoustic design solutions are potential sources of poor indoor air quality. Strict acoustic design objectives (Section 2.3.5.4) are further complicated by the need to mitigate temperature variation with HVAC systems and their associated noise (Section 2.3.5.2). To mitigate the noise generated by the mechanical plant, and meet the appropriate low reverberation times, acoustic elements must be are added (Egan 2007). The acoustic elements (carpet, panels, soft furnishings) are preferred by students (Stewart 1981), but they are difficult to clean (Higgins et al.

2005) and they are a risk factor to good indoor air quality (Mendell & Heath 2005). This is further exacerbated when maintenance budgets are at risk (Mendell & Heath 2005).

Outdoor air can be introduced using mechanical ventilations systems, with automatic or manually controlled operable windows. Control systems can be poorly understood by users, thus adding risk to ventilation systems (Chiu et al. 2014). In schools, manually controlled windows are not always opened as expected, particularly during winter, leading to increased carbon dioxide levels were found to be high due to user decisions to keep windows closed in Denmark (Gao et al. 2014). Further complicating this is that required 'fresh' air ventilation rates in schools vary depending on the country (Clements-Croome et al. 2008). While there is an expectation that the build-up of carbon dioxide, gases and pollutants, due to poor ventilation should reduce learning effectiveness, and some evidence (Bakó-Biró et al. 2012; Coley & Greeves 2004), studies do not consistently confirm this causal relationship (Mendell & Heath 2005).

2.3.6 'Sustainable' schools

South Australian schools reflect their environmental context in that they operate within cost and sustainable development challenges (Section 2.2.4 and 2.2.3) and that they teach education for sustainable development (see Section 2.2.2.4). In some cases these two aspects intersect where school infrastructure is designed to contribute to teaching, as explained below.

Prior to the contemporary tripartite definition of sustainable development (Section 2.2.4.1), a demonstration of the conflict between creating good quality indoor environments for students and operating cost (and logically energy consumption and greenhouse gas generation) emerged in post-war Britain. This occurred with the rapid deployment of cheap, pre-fabricated buildings (Milan & Pattison 1979). These new schools were intended to facilitate social capital building, suggesting social sustainability, yet performed poorly, both in energy use and cost, due to poor insulation and air infiltration due to poor construction (Milan & Pattison 1979). As a reaction to this building stock, passively heated 'solar schools'[17] were built where designers had expectations such '…that occupants will make use of manual controls intelligently if the controls are provided, mainly being motivated by the pursuit of comfort' (Baker 1982). These schools were found to overheat in the UK summer and had poor solar and ventilation control with intended user-control systems being difficult to operate (Harris et al. 1991). Solar schools have also been tried in Argentina, where overheating was experienced during all seasons due, in part, to similar human factor issues with building control (Filippín 2005).

Moving forward to contemporary design, within the design industry there is a general belief that

[17] These passive design strategies should not be confused with the Australian 'National Solar Schools Programme', which retrofitted photovoltaic systems to schools between approximately 2007-2013 (Department of Climate Change and Energy Efficiency 2011)

sustainable schools provide benefits to learning (Robertson 2012, p. 41), and industry construction advice suggests that 'green' schools improve operating costs, health, and productivity (McGraw-Hill Construction 2013). There is also belief that buildings, themselves, can be used as a teaching tool about sustainability, given the appropriate supporting teaching resources (Section 2.3.4.2). Retrofitting of 'sustainability' elements to existing buildings have been justified as 'demonstration appliances', such as photovoltaic panels and rainwater tanks, for use in teaching and learning (Australian Government c2009; DECS Asset Services 2009).

The success of these retrofits in teaching is untested, although it is anticipated that additional teaching resources are required to integrate these technical elements into teaching and learning (Section 2.2.2.4). In South Australia it is acknowledged that, a 'key staff member' would be needed for the on-going operation of ESD and reporting (DECS Asset Services 2009), as does the North American LEED pre-design ratings tool (Gelfand & Corey Freed 2010, p. 257).

It is also unknown whether these retrofits reduce water and energy use in total in Australia. The experience of other countries suggest that retrofits of energy efficiency elements does reduce energy use, but not necessarily costs due to variable utility pricing (Issa et al. 2010). Furthermore, operating energy needs to be put in its lifecycle costing where it is a relatively small proportion of the total life-cycle energy. In Australian secondary schools, the recurrent embodied energy, i.e., the embodied energy in replacement of building services, fitments, finishes, and roof replacement, is more than five times the operational energy, assuming a 60 year building lifespan (Ding 2007, p. 497). In the past, this lifecycle cost or carbon contribution performance has not been integral to the facilities standards and are discussed in a separate document where specific environmental targets, benchmarking or key performance indicators are omitted (DECS Asset Services 2009) in favour of Green Star-like design principles (e.g., Green Building Council of Australia 2011a).

Possibly at odds with a school's environmental focus, contemporary school guidelines for internal learning spaces are required to be maintained at temperatures within a small band to provide nominated thermal comfort for students (DECS Asset Services 2008)(see Section 2.3.5.2). Thus, rather than fully integrating a low energy passive design in conjunction with stated school pedagogy, Australian school buildings are mechanically heated and cooled. This either raises comfort, and its perceived (and complex) relationship to learning, to higher status than energy consumption and its consequent effect on the environment, or introduces student wellbeing as valid concern, i.e., an unresolved conflict between environmental and social sustainability.

Given the current trend towards sustainability in schools, as both curriculum and integrated building fabric, it might be expected that occupants have awareness of their built environment sustainability, and how it relates to their workplace or learning experience. In office buildings, this is mixed. Some studies suggest the workplace quality is improved by ‘green’ design (Baird et al. 2012). Others report negative correlations between ‘green’ design and their workplace (McCunn & Gifford 2012), and perceived low productivity in ‘green’ buildings as compared to conventional buildings (Menadue et al. 2013). In schools, UK policy advice suggests, using exemplars that perspectives of sustainability have been improved through school design (DfES 2006), as does the OECD (OECD 2006). Qualitative studies tend to confirm that perceptions of sustainability exist (Flowers & Chodkiewicz 2009; Hes 2012; Higgs & McMillan 2006), but these were undertaken in the context of explicitly supported sustainability teaching programmes. There seems to be little evidence for a simple relationship between photovoltaics on a roof and sustainability awareness, let alone behaviour.

2.3.7 Summary

This section presented different perspectives of the school built environment. It started with the ‘learning environment’, which is a holistic concept based on functionalist assumption that school design aids learning achievement. Next, schools as architecture, place, and as a communication tool for the school organisation were considered.

The section then provided a brief summary of school building typologies present in Australia since the commencement of public education. These building types are seen as evidence of attempts at education innovation, yet there exists minimal evidence that they improve education. Rather, to investigate evidence of the effects of school buildings on learning and teaching, the buildings need to be broken down into their components.

The functionality of buildings is reviewed first. A sample of functional spaces needed for contemporary teaching was presented, followed by how school buildings are explicitly included in the education process via their functionality. Temporary building adaption shows that school buildings are used dynamically as a tool, while permanent building adaption provides evidence that pedagogical needs change, yet the fact that buildings are retained suggests that they possess resilience. One contemporary stress on building resilience is the rapid change in ICT, where evidence is suggesting that this change might significantly challenge contemporary school buildings due to its capability to facilitate flexibility. This flexibility will also put stress on furniture and fixtures. Though not strictly part of the building fabric, these are particularly important since students are intimate with them as used objects. Similarly, the school landscape offers zones where students have less interaction with staff, thus making the landscape a place of independence and informal learning, which students ‘own’. Finally, schools as infrastructure for community was touched on, and questions were raised about the tension between public interaction and functional separation for safety and security.

The fabric quality and indoor comfort was discussed by separating it into its components of thermal comfort and control, light, sound and noise, and indoor air quality. This is a pragmatic separation since these are all interconnected and somewhat circular, such as the conflict between soft furnishings needed for acoustic modifications, which degrade air quality through dirt and dust collection if poorly maintained.

Finally, in the context of previous discussions, the special case of a ‘sustainable school’ as both identity and operation was discussed.

In summary, learning space environment research is fragmented and contingent on the certain systemic parameters of each study. The building fabric features more as a tolerated support system for teaching than proven parameter for improving learning effectiveness:

> …human beings tend to resort to simply coping with the given environment rather than actively managing it and this may be related to users not being involved in the design process and thus not ‘owning’ their space. ... Environmental perceptions are not, unless prompted, often at the forefront of teachers’ planning. (Higgins et al. 2005, p. 15)

The taken-for-granted assumption in built environment research is that design matters. This positions the built environment as an active participant in learning (Figure 2.3). This is contrast to the positioning of the constructivist learning paradigm, which sees the environment as passive. The components discussed above show that the detail required to design schools is extensive. It is proposed here that the ‘passive’ environment is actually ‘actively passive’, in the sense that it is very actively designed to be invisible and to not interfere with learning.

Ultimately, it raises the question as to whether the architecture of school buildings should be designed as a sympathetic platform for a very wide range of learning activities. Alternatively, should a high priority be put on their value as an aesthetic artefact to be loved for its significance. Regardless of the chosen strategy, the occupied school performance needs to studied. The section discusses options for school built environment appraisal.

2.4 The performance of the school built environment

The previous discussion has been about the intentions of the built environment in schools. This section presents possibilities for evaluating the performance of the school built environment. These are numerous both in their name and their focus on what is to be learned from appraising occupied buildings. Evaluation processes use a wide range of appraisal methodologies depending on the paradigm of origin, and their positioning on a building-focussed to occupant-focussed spectrum. Both involve quantitative and qualitative data collection and analysis.

The building evaluation process is first discussed from the perspective of the building discipline paradigm and its different 'performances' found in literature. Below is not an exhaustive summary. Due to the high degree of variation, these have been grouped together pragmatically so that they address the previous discussion about school built environments. Following this, other sources from non-building paradigms, such as environmental psychology or education literature, are presented for comparison and as a source for the process used in this inquiry.

2.4.1 Building performance evaluation and appraisal

Building appraisal has many names: 'post-occupancy evaluation' or POE; 'building-in-use studies'; 'building diagnostics'; 'building pathology'; and 'building performance evaluation'. All assume that there exists performance criteria against which a building may be measured against in its operating state (Preiser 1995). This inquiry uses the term 'building performance evaluation'[18] for the appraisal process.

Performance also depends on the type and context of the appraisal process (Zimring 1989). Building performance evaluations have different purposes (e.g., indicative, investigative, or diagnostic) so require different levels of data collection (Preiser 1995). They may be performed to compare buildings against each other within a building class (Baird & Field 2013) or against benchmarks (Dykes & Baird 2014). Alternatively, evaluations may form the basis of mixed method scholarly research (e.g., Becker 1989; Menadue et al. 2013), while challenging building 'science' to rigorously include contextual knowledge using interdisciplinary methods (Berker & Bharathi 2012).

There is an assumption that the design brief contains performance criteria, and that these criteria are centred on three perspectives: occupants and their needs; environmental performance; and value for money (Leaman et al. 2010). This assumes that clients know what they want and are able to communicate this in detail, which is not necessarily the case a priori to the engagement of the lead designer (Lawson 2004, p. 23). It also assumes implicitly that the building should be 'fit for purpose' so that there is an intended performance, yet architects are not bound to this legal condition (Section 2.3.4).

More pragmatically, the approach to building performance evaluation depends on where the investigator is located on the socio-technical continuum of building-occupant interaction. At the social end, it is understood that buildings are for people and the building performance (including the design causing the performance) is judged on its suitability for the people that use it (Markus et al. 1972, p. v). At the other end of the spectrum, buildings might be designed to encode the

[18] In practice, I have found 'post-occupancy evaluation' to be misleading. Although it refers to the time after construction has been completed in which buildings are occupied, I have found that it confuses building users, since, as uses have said to me 'we have not left the building!', i.e., it is not after occupation.

'attitudinal fix' required to reduce energy and resources use, thus privileging environmental performance over user interaction (Hyde 2014). The former approach is qualitative and seeks data from occupants via questionnaires and other sources such as photography (Preiser et al. 1998, pp. 73-80), while the latter relies on more quantitative data.

The timing of building performance evaluation varies depending on who takes responsibility for the process. Building performance evaluation may be performed as part of the design process (da Graça et al. 2007; Markus 1967), to implement continuous improvement in buildings during ongoing facilities management (Preiser 1995) or design defects (Hassanain et al. 2014), to create organisational learning about the facilities (Gelfand & Corey Freed 2010, p. 257; Zimring 1989), or improve strategic implementation of building programmes (Ornstein & Ono 2010). While drawing on established building performance evaluation, appropriate methods for evaluating educational buildings are not well established (Cleveland & Fisher 2014).

The following discussion separates out the various building performance approaches in recent literature, with the intent of exploring options for the built environment evaluation within this inquiry. The options are categorised based on who is involved in the data collection, and the reason for the data collection and evaluation.

2.4.1.1 **Holistic models of building performance**

Holistic models are models that combine a range of building performance indicators to link user perspectives and quantitative aspects of building performance (Preiser 1989). These indicators tend to be selected to provide feedback on indicators such as energy use and user satisfaction of selected indicators including building maintenance, comfort indicators, and productivity (PROBE study, Cohen et al. 2001), with the intention of providing feedback to clients and design teams (Leaman et al. 2010) through a commercialised evaluation product (Bus Methodology 2015; Centre for the Built Environment 2008). Taken at face value, these approaches might be expected to offer the most comprehensive established building performance evaluation process. Certainly, they have proved useful as a benchmarking tool in scholarly research (Baird & Field 2013; Baird et al. 2012), and have been used by the UK Government to demonstrate sustainable school case study exemplars (DfES 2006).

In schools, other examples of holistic building performance evaluation have also been tried. An anthropocentric-building systemic appraisal was applied to selected Scottish[19] schools with extensive participation of school staff (Markus et al. 1972). Other British holistic models have been

[19] While Scotland is part the United Kingdom, this country-within-a-country has changing levels of self governance. The level of self autonomy and political climate in Scottish education matters is unknown at the time of (Markus et al. 1972), and not necessarily relevant other than to acknowledge the likely possibility of independence of educational strategy from that at the level of British government, hence, the identification of 'Scottish schools'.

based on expert evaluation of design factors, student performance indicators, and 'field work experience' without qualitative input from users (Barrett et al. 2013). In Australia, qualitative appraisal of new schools soon after occupation have used questionnaires, interviews, observation, and physical data in evaluations (Newton, Wilks, et al. 2012);

Other holistic approaches do include students in building performance appraisal. Professional literature has reported using student interviews (Watson 2004a) while others offer a range of data capture techniques (Sanoff 2001a). Peer-reviewed literature has reported scholarly approaches to including students perspectives of old and new schools soon after occupation (Leung & Fung 2005), appraisal of a building for its indoor environment quality and as a teaching tool (Hes 2012), and school building optimisation (da Graça et al. 2007), the latter using contemporary architectural practice advice (Sanoff 2001a). Another holistic evaluation reported in peer-reviewed literature focussed on energy-use has rejected the use of surveys in secondary schools due to perceived need to over-simplify the test instrument, but has included walkthroughs and collection of drawings (Wheeler & Malekzadeh 2015); however, it is unclear what underpinned this latter visual data approach. In contrast, a multi-data evaluation process that did include surveys has been extensively tested in primary schools (Newman 2010), but uses only general questions about design of school infrastructure, possibly due to the author being positioned in the discipline of geography.

All of the above used various quantitative and qualitative inputs, and various inputs from experts and users. Ultimately, all aim to present unique models that are specific to their intended purpose. The remainder of this section dissects these models and includes other single studies according to the nature of the data collected and its intended purpose.

2.4.1.2 Expert judgement of operational performance

Assessing the quality of the fabric of the built environment and its operational performance can be seen as a specialist capability that needs 'experts' to make a professional judgement, where 'experts' are people other than building occupants, who have specific skills and knowledge (Preiser et al. 1998, pp. 35-36). Experts typically assess the technical performance of the building (Bordass, Cohen, et al. 2001a; Pegrum & Bycroft 1989) using protocols developed solely by experts (Alwaer & Clements-Croome 2010; Lavy et al. 2014a, 2014b). Expert 'walk-throughs' or 'walk-rounds' are also reported in literature (Simon et al. 2007; Zhang & Barrett 2010), although it is noted that the expertise level of appraisal personnel is not made explicit.

This might be seen as a pragmatic solution where time and cost limitations exist, and value is seen in the specialist knowledge experts bring to the process (Parnell et al. 2008). This is, after all, the model professional architecture uses in building assessment (Australian Institute of

Architects 2012b; Lawson 2004). Despite this, the equivalence between expert assessment and rigorous social science methods is not necessarily established (Bechtel 1989), as demonstrated by minimal correlation between expert appraisal and user perspectives in a recent school evaluation (O. Hopland 2014).

Caution around the social construction of expert knowledge might be prudent, since the 'opinion' of a single expert has been shown to differ from a group of experts' collective 'expert information' and 'expert evidence' (Kaplan 1992). It has also been argued that expert-led questioning is '… developed by professional appraisers who may have their own professionally vested interests', so restricts the scope of responses (Asprino et al. 1981, p. 67), suggesting a form of 'bounded rationality' (Bendor 2001; Simon 2001).

Despite the convenience of expert assessment, there are two concerns. The first is epistemological. It is unlikely that a visiting expert can ever anticipate the responses of occupants collected by social science methods, particularly if users, through their everyday use of the buildings, may have higher expertise in specific buildings (Sanoff 2001a). The second is ethical. Omitting the occupants as a key stakeholder in the building performance contravenes design imperatives associated with ethical approaches such as responsive cohesion (Fox 2006).

2.4.1.3 **Environmental and sustainability performance**

While this inquiry does not investigate energy use specifically, it does engage with the expectations of building sustainability as introduced last century to architectural design (Olgyay & Olgyay 1963; Wells 1971), and have been promoted outside of the architectural profession by various ratings tools. These include LEED, '…a green building certification program' (USGBC 2015), which has been promoted as contributing to 'sustainable schools' (Gelfand & Corey Freed 2010, pp. 8-9), or as a complement to educational indicators about sustainability (Ruano & García Cruzado 2012). Similarly, in Australia the Green Star ratings tool claims to offer 'independent verification that a building…is sustainable' and that certified buildings, in addition to reducing power use and operating costs can 'increase student learning and engagement' (Green Building Council of Australia 2015, p. 6). While evidence supporting these claims was not found, it was assumed that these contributed building performance expectations.

Referring to Section 2.2.3, energy use alone has long been a concern due to the risk associated with energy supply (Baird 1984), and have been included in holistic building evaluations (Bordass, Cohen, et al. 2001b; DfES 2006) and school life cycle analysis (Ji et al. 2014). Of interest here is the sensitivities in energy use due to occupant technology use and activities (Pearce 2006a), controllability (Bordass, Cohen, et al. 2001b) and socio-technical adaptability (Chiu et al. 2014).

2.4.1.4 **Economic performance**

In Australia, there is a history of including economic performance in building performance evaluation of federal public buildings (Pegrum & Bycroft 1989). In the 1980s, economic performance was described as 'value for cost (cost-in-use)' and was performed by evaluating cost records such as energy use, maintenance, cleaning, and other service costs (Pegrum & Bycroft 1989). At that point in time, the objectives did not include more recent developments in costing of resource use and waste treatment and the accounting of life-cycle costing (Ding 2007). Methods are available for lifecycle costing in schools (Ding 2007; Issa et al. 2010), however they do not appear in contemporary holistic commercial building performance evaluation procedures, despite (or because of) political and economic pressures on education funding in Australia (e.g., Garnaut 2011). This is somewhat ironic given the positivistic approaches to public decision making (see Section 2.2.3) and the positivistic possibilities of the quantitative data available in this scope of performance.

2.4.1.5 **Comfort performance**

Creating appropriate thermal comfort for school occupants is perceived as important, and two test procedures are in current use (Section 2.3.5.2). Comfort studies test perceptions of comfort against simultaneous measurement of environmental conditions (air temperature, globe temperature, relative humidity, airflow velocity) using location and culturally specific adaptive models based on 'real-world' or 'field-based' data. These procedures are well established (de Dear 2004; Nicol et al. 2012); however, comfort model development is ongoing (de Dear 2004; Gunay et al. 2013), including investigations into the complexity of comfort sensation and tendency towards alliesthesia (de Dear 2011; Healey 2014) (or, more generally, 'focusing illusion' in environmental economics (Kahneman & Sugden 2005)), and its implications (Halawa & van Hoof 2012). These methods have been extended to children using age-appropriate modified scales with mixed results (Section 2.4.1.5). Regardless of the well-developed rigour of this approach, data collection is time consuming for both researcher and participants, and tends to be for the purpose of scholarly research, not building performance evaluation.

In contrast to this, building performance evaluations tend to collect historical thermal comfort perceptions of building performance during previous seasons without measurement of the comfort environment. Examples of this approach include the PROBE series (Cohen et al. 2001), the Centre for Built Environment (Centre for the Built Environment 2008), and others (Baird et al. 2012; Vischer 1989). In offices, these sets of data are not necessarily equivalent to comfort studies, and may be modified by other attitudes, such as dissatisfaction about the workplace (Deuble & de Dear 2014).

2.4.1.6 **Personal productivity**

There is an assumed direct link between built environment and learning, which is positively correlated, i.e., good environment contributes to better learning (Section 2.3.1). This parallels the assumptions that appear in holistic building performance evaluations, i.e., that personal productivity is improved by a superior built environment. Although productivity may be the 'subtext' behind building performance evaluations (Leaman et al. 2010), testing this is typically through self-reporting from building users without testing actual work output (Baird et al. 2012; Dykes & Baird 2014; Leaman & Bordass 2001). Similarly, in the education sector, changes to the educational built environment, and its link to learning and teaching efficacy, also rely on self-reporting (Green & Turrell 2005).

Ideally, finding causation factors between learning and teaching and the built environment would optimise the funding spent on school built environments, however the complexity of this research task is difficult (Green & Turrell 2005). Teaching and learning achievement has been linked to quality of daylight, where the latter is assessed by experts (Heschong Mahone Group 1999). Similarly, correlations have been found between learning achievement and light, flexibility of furniture and arrangement, circulation quality, and 'stimulation' based on colour and design complexity (Barrett et al. 2013), however, the expert assessment protocol of school building quality, or the background of assessors, is not available. These correlational results, although interesting, do not provide causative knowledge, and not in terms designers can apply in practice should one wish to engage in architectural determinism.

2.4.1.7 **Satisfaction with building performance**

In contrast to productivity, satisfaction with the building performance is an opinion that can only be reported by users. Some building performance models include overall building satisfaction in their data collection (e.g. 'Probe' process based on Building Use Studies, BUS, in Cohen et al. 2001), noting that satisfaction with a building does not predict occupant behaviour such as, say, increased productivity (Francescato et al. 1989). Alternatively, satisfaction is seen as a measure of 'fitness for purpose' (Pegrum & Bycroft 1989), but this overlooks the aesthetic, architectural or non-functional contributions of buildings to satisfaction. Thus, satisfaction with the building requires context.

Since satisfaction with comfort has a significant history, it was separated and addressed in Section 2.4.1.5. The remaining satisfaction indices vary between studies. Within the BUS system, satisfaction include attitudes towards design, personal needs, productivity, and health (Baird et al. 2012). Alternatively, user satisfaction can be distributed between 'functional performance' and 'aesthetics' (Pegrum & Bycroft 1989).

Within school building performance evaluation, data collection varies between studies. Data from school staff about their satisfaction with school buildings has been collected with questionnaires using scales (Barrett & Zhang 2012; DfES 2006) and open questions (Barrett & Zhang 2012), and interviews (Newton, Wilks, et al. 2012). Student data collection typically includes questionnaires (Leung & Fung 2005) or interviews (Barrett et al. 2011; Lai 2013). Staff satisfaction topics include indices about design, needs, perceived health, and image to visitors (DfES 2006), functionality (Barrett & Zhang 2012) and flexibility of space (Newton, Wilks, et al. 2012). Student topics include satisfaction with ICT and hygiene (Lai 2013), flexibility of space, furniture, circulation, ICT, cleanliness and maintenance (Leung & Fung 2005), and functional design, outdoor facilities and ICT (Barrett et al. 2011). The possibility of architecture providing a level of satisfaction does not appear to have been tested.

Thus, 'satisfaction' of users with building performance varies by study. To date, satisfaction tends to focus on functional aspects of buildings, though, not always, with some hints of design-related satisfaction addressed; however, while it was considered in the UK as important in design up until early this decade (CABE 2011), the satisfaction with architecture as a visual delight in and of itself is not addressed, likely due to the commercial and economic context of buildings under study (see Section 2.2.3). It might be too flippant to enjoy architecture that has been earnestly designed for a serious public function.

2.4.2 Built environment evaluation of schools

Building performance evaluation evaluates the performance of building fabric and fixtures, i.e., it is a limited process. It originated in the building industry and, consequently, takes on the paradigm of the building construction and maintenance industry. It is limited because it both omits human quality, and also architectural quality of buildings, both stand-alone artefacts, or in their urban (or rural) context.

This building-centred approach alone is unable to address the performance of the built environment so that its cohesion and, in turn, ethical contribution may be judged (Fox 2006, p. 350; Fuller et al. 2008; Radford 2009, 2010; Williamson et al. 2003). To evaluate ethically, it must be accepted that people are involved in using and mediating the design and use of buildings. Given the purpose of schools, this objective is not difficult to imagine (Markus et al. 1972, p. 1). Despite this, research into user-school built environment system is, as has been shown, restricted in the building oriented literature. To expand this, we must delve into social science, specifically, sociology, anthropology, and environmental psychology.

Sociology tells us that architecture is a social and political construction, with contested definitions of both practice and product (Jones 2011, pp. 2-3). Anthropology has been diverted into social structure rather than material culture (Buchli 2013, pp. 1-2), with attention to gendered buildings and space (Buchli 2013, pp. 103-105). It is difficult to apply these ideas in school architecture, since the typology of single classrooms potentially gives spatial ownership to teaching staff. Anthropology, does, however provide some useful methods for studying spatial use (see Section 3.5).

Environmental psychology provides assessment methods that include aspects of both interior architecture and landscape architecture; however, they tend to focus on early learning, i.e., pre-primary school environments. Likert-type scale approaches include the ‘Early Childhood Physical Environment Scales’ (Moore 1986; Moore & Sugiyama 2007), in conjunction with other qualitative methods (thematic analysis, Berris & Miller 2011). Open-ended interviews have been used to investigate primary school students perceptions (Simon et al. 2007), and focus groups and questionnaires used with secondary school students (Edgerton et al. 2010). The use of open-ended test instruments for school students opens up the definition of school environment to include elements other than the school building fabrics. Students’ experience school as more than buildings and report attitudes about the exterior landscape, both hard and soft, and outdoor equipment (Edgerton et al. 2010; Simon et al. 2007). Under the responsive cohesion framework, this suggests that building performance evaluation alone is not representative of school students experience and must be extended to include perspectives of the outdoor environment. However, none of the social science approaches provides the architectural detail to feed back into the design process.

2.4.3 **Summary**

This section reviewed the current portfolio of built environment performance evaluation processes. It first reviewed building-specific tools. These included well established, often industry-driven processes, which collect data about a range of variables and perspectives of buildings using building monitoring data and evaluation by ‘experts’. These were grouped together as ‘holistic’ models to introduce them, with selected components discussed in conjunction with other topic-specific evaluations of buildings

The use of ‘experts’ is common in building evaluation. While there is no doubt that specialist knowledge is useful for interpreting the complexity of buildings, particularly for the building industry audience, there is an awareness that occupants have a role in how buildings perform. Environment and sustainability performance offers the possibility of positivistic measurement of resources use (energy, water, materials quantity surveying, etc.). Collecting positivistic data about evaluating occupant behaviour and needs is more complex, in both the collection phase, and the interpretation phase, this latter phase being a more suitable task for those *qualified* to interpret occupant perspectives, such as sociologists, anthropologists, and environment psychologists. Despite this, the building disciplines have attempted to collect data about user perspectives about comfort, productivity, and satisfaction with the building.

All of these are applicable in their own ways to schools. However, schools have school grounds and these are important because they are the domain of students (Section 2.3.4.6), and, if the evaluation is to respond to the needs of users, these must be included in the built environment evaluation of the school. Environmental psychology approaches provide precedents for evaluation processes, however they omit the architectural detail required to advise built environment designers.

There is no doubt that the processes described in this section are potentially time consuming and expensive to perform and it might be tempting to ask, 'why bother?' From the educationalist's perspective, improvement tends to be an incremental (Hattie 2009, p. 12). Towards the end of last century it was suggested that building performance would need 'hybrid practitioners', i.e., ' a new generation of design researchers whose education and experience span social science and design will be required to bring about an effective synthesis of skills needed in this field [of POE]' (Farbstein 1989, p. 292). While the link between building performance and student and teacher performance is complex, there remains the possibility for small, and hopefully cheap, improvements combine to improve users' experience of their educational built environment, but these might need hybrid practitioners to seek them out.

2.5 Learning from schools

The objective of this inquiry is to learn from existing school building architecture. To do this, we must know first what is expected of it, and then evaluate its performance from the perspective of the buildings and the users' expectations of the buildings.

Section 2.2 presented a context for the interpretation of the school built environment. In both education and built environment literature, the metaphor of a system is often used to represent the interaction between students and their physical environment. This a useful tool for making sense and exploring possibilities between students and their environment, however, the model is only a metaphor and serious questions arise on further examination. Systems have boundaries and sit within contexts. The context presented in this chapter raises queries about how the physical environment is really seen by educations in pedagogical terms and whether differs for school designers. For those educators using a constructivist paradigm, the built environment is not necessarily seen as 'active' in education, yet the design advise starts from the position that the built environment is both active and facilitates learning.

The context of schools shows that schools, at least in Australia, are part of the political system. Since all public schools, and, in part, private schools are funded by public money there are monetary limitations and constraints to infrastructure. There are also productivity expectations, as demonstrated by rankings systems, that further contribute to positivist approach to schools and their infrastructure. Such an approach is not necessarily wrong; it simplifies the distribution, use, and outcome assessment of significant amounts of public funds. However, if new school built environments are to be proposed they should engage with this political positivism in their own language. Evidence should be quantifiable, reliable, and simple.

Two aspects of education were discussed that impact on the built environment. Education for sustainable development is evolving, and placing increasing expectations on school infrastructure to demonstrate sustainable development, yet the effectiveness of this sort of infrastructure is unknown. Information and communication technology is changing rapidly and has the potential to significantly change teaching and learning. This, in turn, has the potential to change the needs of the built environment rapidly, in particular the need to design for portable screens. However, the need to design for screens should not at the expense of for designing for people. Here we can learn from previous sudden changes in technology, and how it might be appropriate to respond to these changes.

Finally, schools are workplaces. As such, they can be viewed through management and organisational studies lenses, and are subject to workplace health and safety. It is not all about the children.

To develop a context for what is expected from the school built environment, generally and specifically to South Australia, Section 2.3 reviewed design advice, facilities guidelines, and literature from a range of disciplines. The ubiquitous term ‘learning environment’ was discussed and shown to be both encouraging of a good physical environment, yet also vague in its outcomes. There is little evidence for a link between a good physical environment and learning achievement, yet this is not to say that it does not exist; only that it is currently more theory than established causation. The quality of school buildings probably influence student learning and affect in some way, but the specific mechanisms are not clear, only that poor environments are more likely influence student learning and affect negatively, which suggests the quality of the building has some importance. Furthermore, the short history of school building environment innovations presented is evidence that the belief of the importance of the school built environment.

What is expected of schools is then broken down into its functionality, its fabric quality and indoor comfort, and its importance as place. These address design advice from the perspective of education, built environment, and environmental psychology literature. Ultimately, the perspectives of the school built environment is fragmented according to professional paradigm. However, the notion of the built environment being 'passive' in learning, particularly if learning is extended beyond the formal curriculum, is questioned. In the built environment community, is that it is clearly not passive and is designed to facilitate learning and teaching. There is also another possibility in that facilitating learning and teaching the built environment is designed not to intrude on the process of learning and teaching.

Evaluating the school built environment is a process, and the different approaches are discussed in Section 2.4. These range from pragmatic process that grew from industry to those grounded in scholarly research. The former focus on the building operations and collect data about buildings through expert analysis and user questionnaires. The latter tend not to divide the indoor and outdoor environment and use more qualitative approaches. Neither of these attempts to quantify findings that are specific to architectural design. All are dependent on the background of the originator.

Architectural determinism is a questionable endeavour. People do not, nor should they, do what architects programme them to do. First, people occupy buildings and then modify and personalise them, so it is difficult to design cohesively for the impact of time. Second, architecture and building science, do not have an academic pedigree in rigorously addressing behavioural and cognitive experience and needs of building occupants, thus even if we wanted to design to include users' perspectives we will do so based solely on professional guesses.

Thus, in learning from architecture, we need to be able to hear the perspectives of the occupants of architecture. In the case of schools, we need to hear from staff about their workplace, and students about their learning-place. Given the purpose and stakeholders involved, schools are a unique building type, so we need unique building performance evaluation processes that allow all voices to be heard. If the assumed potential for enhancing learning and affect through the built environment is accepted, we need built environment evaluation processes to include the scope and detail required for architects to learn from what has been tried before, since, rightly or wrongly, intentionally or unintentionally, architects program the school space during the design phase.

This literature review shows that the scope of influence of design is potentially very broad, and covers a range of disciplines. Designers are not teachers, psychologists, or cognitive neuroscientists, but they do need to draw on these disciplines to design innovative educational facilities that meet the needs of users over time. Innovation needs checks and balances, so it would be useful to learn from other attempts at architectural innovations and create a framework for testing risk against new indicators of quality.

3 Methodology and Ethics

3.1 Introduction

Having presented the topic of inquiry and identified the gap in current literature, this chapter discusses the research strategy used to fill that knowledge gap. It outlines the methodological context for the selected research process, the ethical context and its influence on the research process, the strategy of inquiry (case study) and the merits of the methods used to collect data for the purpose of mixed methods meta-inference. It presents a parallel mixed methods process to structure the remainder of this inquiry and discusses in turn each method of data collection and the analysis required to ensure research credibility. It also discusses the special considerations needed for undertaking research in operating schools, and presents how these influenced the research design, while ensuring that high research quality was maintained.

3.2 Research strategy

The overriding research strategy used in this inquiry was driven by four factors. First, this research has its origins in professional practice, with the objective of contributing to both scholarly knowledge and professional practice, so professional knowledge needs to be positioned to inform scholarly methods, yet quarantined from the scholarly inquiry process. Second, post occupancy evaluation tends to investigate real world circumstances of occupied buildings, thus falls into naturalistic research and its consequent inference challenges. Third, previous professional experience with the complexity of schools and their users informed the decision to keep the sample size small and focus on exploration and depth of research, i.e., use a case study strategy and design in flexibility to allow adjustment for research opportunities and challenges. Finally, architectural research sources various physical, environmental, and social data, and this inquiry was explicitly informed by mixed method research literature. This inquiry resolves these by adopting a pragmatism knowledge claim, using case study as a strategy of inquiry, and identifies the mixed methods research inference quality process used in this study. Ultimately, this inquiry aims to develop ‘informed judgement’ (Fox 2006, pp. 85-88).

3.2.1 Pragmatism

Architecture is sometimes seen as a ‘meeting ground for a number of academic disciplines’ (Hillier & Leaman 1972) and, so this research draws on a number of exogenous systems of enquiry (Groat & Wang 2002, p. 24) and a range of research strategies to fit different research inquiries (see chapters 6 to 12 of Groat & Wang 2002; Maxcy 2003). This applied mixture of methods falls under a pragmatic knowledge claim (Creswell 2003, pp. 11-13).

Pragmatism is described as a 'living philosophy' (Talisse & Aikin 2008, p. 4) where, rather than relying on expert beliefs, the perception exists that knowledge is 'fallible' and must be constantly refuted, or strengthened to resolve ‘doubt’ as more evidence appears, through continuous evaluation (Talisse & Aikin 2008, pp. 15-19,30). In presenting knowledge, the intended audience must be convinced (Metcalfe 2008). Where knowledge is found to be incorrect by the intended audience it could be rejected outright, but this is in danger of throwing out the knowledge baby with the fallible bathwater. 'Perspective falliblism' allows knowledge to be considered as truth from a particular perspective but acknowledging the contradiction with another similar body of knowledge (Talisse & Aikin 2008, p. 53), or may open up an interdisciplinary 'dialogical encounter' (Baert 2005). In a built environment performance evaluation, this is useful to consider if the intended audience is consists of a wide range of stakeholders.

Pragmatism is attractive because it allows the inclusion of practical knowledge, or praxis (Flyvbjerg 2004b; Johnson & Onwuegbuzie 2004), and this makes it particularly useful in a practice-based academic discipline such as architecture (Melles 2008). Having said that, pragmatic mixed methods must also demonstrate the rigor required by each possible audience (Tashakkori & Teddlie 1998, p. 38).

Under pragmatist knowledge claims, both case study and mixed method research are appropriate strategies (Maxcy 2003). Within mixed methods research one interpretation of the interaction between theory and mixed empirical observations is presented visually in Figure 3.1. To the left of the dashed line, the darker arrows show triangulation convergence of empirical results as one example of the outcome of a mixed method pragmatic inquiry (Erzberger & Kelle 2003, p. 465 Figure 416.463). The right side of the diagram extends the theory and empirical planes beyond the scholarly realms of knowledge into praxis to acknowledge the influence of practice on a practical discipline such as architecture. This intersection of knowledge production and praxis, or ‘Mode 1’ and ‘Mode 2’ knowledge is found in other disciplines (Swan et al. 2010) and is ‘transdisciplinary’ (Gibbons et al. 1994), and as discussed in section 2.3, practical theory, as design advice, is a significant influence within the design of schools. Similarly, practical empirical research processes are an inherent part of architectural practice (Downton 2003; Lawson 1990; Sanoff 1977). Figure 3.1 acknowledges that these exist, are connected to scholarly architectural research, but are different in their quality of knowledge. Thus, this inquiry includes influences from South Australian professional architecture practice due to the background of the author. However, this inquiry has been designed to ensure this practical knowledge is either kept on the right side of the theory/practice continuum, where it informs the usefulness of this inquiry, or explicitly brought over to the left via the use of analogous scholarly data collection and inference methods.

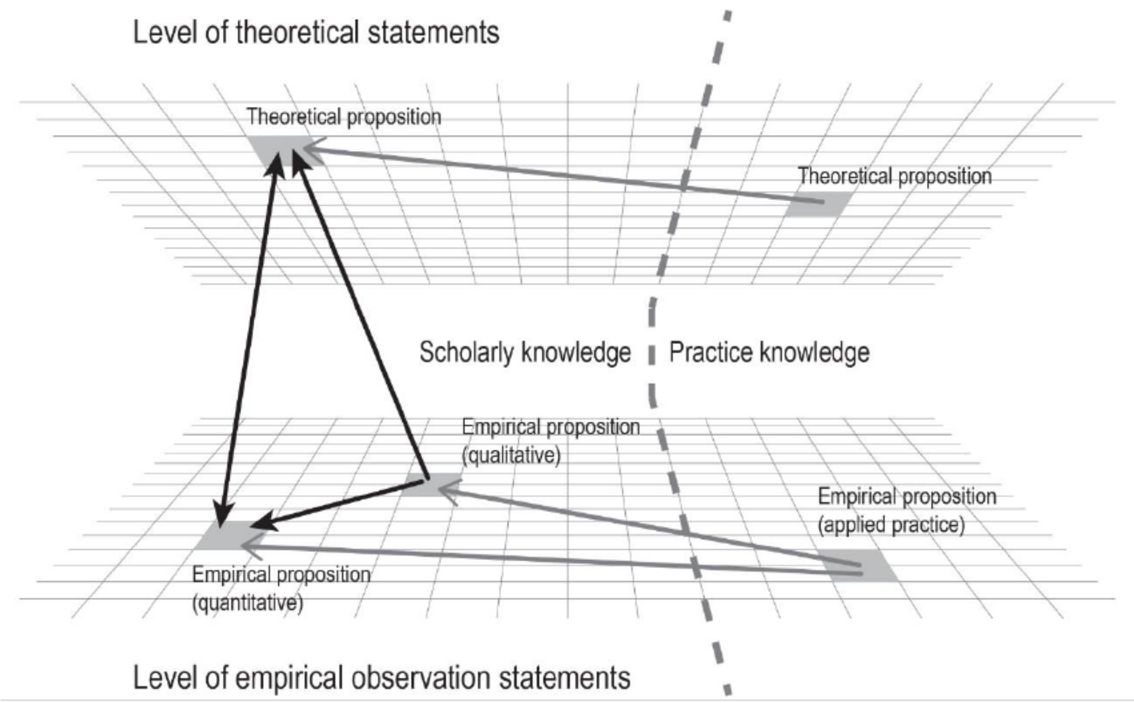


Figure 3.1: Triangulation convergence of results, shown with practice knowledge influence, after (Erzberger & Kelle 2003)

The remainder of this section discusses the main research strategy, case study, followed by a parallel discussion about mixed methods and inference.

3.2.2 Strategy of inquiry: case study

This project intended to develop a deep understanding of the performance of the built environment of selected South Australian primary schools in the context of school culture, operations and sustainability goals. Given the complexity of the contemporary school - built environment system, this suggested the use of case study strategy of inquiry (Yin 2008, p. 8) where cases were to be used as 'exploratory' (Yin 2008, p. 8) and to develop 'contextual dependent knowledge' as is appropriate for practice in the real world in which 'there appears to exist only context-dependent knowledge…' (Flyvbjerg 2004a).

This project started in the professional world with some a priori theoretical expectations. It also set the objectives that explicitly state that the results should be applied in the professional world. The richness of the data collection also included the use of grounded theory induction, thus combining both the above approaches. This deduction – induction – deduction process is best described as 'abduction' (Teddlie & Tashakkori 2009, p. 89).

Selecting an appropriate number of case studies was a 'real world' problem. The sample size can be considered large enough '…when the researcher is satisfied that the data are rich enough and cover enough of the dimensions they are interested in' (Liamputtong & Ezzy 2005, p. 49). Alternatively, it can be argued that 'small-N' studies are useful due to depth of research and strategic selection and goes on to provide four 'information-oriented selections' (Flyvbjerg, p. 230):

- Extreme/deviant cases – 'especially problematic or especially good'
- Maximum variation cases – selected based on variation of one dimensions such as cost or size
- Critical cases – useful for testing falsification such as in a typical case
- Paradigmatic cases – 'to develop a metaphor or establish a school for the domain that the case concerns.'

It was anticipated that limited resources and recruitment limitations would put the inquiry into the 'small-N' case study category, thus the research was designed to counter this with depth and strategic selection as addressed in Section 3.4. Regardless of richness justifications, a small number of case studies will likely lead to bias in theory development, however, the depth of investigation allows for more questioning of assumptions and recognition of falsification (Flyvbjerg 2004a, p. 237). This infers a grounded theory approach in which constant testing of assumptions and results through open coding and theoretical memos provides an in-built mechanism against bias (Pidgeon & Henwood 2004). While this argument of self-regulation is noble, this inquiry could be considered as presenting "preliminary findings" (Yin 2008, p. 72) as more honest, but less assertive knowledge, claim. Alternatively, this inquiry could serve in future meta-analyses as one part of the puzzle towards finding 'big effects' (Hattie 2009, pp. 10-11), thus, any bias[20] risk is distributed in the bigger, future picture. In this study the benefits outweigh the risks, but only if the risks are kept explicit.

One risk that appeared early in the study was the scope of occupants and infrastructure studied within a case study school. One proposition in case study analysis is the 'unit of analysis' selection (Yin 2008, p. 29) or case boundaries. In this research, the obvious unit of analysis is a single school, i.e., the physical entity that provides the location of the provision of an education service by a certain group of staff to a certain group of primary school students. This is indeed an ideal objective in this research there are a number of challenges that make this difficult in reality.

First, in this study there was always an intention to delve into users' perceptions about their built environment. If all users experienced the same built environment, i.e., a school consisted of a

[20] One area of bias that is possibly more influential that a small number of case studies is the relationship between researcher and participants. Working with schools inevitably leads to development of professional relationships, so the inquiry acknowledges potential bias in this area. The study will not include any buildings on which the author has performed any master planning, design, documentation or contract administration.

single classroom, then it might be possible to use the school, itself, as the main unit of analysis. However, in the location of the study, con-urban Adelaide there are no single room public schools. All schools available for sampling provided education for more than one class.

Second, it was always the intention to compare and contrast users' perceptions with environmental data. Since environmental monitoring equipment was a limited resource and the objective was to provide a number of case studies, it was decided to not to collect environmental data in all rooms of a single case study school.

Third, access needed to be negotiated with school staff to provide a balance between collecting useful data and not intruding too far into school operations. This, again, limited the extent of data collection within a single case study school.

Given the above, it was decided to sample a case study school by focusing on a number of class spaces in each school. These rooms, called classrooms[21] in this research, held one or two classes. These rooms contributed to the school unit of analysis as a secondary 'unit of analysis'. The remainder of this research refers to the unit of analysis 'level' under analysis, such as school level or classroom level, and depends on the data collection method, which is further developed in chapter 3.5.

There is an implicit assumption that richness of a case study is arrived at by obvious triangulation or convergence of evidence. The mechanics of integrating inferences from different data sources is taken from mixed methods methodology. The next section outlines the mixed methods methodology applied to the case study.

3.2.3 Mixed methods research

Post occupancy evaluation research precedents implicitly use both qualitative and quantitative data (e.g., Cohen et al. 2001; Williamson et al. 2010). The location of mixed methods in the epistemological debate varies from constructivist according to architectural research methods (Groat & Wang 2002, pp. 176-177), to pragmatist (Creswell 2003; Johnson & Onwuegbuzie 2004), to being technically independent of epistemology (Bryman 1984), thus offering a symptom of the paradigm wars (Teddlie & Tashakkori 2003). Despite this, explicit mixed method research has been recommended for applied disciplines (Bryman & Bell 2007; Johnson & Onwuegbuzie 2004), including architecture research (Melles 2008), thermal comfort investigations (Roussac et al. 2011) using a mix of observational, survey, other data (e.g.(Gunay et al. 2013; Yun et al. 2014)), however these latter inquiries do not necessarily name their approach as mixed method research.

[21] It is noted that some schools use other pedagogical terms for 'classroom', such as 'learning space' or 'home space', however, for the sake of international familiarity, and uniformity between case studies, 'classroom' will be used.

Precedents are also found in spatial and education related research, such as evaluation of historical site interpretation programs (Farmer & Knapp 2008), study of children's mobility patterns at and outside of school (Christensen et al. 2011), or assessing teachers commitment to environmental education (Sosu et al. 2008). Furthermore, it is recognised that there is power contained within mixed-methods for interdisciplinary research:

> …it is highly likely that much can be learned about generative and thoughtful missed methods practice from the extraordinary explosion of provocative mixed methods empirical work *and* from more concerted and deliberate conversations across disciplines and fields of applied inquiry practice. [emphasis in original] (Greene 2008)

This inquiry continues this precedent in practice and pursues the challenge in the evolving mixed method research design paradigm to maintain inference quality. Specifically, this work draws on the mixed method paradigm as presented by Teddlie and Tashakkori (2009), in preference to Creswell and Plano Clark (2011), as it was found to provide more flexibility in application beyond pure social science inquiries, as required by this study. The former acknowledges that mixed methods design is fluid and depends on the inquiry (Teddlie & Tashakkori 2009, p. 139). It also acknowledges it is difficult to prioritise the influence of different strands of the mixed methods and reflects this by omitting the lower case notation convention for non-dominant strands, i.e., *QUAL* notation preferred over *qual* (Teddlie & Tashakkori 2009, p. 141), rather than *a prioi* nomination of methodological strand priority (Creswell & Plano Clark 2011, p. 105).

This study is primarily a parallel mixed method approach, which uses qualitative and quantitative strands that are applied to a multilevel case study. For initial simplicity, a basic parallel mixed methods model is presented in Figure 3.2. This shows two strands of nearly independent qualitative and quantitative inquiry, with each strand using its own paradigm inference quality standards, i.e., trustworthiness and validity in qualitative and quantitative research respectively (Teddlie & Tashakkori 2009, pp. 296-298).

The recommended process of integrated inference in mixed methods varies in literature (Erzberger & Kelle 2003; Miller 2003). This inquiry uses endpoint mixing, as indicated by 'meta-inference' in Figure 3.2, and is subject to an integrative framework of inference quality according to the research design quality and interpretive rigor (Teddlie & Tashakkori 2009, pp. 301-302).

Figure 3.2 also shows two additional dimensions, case study and unit of analysis, used in this inquiry to indicate that these parallel mixed processes are repeated for each case study, and each unit of analysis within each case study.

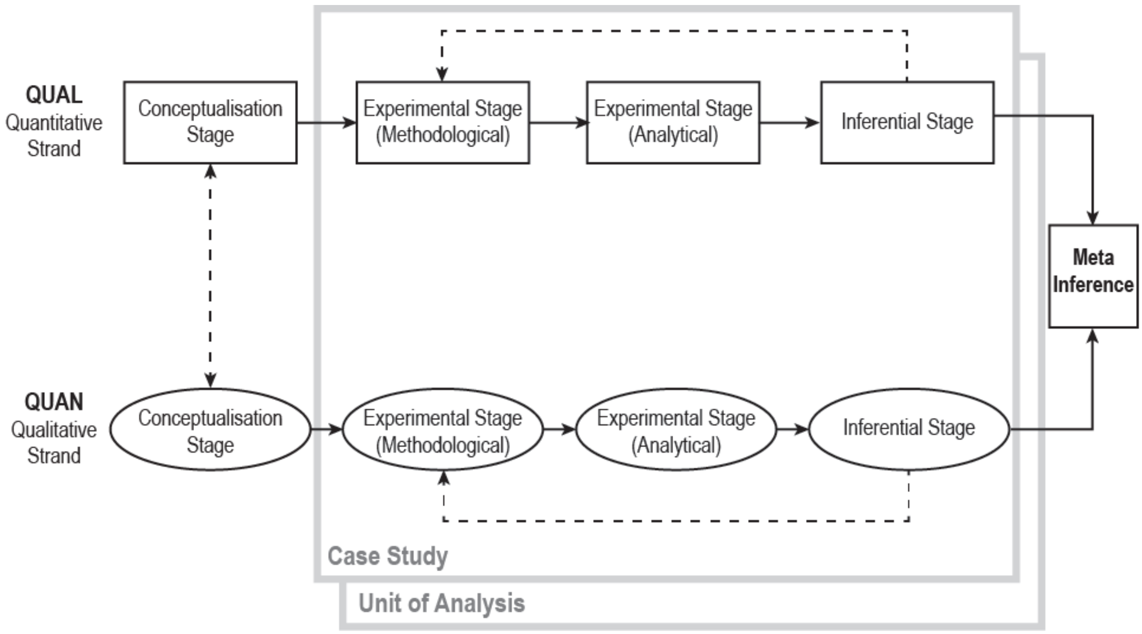


Figure 3.2: Parallel mixed method design overview, with case study and unit of analysis overlay, (after Teddlie & Tashakkori 2009, p. 266)

Expanding on the overview in Figure 3.2, and noting that application of real world mixed methods can be complex (one example of 20 steps in Teddlie & Tashakkori 2009, p. 158) and nested (Teddlie & Tashakkori 2009, pp. 156, 279), Figure 3.3 shows a more detailed map of the mixed methods path used. Preliminary contextual qualitative methods were applied sequentially at the beginning of the experimental stage to collect data about context of the case study schools and buildings. This data fed into mixed data collection to create a detailed building context, and into the user perspectives data collection. Both of these data collection groups had qualitative and quantitative components. These data collection groups used appropriate parallel inferential tools to develop findings by school or classroom level (unit of analysis), and by case study.

The QUAL and QUAN strands of each data group are expanded below in Table 3.1. This presents the main data type collected and the inference tools used prior to the meta-inferential stage. The school and classroom unit of analysis are shown in the inferential stage, together with 'integrated levels' to indicate that some data covered both the school level and the classroom.

Given that this inquiry posed exploratory questions rather than solid hypotheses for testing (although the existence of school architecture is a physical theory in itself), meta-inference was then applied to the study *as a whole* to identify emergent themes using grounded theory principles, such that theory was developed through '…an ongoing dialog between pre-existing theory and new insights generated as consequence of empirical observation' (Liamputtong & Ezzy 2005, p. 266). As suggested in the diagrammatic representation above (Figure 3.1), the triangulation of the quantitative data provided the starting point for inference of the entire inquiry.

Table 3.1: Experimental stage data collection and inference strategy by mixed method paradigm strand

Experiential stage			**Inferential stage**		
Data group	**Paradigm**	**Data collected**	**School level**	**Classroom level**	**Integrated levels**
Building context - Overview	QUAL	Drawings from government archives			Architectural interpretation
	QUAL	Public internet documents about school and school architecture			Architectural interpretation; Content analysis
Building context - detail	QUAL	Visual data via study-specific photos	Visual ethnography; grounded theory	Visual ethnography; grounded theory	Architectural interpretation
	QUAL	Architectural building properties via site notes			Architectural interpretation
	QUAL	Occupant activity via site notes		Grounded theory	
	QUAN	Environmental data via loggers		Descriptive statistics	
	QUAN	Environmental data via portable measuring equipment via site notes.		Descriptive statistics	
User perspectives	QUAN	Selected building perspectives using semantic scales via survey	Descriptive and inferential statistics	Descriptive and inferential statistics	Inferential statistics and factor analysis
	QUAL	Selected building perspectives using open questions	Grounded theory	Grounded theory	
	QUAL	Unsolicited building perspectives from incidental conversations		Interpretive	

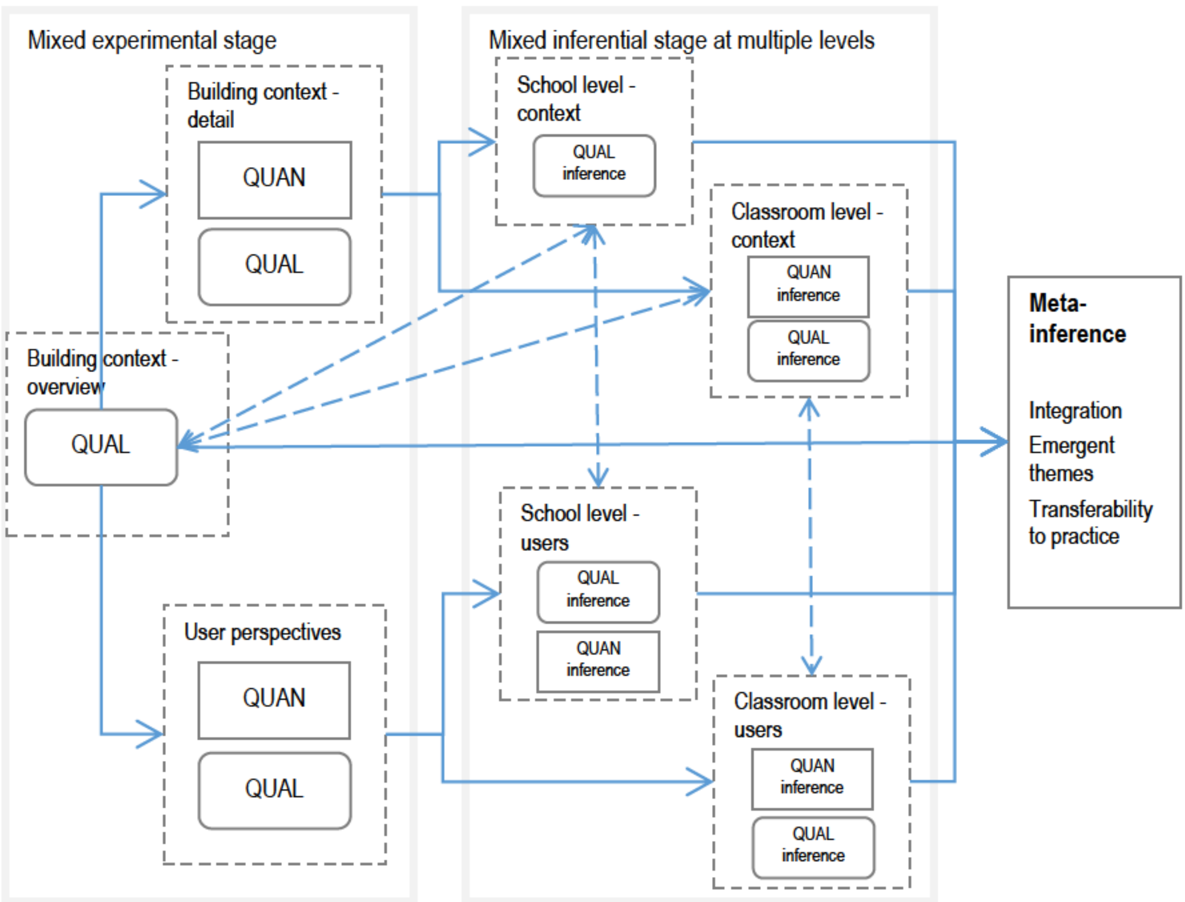


Figure 3.3: Mixed methods research map

A secondary interpretation of the open responses (i.e., use of the original non-quantised responses to the open questions) was then used to check for interpretive consistency, agreement, distinctiveness, and integrative efficacy of the findings as a whole. This was then evaluated against current literature (theoretical consistency) and the research questions posed (interpretive correspondence), in order to meet the proposed characteristics of good inferences in missed methods research (Teddlie & Tashakkori 2009, pp. 301-302). In case studies, this qualitative process involves some iteration in reviewing all date, and it has been suggested that researchers '"play"' with their data using matrices or arrays (Yin 2009, p. 129). This suggestion is taken up here and presented in section 7.1.1, with the outcomes discussed in the remainder of chapter 7.

The remainder of the chapter reflects on the impact of formal human research ethics on this inquiry, provides a summary of the case study schools, and discusses each data collection method used in the schools, together with its corresponding analysis methods.

3.3 Research ethics

The school built environment is home to both adults and children for a significant part of each weekday. Students are experts in their learning environments (Moos 1980, p. 240; Parnell et al. 2008), so to exclude students from commenting on their school is to miss the voices of the key stakeholder group for which these building exist. As with other studies (DfES 2006), this void would then need to be filled through 'experts' acting as agents for this vulnerable group, which may not provide a reliable report of users experiences, it also risks reducing justice in the research process (National Health and Medical Research Council et al. 2007, p. 56).

Prior to commencing the research precedents for including children in built environment research were found (Appendix C.1) and it was concluded that children were capable of being included in the research from the school year that students turn ten years old. In 2012, in South Australia, this corresponded to year 5, which was the first year of senior primary. Appropriate information sheets and test instruments were developed based on this age group (Appendix C.3) and ethics approvals sought and granted from the relevant committees (Appendix C.2).

After initial data collection it was observed that the delineation between school building and occupant was not as obvious as anticipated. It was noted that in classrooms the fabric of school buildings was modified by the occupants in both permanent and transient ways, for example, during the study, verandas were observed to be permanently extended and windows were found to be decorated with transient pedagogical displays. This fuzziness, or liminality, between the end of occupant fabric and start of building fabric raised further human ethical issues that needed to be encoded in the consent forms.

This ethical nuance was solved by drawing on the SOGI (society, organisation, group, individual stratification) sociology model (Wilson & Rosenfeld 1990, pp. 4-5). For the purpose of this pragmatic research, with the intention of respecting all participants in the context of architectural research, it was proposed that distinction be drawn between occupant fabric and the building fabric (see Figure 3.4).

Using photographic data collection, as an example, it was proposed that photographs of buildings and photographs of changes to the building fabric, that neither showed transient occupation by staff or students, should be considered as the responsibility of the group or organisation, i.e., that the decision making about the changes was not an individual responsibility and, as such, did not require individual participant consent. In practice, it required only the consent of the principal for outdoor visual data recording, and class teacher consent for interior photographic recording.

For building fabric additions by the transient occupation of the building by staff and students (the most vulnerable), such as display attached to windows, it was proposed that this exists through traceable and individual decision-making and, consequently, it does present a human ethics risk. However, it was asserted, and accepted, that this risk is low if correct protocol is followed (National Health and Medical Research Council et al. 2007; NHMRC et al. 2007) and that the mechanics of obtaining consent from all classroom occupants before any site notes or photographic recording was undertaken was prohibitive. The protocol used for visual data collection is discussed further in Section 3.5.4, but this approach is applicable to all data collection.

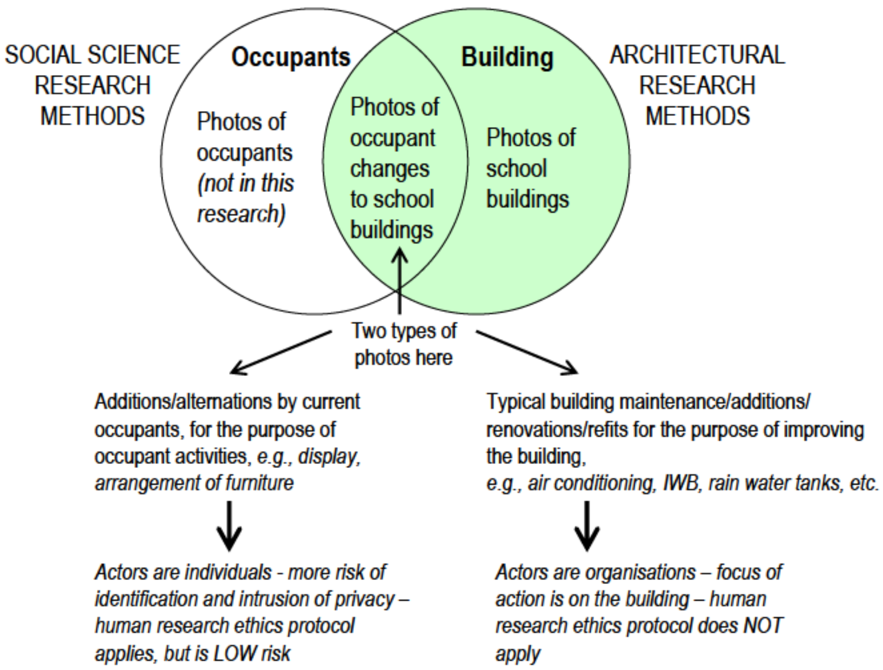


Figure 3.4: A visual interpretation of the ethical considerations when photographing school buildings

3.4 Case study school selection

Adelaide metropolitan primary schools were approached to be case study schools due to prior professional experience with Adelaide education authorities and to fit available resources.

The intention was to select case studies that were either 'extreme', 'maximum variation cases' or 'critical' (Flyvbjerg 2006, p. 230) to maximise the depth of learning (Section 3.2.2). Within the research catchment area, schools were approached if they had been recognised with an architectural award from either the Australian Institutes of Architecture (RAIA) or the Australasian branch of the Council for Education Facility Planners International (CEFPI), or Designshare.com, the latter two being awards for educational architectural facilities. These awards implied that the schools were ‘extreme’ in their quality of architecture. Schools were also approached if their facilities included buildings classified as State Heritage, i.e., as ‘maximum variation cases’ due to age, or if they made claims about their facilities such as being ‘a sustainable school’, i.e., as a ‘critical’ cases.

The main driver of the selection process was to obtain consent from architecturally recognised case study schools in time for the start of the 2012 school year. During September and October 2011 a targeted approach was used to ask schools to participate in the study, resulting in ‘purposive sampling’ approach (Teddlie & Tashakkori 2009, p. 173). This allowed the benefits of the research to be explained directly to decision makers within schools. The selection process is summarised in Table 3.2.

Table 3.2: Case study school selection process

Selection phase	Phase description	Number of schools
List of possible schools to approach	This included any school that either made claims about its sustainability or was architecturally recognised (acknowledged by award or heritage listing) or interesting for other self-claims (pedagogy) or may be available via professional networks of candidate and supervisor	Over 25
Schools considered further	This list developed from further investigation of the school sites (e.g., the proportion of classrooms in transportables) and design of study (e.g., limitations due to lack of funding for personal use of car and lack of funding for purchase of additional measurement equipment)	14
Schools approached	Schools approached via phone and email/post	11
Responded with No	Schools that rejected the approach via phone or email	2
No response	Schools that did not respond to initial or follow up communication (phone, email, post)	3
Responded with yes	Schools that agreed to participate	5 as case studies (1 declined survey participation)
Total number of buildings under inquiry		15 buildings
Total number of learning spaces under inquiry	classrooms and resources/library	22 learning spaces

It was found that approaching a school during term 4 of the school year did not seem to be an ideal time to invite schools to participate in an on-site project, and this is reported here for future reference. The staff contacted gave the feedback that schools were very busy, and principals are extraordinarily busy. Schools also have a large number of tertiary students approaching them for work experience placements (education students) and other social science research projects. Despite these challenges, five schools did initially agree to participate.

The final case study school participants were all Reception to Year 7 (R-7) schools and are a mixture of South Australian Department of Education and Child Development (DECD) and Catholic Education Office (CEO) schools. The ethics protocols used did not allow for schools to be publically identified, or for comparison between the two different education authorities. This inquiry uses pseudonyms that refer to aspects of the colouring of the either interior or exterior of school buildings. The five case study schools that agreed to participate in the research are summarised in Table 4.1.

The classrooms to be observed in detail were selected by combining the needs of the research and the school and negotiated with principals. Initially, in an attempt to keep some consistency between schools classrooms on a north east corner and north elevation were requested to test extremes of heat perception and anticipated lighting conflict with technology, both associated with morning sunlight[22]. These were cross-matched with the rooms that housed years 5/6/7 years so that both physical and qualitative data obtained from surveys could be triangulated. Junior primary classroom was also identified for inclusion, but with observational data only and without surveys. A summary of the final classroom sampling is given in Section 4.2.2.

Each principal was consulted to identify which teachers would be open to the research. In some cases, the school suggested alternative rooms for participation and these were accepted without further negotiation for two reasons. First, since the schools are operating schools and they agreed to participate with minimal return to them, it was felt that concessions should be accepted in the context of real world research. Second, it was anticipated that classrooms and schools that were willing volunteers would provide richer data than demanding participant classrooms on, say the northeast corner of the school.

3.5 Research Methods

This section weaves together the multiple methods of data collection and multiple analysis methods used their benefits and their contribution to the research. It commences with the data used to provide contextual knowledge of the case study architecture, i.e., the building data, public documents, site visit notes and visual data. It then outlines the environmental data collection

[22] This decision was informed by anecdotal evidence witnessed during professional practice.

methods and ends with the occupant surveys used to collect user perspectives.

3.5.1 Building data

The objective was to be able to describe the building with architectural authority and identify the original building and consequent modifications, within the constraints of this project.

Architecture is a profession and part of a 'knowledge industry' (Schön 1983, p. 8). Other professional services rely on on professional knowledge, which has been politically and socially created and dispersed within firms (Robertson et al. 2003), using professional associations (Swan & Newell 1995), or learning within specific projects (Bresnen et al. 2003; Scarbrough et al. 2004). Knowledge can be codified for retention and, in the practice of architecture, this includes visual artefacts (Whyte & Ewenstein 2007; Whyte et al. 2008; Whyte et al. 2007) and digital representations (Jaradat et al. 2013). Normative references are also found for codified construction knowledge (Ching & Adams 2001) (Wilkie & Arden 2001), architectural detail knowledge (Davies & Jokiniemi 2008), site planning (Thomas 2002) and landscape construction detail (Thomas & Ryan 1999).

Referring to the practice knowledge from the peak architectural professional association in Australia, this analysis did not perform professional 'Feasibility Study', 'Record Documents' services (Australian Institute of Architects 2010) or prepared a 'dilapidation report' (Australian Institute of Architects 2011b) or provided any heritage services (Australian Institute of Architects 2011a). However, this inquiry was informed by the processes and knowledge involved in providing these services, together with the professional knowledge obtained through the knowledge dispersal process described above, and codified normative knowledge where available.

Where possible architectural drawings were sourced from the education authorities or schools themselves. These were compared to the current building formation, via visual inspection during site visits (see Section 3.5.4) and photographs (see Section 3.5.4) in order to interpret relevant changes. Spot area measurements were made to check the accuracy of available drawings, but a full professional 'detailed existing building measurement' (Australian Institute of Architects 2010, p. 5) was beyond the scope of this research.

It has been proposed that designers, to a certain degree, use ethnographic methods in the design process through their incorporation of human-centred research in the design process (Bichard & Gheerawo 2011) and research (Cohen & van Ryzin 1979, p. 406), to a certain extent, ethnography did influence the interpretation of building data. However, to provide a context for the interpretation of the user perspectives, the building fabric analysis process is better described as using architectural logical argumentation and cross-categorisation and elaboration (Groat & Wang

2002, p. 332). The architectural data and photos sourced were used to develop a forensic building construction history. Specifically, post-occupancy building modifications were identified where they could potentially change occupant experience, such as a change in floorplan layout or a retrofit of electrical equipment. It was also used, in conjunction with site notes and photographs, to compare the building to current and historical building regulations.

This development of the built environment context, together with other public and visual sources, exploits the strength of mixed methods research. Its contribution to the multi-strand design is appropriate to the objectives of this inquiry (design quality), and provides opportunity to compare inferences about user perspectives with cohort specific built environment contextual data, thus providing opportunity to improve interpretive consistency (interpretive rigor) within the meta-inference integration of data (Teddlie & Tashakkori 2009, p. 301).

3.5.2 Public documents

In parallel to architectural documents used for architectural building data, other written and published records are also useful as unobtrusive research methods in social science research (Liamputtong & Ezzy 2005, p. 106). This inquiry used publically available documents sourced from the World Wide Web to contribute to the development of case study contexts. In particular, documents were sourced from the relevant education authorities, the case study schools, architecture descriptions from professional sources, and other commentary about the case study built environments. These public documents were sourced in two stages.

The first stage occurred during the initial contextual development and case study selection, and formed a sequential QUAL stage which both preceded and contributed to the main mixed methods research stage. Schools were approached based on their architectural point of difference (Section 3.4). This was largely determined through examining public documents such as the Australian Institute of Architects Awards Gallery (Australian Institute of Architects 2013), the South Australian Heritage Places Database (Department of Planning 2013) and school websites.

Once schools had been recruited, during the main experimental stage further public documents about the case study schools' built environment were sourced. These were divided into four categories. First, documents relating to the educational facility standards and pedagogical were sourced from the relevant educational authorities. The facility standards were used to contribute to the interpretation of the observed built environment, whereas the pedagogical documents were used to provide a context for user perspectives and were interrogated for the assumed role of the built environment.

Second, documents authored and distributed by the case study schools were collected. These included documents such as school 'context statements' and newsletters. There were used to provide context about the operations of the schools, including pedagogy, and were interrogated for examples of mention or use of the school built environment.

Third, architecturally authored documents about the case study schools were sourced from architect websites or from other websites that wrote specifically about school architecture and facilities, and included competition submissions and jury citations. These were collected to provide contextual evidence of assumptions by architects about their interpretation of the relevant case study school operation and built environment.

Finally, the World Wide Web was searched for other mentions of the built environment or architecture of the case study schools to provide additional context for interpreting the school architecture.

The school documents were used to logically construct, in conjunction with building data and photos, a recent development and renovation history, and, through content analysis, expectations of the built environment. Additionally, the data was used to interpret the school pedagogy as intended to be communicated to a public audience without specialist training in education. Both of these data collections were used to provide context for user perspectives and contribute to good interpretive consistency from multiple inference sources (Teddlie & Tashakkori 2009, p. 301).

3.5.3 Site visit notes

Notes were taken at each site visit using the pro forma in Appendix E. The scope of these notes was restricted to inquiry-specific data, and omitted what might be considered the fine detail of architectural practice site visit notes. The pro forma also acted as an aide memoire to limit the human generated data to that approved by the ethics committees.

The notes collected quantitative and qualitative data for the building context detail for both QUAN and QUAL paradigms. The outline of the analysis methods by site visit data are shown in Table 3.3, and discussed below, except for the quantitative environmental spot measurements, which are discussed in 3.5.6.

Building fabric data, including permanent and temporary additions to the fabric were recorded to identify obvious changes and their effects. The activity present and state of the classroom services and windows, together with the activity, were recorded for comparison to the environmental logging data.

Notes were made on the classroom as it was being used, or as it was left after last occupant activity, i.e., as a 'setting' for human activity and culture (Liamputtong & Ezzy 2005, p. 105). Thus, the state of services, windows, and temporary additions to the building fabric, such as student work display, had a dual role and were recorded as unobtrusive observations of use. Furniture and ICT configuration were also recorded as indicators of use. All of these provided context for interpreting the user survey.

Grounded theory was used to collect extra data where unexpected but relevant details were observed, and where it was judged ethically sound. Examples of this additional data was noting as aircraft noise heard and windows used for display. The latter observation was originally not identified as a possibility, but on early visits, the extent of window display was observed and it was felt that this should be noted as part of the dialogue between natural light and energy saving. This is an example of sequential mixed methods process in which early qualitative data prompted further investigation.

Table 3.3: Site visit notes and analysis methods

Data	Description	Inferential method	Triangulation
Identifying	Location, date, time		
Building data	Room dimensions, construction, dilapidation	Professional architectural judgement	With other building data. See 3.5.1, 3.5.2, 3.5.4.
Permanent additions to the building fabric	Any obvious permanent changes to the original building fabric.	Professional architectural judgement against constructions drawings were available	With other building data. See 3.5.1, 3.5.2, 3.5.4.
Temporary additions to the building fabric	Temporary additions to the building fabric, in particular pedagogical display	Ethnographic interpretation	With other building data. See 3.5.1, 3.5.2, 3.5.4. perceptions of school. See 3.5.7
Activity	Presence or absence of staff and students that may affect environmental conditions	Qualitative quantisation	environmental data analysis. See 3.5.5
Spot environmental measurements	Location and type of spot measurements on classroom sketches	Descriptive statistics. See 3.5.6 for spot measurements	environmental data analysis.
Logging equipment issues	Notes about problems with accidental relocation and dysfunction	Descriptive statistics	environmental data analysis. See 3.5.5
State of classroom services	Location, type and current operative state of HVAC and artificial lights	Descriptive statistics Ethnographic interpretation	environmental data analysis. See 3.5.5 perceptions of classroom environment. See 3.5.7
State of classroom windows	Use of operable windows, blinds or curtains, where present, for the purpose of ventilation or daylight control	Descriptive statistics Ethnographic interpretation	environmental data analysis. See 3.5.5 perceptions of classroom environment. See 3.5.7
Furniture	Positions of selected loose furniture and changes to classroom set up.	Qualitative quantisation, grounded theory	perceptions of school. See 3.5.7
ICT	Presence or absence and type	Ethnographic interpretation	perceptions of school. See 3.5.7
Incidental conversations with students or staff	Conversations were information is offered unsolicited and is within the research scope	Ethnographic interpretation	perceptions of school. See 3.5.7
Other observations	Any other observations	Grounded theory	perceptions of school. See 3.5.7

Thus, in addition to recording the quantitative environmental spot measurements, the qualitative site notes acted as a source of triangulation for the building data (Section 3.5.1) and public documents (Section 3.5.2) together with a record selected aspects of occupation which could be interpreted in conjunction with the visual data (Section 3.5.4). All of these strands provided context for interpretation of the survey data (Section 3.5.7) and, created credibility in the qualitative inferences (Teddlie & Tashakkori 2009, pp. 295-296), and contributed to the interpretive consistency in the later meta-inference (Teddlie & Tashakkori 2009, pp. 301-303).

3.5.4 Visual data

This section outlines the collection and interpretation of the photographs taken specifically for this study. In professional architectural practice photography is a common tool for recording site and building configurations for use during the design process away from the site in question (Downton 2003, p. 20; Lawson 2004, p. 96; Sanoff 1977, p. 41; 1991), and also for post-occupancy evaluation (Preiser et al. 1998, p. 80). This visual remote access makes it an obvious candidate for architecture research, particularly where access to the site is limited by ongoing operations and occupation.

Translating this to the scholarly sphere, discussions about visual research methods in architecture tends to focus on the building itself (Groat & Wang 2002) whereas social science research methods literature proposes a range of ethnographic and cultural interpretation methods focusing on the presence of people in the photographs (van Leeuwen & Jewitt 2001). To a social science researcher visual research methods are 'not a soft option' (Robson 2002, p. 372) and may be rejected due to perceived anthropological data ‘overload’ (Collier & Collier 1986, p. 13). Furthermore, there is vigorous paradigmatic discussion underway about visual epistemology and interpretation processes (Wall et al. 2012). Regardless, the use of photography as visual tool is familiar to architectural researchers, and it is hypothesised here that the scope of interested is restructured to specific subjects, such as the building fabric, so that researchers are not ‘overloaded’ with data. Thus, it is argued here that it is a an appropriate for the research design (Teddlie & Tashakkori 2009, p. 301) and since visual/photographic data is typically used in conjunction with other data collection methods (Pink 2003), there is a natural complementary or triangulation role within this mixed method research (Robson 2002, p. 27).

In this study visual data was predominantly collected through study-specific photography, i.e., the photography is contemporary to the time of study and taken by a single photographer with a single camera. This building class presents a number of ethical problems (Section 3.3), however ease of photographic recording as an unobtrusive method (Liamputtong & Ezzy 2005, p. 111), used in the context of time-restricted observation, offered more benefits than challenges, but only if the challenges are addressed explicitly. These challenges are located around the technical and cultural decisions made by photographer, and the dialogue about the perceived loss of context and bias of visual data (Collier 2001, p. 35) as opposed to mechanical recording without filtering of what is included in the camera's frame (Collier & Collier 1986, p. 9).

Principles for photographic data collection were developed for this study where the subject was clearly identified (buildings not people), the process was clarified (ethics and researcher behaviour on site), and the need for critical reflexivity was stated. These are detailed in Appendix F. The next three sections discuss the limitations of photographic data, together with the data collection and analysis processes used to mitigate the inherent subjectivity.

3.5.4.1 **Limitations to photographic data collection in this project**

The photographic data collection had limitations imposed due to equipment and access to spaces. The camera used was a 2007 Fujifilm FinePix-31fd with inbuilt lens 8-24mm, f-stop 1:2.8 – 5, and 6MB image size. The smaller Fujifilm camera was selected for use over an available digital single lens reflex camera because the Fujifilm camera was unobtrusive and easily operated in one hand, as opposed to the larger DSLR body that, as found in previous use[23], draws attention to itself.

The limitation to the Fujifilm camera is that it is difficult to quickly adjust for non-uniformly lit scenes, such as an interior with strong daylight from a window, so some post processing (Photoshop or similar) was used to improve scene clarity during analysis. Since the objective was to record absence or presence of building fabric items, not to capture scenes with high aesthetically quality this small camera was considered acceptable for this purpose.

The time and space available during the ongoing operation of the school also acted as a limiter to photographic quality. It was useful to record the setup of a classroom at the time of teaching. However, photos could not be taken during class time, so it is useful to take a photo just after the classroom had been vacated. Classes moved around often, so any opportunity to photograph a room was taken, if only as a partial record to complement notes.

Finally, there some limitations set by individual teachers. Although a principal may have agreed to the project, given the teachers are also stakeholders, any photography was checked with the teachers before proceeding. Teachers were very generous and allowed photographs to be taken, with the only omission being keeping them out of the frame if they were working at their desks in an otherwise empty room.

3.5.4.2 **Process for photographic data collection**

Photographic data was collected on a number of visits over the 2012 school year (see Table 3.4 frequency breakdown). On each visit, individual classrooms had different access availability due to the presence or absence of students and the nature of the lesson in process. While it may not be possible to document entire rooms on each visit, over the year each room were documented where opportunity allowed.

[23] Personal experience has shown that the available Canon DSLR 40D camera really does draws attention to itself, as demonstrated by an incident in 2009 outside Peckham Library, London, where locals offered to pose for the 'professional photographer' and security staff had to break up the gathering.

Table 3.4: Number of photographs taken by school

School	Photographs taken
Purple	424
Orange	648
Red	590
White	723
Yellow	369
TOTAL	*2754*

The photographic data collection process used is based on a visual inspection / dilapidation inspection process used in professional practice (Australian Institute of Architects 2011b), and is supplemented by analogous visual ethnography practices (Collier & Collier 1986) as follows:

Prepare for the visit. Review aerial photos, available construction drawings and photos available on the internet. The purpose of this is to become familiar with the extent and character of the school and identify architectural items of interest or obvious modifications to the school

External photos. Take long views to show elevations, corner junctions, roof visible from ground and immediately adjacent landscape treatment. Take detail views of original building elements, renovations, retrofits, obvious dilapidation, and current occupant additions. Typical systemic architectural assessment of a building exterior includes roof, chimneys, storm water, walls, doors, windows, timberwork, metalwork, paving, services, and painting.

Internal photos. Take general panoramic views of classroom walls, ceilings and furniture layout (note ceiling and floor materials do not appear clearly in photos and must also be noted) by working progressive around each corner and wall centre (Figure 3.5). Due to the geometry of the classrooms, the variable furniture layout, limited time available and the camera limitations, each classroom tends to need a different photographic documentation strategy. Detail photos of windows, fresh air vents, display and other unique items of interest are also taken.

Photo filing. All photos were filed within a case study file according to the date they were taken.

To ensure that contextual information was preserved, in addition to the photo EXIF information each photo was documented with location, view direction, view description, and ethics issues information. A specialist standalone (as compared with the integrated EXIF database) photo context database was created in MS Office Access to store pertinent contextual information to this project. The database was expandable and flexible, i.e., new fields of data could be added as required and included forms for specific data entry.

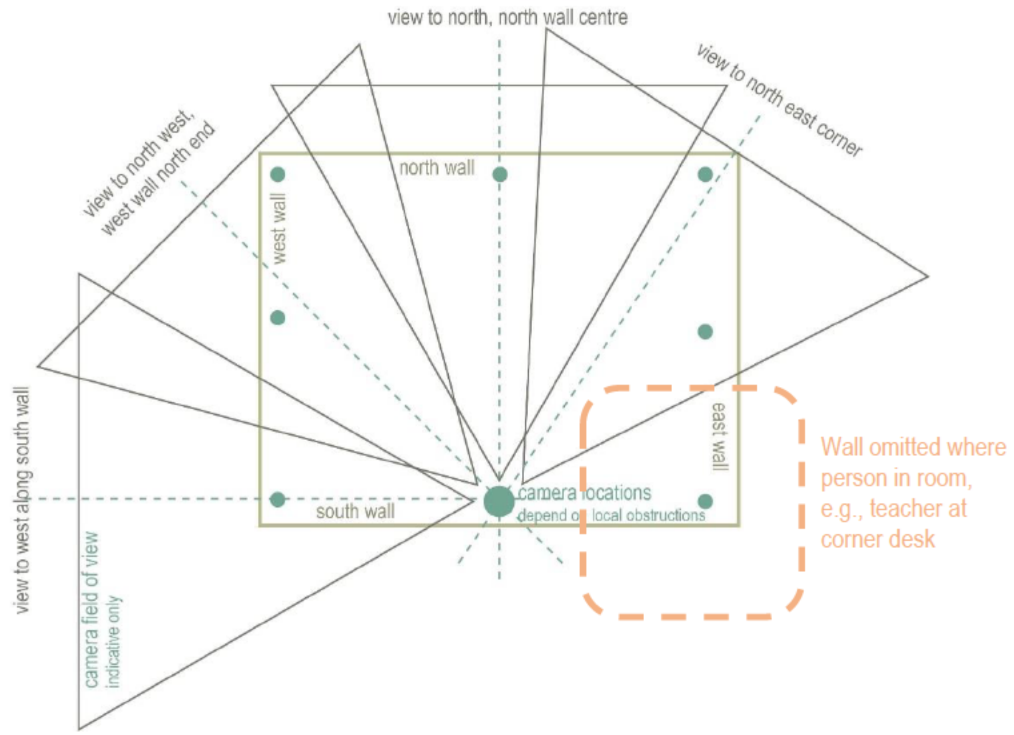
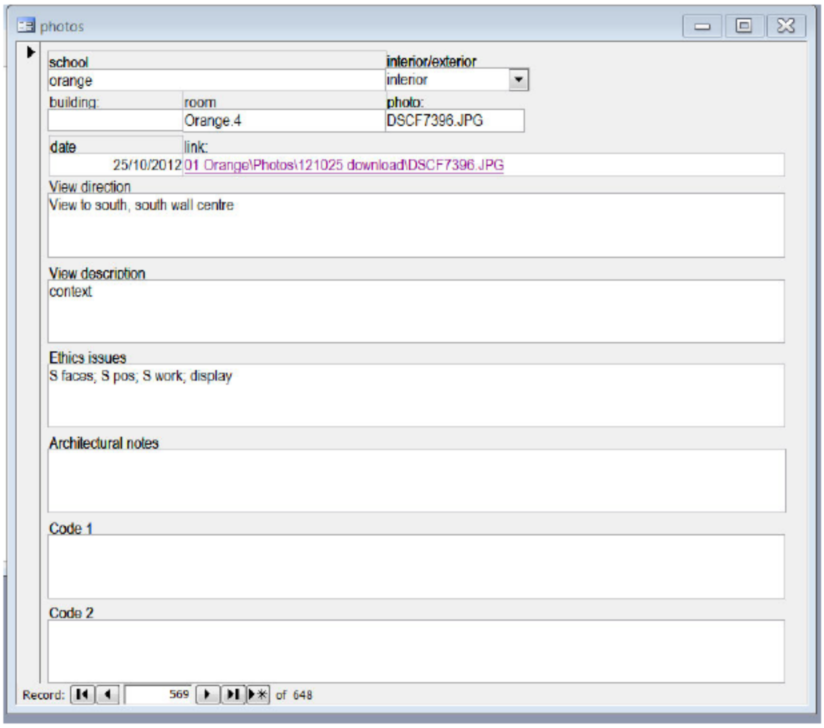


Figure 3.5: Camera location and view description strategy

As an example, Figure 3.6 shows an example of a partially complete photo information form showing contextual information, but with coding information to come. Photo identification data was recorded in the first three rows of the database data entry form. The school, room, interior/exterior location and date of each photo was recorded. If obvious, specific photo subjects, such as unusual window display.


photos

school: orange
interior/exterior: interior
building:
room: Orange.4
photo: DSCF7396.JPG
date: 25/10/2012
link: 01 Orange\Photos\121025 download\DSCF7396.JPG
View direction: View to south, south wall centre
View description: context
Ethics issues: S faces; S pos; S work; display
Architectural notes:
Code 1:
Code 2:
Record: 569 of 648

Figure 3.6: Photo context database form showing partial entry of data

The *view direction*, recorded the approximate compass direction of the camera together with the wall or corner at the centre of the photo. The *view description* typically recorded the main intention of the photo, e.g. a context photo or a detail photo of, say, a vent, but also may also include notes about specific items in a context photo, such as a slider door in a wall.

The *ethics issues* field noted all image subjects that could be considered sensitive. Three forms of sensitivity were assumed:

- Identification - people, written names, photographed faces in photographs
- Privacy - possessions and personal items
- Copyright and moral rights - reproduction of work, e.g., student work on display or learning material on display.

While it was never the intention to publish photos other than exemplar photos that visually, demonstrate a research finding, these were recorded as a quality assurance process for obscuring sensitive photo areas.

The *architectural notes* field was used to make notes from the perspective of an architect, such as comments about an interesting construction detail, with the intention of reviewing them later for relevance for this research project.

The *code 1* and *code 2* fields were intended to be used for grounded theory research method with post-coding, however because the emergent codes for this inquiry, from the perspective of this discipline, were relatively simple, they were incorporated in the site visit database. Undoubtedly, a different discipline, such as an education researcher would have found a far more complex code system in the photograph data set.

3.5.4.3 **Analysis of photographic data**

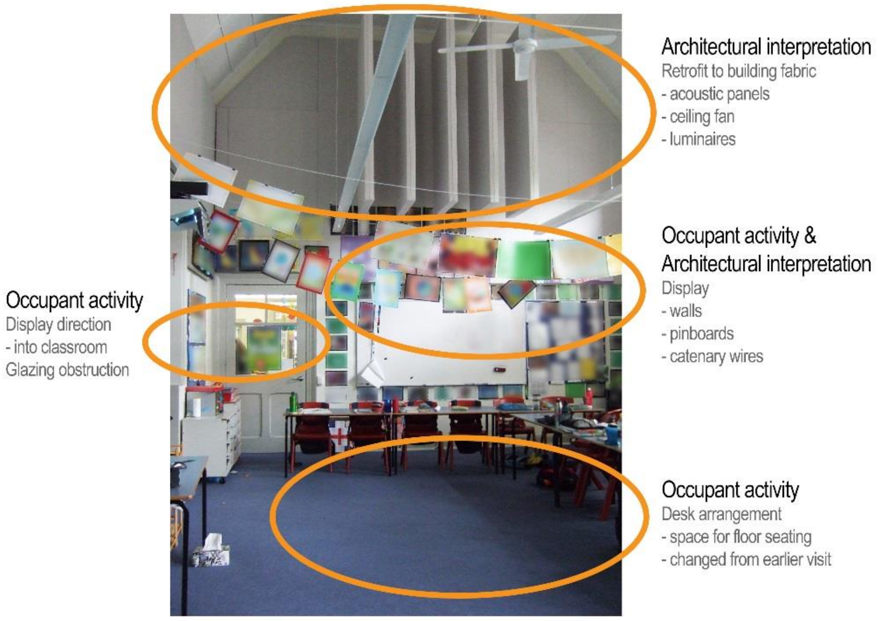
As outlined in Table 3.1, the photographic data was analysed for different purposes. This is demonstrated in Photograph 3.1.

First, an overall inspection undertaken in conjunction with a review of the site visit notes to 'observe the data as a whole' and 'trust feelings and impressions' (Collier & Collier 1986, p. 178). This stage checked congruency between notes and photos and corrected obvious errors, but started to identify potential codes and ethics issues.

The photography was used to compare the current state of the building fabric to construction drawings and other publically available documents where available, using architectural interpretation. This was applied to schools as a whole unit of analysis and, in conjunction with site visit notes (Section 3.5.3), was significant in identifying permanent modifications to the building fabric (Section 4.4).

Next, at both school and classroom levels, the photographs were used as unobtrusive ethnographic data collection to observe user interaction with the building fabric and to provide visual context for interpretation of survey data.

Finally, the photographs were used to confirm and expand the coded and quantised site visit notes, as analogous to content analysis. Thus, the photographs acted as qualitative ethnographic data that, together with the site visit notes, created credibility in the qualitative inferences (Teddlie & Tashakkori 2009, pp. 295-296), and contributed to the interpretive consistency in the later meta-inference (Teddlie & Tashakkori 2009, pp. 301-303).



Photograph 3.1: Interpretation of photographic data and coding (DSCF7055_121018mod)

3.5.5 Environmental monitoring data

Environment data was collected using two methods. Environmental data loggers were installed for the duration of the school year and used to monitor the temperature, relative humidity and light illuminance environment, depending on the capability of the logger. Hand-held instruments were used to collect temperature, relative humidity, surface temperature, light, and noise, during site visits. This remainder of this section discusses the environmental logger preparation and installation, data collection and cleaning, and analysis methods used in this inquiry.

3.5.5.1 Preparation, installation and data collection

The battery powered environmental data loggers used captured temperature, relative humidity and light environmental data, depending on the model of the logger available. Examples of these are shown in Photograph 3.2.

Photograph 3.2: Examples of environmental loggers: outdoor (top left), indoor (bottom)

Prior to installation, all loggers were operated in a controlled environment to check for stability and accuracy, within specification limits (Appendix H.1).

All loggers were set to log at half hour intervals on the hour and half hour. This timing was selected based on the logger on-board memory capacity and the feasibility of the planned download schedule. With a half hour sample interval the maximum logging period for an older style logger collecting temperature, relative humidity, and light data was 53 days, requiring a visit approximately every six weeks for data recover. This was deemed optimal since a smaller sample time would mean increased visits for download, increased intrusion into schools and increased travel costs beyond the feasibility of this project, and a larger sample time would not capture variation in the environmental conditions during the relatively short school day.

The intention of environmental loggers was to capture data that reflected the environment experienced by occupants, so the ideal location for loggers would be at head level centrally located amongst the occupants. In the school situation, it was felt that this would be difficult to achieve for four reasons. First the only centrally horizontal surfaces in a class room were student desks and these vary from 560mm to 720mm depending on the age, i.e., lower than student head or torso. Second, it was known from professional experience that teachers tend to move desks around during the year and, if this professional knowledge could be generalised to other schools, there was a risk that loggers would be moved if placed on student tables. The third concern was that loggers placed centrally on student desks would be at risk of accidental damage from student activity, such as drink bottle spills, or be accidently knocked to the floor or covered by papers. Finally, there was an equity concern that it was unfair to students to take up their already small desk space with a measuring device.

It is also noted that the most valid temperature measurement technique is either the 'environmental temperature' or 'dry resultant temperature' depending on the season. However, both of these required a black globe thermometer measurement in addition to a dry bulb thermometer measurement (Greenland 1998, pp. 3/28-29; Szokolay 2008, p. 18). During the research design phase of the project there were concerns about location and safety of the equipment, as described above, and it was also considered a risk to recruitment to insist of overhead installation of a black globe configuration. It was assessed that given the intention of this research was to be pragmatic in obtaining data in real life situations, any minor loss of accuracy would be offset by contribution to the whole picture approach of this research.

Given the above, there were two alternative locations considered. The first was loggers installed horizontally on fixed shelving around the edge of the classroom. Again, drawing on professional experience, it was known that storage and display space for pedagogical materials was always at a premium so co-opting shelving for installation of a small, lightweight logger had risks such as inadvertent logger removal, in addition to not adhering to the principle of not intruding on school operation.

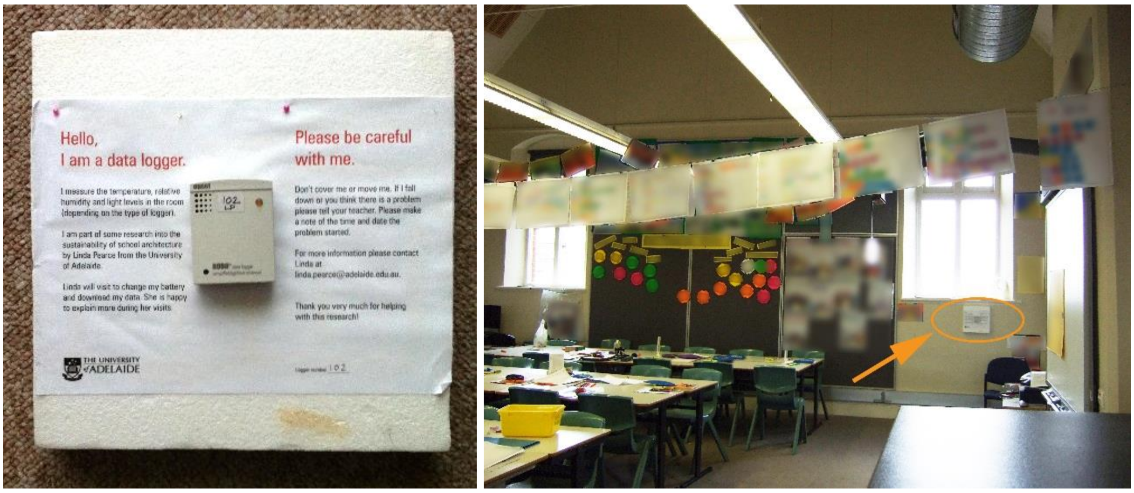
The second alternative was riskier for the research but felt to be less obtrusive to the class operation. It was decided to install the loggers vertically on walls to keep the loggers away from active teaching and learning zones. The height of the loggers was considered with the input of staff. One option was to install the loggers out of (compliant) student reach, i.e. over 1800mm AFL (c.f. Gao et al. 2014; Milan & Pattison 1979). Alternatively, positioning the loggers at a student level (1100mm AFL) was considered more appropriate to capture student experience, if a little low for staff.

Given that some of the walls were high thermal mass[24], loggers were installed on 300x300mm^2 R=2 foam backings to reduce localised radiation influences. In addition to this physical design, the foam backs allowed a logger 'zone' to be created, which was reinforced by an information sheet explaining the research and the role of the logger (see Photograph 3.3). Originally this foam backing was only intended to be used on mass walls, but feedback from the teachers suggested it created both an official 'look but don't touch' feeling and prompted questions.[25] Ultimately, the benefit of a lower installation level proved to be appropriate with no loggers being stolen or vandalised, apart from two that were installed in locations without good passive monitoring.

[24] Materials such as solid stone or rammed earth take a relatively long time to heat up and cool down when used in building construction. In the context of building construction the use of these materials are known as 'massive construction'. The delayed heating and cooling effect is known as 'capacitive insulation' where different construction materials add a time lag to thermal environmental conditions in a room (Szokolay 2008, pp. 47-62). Due to the heating / cooling time lag, the wall surface temperature may differ from the ambient air temperature, thus insulated mounts were used to reduce the influence of the mass wall on the environmental logger.

[25] Since students were aware of the loggers through this explicit visual presentation and, as they saw me do regular maintenance, I became known and welcomed as the 'logger lady', i.e., a safe adult. Students asked many questions so maintenance visits had some delightful moments. I note this here to encourage future researchers about the unexpected rewards of school research.

Where possible each installation was negotiated with the teacher to avoid infringing on pedagogical display and workspace (Photograph 3.4). Referring to Appendix H.2 for all locations, this meant that loggers in rooms with similar architecture were not placed in the same locations, yet it was considered that the relatively small sizes of the rooms and the need to maintain occupant engagement for a school year outweighed the potential error in, say, placing all loggers on a south wall.



Photograph 3.3: Logger backing detail and installation example – left, detail (at end of the year); right, in-situ Yellow.3 on south wall, logger 102 (DSCF6353_120731mod.jpg).

Photograph 3.4: Locating loggers within pedagogical display – left, Red.5 in January before start of school year (DSCF5734_120124mod.JPG); right, Red.5 in August (DSCF6408_120802mod.jpg).

Once installed, further opportunities and limitations of environmental logger data emerged. The foam backings for the loggers were found to be both useful and intrusive. Initially, the foam and the notice gave the impression of the loggers being a special piece of equipment and were treated with respect to the point of teaching staff (very kindly) replacing loggers if they fell down due to initial fixing problems, using a range of pins, tape and adhesive putty to return fallen loggers to the foam backing. Staff also emailed the researcher with logger updates and wrote notes on the foam backing with times and dates when they noticed the loggers had fallen. This care for the research project was put down to the general 'goodness' and caring of the staff and the initial effort in developing a relationship with each teacher through negotiation and communication about the loggers. Students also treated the loggers well. There was some evidence of graffiti and wear and tear on the form backing, but students seem to ‘own’ their loggers.

During the school year there were hints that the loggers were intruding on display space with the observation of one being covered by display, and others delivering suspicious light levels during some days. The data of all known dates of logger problems was checked and removed if there was any doubt about validity.

Two loggers were lost, one indoor and one outdoor. The indoor logger was inadvertently installed over a rubbish bin[26] location (bin not in place at time of installation) in a library space away from the passive surveillance of the teacher librarian's desk. It was thought that the logger fell into the bin, which was then emptied during normal school cleaning. The outdoor logger was installed at a place that accessible to students outside of an unused classroom. In hindsight, both cases deviated from the aim to create 'ownership' of loggers at a local level as a way of mitigating risk of loss, i.e., the losses were probably more due to poor initial location choices rather than occupant delinquency. The corollary of this is that 45 loggers survived a school year in place, which is considered a remarkable proof of concept for future real life research protocols.

In addition to the compromised data due to logger displacement or covering, other circumstances prevented data collection every 53 days, as originally planned, so there are a number of data gaps, particularly between May - July 2012. Additionally one logger was restarted 12 hours later than intended after a collection and another was not restarted, both due to operator error.[27] While disappointing for completeness, the hottest and coldest parts of the year and the spring transition all have some data, so, given the mixed methodology, the available data is acceptable.

3.5.5.2 **Data cleaning and analysis**

Not all data was considered to represent the environmental conditions present, due to non-optimal logger installation, e.g., in direct sunlight at some point in the school year, or accidental logger relocation. Given this, all logger data was 'cleaned' to identify non-typical data and treat this accordingly. This was done in a number of stages, as described below, with the final logging

[26] Trash can

[27] Both of these mishaps occurred during term 3. Around this time, students had become familiar with my research visits, and me, and had more confidence to ask questions about architecture and research. While this provided an ethical beneficence back to participants, I was actually distracted by inquisitive school occupants, i.e., I was a victim of my own success of making the project friendly and accessible to school children and staff.

periods found in Appendix H.3.

First, the quality of data was defined according to Table 3.5. If the logger was known to have been relocated away from the space under study the data was deemed compromised and removed. If the logger had fallen down the data was visually inspected for deviation from typical conditions. Generally, temperature and relative humidity data were found to be unaffected, but light was often diminished, so rejected as compromised.

Second, school-hours data was extracted for initial investigation. Each school has slightly varied start and finish times, but with loggers set to log on the half hour, the hours deemed to be relevant were 8.30 am and 3.00 pm. Two points should be noted here. This research does not assume that occupancy is restricted to these hours. On the contrary, obvious occupation was noted after hours and the weekend, but for the purposes of student survey comparison, these "core" school hours were initially investigated. The second point to note is that lesson break times were not extracted from the "core hours" because of the variability of break times between schools and the variability of occupation during both lesson and break times. For example, it was observed that during lesson time classrooms may be empty while students visit the library or the gym and during break times the classes may be occupied due to extreme weather (heavy rain or temperatures over 36°C). Furthermore, during both lesson times and break times, teachers were observed to work alone in classroom without students. Thus, it was decided that a binary occupancy was indeterminate and that all data during the nominated school hours should be considered.

Table 3.5: Data quality definitions

Data classification and treatment	Source of data issue	Data affected	How identified	Action
Compromised	Unintended relocation (moved by occupants, fell off wall)	Temperature Relative humidity Light	Reference to emails/conversations about logger falling down. Check unexpected temperature peaks or lows against outdoor temperature to rule out free running room. If found, check for inconsistent light measurements	Remove data before analysis
	Logger in direct sunlight	Temperature Relative Humidity Light	Visual inspection of data time series. Check sudden temperature peaks and relative humidity falls against outdoor temperature and RH to rule out free running room with bright sunlight.	
	Logger covered by display	Light	As above.	
Outliers	Unknown	Temperature	Visual inspection of time series and box plots Direct sunlight on logger ruled out.	Create datasets with and without outliers
	High light levels in morning or evening	Light	Visual inspection of time series and box plots Direct sunlight on logger ruled out. Logical interpretation based on room architecture, placement, sunlight modelling in Revit, time of day.	
Valid data				All remaining data

Third, a visual check of the time series data was made month by month of the core hours and after hours data sets. During this check any visually unusual data, such as where the time series obviously varied from other co-located loggers or outdoor BOM data. Any unusual data found were the result of logger location and the compromise between ideal logger location, room architecture, room layout, operational and pedagogical needs. For example, loggers in rooms with east and west facing windows were occasionally subject to direct sunlight through the windows that resulted in occasional light peaks. If there were no corresponding rise in temperature or drop in relative humidity these light peaks were classed as "outliers", i.e., they were considered valid, but unusual data and retained as possible indicator of glare.

To determine whether a temperature peak was due to direct sunlight or to ambient conditions, e.g., the cooling off on a hot day, peaks were identified visually in a graph and by comparing data points to the previous. If a sudden temperature rise (greater than 2.5°C) was noted it was then compared to the outdoor temperature and any other adjacent logger. If the outdoor temperature was similar to the peak then it was considered a valid data point. If the outdoor temperature was significantly lower than the peak then the data point was considered to be compromised and removed.

The loggers used were limited to measuring relative humidity above 25%. Thus, when there was extremely low humidity on hot dry days, the loggers did not return the accurate results. This occurred less than five days during the core hours so the data was not removed. The final datasets are listed in Appendix H.3.2. The data set used most in this inquiry is designated DS-C-OL-A, which indicates that it is a core hours only data set, with all valid data collected included, including uncompromised outliers.

Outdoor temperature data was collected at all sites. The loggers were installed in locations that provided as much security as possible, but this led to installations that were not physically comparable. This, in turn led to lack of confidence in the collected data. In lieu of this outdoor environmental data from adjacent weather stations was purchased from the Australian Bureau of Meteorology.

The final datasets were considered from a post-positivist paradigm, i.e., they represented the environmental reality with appropriate validity (Groat & Wang 2002, pp. 32-33), and subjected to quantitative data analysis and inference processes (Teddlie & Tashakkori 2009, p. 298), in this case the use of descriptive statistics. The intention was to create environmental summaries to provide context for user perceptions, as a meta-inference (Teddlie & Tashakkori 2009, pp. 301-302) about environmental conditions of occupied schools.

3.5.6 Environmental spot measurements

To supplement the environmental data collected from the loggers installed on classroom walls, a range of spot measurements were collected around participating classrooms during site visits.

These spot measurements were collected using portable measuring instruments, which measured surface and air temperature, and light, and were located within the classroom using a laser tape. Sound was also measured at the same location using noise level measurement equipment that was readily available to the study.[28] The measurement instruments used are listed in Appendix H.4.

3.5.6.1 Data collection

Spot measurements were made at site visit and recorded on the site visit notes (see 3.5.4), together with the location of the measurement relative to the walls, using a laser tape.

Prior to taking the measurements, the activities in the classroom were observed. If the teacher was obviously busy with students, or the students were doing quiet work, measurements were either not taken or delayed so as not the interrupt learning activities, as per ethical research principles.

If there was less risk of interruption to learning activities, and teachers approved, measurements were taken sitting at an unoccupied desk. This varied from visit to visit, as did the layout of the room. While the lack of consistent location for spot measurements did not allow comparable longitudinal spot measurements, it did have the effect of random sampling of the space for comparison against facility design recommendations, i.e., all of the classroom should meet design guidelines and relevant Australian Standards, so, within the space, any location is a valid test location.

3.5.6.2 Spot environmental analysis

As for the environmental logger data, the data was considered from a post-positivist paradigm. The sample sizes for each space were small and descriptive statistics were treated with caution. Rather selected spot data was triangulated against environmental logger data, were collected (temperature, relative humidity, and light), and all spot data provided context for interpretation of the user survey.

3.5.7 Occupant surveys

This inquiry provided a key point of difference through its inclusion of perspectives from school users about their built environment. These were collected using written surveys was used as a test instrument to collect occupant perceptions about their school buildings. Two forms of surveys were prepared for each of the participant cohorts, staff and year 5-7 students. Both included a

[28] It is acknowledged that the acoustic quality of learning spaces is an important aspect of this topic. While the author has some expertise in acoustic design, the experience of working with true acoustic experts provided enough insight to know that undertaking a high quality and comprehensive acoustic evaluation was beyond the scope of this inquiry. It was judged that it would be equivalent to another PhD. Additionally, the appropriate recording and channel sounding test equipment (Parkin & Humphreys 1958, pp. 239-285) was not available, nor was there funding to purchase it for this study. It is certainly of interest for future investigation.

large portion analogous questions with some cohort specific questions, but differed to cater to the different literacy capabilities of the cohort. This section outlines the survey preparation, delivery, and analysis, and discusses the lessons learnt about the process of including the voice of school users in post occupancy evaluation.

3.5.7.1 **Survey development and testing**

Prior to designing the survey test instrument the needs and capabilities of the target participants were investigated. The two groups of interest – staff and students – were similar in that both were users of the school built environment and both were deemed to have significant time constraints for participation in surveys due to their obligations to teaching and learning within the case study schools. This posed the challenge of using an instrument to collect data quickly.

The cohorts differed for a number of obvious reasons, such as age and education levels, thus the instruments would need to be adjusted to match literacy and numeracy levels. The cohorts also differed in their relationship with the school community in that staff were employed to provide an educational service, whereas students were consumers of that service, and it was anticipated that there might be different levels of willingness to participate due to employment obligation and optional consumer participation. Thus, the challenge was to use an instrument that was age appropriate and created enough interest to both start and complete participation.

These assumptions about participants were discussed at the initial school recruitment meetings and it was confirmed that time, delivery, and language capabilities were of concern to senior school staff. However, senior staff were particularly concerned that staff members would want an opportunity to write about their experience and not be limited to scale questions. Thus, the objective of the survey design was to create a survey that could provide a range of answer options that allowed a respondent to complete the survey in at least a basic way in under fifteen minutes and still provide the depth of data needed for a case study methodology. Alternatively, the survey design gave enthusiastic participants the opportunity for a deeper response. It was also decided that the survey should be paper based so as not to infringe on limited school computer availability.

Before taking on the task of developing a survey other pre-existing surveys were investigated (Centre for the Built Environment 2008; Leaman & Bordass 2001) and found to not provide the required qualitative depth and questions specific to this research. At the time of development there was no awareness of 'The Children's Physical Environment Rating Scale' (Moore & Sugiyama 2007), however it would have not been useful since it relies on expert, not user, assessment in areas such as early childhood built environments (Berris & Miller 2011). Other environment rating scales did not provide data specific to building fabric (Hawcroft & Milfont 2010).

Since the purpose of this research was not to develop a complex testing tool about social attitudes of psychological phenomena, such as a Likert scale (Carifio & Perla 2007; Likert 1932), it drew on the significant precedents for developing ad hoc surveys in built environment investigation (Leaman & Bordass 2001), and comfort surveys (Bedford 1936; de Dear 2004). In doing so, it developed a survey specific to this inquiry (Bryman & Bell 2007, p. 264) to collect the perspectives of school users about their built environment.

The survey strategic format in Table 3.6 was developed to allow a range of responses to cater to participants' preferences and capabilities using scale, multiple choice and open-ended. Scale questions were intended for statistical parametric multivariate analysis, whereas multiple choice were intended for descriptive statistics.

Open-ended questions were provided to increase the interpretive consistency of the mixed-methods meta-inference (Teddlie & Tashakkori 2009, p. 301) by allowing undirected perspectives on built environment. For example, the question about school uniqueness was intended as a way of discovering the priority of the built environment to users over other aspects of school, rather than as a test of built environment knowledge. These open-ended questions were qualitatively analysed using post-coded grounded theory methods. The layout of the paper surveys are found (reduced from their original A4 size) in Appendices I.1.1and I.1.2 for students and staff respectively, with their corresponding code tables reported in Appendices I.2.1 and I.2.2.

Semantic scale format was selected primarily for the ability to return more nuanced responses from more varied and age appropriate questions. For example, instead of asking how much they agreed with the statement 'My school buildings always make me feel safe' and creating a scale based on a number of questions, as in a Likert type scale (Carifio & Perla 2007), a semantic scale is restricted to single questions, such as '...describe your school buildings: Feels safe and secure, vs., Does not feel safe and secure'. This allowed participants to explicitly consider the opposite and respond with appropriate 'potency' (Lemon 1973, p. 106). This latter is considered important due to the exploratory intention of these case studies.

This also allowed compliance with the request from senior staff that questions be made as neutral as possible to prevent feeding discontent should that be present. While, a post occupancy evaluation inevitably needs to ask about what is not working well, the adjectival pair scales allowed balance options for selection, thus respecting participant decision-makers.

In addition to inferential statistics, the semantic scale format offered the possibility of factor analysis in the data, i.e., the investigation of underlying constructs in the data, which was consistent with the exploratory intentions of the case study (Osgood et al. 1957).

Table 3.6: Survey strategic format

Perspective group	Scale	Multiple choice	Open questions	Strategic intention
School level Unit of Analysis				
School			School uniqueness	General user perspective of school. May or may not include built environment. Open question used to reduce priming.
School sustainability	Sustainability	Sustainability	Sustainability	User perspectives of sustainability.
School buildings	School buildings as place As functional space As healthy and safe	School buildings as place Visual perceptions of school	Contribution to teaching and learning School buildings as place Redesign preferences	Multi-response, multi-dimensional perspectives of school buildings and built environment as a whole.
Community			Open, non-leading (staff only) As a community asset	Find depth of use and depth of awareness.
Classroom level Unit of Analysis				
Teaching and learning	ICT	Teaching and learning and the classroom space. Sustainability elements.	Teaching and learning and the classroom space.	Learning activities within the classroom as experienced by students. Teaching activities as intended by staff. Opportunity for designed sustainability elements to be recalled without priming in open questions.
Classroom design	Classroom design Classroom size Classroom views		What occupants like Classroom redesign.	Perspectives of selected functional design aspects, and what is liked about the classroom
Classroom as dynamic space	Furniture rearrangement	Internal space rearrangement Display	What occupants change Display	Perspectives of how the classroom is rearranged or temporarily modified.
Comfort and control	Noise, temperature, light. Sustainability elements associated with control.	Controls visible (students) or available (staff)	Any other comments	Thermal, light and aural environment perspectives and preferences.
Toilets (associated with classroom level)			Open, non-leading	Perspectives of selected non-classroom space at classroom scale. Selected based on professional experience of school toilet design.
Demographic data				
Staff and student participant characteristic	Satisfaction with school	Demographic data		Collection of diversity data. School satisfaction scale used to check for low satisfaction driving negative responses.

The semantic scale was also applied to questions about users' environment, however, since the questions asked about memory of comfort, rather than comfort at particular time, they should not be confused with comfort study approaches (Bedford 1936; Gifford 1997). The 'comfort' questions in this inquiry should be considered as an extension of perception scales about the built environment.

Scales were selected to be five points rather than seven points as often found in other built environmental studies (Leaman & Bordass 2001). This was done specifically to reduce decision choices for time-poor participants. Similarly, since the participants were being tested for attitudes towards items (architecture) that are outside of their expertise or daily experience, scale words and scale phrases were selected to make semantic opposites less ambiguous and easy to quickly interpret. For example, under the perception of maintenance scale the scale pair 'well maintained - needs some work' where the more 'dilapidated' would be more technically appropriate for architecture but likely not understood well by participant cohorts.

This surveys were first tested using informal methods to test content validity (Campanelli 2008, pp. 178-179). In a semantic differential response format, internal consistency is influenced by relevance to the participant and 'semantic stability', i.e., the meaning of the adjective scale pair in the context of the question (Valois & Godin 1991, p. 382). This, and the interpretation of the multiple choice and open questions, was tested by giving the intended survey to four children aged 9-12 not associated with the case study schools. The survey was given to the children by their parents to create the most comfortable conditions for participation. Parents then gave feedback about the time taken and any queries about survey language or layout. Completed surveys were inspected for illogical responses. Surveys were adjusted as required

An online pilot version of the staff survey was used to obtain feedback from professional educators recruited through networks, but not involved with the case study schools. Surveys were refined where needed. The amended student survey was then presented to case study school principals, who acted as 'expert reviewers' to ensure it was suitable for their staff and students (Campanelli 2008, pp. 183-184) and proceeded without further adjustment.

3.5.7.2 **Survey delivery and data preparation**

Survey delivery was initially negotiated with the five case study school principals to confirm their preference for either electronic or paper delivery. Four principals agreed to proceed with the survey with all preferring paper delivery.

Having received school level approval, student consent forms were delivered to class teachers for distribution and collection. These required the consent from student's parents or guardians, and was required before proceeding with surveys within the class.

Survey delivery to students was then negotiated with participating year 5 – 7 class teachers. Given the known time constraints within the teaching day it was decided to allow class teachers to select their preferred delivery method rather than impose a fixed delivery method and risk having it rejected due to inconvenience to teachers. The delivery and collection of these varied according to local needs, with three delivery methods used: researcher in class facilitating the survey with teacher assistance; teacher alone facilitating the survey in class with later collection by researcher; or students complete in their own time and return the survey using reply paid envelopes.

All staff surveys were distributed by principals to their staff with reply paid envelopes for return.

Table 3.7 summarises the process used at each participating school and classroom. Ultimately, 147 student surveys and 44 staff surveys were returned from case study schools. Once collected, data was divided and analysed using methods appropriate to the question type and the number of responses, using both MS EXCEL and SPSS, as summarised in Table 3.8.

Table 3.7: Delivery schedule to participating schools

School Classroom / staff	Consents Delivered	Survey type	Survey delivered	Given to participants	Researcher present during survey	Collected or Reply paid envelope
Yellow staff	5/11/12	Staff	5/11/12	By principal	No	Reply paid envelope
Yellow.3	19/7/12	Student	29/10/12	29/10/12	Yes	Collected
White staff	1/11/12	Staff	1/11/12	By principal	No	Reply paid envelope
White.3	18/7/12	Student	1/11/12	By teacher	No	Collected
White.4	18/7/12	Student	1/11/12	By teacher	No	Collected
White.5	18/7/12	Student	1/11/12	By teacher	No	Collected
Orange staff	30/10/12	Staff	30/10/12	By principal	No	Collected / Reply paid envelope
Orange.4	20/7/12	Student	7/11/12	By teacher	No	Collected / Reply paid envelope
Orange.5	20/7/12	Student	7/11/12	7/11/12	Yes	Collected
Red staff	16/5/13	Staff	16/5/13	By principal	No	Reply paid envelope
Red.4	19/7/12	Student	23/11/12	By teacher	No	Reply paid envelope
Red.5	19/7/12	Student	15/8/12	15/8/12	Yes	Collected

When translating surveys into electronic form some adjustments were made to data. Where a mark was made on an imaginary interim scale point, it was assumed that the participant was expressing an intention that was not neutral so it was rounded up or down to the nearest scale score depending on which side of neutral the mark lay.

Table 3.8: Survey data analysis strategies

Question type	Qualitative method	Quantitative method	Software package	Comments
Scale	Nil	ANOVA Multiple linear regression Factor analysis	SPSS	Treated as interval data
Multiple choice	Nil	Contingency table	SPSS and Excel	Treated as categorical data
Multiple choice	Nil	Multiple linear regression	SPSS	Treated as binary ordinal data are selected re-coding
Open questions	Post - coded grounded theory	Nil	Excel	Treated as quantised categorical data after coding

Where comments or spelling were ambiguous the comment was evaluated in the context of photos to try to anticipate the intention of the comment (also see Appendix D.3: *Not everyone speaks 'architecture'*). Some comments included arrows and diagrams so there were described in square parenthesis.

Comments were translated to electronic form as written, but spelling corrections are made in any quotes in this thesis. Since this study is about architecture and not literacy, this is deemed appropriate and respectful to participants. However, quotes do include the language structure as written, unless the comments could not be deciphered in the context of the built environment, they are not used.

The remainder of this section further describes the individual analysis methods and their contribution to meta-inference.

3.5.7.3 **Quantitative analysis**

Quantitative methods were used to analyse the multiple choice and scale questions in the survey using descriptive and inferential statistics, and factor analysis (Tabachnick & Fidell 2001), according to inference validity appropriate to the research method (Teddlie & Tashakkori 2009, p. 298).

Multiple-choice questions were treated as categorical scales and reported as contingency tables with frequencies and percentages of respondents.

The five-point scale questions were treated as interval scales with normal response and parametric statistics were applied as precedent in other scale inference precedents (Carifio & Perla 2007, p. 115; Lemon 1973, p. 105). ANOVA was applied by case study schools and reported to compare case studies both as original case means using original *N* and harmonic means due to the different *N*s across cases. Differences in variances are also reported, but the ANOVA has not been rejected due to the small scale.

Multiple linear regression was also applied to the scale data set as a whole, to significance of $p < 0.0005$ using stepwise regression in SPSS. Regression coefficients, coefficient of determination, and goodness of fit are reported and the inferences are discussed in terms of the architectural context. Where regressions are reported it should be assumed that all tests of normality, linearity, multi-collinearity, homoscedasticity, residuals and outliers were performed and the analysis does not violate any assumptions. Where violations do occur they are reported and, if relevant, included analyses are justified.

The user surveys could also be viewed as a group of variables that may contain '...coherent subsets that are relatively independent of one another. ... [and] are thought to reflect underlying processes that have created the correlations among variables' (Tabachnick & Fidell 2001, p. 582). These constructs (Robson 2002, p. 442) or latent variables (Kerlinger & Lee 2000, p. 826) can extracted using mathematical matrix processes and known collectively as factor analysis (Tabachnick & Fidell 2001, pp. 612-613), each of which have various strength and weaknesses (Costello & Osborne 2005).

There is precedent for using 'factor analysis' and 'principal components analysis' in built environment studies (Burley & Brown 1995; Fernandez et al. 2005; Marans & Stimson 2011, pp. 44, 69, 385, 405) and educational studies(Costello & Osborne 2005). This inquiry included scale variables based on semantic scale techniques making it possible to select and apply a form of factor extraction to test the data for any useful constructs (Osgood et al. 1957, p. 110) that may add to the understanding of school building perspectives. When selecting the extraction technique, Principal Components Analysis (PCA) extraction was used exploratory for testing number of factors to be extracted, but rejected as a final technique because of the potential for over estimating the total variance accounted for (Costello & Osborne 2005). The final extraction used Principal Axis Factoring (PAF), selected for its ability to extract only common variance and applicability with non-normal data sets (Tabachnick & Fidell 2001), this latter property being prudent for the possible limitations of five point scales.

Thus, all quantitative analysis was undertaken to maintain appropriate method validity and contributes to appropriate analytic adequacy to contribute to the quality of the mixed methods meta-inference (Teddlie & Tashakkori 2009, p. 301).

3.5.7.4 **Qualitative analysis**

Open response questions were analysed using grounded theory where they were post-coded, initially without the intention of using pre-existing theory, i.e., as a thematic analysis (Liamputtong & Ezzy 2005, p. 265), but within the context of an architectural scope of interest suggesting an implied theory within the ‘context of discovery’ (Erzberger & Kelle 2003, p. 465). Coding followed a three-stage coding process analysis (Liamputtong & Ezzy 2005, pp. 268-270) in which responses were given preliminary detail codes in the context of the question and the school environment of the participant. These were then collected together according to a category code. Finally, all detail and category codes were reviewed and reduced. While some coding strategies were informed by social science discussions (Creswell 2003, p. 193), many developed specifically from architecture and the built environment, as expected due to the survey subject.

Coding aimed to code participant descriptions specifically rather than translating into architect/engineering terms, although professional influences did inform the coding. For example where a student reports that they want air to 'blow in a wide area' (Student 136), it is coded as 'Preference - air distribution - more uniform', rather than introducing services engineering terms such as 'supply air' or SA. This is to ensure non-technical readers can understand.

Similarly, where toilets were described as 'ugly' this was originally assigned to 'visual appearance' rather than 'architectural' to code the answer before assigning it to what could be an professional design team responsibility. However, the term 'facilities management' was used to distinguish between 'daily management', where the latter covers cleaning and consumables replacement. This *is* grounded in the operational world were the former is the longer-term capital expenditure, while the latter could be considered an operational expenditure.

The intention of using open questions was to provide an opportunity for both staff and students to first, empower participants to provide detail about what they felt was important and, second, with differencing language skill levels in mind, provide an alternative opportunity to scales for students to participate. Open questions were worded to prompt detailed responses, however it was found that some participants responded with a range of responses, which do not conform to the expected response types or conform but do not provide detail coding opportunities. Since they do not provide detail, for the purposes of this study, they have been grouped together as category code 'other'. These are coded as shown in Table 3.9.

Table 3.9: Coding responses without detail

Open question type	Response to open question	Conforming or non-conforming	Interpretation	Category code	Detail code
All	Response is undecipherable due to writing or spelling or language	Conforming		Other	indeterminate
Request for specific information, e.g., 'please describe...'	'No'	Non-conforming	Implied dissenting	Other	dissenting
	Disputes premise of question 'Nothing'	Conforming		Other	Code disputation, e.g. 'Nothing'
	'Don't know'	Conforming		Other	Don't know
	Yes', 'maybe', 'a little bit'	Non-conforming	Implied assenting	Other	assenting
Request for general comment, e.g., 'any other comments about...'	'No', 'Nothing'	Conforming		Other	No further comments
	Don't know	Conforming		Other	Don't know
	'Yes', 'maybe', 'a little bit' but without further detail	Non-conforming	Implied assenting	Other	assenting

nce coding had been finalised the category codes the codes were quantised (Teddlie & Tashakkori 2009, p. 155) and presented visually and the detail codes were presented as rankings. These are, again, used in the meta-inference process and interpreted as contribution to the survey quantitative findings, and vice versa, in the context of specific and common built environment contextual findings to contribute to this inquiry’s meta-inference (Teddlie & Tashakkori 2009, p. 301). Where pertinent, quotes from open questions are presented to provide an example of codes. Participant sources are referenced using codes, where ‘O.Stu100’ refers to ‘Orange student, student number 100/147’, and ‘O.Sta10’ refers to ‘Orange staff, staff number 10/44’. Other schools and participants have the prefix and suffix changed accordingly.

3.6 Summary

This section presented the epistemological considerations of this inquiry, together with the research strategy used, the implications of human ethics research had on the research design, and summarised the mixed methods used to create the rich meta-inference required of this study. This process responds to research question 1.

The epistemological considerations were presented to acknowledge and separate the influence of professional and scholarly knowledge within this inquiry. The professional knowledge provided implicit a priori theory about the school built environment and influenced the case study research strategy and selection of mixed methods research as the most appropriate data collection required to answer the questions posed. The epistemological discussion was included to reflexively address this, and put professional knowledge in its rightful place for this inquiry – there, but off to the side – to focus on the real task of scholarly knowledge creation.

The case study strategy of inquiry was introduced, together with an outline of the mixed methods research methodology used as an appropriate inferential tool in this research. The human ethics research consent raised a number of interesting questions about the boundaries of used architecture, and the liminality of the junction between built fabric and human users, which was discussed in detail to address these questions and integrate them into the research.

Taking into account the research strategy and ethics, the recruitment process of the case studies elaborated the considerations need for selecting architectural appropriate educational buildings, together with the practicalities of making research participation attractive to operating schools.

Finally, each method was presented with commentary about the data collection used and the appropriate analysis and inference required for each method as a stand-alone endeavour, together with their contribution towards a whole-study meta-inference, as required to comply with the case study / mixed methods analysis.

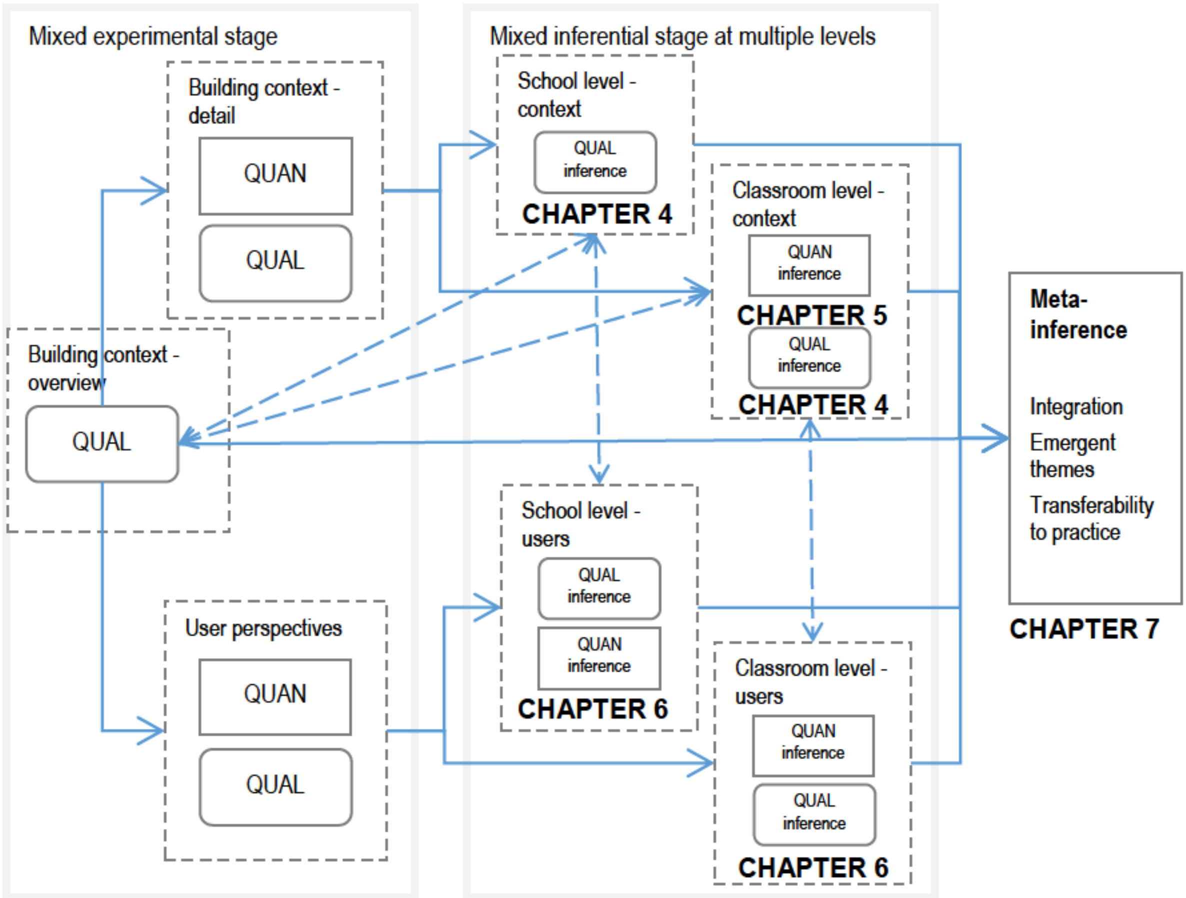


Figure 3.7: Structure of the remainder of the thesis

The remainder of this research is outlined in Figure 3.7, above. The case study built environment context is presented for each case study school in chapters 4 and 5 where the architectural and environmental contexts are discussed respectively. Chapter 6 presents the user perspectives for each case study school and discusses them in light of the built environment context observed. Chapter 7 looks at the data as whole to identify emergent themes and discusses how these may be applied to post occupancy evaluation and architectural practice. The conclusion to this work is presented in Chapter 8.

4 Case study architecture and use

4.1 Introduction

This chapter and the next present analysis of architectural and physical aspects of case study schools. These aspects provide a physical context for interpretation of the user perspectives. This chapter describes the architectural configuration of the case study schools, together with public descriptions of the schools by the school itself and other commentators. It also presents observed building fabric modifications, and spatial use of classrooms. To do this, it draws on public documents, observations, site notes and research-specific photographs, and uses architectural interpretation and visual ethnographic methods (Section 3.5). The data collection and inferential stages are highlighted in the mixed methods research map in Figure 4.1 below.

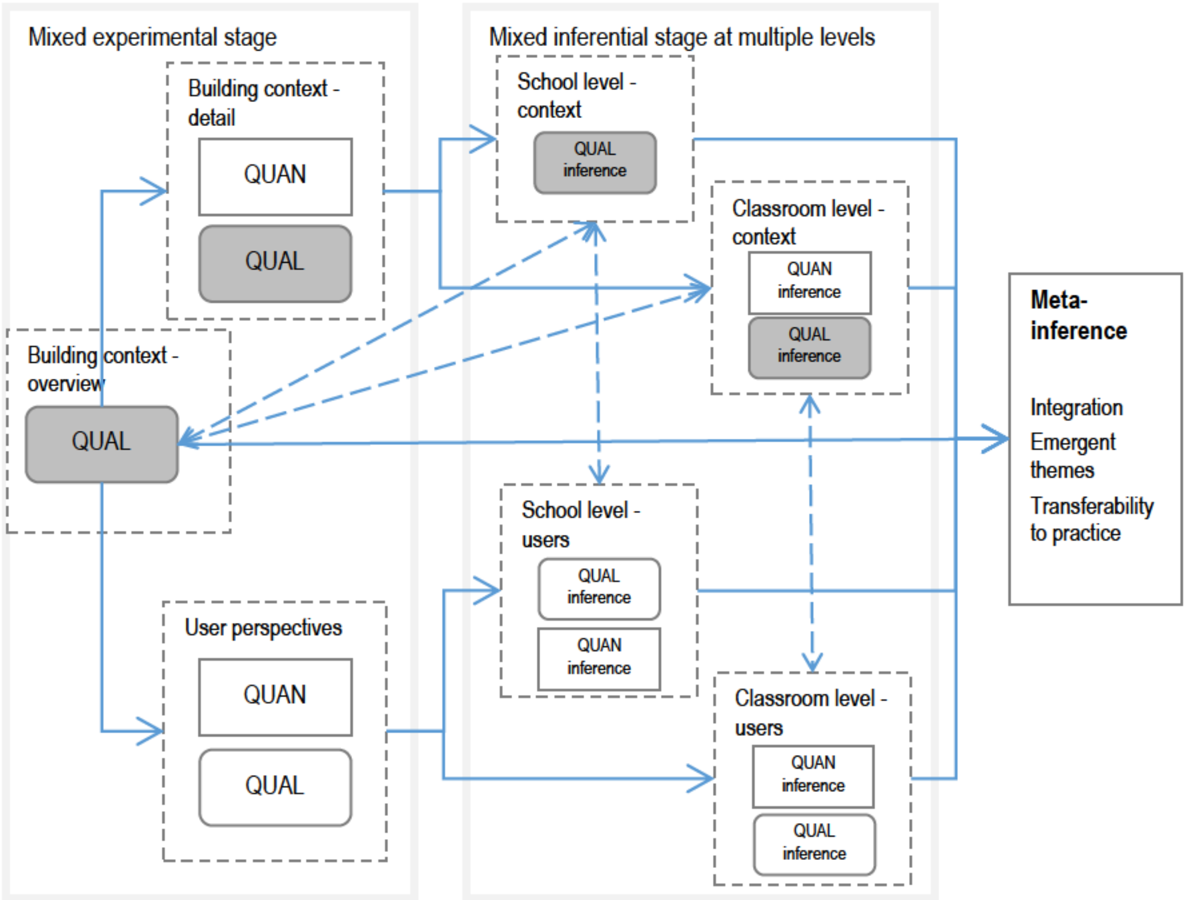


Figure 4.1: Mixed methods research map for the case study architecture and observed use

All photos presented here were taken by the author for the purposes of this inquiry, unless otherwise indicated.

4.2 Architectural configuration

This section presents the architectural configuration observed that is relevant to this inquiry. It does not intend to provide full construction documentation of the case study buildings and site elements. Rather, selected aspects of the buildings and site are collated to provide a spatial background to the case studies. Selected observed building elements are included to provide context for the later user survey responses.

The documents used in describing the case study school are listed in chapter Appendix A: *List of data sources*[29], i.e., separate from the main list of sources in chapter 9.

4.2.1 Case study schools and site plans

The five case study schools that agreed to participate in the research are summarised in Table 4.1.

Table 4.1: Summary of case study schools

School Approx. total floor area[a] 2012	Enrolment 2012 Floor area / student	Year opened	Description	Building constructions	Award or heritage
Yellow 1415 m²	178 7.9 m²	1877 – 1996 Reopened 2004	Buildings include stone buildings over 100 years old and renovated warehouses.	Solid mass Masonry veneer Lightweight - permanent	Architectural award and local heritage
White 4580 m²	613 7.5 m²	2003	Greenfield school less than 10 years old. Brick veneer construction with various passive energy saving devices built into the fabric and centralised HVAC control	Lightweight - permanent Masonry veneer Lightweight - transportable	Architectural award
Orange 4300 m²	597 7.2 m²	1998	Greenfield site. Construction approximately 60/40 solid mass and transportables (both timber and steel framed and clad). Permanent buildings include various passive energy saving devices built into the fabric.	Solid mass Lightweight - transportable	Architectural award
Red 3130 m²	324 9.7 m²	1877	All buildings are older than 50 years except for a recent multipurpose hall and addition. Older buildings range from solid stone to solid brick construction. Significant interior renovations are evident in all older buildings	Solid mass Masonry veneer Lightweight - permanent	State and local heritage listings
Purple 1630 m²	191 7.9 m²	1947	All buildings are less than 15 years old and are brick veneer construction. Acoustics and spatial design for pedagogy is obvious on inspection	Masonry veneer Lightweight - permanent Lightweight - transportable	Architectural award

a. Excludes other facilities such as Birth-5 child care and co-located schools

Case study site plans are shown below (see Figure 4.3 to Figure 4.7, legend in Figure 4.2). These plans were prepared using aerial images obtained from Google Earth and supplemented by notes and photographs taken during site visits. The intention of the images are to inform the reader of relative site layouts, not detailed and quantitatively accurate site planning information or

[29] This list of data sources contains identifying information. It will be redacted in the final embargoed version.

analysis[30], so contain some plan simplifications. Road names are omitted so as not to compromise case study anonymity.

All schools were observed to not be undertaking any construction work, with the exception of Orange School, where expansion to teaching spaces was also observed using four transportable classrooms (25/10/12).

In addition to identifying the case study classrooms, selected features are included to compare the schools for porosity to the public (fences and entrances), programmed play and sports areas, orientation of the front office, presence of non-aesthetic soft landscape (productive gardens or ecosystems), and landmarks. These latter site features were selected for inclusion because they either feature in open question responses, or are architecturally logical to include for later discussion. Other features, such as circulation paths, car parks, and informal gathering locations, were omitted for simplification of site plans and because they were beyond the scope of this inquiry, but are acknowledged as being an integral part of the site plan.

School site plans in South Australia are not uniform and there is some evidence for adventurous school planning (Public Buildings Department 1976). Orange School (Figure 4.3) and White School (Figure 4.4) are significantly physically larger than the other case study schools. Orange school is co-located with another school, which did not wish to participate. In addition to sharing sports facilities, the two schools only share study room Orange.1 (library/resources) and the rooms to the east of these buildings (canteen and art classrooms). From the perspective of this research there is minimal infrastructure integration, but the specialist nature and significant establishment costs of this shared infrastructure is noted as an alternative solution to increasing facility variety in primary schools.

The site plan of White School differs significantly from Orange School in two ways. First, the School is spread out and two campuses are visible, to the east (junior primary) and west (middle and senior primary) of a central feature. This central feature is a reclaimed water ecosystem with a bridge connecting the two campuses. The second notable feature is the absence of perimeter fencing. The School is designed to be open, with the central reclaimed water ecosystem accessible at all times.

Yellow (Figure 4.5), Red (Figure 4.6), and Purple (Figure 4.7) are smaller, as befits their smaller enrolment, and located in denser population areas.

[30] For a professional site plan the author would measure up the school and draw a 'cut plan view' and interpret the site using processes described in Thomas (Thomas 2002), or similar.

Figure 4.2: Legend for site plans Figure 4.3 to Figure 4.7

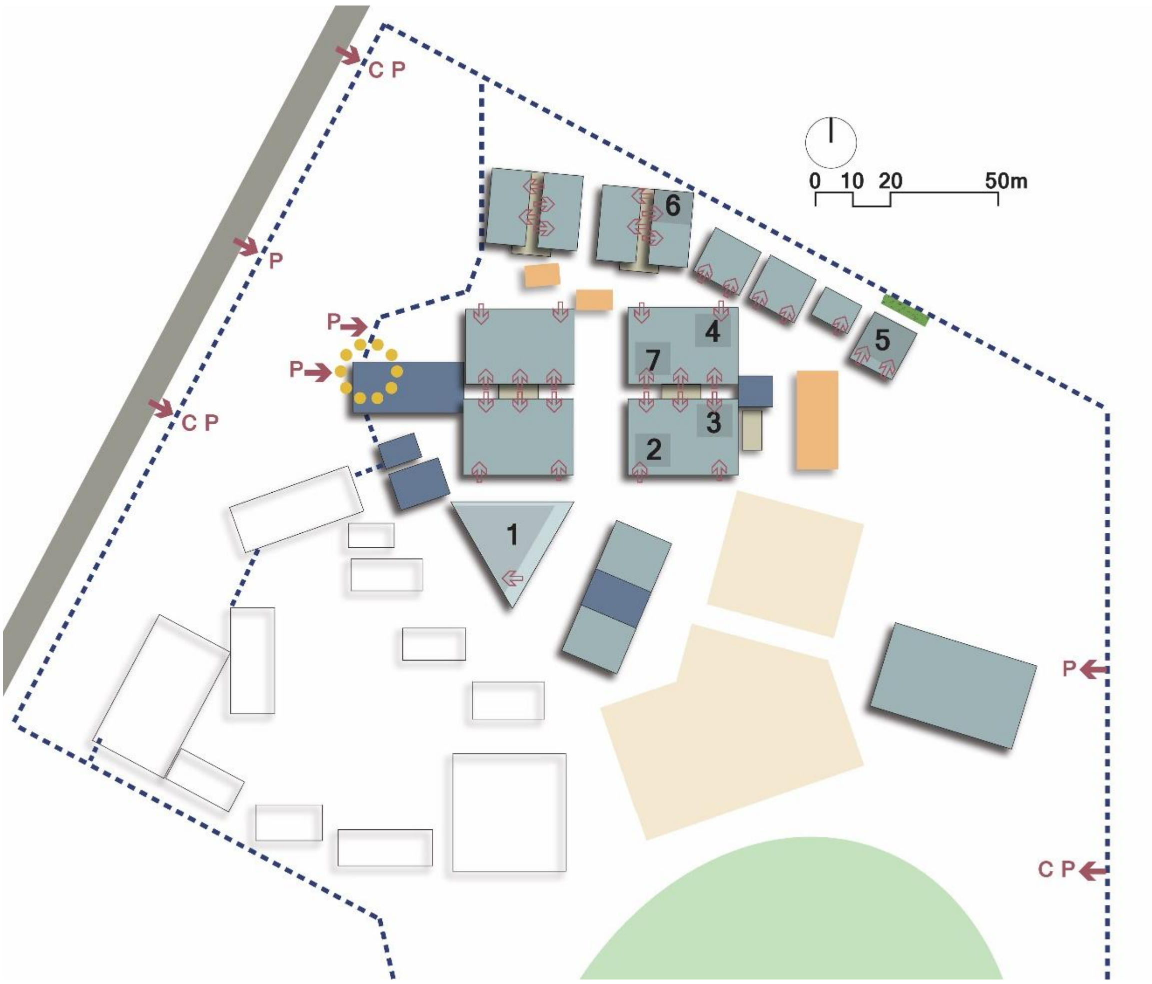


Figure 4.3: Orange School site plan (co located school shown in outline)

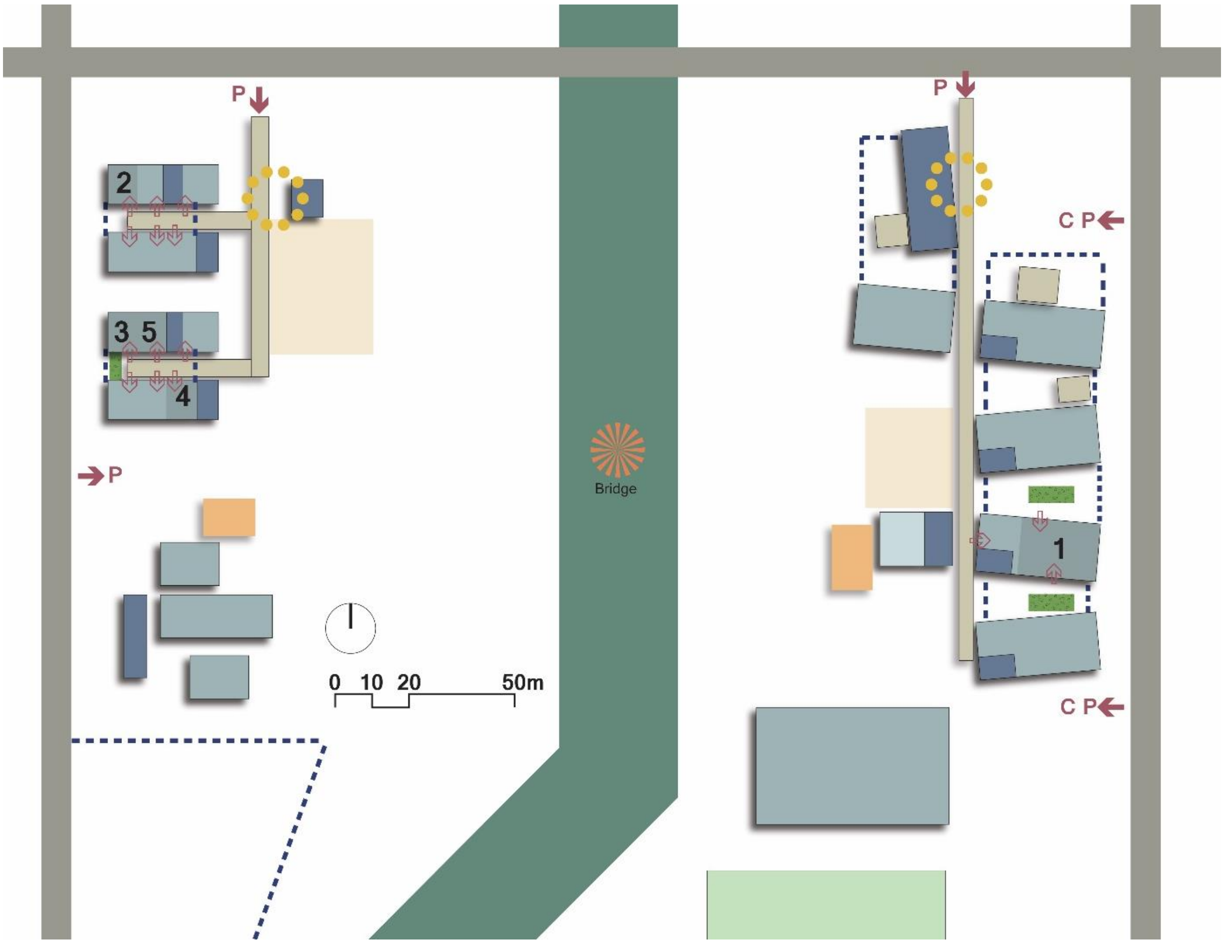


Figure 4.4: White School site plan

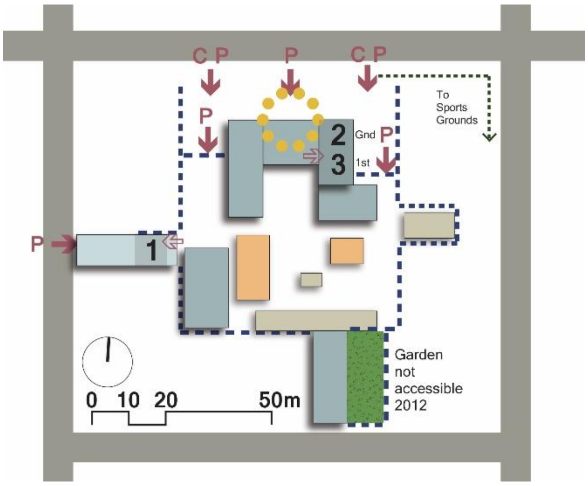


Figure 4.5: Yellow School site plan

The extent of school boundaries also varied, with Yellow, Orange and Purple fully enclosing their schools within at least 1800mm AFL fencing. Red school fence is an approximately 1200 AFL random rubble masonry fence and acts as more boundary marking than security fence, since its fence line low and permanently open. This possibly is acceptable due to the sense of security provided by the police station located over the road. White school, as discussed previously, is fully open to the public at all times with only the building districts closed off after hours. All have fence lines had major sections along their lengths which use steel palisades or security mesh so that fencing, resulting in occupants not being visually divided from the public.

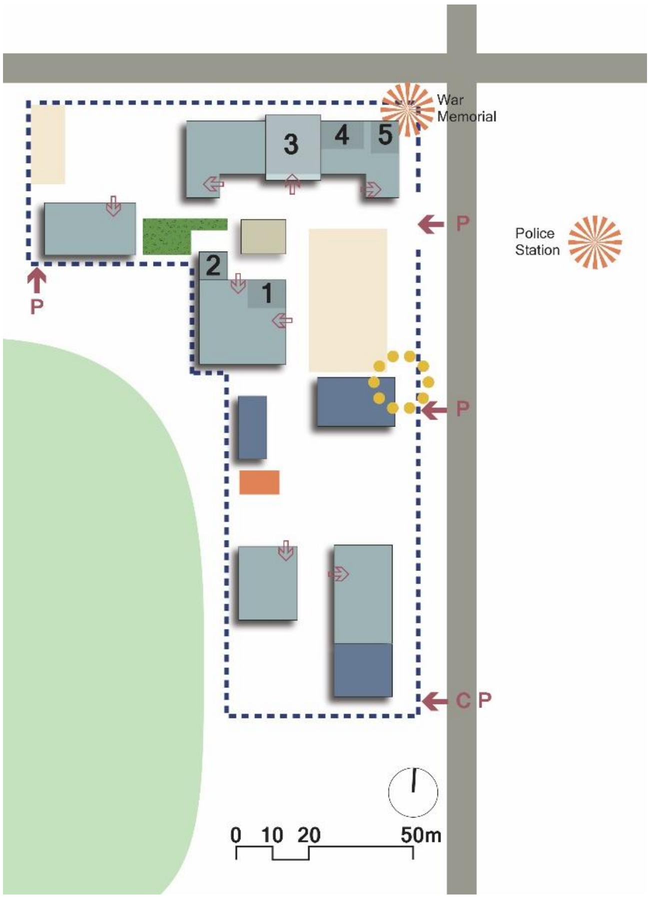


Figure 4.6: Red School site plan

Purple, Orange and White had classrooms opening directly to the outdoors so that circulation between rooms and buildings was exterior and under the cover of roof overhangs and covered ways. The two older schools, Red and Yellow, used internal circulation for access to classrooms, as per the original plans, but it was observed that Red School had two exterior doors that appeared to be retrofitted in the building housing Red.3-5.

While it is noted that school play, sports, and landscape facilities are an important area of student and staff amenity, it was beyond the scope of this inquiry, and beyond the scope of researcher expertise, to provide a critical analysis these facilities. However, when responding to questions about the exterior of the school, students mentioned many of these built environment elements in their responses. Given this, observed landscape elements are listed in Table 4.2 to provide context for later interpretation.

All schools had some form of outdoor fixed play equipment for climbing activity, as well as outdoor seating, soft landscaping (gardens and trees) and a green (either live or fake turf) play area. Furthermore, all schools, except Yellow School, had an on-site hardstand play area. Only Orange school had an on-site turf oval, while Red School was adjacent to a public turf sports oval. Both of these were shaped for Australian Rules football. Yellow school had lesser variety

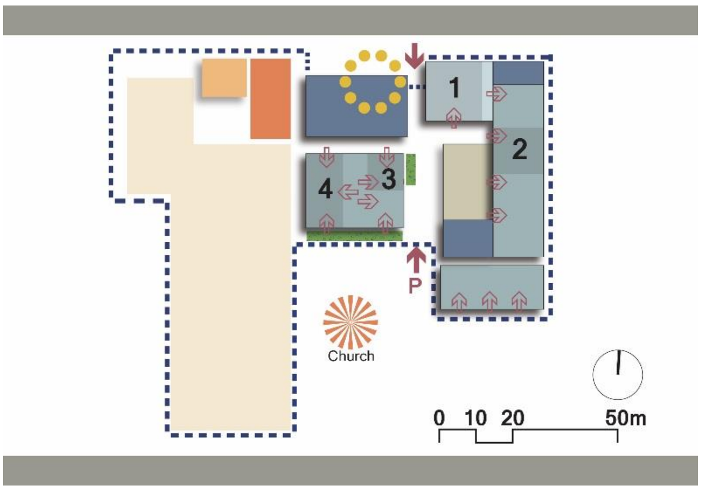


Figure 4.7: Purple School site plan

in their landscape built environment due to their small site size. In lieu of on-site facilities, they made use of public facilities two blocks away.

Table 4.2: Landscape built environment elements by school

School	Play equipment	Hardstand play area	Turf sports oval	Green play area	Outdoor seating	Gardens and trees	Ecosystem	Food production
Yellow	■	nil	nil	■ (live & fake)	■	■	nil	■ (no access 2012)
White	■	■	nil	■	■	■	■	■
Orange	■	■	■	■ (live & fake)	■	■	nil	■
Red	■	■	■ (public oval)	■	■	■	nil	■
Purple	■	■		■	■	■	nil	■

All schools had some form of productive garden (edible plants), but the larger shared community garden in Yellow School was not accessible during 2012. White School also had a re-vegetated eco-system (water, plants and attracted animals) through the middle of their school. This was observed to be used more as a learning tool than a play area.

4.2.2 Form, character, fabric and classroom descriptions

All participating schools were very different in their form, character and fabric across the schools, as were some classrooms within schools. A brief description of all the fabric of all participating classrooms in listed in Table 4.3. Corresponding floor plans are found in Appendix H.2.

Table 4.3: Participating classroom building fabric summary

School	Year built	Building height / level	Building constructions	Permanent or temporary	Architectural Award / Heritage
Yellow.1	1970 (approx.)	Single storey	Block veneer	Permanent	
Yellow.2	1882	Two storey / ground floor	Solid mass (stone)	Permanent	Award / Heritage
Yellow.3	1882	Two storey / first floor	Solid mass (stone)	Permanent	Award / Heritage
White.1	2002	Single storey	Lightweight / Masonry veneer	Permanent	Award
White.2	2007	Single storey	Lightweight / Masonry veneer	Permanent	
White.3	2007	Single storey	Lightweight / Masonry veneer	Permanent	
White.4	2007	Single storey	Lightweight / Masonry veneer	Permanent	
White.5	2007	Single storey	Lightweight / Masonry veneer	Permanent	
Orange.1	1998	Single storey	Solid mass (rammed earth)	Permanent	Award
Orange.2	2001	Single storey	Solid mass (rammed earth)	Permanent	
Orange.3	2001	Single storey	Solid mass (rammed earth)	Permanent	
Orange.4	2001	Single storey	Solid mass (rammed earth)	Permanent	
Orange.5	2004 (approx.)	Single storey	Lightweight	Temporary	
Orange.6	2010	Single storey	Lightweight	Temporary	
Orange.7	2001	Single storey	Solid mass (rammed earth)	Permanent	
Red.1	1902	Single storey	Solid mass (solid brick)	Permanent	Heritage
Red.2	2006	Single storey	Brick veneer	Permanent	
Red.3	1877	Single storey	Solid mass (stone)	Permanent	Heritage
Red.4	1877	Single storey	Solid mass (stone)	Permanent	Heritage
Red.5	1877	Single storey	Solid mass (stone)	Permanent	Heritage
Purple.1	2007	Single storey	Brick veneer	Permanent	
Purple.2	1993	Single storey	Brick veneer	Permanent	
Purple.3	2010	Single storey	Lightweight / Masonry veneer	Permanent	Award
Purple.4	2010	Single storey	Lightweight / Masonry veneer	Permanent	Award

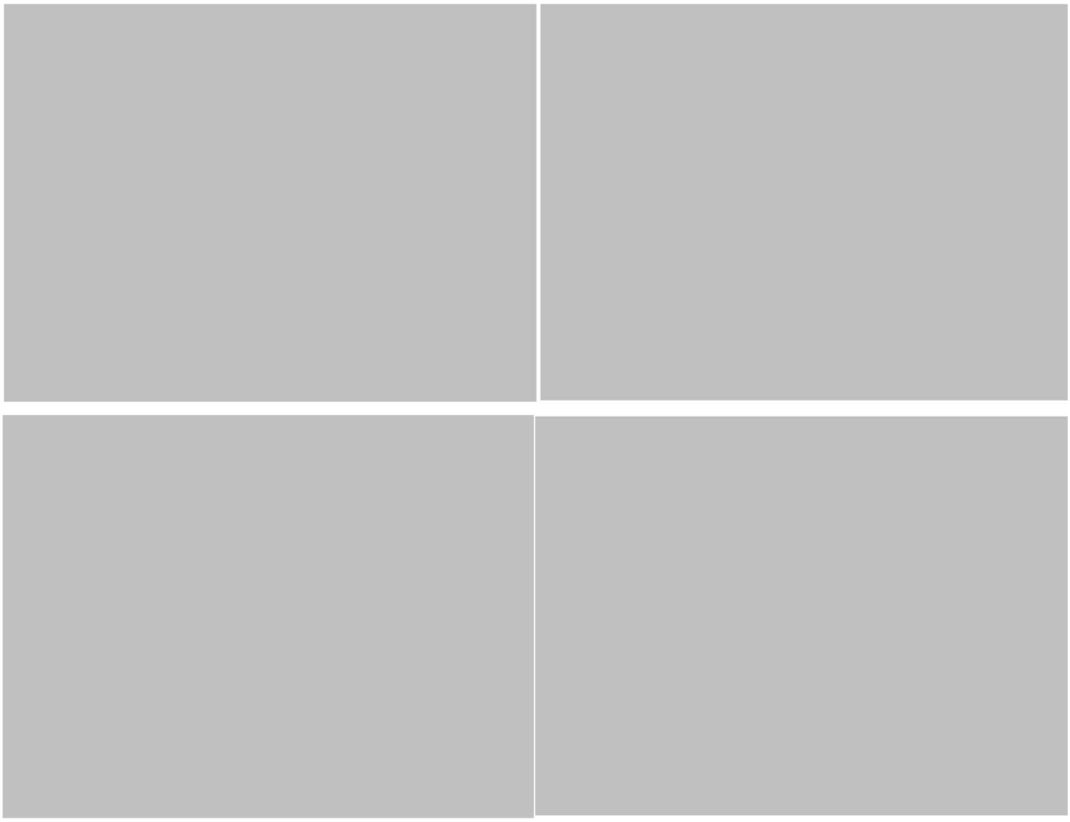
Both campuses of White School dominated by their ventilation chimney stacks, which are easily seen from outside of the schools. The east campus (Photograph 4.1) is a combination of simple rectilinear and triangular forms, expressed in neutrally painted brickwork and fibre cement, ‘zincalume’ corrugated iron, and aluminium windows. The west campus (Photograph 4.2) uses similar materials, but different less neutral paint hues, with contrasting colours on the south side.


Photograph 4.1: White School east campus – left, White.1 east elevation, view from street (DSCF3273_090221mod.jpg); right, part south elevation, view from south courtyard (DSCF7749_121128mod.JPG)

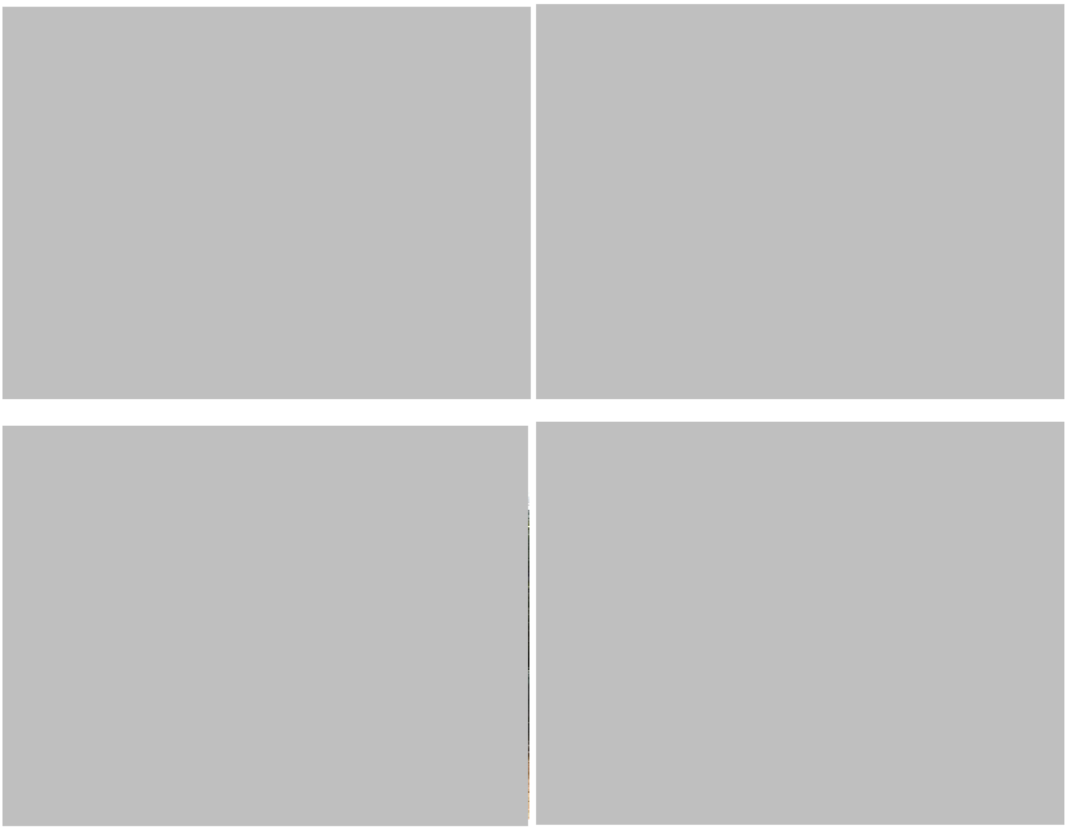

Photograph 4.2: White School west campus – north west corner left, with White.2 at front, view from street (DSCF5451_111118mod.JPG); right, south east corner, with White.4 under right most chimney, view from central play area (DSCF5448_111118mod.JPG)

Orange School comprises of a combination of permanent buildings and portable buildings (‘transportables’). The permanent buildings (Photograph 4.3) also had ventilation chimney stacks visible, however these, and the roofline were lower in height and roof slope than White School buildings so that their ventilation chimneys are less dominant. Their materiality, as seen by students, is rammed earth walls, painted steel, and corrugated roof sheeting.

Two types of transportables also participated in the study. These types are shown in Photograph 4.4. The older type (top) are clad in ‘weatherboard’ type cladding (likely fibre cement), while the older type are rendered fibre-cement. Note that both types have decking installed around them and attempts have been made to integrated into the site by picking up on the permanent building detailing, such as steel work colour in the veranda additions.

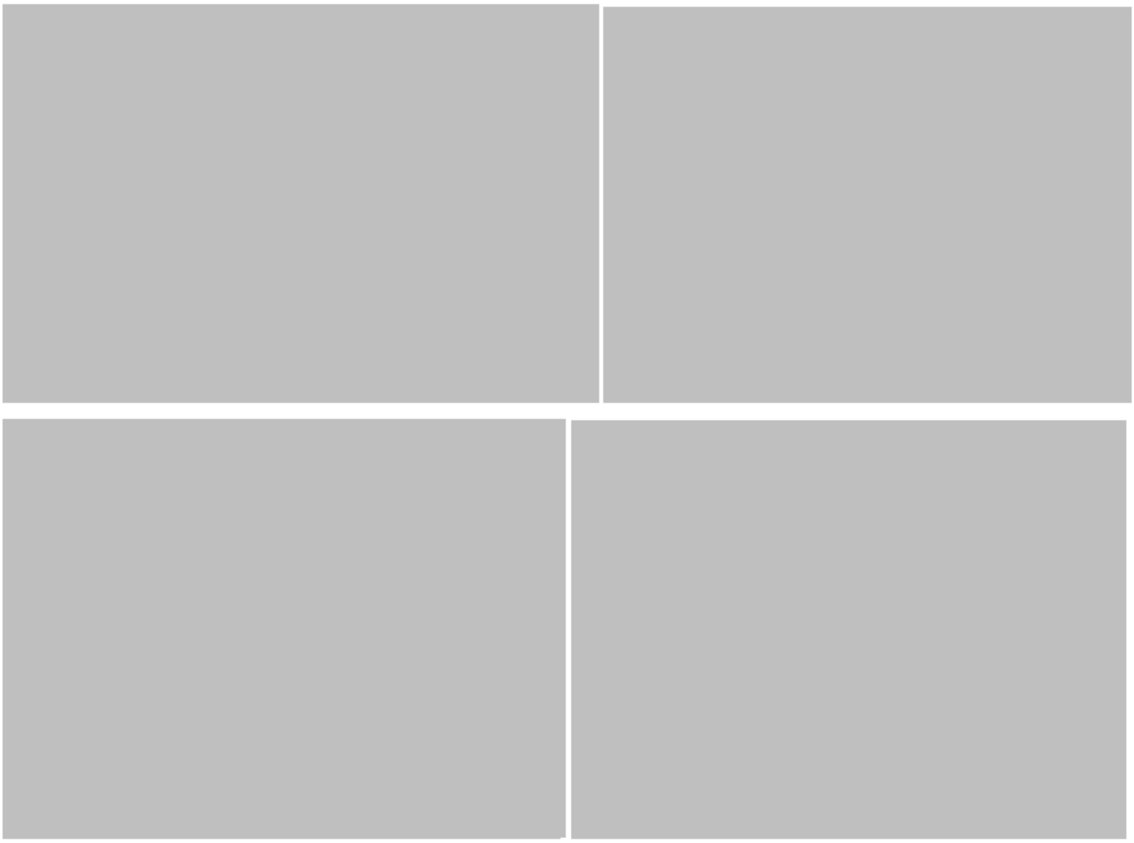


Photograph 4.3: Orange School permanent buildings – top left, view to south west, Orange.3 rear (DSCF5529_111125mod.JPG); top right, view to west, Orange.4 (DSCF5528_111125mod.JPG); bottom left, Orange.2 (DSCF5555_111125mod.JPG); bottom right, south elevation, Orange.2 (DSCF5553_111125mod.JPG).



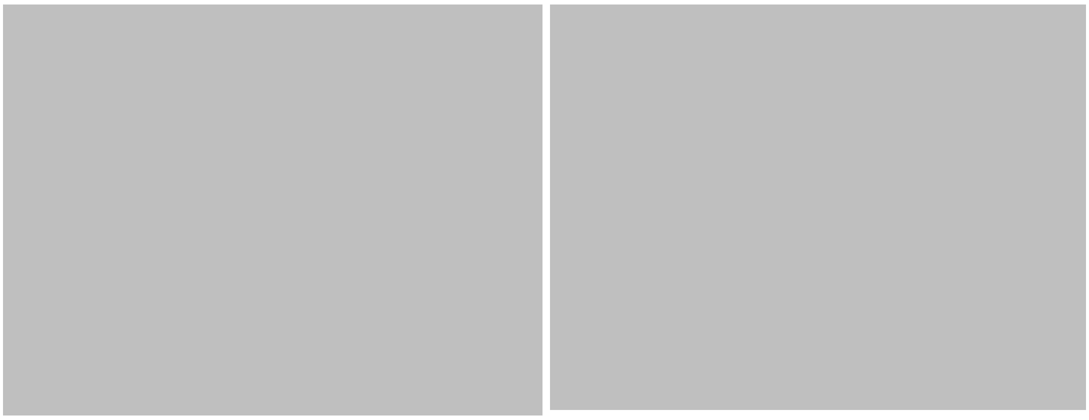
Photograph 4.4: Orange School transportable buildings - top left, Orange.5 south elevation (DSCF5533_111125mod.JPG); top right, view to west Orange.5 (DSCF7342_121025mod.JPG); bottom left, Orange.6 east elevation (DSCF7407_121025mod.JPG); bottom right, Orange.6 end on right (DSCF5519_111125mod.JPG).

Red School is a combination of late 19th century school architecture and contemporary additions. Photograph 4.5 shows the different stages that participated in this study. The oldest stage is shown in the lower images. This stage comprises of solid stone with plinth and brick detail around openings, with brick detail stringer lines. The roof is corrugated iron and shows finial detailing and metalwork with original vents (not visible and now not used). The stone used in the face is locally sourced blue stone. The top left image shows an early 20th century solid brick building with the original roof ventilation metalwork (now not used). The detailing of the shade devices are very likely later additions. The top right image shows an early 21st century extension to this building.



Photograph 4.5: Red School – top left, north east corner Red.1(IMG_2481_111003mod.JPG); top right, north elevation Red.2(DSCF5376_111117mod.JPG); bottom left, north elevation of Red.5 and Red.4 (DSCF7610_121123mod.JPG); bottom right, north east corner Red.5 (DSCF7625_121123mod.JPG).

Yellow School is contemporary with the earliest building of Red School, and shows similarities in construction Photograph 4.6, above. In contrast to Red School, the main building is two story, and the roof is tiled. The east side first floor windows are likely to have been remodelled at some stage, as indicated by the different shape and detailing. Note that the room Yellow.1 is in a building that is surrounded by buildings so no useful elevations were available, but it should be noted that it is block veneer construction.

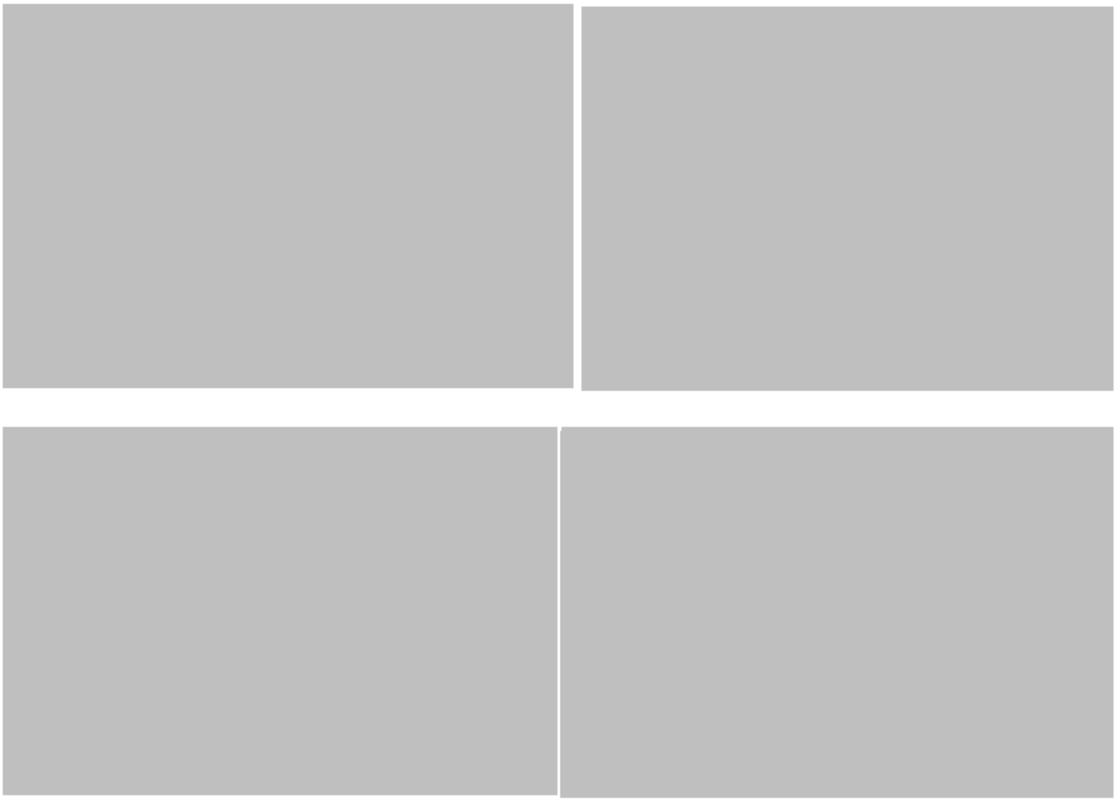


Photograph 4.6: Yellow School – north east corner, left (DSCF5485_111118mod.jpg); north elevation, east end (DSCF5487_111118mod.jpg)

The oldest buildings[31] of Red School and Yellow School use materials typical of 19th century Adelaide vernacular, in particular the local stone and red brick; however, thse local materials and decorated gables and gablets are also used in 1990s Federation revival (Persse & Rose 1994, pp. 126-129) so it is difficult to be confident that non-designers will accurately date these buildings, particularly 12 year old students born around the year 2000.

Purple school is late 20th century, early 21st century (Photograph 4.7). All buildings are predominantly brick veneer, of varying age, with corrugated powder coated steel from the window header to the underside of the eves. The later building, containing Purple.3 and Purple.4, varies slightly, with the use of block veneer parapet walls on the east and west side, and use of powder coasted corrugated steel on the south side classing.

[31] In the professional opinion of the author, the oldest buildings of Red School and Yellow School show similarities and differences. In both the walls are solid stone using local stone mortared in a 'random rubble' formation with pointing. The Yellow School mortar seems to have been replaced with non-traditional material, as allowed by a local heritage listing. The pointing on Yellow School is also poorer quality. Both schools have ridged roofs; however only Red School has hips. Both schools have gables but they differ in that the Red School gables includes kneelers, but omit the timber gablet detail of Red School. Both schools have also finals on the gables but differ in material so that the Red School finial is metal and the Yellow School finial is timber. The roofing materials are also different. Red School uses long sheet galvanaised corrugated iron. The good condition of this suggests that it has been replaced. The Yellow School roofing material is some form of tile and difficult to investigate from the ground. The original drawings suggest that tiling is the original intention.



Photograph 4.7: Purple School – top left, north elevation Purple.1 (IMG_2492_111210mod.JPG); top right, west elevation Purple 2 (DSCF6182_120403mod.JPG); bottom left, south east corner of building with Purple.3 and Purple.4 (IMG_2492_111210mod.JPG); bottom right, north elevation Purple.3 (IMG_2501_111210mod.JPG).

4.2.3 ESD, 'Eco', and 'sustainability' design features

The definition of sustainability is inconsistent and contested (Section 2.2.4). Items associated with ESD, 'Eco', and 'sustainability' according to guidelines (Australian Government c2009; DECS Asset Services 2009) that were observed in the participant schools are shown in Table 4.4. All buildings were observed to have the possibility of mixed-mode use, i.e., all had both operable windows and HVAC systems. However, it was observed that the operable windows were often not used, as indicated.

Table 4.4: Observed available sustainable components and programmes in part of all of the school.

Components and programmes	School infrastructure > 30 years old		School infrastructure < 30 years old		
	Red	Yellow	Orange	White	Purple
Natural ventilation[e]	*Operable windows*	*Operable windows*	Operable windows, vents	Operable windows, vents	Doors to exterior
Daylight (Glazing height)	glazing > 1200 high	glazing > 1200 high	Permanent - glazing > 1000 high Skylights	glazing > 1000 high	glazing > 1000 high and full length.
Sill height	1200	1200	800, 1100	0, 1000, 1200	0, 1200
Daylight control	No shade devices Retrofitted interior blinds	No shade devices Retrofitted interior blinds	Shade devices Permanent - retrofitted film Transportables - blinds	Shade devices Interior blinds to west buildings. Veranda extension to east buildings	Shade devices
Insulation - roof	Likely[a]	Classrooms - unikely[b] Library - No	Permanent buildings - Yes Transportables- no	Likely[a]	Likely[a]
Insulation - ceiling	Unknown	Library	Yes	Likely[a]	Likely[a]
Insulation - walls	No, except one classroom	No, except library	No - permanent buildings Yes - transportables	Likely[a]	Likely[a]
Thermal mass - walls	Yes	Yes	Yes	No	No
Thermal mass - floor	Yes	Yes	Yes	Yes	Yes
Reduce waste and resources during construction	Possible - use of local mass wall material	Possible - use of local mass wall material	Possible - use of local mass wall material	Unknown	Unknown
Energy efficient components	T5 lamps Heat exchanger[b]	T5 lamps	T5 lamps	T5 lamps BMS Heat exchanger[c]	T5 lamps Heat exchanger[b]
Energy use limiting components	Timers HVAC, lights	Timers HVAC, lights	Timers HVAC, lights	*Fully automatic HVAC* Timers lights	Timers HVAC, lights
Renewable energy components	Photovoltaics	Photovoltaics	Photovoltaics	Photovoltaics	Photovoltaics
Water harvest and reuse	Rainwater tanks - water used for toilet flush	Nil	*Rainwater tank (disconnected)*	Connected to suburb recycling system	Rainwater tank
Water use limiting components	None observed	None observed	None observed	Water saving taps	None observed
Low VOC installations[d]	Possibly - natural fibre carpet	Possibly - natural fibre carpet	Possibly - natural fibre carpet	Possibly - natural fibre carpet	Possibly - low VOC synthetic fibre carpet
Site biodiversity increased	Food production garden	Food production garden	Eco-system reinstated Food production garden	Food production garden	Food production garden

a. No roof access due to WHS issues, or drawings and specifications not sighted. Roof sheeting looks like it has been replaced within last 15 years, so roof insulation needed to comply with Australian Building Code.

b. No roof access due to WHS issues. Roof tiles do not look like they have been replaced within the last 15 years. Roof tiles possibly original

c. No roof access due to WHS issues, or drawings and specifications not sighted. Component considered likely due to ceiling vent configuration.

d. Based on professional observations, i.e., previous professional specification of carpet ranges in school projects.

e. Observed low or non-use in *italic grey*

4.2.4 Indoor environment control components

All case study schools exhibited a range of passive and active components available for controlling temperature and ventilation. The energy efficiency of the installed active components is unknown due to lack of access for forensic investigations of plant. Table 4.5 shows observed components. All schools had some form of automation, but all, except White School, had manual override switches visible on classroom walls. An example of this is shown in Photograph 4.8, where both the controls (lower on the wall, above light controls) together with the set point control panel, this latter not being centrally controlled in some schools (Orange, Purple, and some Red classrooms). There were no observed use of portable heating and cooling appliances. No portable fans were observed in the study classrooms.

Photograph 4.8: Typical local controls, Red.3 shown – left, HVAC set point control above, with controls below (DSCF6477_120802mod.JPG); right, detail of controls, HVAC f above, lights below (DSCF6476_120802mod.JPG).

White School components were controlled through two building management systems that were intended to be accessed through the local computer network. Attempts to access this network on one pre-arranged visit and two attempts during spot measurement visits proved fruitless due to lack of access to the appropriate server. In lieu of this, the available instructions were reviewed in attempt to judge ease of use. The instructions issued to staff were found to be five pages long and showed two different procedures for the two campuses. There also seemed to be staff who were specialists in accessing and setting the controls. This lack of access to the BMS removes egalitarian access to local control through over-engineering and removes potential for specific teaching and modelling behaviour.

Table 4.5: Summary of passive and active HVAC by case study classroom

Class	Heating / Cooling			Ventilation			Operable external windows			Ceiling Fan	
	Type	Control	Used[a]	Type	Control	Used[a]	Installed	Control	Used[a]	Installed	Used[a]
Yellow.1	Wall mounted split inverter	2 hour timer + override	■	Nil	Nil	Nil	Yes	Manual	N/A	Nil	Nil
Yellow.2	Ducted	2 hour timer + override		Mech?	2 hour timer + override	N/A	Yes	Manual	N/A	Nil	Nil
Yellow.3	Ducted	2 hour timer + override	■	Mech?	2 hour timer + override	N/A	Yes	Manual	N/A	Nil	Nil
White.1	Ducted	Automatic	■	Wall vents / Mech	Auto	N/A	Yes	Auto	N/A	Nil	Nil
White.2	Wall mounted split inverter	Automatic	■	Wall vents / Mech	Auto	N/A	Yes	Auto	N/A	Nil	Nil
White.3	Wall mounted split inverter	Automatic	■	Wall vents / Mech	Auto	■	Yes	Auto	■	Nil	Nil
White.4	Wall mounted split inverter	Automatic	■	Wall vents / Mech	Auto	■	Yes	Auto	■	Nil	Nil
White.5	Wall mounted split inverter	Automatic	N/A	Wall vents / Mech	Auto	N/A	Yes	Auto	N/A	Nil	Nil
Orange.1	Evaporative cooling Gas ceiling infrared heating	Manual Manual	■ ■	Wall vents	Manual	N/A	Yes	Auto/ Manual	■	Nil	Nil
Orange.2	Under ceiling mounted split inverter	2 hour timer + override	■	Wall vents	Auto/ Manual	N/A	Yes	Auto/ Manual	N/A	Nil	Nil
Orange.3	Under ceiling mounted split inverter	2 hour timer + override	■	Wall vents	Auto/ Manual	■	Yes	Auto/ Manual	■	Nil	Nil
Orange.4	Under ceiling mounted split inverter	2 hour timer + override	■	Wall vents	Auto/ Manual	N/A	Yes	Auto/ Manual	N/A	Nil	Nil
Orange.5	Ceiling mounted split cassette inverter	2 hour timer + override	■	Nil	Nil	Nil	Yes	Manual	N/A	Nil	Nil
Orange.6	Under ceiling mounted split inverter	2 hour timer + override	■	Nil	Nil	Nil	Yes	Manual	N/A	Nil	Nil
Orange.7	Under ceiling mounted split inverter	2 hour timer + override	■	Wall vents	Auto/ Manual	N/A	Yes	Auto/ Manual	N/A	Nil	Nil
Red.1	Under ceiling mounted split inverter	2 hour timer + override	■	Mech[b]	2 hour timer + override	N/A	Yes	Manual	■	2	■
Red.2	Ceiling mounted split cassette inverter	2 hour timer + override		Mech[b]	2 hour timer + override	N/A	Yes	Manual	N/A	2	■
Red.3	Ducted, plant in office ceiling	2 hour timer + override	■	Mech[b]	2 hour timer + override	N/A	Yes	Manual	N/A	3	N/A
Red.4	Wall mounted split inverter	2 hour timer + override	■	Mech[b]	2 hour timer + override	N/A	Yes	Manual	N/A	2	■
Red.5	Wall mounted split inverter	2 hour timer + override	■	Mech[b]	2 hour timer + override	N/A	Yes	Manual	■	1	■
Purple.1	Ducted	2 hour timer + override	■	Mech	2 hour timer + override	N/A	Yes	Manual	N/A	Nil	Nil
Purple.2	Ceiling mounted split cassette inverter	Timer with override	■	Mech[b]	Timer + override	N/A	Yes	Manual	N/A	Nil	Nil
Purple.3	Ceiling mounted split cassette inverter	Timer with override	■	Mech[b]	Timer + override	N/A	Yes	Manual	■	Nil	Nil
Purple.4	Ceiling mounted split cassette inverter	Timer with override	■	Mech[b]	Timer + override	N/A	Yes	Manual	■	Nil	Nil

a. An element is considered 'Used' if it is observed to be in use during a site visit, i.e., this observation does not preclude the use of elements between site visits.

b. Based on the ceiling SA and RA vent configurations it is highly suspected that there are 'economy cycle' ventilation systems installed, i.e., where outdoor air is vented mechanically into rooms via ducting when the outdoor temperature is within the set temperatures. However, mechanical drawings were not available and wall controls did not differentiate between heating/cooling and ventilation only.

In addition to these specific indoor environment elements, doors were observed to be used to control the indoor environment. Schools had two types of doors - main egress doors (approximately 1000mm wide opening and usually swing doors) and internal doors wider than 1000mm opening (see Section 4.5.3.1). During site visits some swing doors, both internal and external, were observed to be open while students were in the room. Additionally, some doors were observed to use ad hoc apparatus to keep the doors open, such as traffic cones. While external doors are primarily for access to and enclosure of a space, it is hypothesised that they were kept open for one or more of the following four reasons: forgetting to close them; kept open because they are difficult to operate; kept open to increase connection to the adjacent space; attempts to increase ventilation. Given the last hypothesis, observed door states are given in Table 4.6. It was observed that both internal and external egress doors were left open during class time, with two external doors observed to be propped open.

Table 4.6: Main egress doors observed to be open at least once when classes are in progress

	External Egress Door	Observed open during classes	Internal Egress door	Observed open during classes
Yellow.1	Swing - 2 leaf x2			
Yellow.2			Swing - 2 leaf	■
Yellow.3			Swing - 2 leaf	■
White.1	Swing - 1 leaf x2	■	Swing - 2 leaf	■
White.2	Swing - 1 leaf	■ (propped open with traffic cone)		
White.3	Swing - 1 leaf	■ (propped open with door stopper)		
White.4	Swing - 1 leaf	■		
White.5	Swing - 1 leaf			
Orange.1	Swing - 1 leaf x2	■		
Orange.2	Swing - 1 leaf		Swing - 1 leaf	■
Orange.3	Swing - 1 leaf		Swing - 1 leaf	
Orange.4	Swing - 1 leaf		Swing - 1 leaf	■
Orange.5	Swing - 1 leaf x2			
Orange.6	Swing - 1 leaf	■		
Orange.7	Swing - 1 leaf	■	Swing - 1 leaf	■
Red.1			Swing - 1 leaf	■
Red.2	Swing - 2 leaf		Swing - 1 leaf	■
Red.3			Swing - 1 leaf	
Red.4			Swing - 1 leaf x2	■
Red.5			Swing - 1 leaf	
Purple.1	Swing - 1 leaf		Swing - 1 leaf	
Purple.2	Swing - 1 leaf			
Purple.3	Slider - 2 leaf	■		
Purple.4	Slider - 2 leaf x2	■		

The core operating hours of each case study school varied slightly, as shown in Table 4.7, with all schools providing schooling for approximately 6 1/2 hours each day, including 'breaks'. These can be considered as part of the pedagogy (see Section 2.3.4.6) and may be taken indoors during inclement weather, due to Child Safety & Wellbeing policies (Department for Education and Child Development 2013). This practice was observed at Red School (15/8/12, rain) and Orange School (17/8/12, rain; 29/11/12, heat). These hours are less than those assumed by the energy efficient provision of the 2012 Building Code of Australia, which propose appliances are used between 8am and 4pm at great than 70% load (Australian Building Codes Board 2012).

Table 4.7: Core operating hours

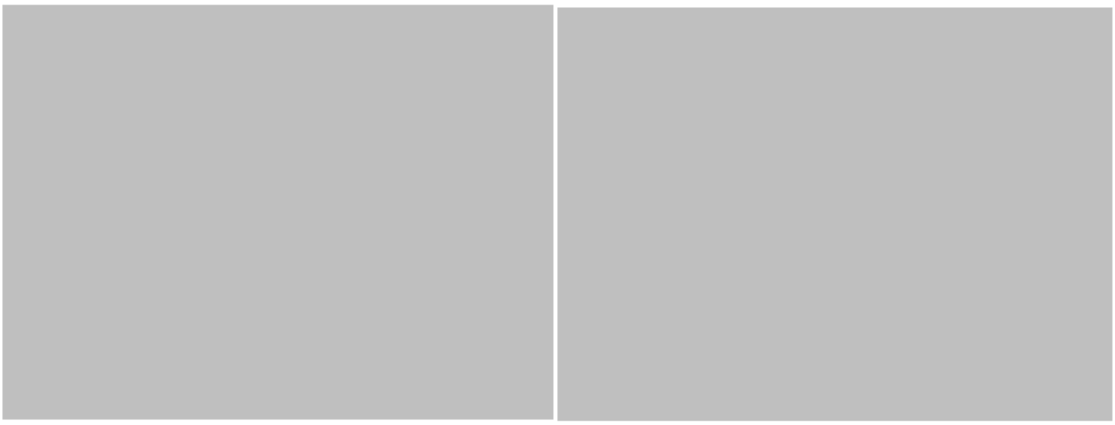
School	yard supervision starts	start	first break	break (mins)	start	second break	break (mins)	start	end	yard supervision ends
Yellow	8.40 am	8.55 am	11.00 am	30	11.30 am	1.15 pm	25	1.40 pm	3.25 pm	3.30 pm
White	8.15 am	8.30 am	10.40 am	20	11.00 am	1.00 pm	30	1.30 pm	3.00 pm	3.15 pm
Orange	8.30 am	8.45 am	11.00 am	20	11.20 am	1.00 pm	30	1.30 pm	3.10 pm	3.25 pm
Red	8.30 am	8.55 am	11.20 am	25	11.45 am	1.20 pm	25	1.45 pm	3.15 pm	3.15 pm
Purple	8.35 am	8.50 am	11.00 am	30	11.30 am	1.00 pm	30	1.30 pm	3.00 pm	3.20 pm

4.2.5 Views, Artificial lighting and daylight design

All case study classrooms had both artificial lighting and daylight. Artificial lighting was typically T5 lamps in either hung or surface mount luminaires.

Daylight was available from a mixture of user level windows, skylights and clerestories, with some film on glazing and some interior blinds. The older buildings were without exterior verandas or shade devices. The observed fenestration and treatment is summarised in Table 4.8. This should be read in conjunction with the temporary user modifications described in Table 4.22 and Table 4.23.

Views out of the classroom varied depending on the architecture and the use. The permanent Orange School buildings had views onto bag racks. The White, Red and Yellow schools had high sills (greater than 1000 AFL) so views were restricted to sky and trees when seated, particularly with blinds down where installed. The standing view from Yellow.3 to the east (opposite the view to the IWB), was of the Adelaide Hills, so relatively attractive. Examples of views are shown in Photograph 4.9.



Photograph 4.9: Examples of views – Orange.7 view to bag rack and chimneys (DSCF6562_120803mod.JPG); Yellow.3 view to east from standing position (DSCF6338_120731mod.JPG).

Table 4.8: Summary of fenestration treatment by case study classroom

Class	External Windows	Operable windows (external)		Veranda / shade device	Window film	Interior blinds		Skylight (S) / Clerestory (C)
	Direction	Installed	Control			Installed	Maximum coverage	Operable (Op)
Yellow.1	N	■	Manual	■	■	■	100%	nil
Yellow.2	N	■	Manual	nil	nil	■	100%	nil
	E	■	Manual	nil	nil	■	100%	
Yellow.3	N	■	Manual	nil	nil	■	100%	nil
	E	■	Manual	nil	nil	■	100%	
	S	■	Manual	nil	nil	■	100%	
White.1	N	■	Automatic	■	■[a]	nil	nil	C ■ Op
	E	nil	Fixed glazing	nil	■[a]	nil	nil	
	S	■	Automatic	nil	nil	nil	nil	
White.2	N	■	Automatic	■	nil	■	60%	C ■ Op
	S	■	Automatic	■	nil	nil	nil	
	W	nil	Fixed glazing	nil	nil	■	100%	
White.3	N	■	Automatic	■	nil	■	60%	C ■ Op
	S	■	Automatic	■	nil	nil	nil	
	W	nil	Fixed glazing	nil	nil	nil	nil	
White.4	N	■	Automatic	■	nil	nil	nil	C ■ Op
	S	■	Automatic	■	nil	nil	nil	
White.5	N	■	Automatic	■	nil	■	60%	C ■ Op
	S	■	Automatic	■	nil	nil	nil	
Orange.1	N			■	■	nil	nil	S ■
	SE	■	Auto/ Manual	■	■	nil	nil	
	NW			■	■	nil	nil	
Orange.2	S	■	Auto/ Manual	■	■	nil	nil	nil
Orange.3	N	■	Auto/ Manual	■	■	nil	nil	S ■
Orange.4	N	■	Auto/ Manual	■	■	nil	nil	S ■
Orange.5	N	■	Manual	nil	nil	■	100%	nil
	S	■	Manual	■	nil	nil	nil	
Orange.6	E	■	Manual	nil	nil	■	100%	nil
	W	■	Manual	■	nil	nil	nil	
Orange.7	S	■	Auto/ Manual	■	■ (2100-3000AHL)	nil	nil	nil
Red.1	N	■	Manual	■	nil	■	80%	nil
	E	■	Manual	■	nil	■	80%	
Red.2	N	■	Manual	■	nil	■	100%	C ■
	E	■	Manual	■	nil	■	100%	
Red.3	N	■	Manual	nil	nil	■	70%	nil
	S	■	Manual	nil	nil	nil	nil	
Red.4	N	■	Manual	nil	nil	■	70-80%	nil
Red.5	N	■	Manual	nil	nil	nil	nil	nil
	E	■	Manual	nil	nil	■	80%	
Purple.1	N	■	Manual	■	nil	■	100%	C ■ Op
	S	■	Manual / Auto	■	nil	nil	nil	
	W	nil	Fixed glazing	■	nil	nil	nil	
Purple.2	N	■	Manual	■	nil	nil	nil	nil
	S	■	Manual	■	nil	nil	nil	
	W	■	Manual	■	nil	nil	nil	
Purple.3	N	■	Manual	■	nil	nil	nil	S ■
Purple.4	N	■	Manual	■	nil	nil	nil	S ■
	S	■	Manual	■	nil	nil	nil	

a. Ephemeral installations by current users. Not permanent installations

View obstruction is discussed in the context of permanent changes to control daylight (Section 4.4.3), display (Section 4.5.3.3), and view control (Section 4.5.3.5).

4.3 Public descriptions of case study schools

Public documents other than construction drawings were sourced from the World Wide Web to provide community context for the case study schools (Section 3.5.2). The documents collected were restricted to authors who had a connection with the case study schools, i.e., newspapers were not interrogated. The document content was analysed to develop public perspectives of case study schools from the building design team, the schools themselves, and other publically available commentary with a connection to the schools.

Previously, case study school candidates had been assessed for their recognised architectural value during the selection process (Section 3.4). The architectural commentary associated with these schools, together with any commentary available on the websites of the design teams (architects and engineers) that were involved in recent (10 years) construction activity, was reviewed. The commentary has been coded by the features discussed on architect and service engineer web sites, together with samples of text under each code are presented in Table 4.9.

Architects tended to present an overall design strategy and their understanding of the school pedagogy their design was to cater for. Examples of facilities were given to meet these overall strategies, together sustainability objectives and features. One example of a service engineer was found where services elements and control were featured on their website. Architects expressed a variety of strategies, but pedagogy tended to focus on flexibility, space for group work, and sustainability teaching. The facilities mentioned varied from toilets to circulation to pleasant spaces to buildings as teaching tools, while any mention of sustainability was either to state it was present, or list typical elements associated with sustainable development.

Two different types of school documents were assessed for mention of the school built environment. Table 4.10 refers to general school overview documents, such as annual reviews or context statements, this latter being a standard summary of the school. Being formal documents it was expected that these might align to the architectural documents, so the similar coding was used, however design strategy was replaced by key policies. Table 4.11 reviews the mentions of the built environment in newsletters. Because the mentions of buildings, facilities and/or sustainability were found to be few, these have been collated and summarised by schools.

Table 4.9: Architecture description summary of Case Study buildings by architects, service engineers, and jury citations.

	Architect					Services Engineers	
School	**Design process, intent strategy**	**Pedagogy**	**Facilities**	**Sustainability**	**Source** Refer **A.2**	**Features**	**Source** Refer **A.2**
Yellow	'Conservation and adaptive reuse'	'integrated early learning' 'opening up the space and creating more flexibility'	New services, toilets	Daylight	YellowPD 2014	N/A	N/A
	'Conservation and adaptive reuse'	'the first 'Integrated Early Learning Centre' in Adelaide.'	Nil	Nil	YellowPD 2013		
White	'comprehensive consultation'	'flexible interior spaces'	Connected to community facilities	'daylight', 'natural ventilation' 'exemplary environmentally sustainable design principles'	WhitePD 2014 (refers to east campus)	N/A	N/A
	Stakeholder collaboration, including students. Relates to street through windows.	'new century' learning. Small group learning. Landscape offers different play experiences	'Advanced' ICT.	'Natural ventilation', 'environmental concerns', thermal chimneys '...express the importance of sensitive environmental design...'	WhitePD 2010a		
	'...economic, repetitious and robust low maintenance building...' Use of CFD for airflow testing	Building allows team teaching. Sustainability curriculum.	Subject specific learning spaces. Wireless ICT,	Building orientation, natural light, BMS controls windows, thermal chimneys (simulated by CFD), heat exchangers, PV, aquifer recharge, connection to suburb greywater.	WhitePD 2010b		
	'...sensitive resolution ... within its urban context.'	'Environmental initiatives are clearly demonstrated'	'...subtly different spaces...to be enjoyed from classrooms...'	Thermal chimneys, daylight, 'large roof overhangs', solar hot water, BMS, water reuse.	WhitePD 2012a		
Orange	N/A	'activity oriented'	'co-locating' schools 'sharing facilities'	'ecologically sustainable development (ESD)'	OrangePD 2012	N/A	N/A
	Pilot Ecological Sustainable Development (ESD) project. 'reduce energy consumption and greenhouse gas emissions'	Implies that staff will create complementary ESD curriculum.	'demonstrate good environmental practice' to students	Building orientation, glare control, low embodied energy materials, low VOC, thermal flues, timers	OrangePD 2010		
Red	New building character match old buildings	'external teaching spaces'	Facilities re-arranged. 'legible, shaded circulation'	'new...high level windows to provide daylight and ventilation'	RedPD 2014a	AC uses 'heat reclaim to reduce energy use'	RedPD 2014b
						Motion sensors, rainwater toilet flush, economy cycle AC	RedPD 2014c
Purple	Stakeholder consultation, including students.	'...supports students to become more independent, flexible and creative in their learning.'	'...new, adaptable, and connected learning areas...' 'stimulating', 'full of light, air, colour...'	Not referred to specifically	PurplePD 2011	N/A	N/A

Table 4.10: School descriptions from publically available school overview documents

School	Key policies	Pedagogy	Facilities	Sustainability	Sources
Yellow	Multicultural. Integrated early learning centre.	'Composite classes. Flexible teaching and learning to meet the needs of individuals'	Range of facilities for Birth to Year 7, with gym and parenting education.	PV, energy efficient lamps, water saving irrigation, rainwater tank, recycling, drought resistant planting	YellowPD 2012a
	Quality teaching (based on (Hattie 2009)) Literacy, Maths and Science, Wellbeing and Inclusive Practice	Teaching for Effective Learning. 'intentional teaching, reflective practice, wellbeing and involvement.'	Nil	Nil	YellowPD 2012b
White	'Lifelong learners who positively influence our community...'	Teaching for Effective Learning. 'inquiry method', 'higher order thinking skills', 'collaborative learning', 'embedded IT' Ongoing professional development.	Different campuses, zones. Community Hall/ gym	Sustainable practices and care of central ecosystem	WhitePD 2012b
Orange	'developing positive relationships for life-long learning'	'Engaged learning', 'explicit teaching' 'small group consolidation of skills' 'higher order thinking', 'cross age and peer tutoring.'	'modern' Computers Shared facilities Student facilities such as shelter, play equipment, fitness stations	'ecologically sustainable school', heating, cooling, 'natural ventilation', 'other energy saving features'	OrangePD 2012a
	Nil	Teaching for Effective Learning. Australian Curriculum. Ongoing professional development.	Nil	Nil	OrangePD 2012b
Red	National Values Education Project (Opportunity, Creativity, Diversity, Community)	Teaching for Effective Learning. 'Student voice, Key competencies...Literacy, Numeracy, Inquiry based learning' Higher order thinking skills 'Stephen Graham i-Lit explicit teaching'	Heritage listed buildings and memorials. Gym, performing arts.	Nil	RedPD 2012a
	Nil	Teaching for Effective Learning. Increased display of student work.	Nil	Nil	RedPD 2012b
	'...community school based on rich heritage and strong tradition and identity.'	Range of teaching pedagogy. Use data to adjust for student needs. 'student involvement in environmentally sustainable practices.'	'Functional and fun'	'environmentally sustainable', increase use of renewable resources	RedPD 2012c
Purple	Multicultural. '...building positive identities in all our learners with others in a safe, supportive and challenging environment.'	Nil	Nil	Nil	PurplePD 2012a
	Nil	Constructivist. Students 'learners in their own right' Various learning tasks.	Nil	Nil	PurplePD 2012b
	Nil	Nil	Technology school IWBs	Nil	PurplePD 2012c

The school overview documents provided a variety of key policies. Schools provided similar pedagogical ideas to architects, such as group learning. When compared to architects' summary of pedagogy, the school overview documents also provided a large description of the range of their pedagogy, and used more nuanced language, as might be expected given their expertise. Schools listed fewer facilities than architects and identified less fine detail. Schools identified that their school was 'sustainable' or had sustainability features, but none identified as using them in their curriculum as a learning tool. Facilities were mention most in Yellow school newsletters, albeit with a low rate of publication. The prolific White School newsletter publication saw the widest variety of facilities discussed, which is consistent with their stated 'sustainable practices' and focus on different zones and facilities in their overview documents.

Table 4.11: Mention of buildings or facilities in school newsletters during 2012

School	Number of 2012 newsletters available	Mentions of buildings, facilities or sustainability	%	Items mentioned
Yellow	10	9	90	Sustainability (school growth), new group work locations, buildings used in curriculum, garden,
White	45	19	42	New verandas, improved play spaces, signage, circulation, sustainability, interpretive trail, energy, water quality
Orange	20	6	30	Garden, new solar panels, recycling, transportable buildings,
Red	17	4	24	Sustainability project, sustainability audit, waste
Purple	17	7	41	Opening of new building, transportable buildings, gardening project

Table 4.12: Other architecture descriptions from non-architectural, non-school public documents

School	Design process, intent strategy, context	Pedagogy	Facilities	Sustainability	Source Refer **A.2**
White	'Creating a Sustainable and Energy Efficient Environment'	'whole student', 'learn independently, interdependently and collaboratively'	Windows onto street as places of individual and group learning. Wireless ICT. 'individual identity for 'family units".	'Visible ESD design elements'	WhitePD 2005
	Multi-campus '...provides leading edge education services' Stakeholder consultation. 'environmentally responsible.'	Education to whole community.	Modular, flexible spaces for group work and individual study. 'advanced information & communications technologies.'	Daylight, cross ventilation, landscape zones. Triple bottom line sustainability. BMS accessible to students via laptop	WhitePD 2011
	'sensitive and simulating educational environment' 'large volume learning areas'	'holistic learning environment'	Courtyards as learning space. Group work in window bays along street. Shared facilities (library) with community. Artwork.	Cross ventilation via thermal chimneys, 'sun shaded windows', solar hot water. BMS accessible to students via laptop	WhitePD 2006

4.4 Permanent building fabric modifications

Fabric modifications were identified by comparing site observations to original drawings (where available) and discussions with staff. It was not certain that the supplied drawings were 'as-built' and no variation tracking of the original build was made available to identify project changes during the construction. Neither design and construction staff were contacted, nor former school staff, so identification of fabric changes used forensic investigation techniques, but without opening up the fabric.

The fabric was examined for visible changes using professional judgement and were recorded with notes and photographs. The changes noted below are not a definitive list of fabric modifications over the building lifetime, nor constitute a dilapidation report. They are intended only to identify where fabric was very obviously modified by the schools or education authorities.

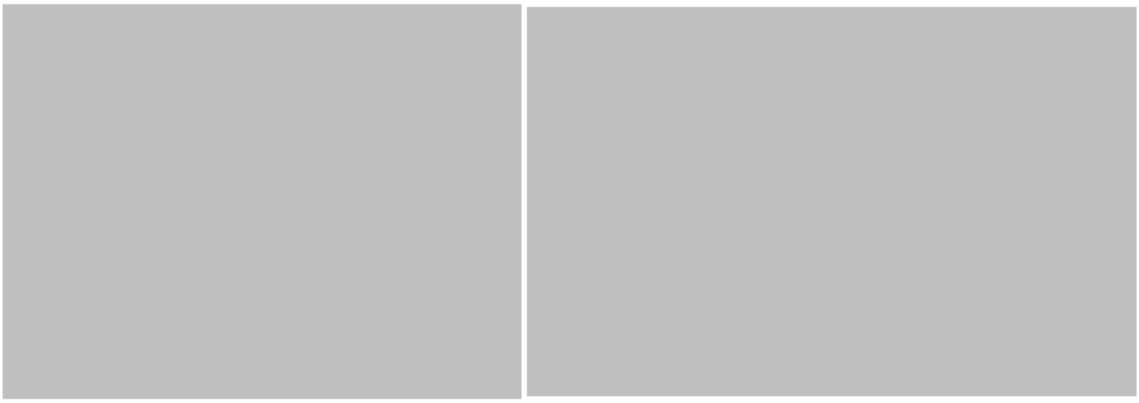
The fabric modifications, discussed below, were considered to be any 'permanent' change to the building fabric, whereas pedagogical personalisation of a space was treated as a temporary change. While both are potentially reversible, a building modification was assumed to have been a significant cost and installed by non-teaching staff. Though a building modification could be considered as personalisation of the school community, this research has assumed that personalisation is a temporary modifications to a restricted indoor space (classroom) by individual teachers and is discussed further within the classroom level of observation (see Section 4.5.2)

4.4.1 Retrofitted 'sustainability' demonstration appliances

All schools had retrofitted energy 'demonstration appliances' for use in 'teaching and learning programs', some of which had the require 'linkage to the school IT system' (DECS Asset Services 2009). These are listed in Table 4.13 together with their visibility to students, i.e., to identify whether students could see them from ground level or their play areas. The contrasting visibility of photovoltaic panels is demonstrated in Photograph 4.10, where it is shown that students might easily see panels on light poles as compared to roof installations.

Table 4.13: Visibility of 'demonstration' appliances

School	Photovoltaic panels		Rainwater tank	
	Installed	**Visible to students**	**Installed**	**Visible to students**
Yellow	Library room, 2010 Light poles, 2010	No Yes - from play area	No	Nil
White	Building 2 and 4 roof, East campus, 2011	No	No	Nil
Orange	Administration roof, 2012	No	Library, disconnected	Yes
Red	Gym roof, unknown	Yes - from footpath outside school	South elevation JP building	Yes
Purple	Library roof, unknown	Yes - from opposite footpath outside of school entrance	Multipurpose teaching centre	Yes



Photograph 4.10: Photovoltaic visibility: Left Yellow School PV panels on lights (DSCF5634_111201mod.jpg) and PV flat on roof at Purple (IMG_2497_111210mod.JPG)

4.4.2 Reconfigured 'sustainability' components

It was also observed that building components that had been installed to reduce energy use had been modified from the original configuration. This was particularly evident in Orange.1, which was originally configured so that cooling was provided using evaporative panels (approximately 4 m^2 each) on the north, west, and south sides of a central tower. This was presumably intended to operate as an evaporative cool tower (Kwok & Grondzik 2011, pp. 179-185). This system was replaced three years after occupation with a mechanical evaporative unit (see Photograph 4.11), suggesting that it did not provide appropriate cooling for occupants.

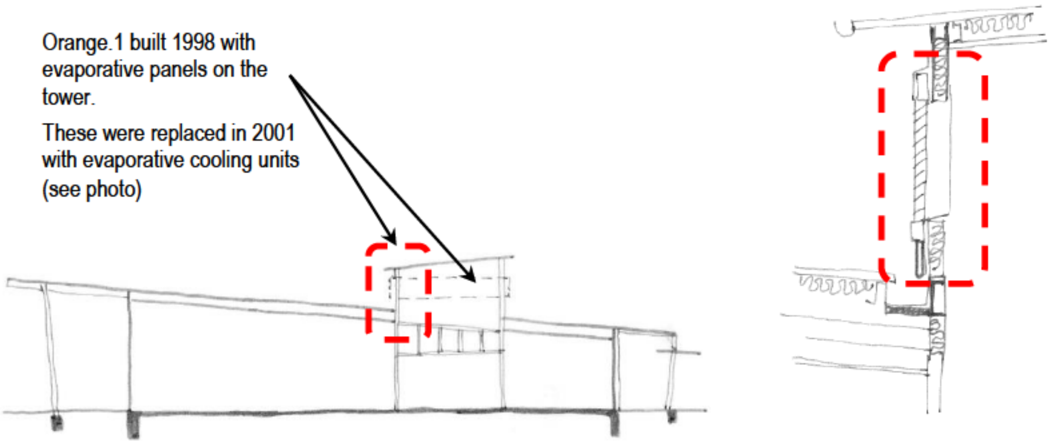


Figure 4.8: Orange.1 removed evaporative panel – east/west section, left, detail, right (not to scale). Based on DAIS3

Photograph 4.11: Orange.1 evaporative air conditioning and modified skylight. Left - exterior view of southeast elevation (DSCF5564_111125mod.JPG). Right - interior view, skylight visible to right (DSCF6083_120328mod.JPG)

4.4.3 Modifications to control daylight

Three types of permanent modifications to windows were observed - internal blinds, window film, and a veranda extension - and listed in Table 4.14. These modifications had the effect of changing both the daylighting design and solar gain of the original designs.

Table 4.14: Permanent building modifications for daylight control

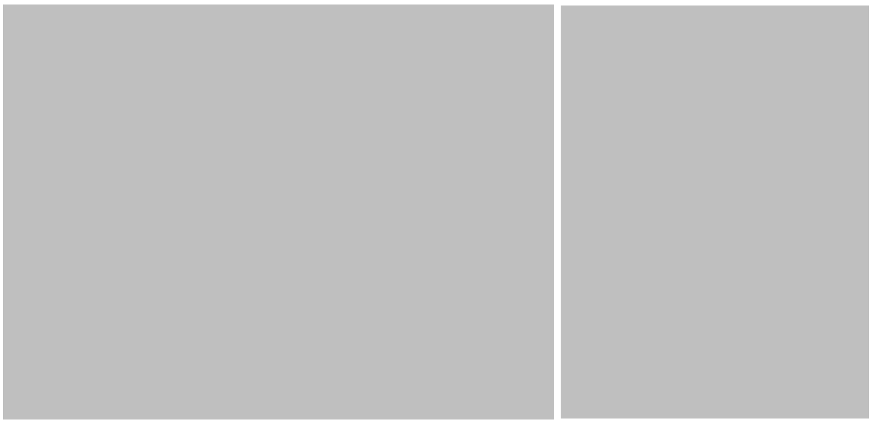
Natural light modification	Description	Observed in case study	Approximate year of retrofit
Internal blinds	Opaque or translucent blinds retrofitted	Yellow.2, 3	2003
		Red	Likely at or after the 2006 renovation
Film	Reflective or heat control tinted film retrofitted to permanent buildings	Orange	After 2001 school extension
		Yellow.1	2008
Veranda extension	Extension of overhang to control light	White - observed during study	2012 - documented during this inquiry

There is also evidence that the east windows to Yellow.2, Yellow.3, and possibly Red.5, were either not built as drawn or have been made larger prior to contemporary drawing evidence. Confirmation of this falls into specialist forensic heritage inquiry methods, but is noted here as a professional observation.[32] This is included to suggest that action has been taken throughout both buildings lives to change light levels.

During the study period, the north veranda overhang on White.1 was observed to be extended so that it was roughly doubled in size (as were all north verandas in this side of White school). Prior to this, the occupants had been attempting to control the daylight on the east end of the north window with scrim, which was noted as absent on the site visit of 18/7/12, and shown[33] in the left image of Photograph 4.12. The exterior of the north elevation of White.1 is shown before and after the extension in Photograph 4.13, with the proportion of the extension shown in Photograph 4.14. It is noted that this modification was completed as an addition to the building, rather than as a

[32] In a professional capacity, the evidence observed would be enough to confirm the windows have been remodelled.
[33] This photo shows only the bottom of the scrim due to students in the vicinity.

redesign, i.e., the existing roof, gutter and downpipes were retained and the overhang and columns were added on and new downpipes were attached to the existing, rather than extending the overhang, matching the columns and providing new downpipes to the extended veranda. The new view out of White.1 is shown in the right image of Photograph 4.12.



Photograph 4.12: Left: scrim in north side, east end, of White.1 pre veranda extension (DSCF5993_120320mod.JPG); Right: north window east end of White.1 after veranda extension (DSCF7677_121128mod.JPG)

Photograph 4.13: White.1 veranda north elevation. Left: February view to south west (DSCF5818_120202mod.jpg) Right: July view to south east (DSCF6194_120718mod.jpg)

Photograph 4.14: White.1 veranda extension components: view along north elevation (DSCF6193_120718mod.jpg)

4.4.4 Retrofitted Interactive Whiteboards

All classrooms had fixed projectors or interactive whiteboards (IWB[34]). All were retrofitted except Orange.6, which was a transportable configured for IWB installation, and Purple.3 and Purple.4. Some classrooms showed evidence of modification and rectification due to IWB installation. Installations and modifications are summarised in Table 4.15.

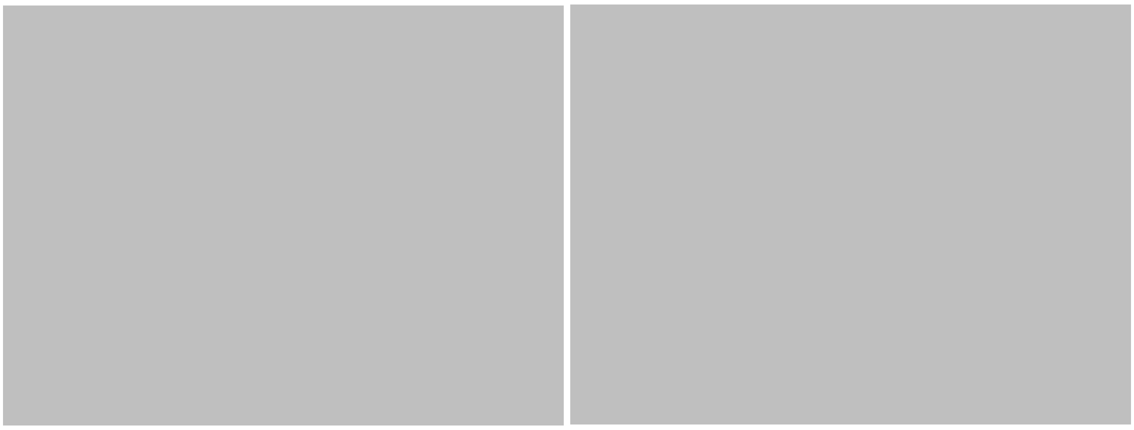
Table 4.15: Modifications for IWB installation

Classroom	Type	IWB location	Visible modifications to fabric for IWB	Sources
Yellow.1	IWB	South wall	nil	
Yellow.2	Projector	West wall and south wall	IWB projector and screen retrofitted to walls. South wall scribe to projector visible. West wall IWB projector hung from light fittings	DSCF8002.jpg DSCF6374.jpg
Yellow.3	Projector	West wall x2	Cable run visible on north end IWB. Both clearly not contemporary with building.	DSCF7436.jpg DSCF7427.jpg
White.1	IWB	North wall and South wall x2	North wall: evidence that joinery 'raised stage' has been removed and operable wall removed off track South wall: IWBs have cable cover visible to projector East end IWB installed under line of operable wall, operable wall removed	DAIS2[a] compared to DSCF7719.jpg DSCF7720.jpg DSCF7721.jpg DSCF7674.jpg DSCF7641.jpg DSCF7643.jpg DSCF5992.jpg DSCF6223.jpg
White.2	IWB	West wall	Cable run visible, i.e., not in wall.	DSCF5856.jpg DSCF6735.jpg
White.3	IWB	West wall	Cable run visible, i.e., not in wall. Holes visible from previous fixture (WB/PB?)	DSCF6933.jpg DSCF6963.jpg
White.4	IWB	East wall	Cable run visible, i.e., not in wall, and non-standard size PB adj, with different colours, suggests a fixture rearrangement	DSCF6908.jpg
White.5	IWB	Not installed		
Orange.1		Not installed (IWB in side room)		
Orange.2	IWB	West wall	nil	
Orange.3	IWB	East wall	nil	
Orange.4	IWB	East wall	nil	
Orange.5	IWB	East and West walls	nil	
Orange.6	IWB	North walls	nil	
Orange.7	IWB	West wall	nil	
Red.1	IWB	South wall	Dado rail chopped into for PB and WB. IWB installed over existing PB and WB.	DSCF6444.jpg DSCF6792.jpg DSCF6815.jpg
Red.2	IWB	West wall	IWB installed over existing pinboard and whiteboard. (photo)	DSCF6420.jpg DSCF6427.jpg DSCF7514.jpg DSCF7531.jpg
Red.3	IWB	West wall	PB may have been removed and replaced by IWB, but no physical evidence	DSCF6467.jpg
Red.4	IWB	South wall	PB removed and replaced by IWB	DTEI2[a] compared to: DSCF7073.jpg DSCF7069.jpg
Red.5	IWB	North wall	nil	
Purple.1	IWB	North wall	Nil - looks integrated, i.e., not retrofit	DSCF7246.jpg
Purple.2	Projector	North wall	Ceiling projector on WB	DSCF7171.jpg
Purple.3	IWB	East wall	Contemporary with building	
Purple.4	IWB	West wall	Contemporary with building	

a. Coded due to participant privacy agreements. For examination purposes only see Appendix A.

[34] School staff and students also referred to IWBs by their brand name 'Smartboards', but IWB is used in this research to indicate all brands.

Visual evidence of two building modifications for IWB installation are presented below, but they should only be considered as examples of IWB installation solutions, not exemplars. The first demonstrates how an existing building fabric was left in situ and the IWB was installed over a pin board and a white board. This occurred in a number of rooms but Red.2 was selected as an example purely for the clarity of the available photographs (Photograph 4.15).



Photograph 4.15: IWB installation in Red.2. View to west, west internal elevation. Left: context view of IWB (DSCF6430_120802mod.JPG). Right: evidence of IWB installation over blue pinboard (DSCF6420_120802mod.JPG)

White.1 provides an example of where building fabric was removed to accommodate IWB installation. The original layout, as derived from the construction drawing floor plan, is shown to the left in Figure 4.9. It was intended to have a raised stage to the northeast corner and three operable walls that could be moved along tracks running north south. No white board locations were shown on the plan, only pinboards.

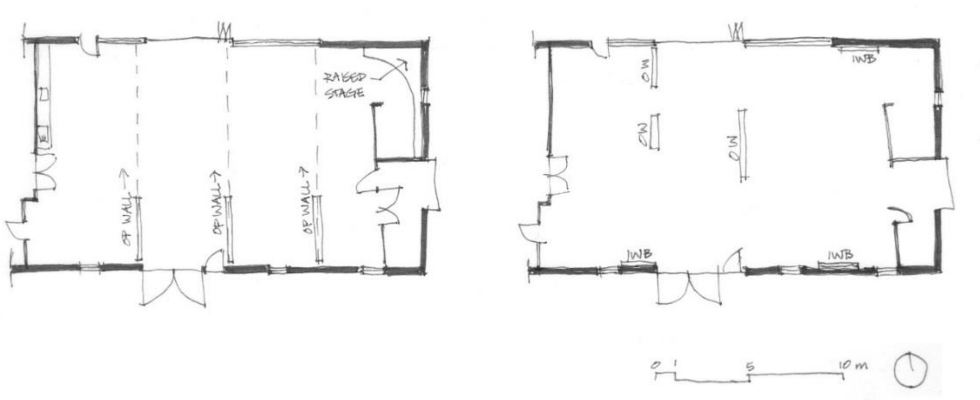


Figure 4.9: Sketch of White.1 floor plan changes. Left: original 2002 layout (derived from DAIS2). Right: observed 2012 layout.

The plan on the right of Figure 4.9 shows what was observed in 2012. The east most operable wall was removed and the other two had been located to the north and centre of the tracks. The pivot door on the east side had been removed, as had the stage. This is consistent with making space for three classes to fit around retrofitted IWBs observed in the locations shown. Photograph 4.16 shows where the stage has been removed to accommodate the north east IWB. Photograph 4.17 shows the southeast IWB location (behind the loose screen) and the pivot door opening relative to current use.


Photograph 4.16: IWB installation in White.1. View to north, north internal elevation, east end. Left: context view of IWB (DSCF7721_121128mod.jpg). Right: evidence of joinery removed for IWB installation (DSCF7720_121128mod.jpg)


Photograph 4.17: White.1 double swing door removed. Left - view to south, left arrow to swing door opening and right arrow to installed IWB on south wall (DSCF7668_121128mod.JPG). Right - view to east showing removed door (DSCF7648_121128mod.JPG)

The building fabric modifications to accommodate IWBs range from minor to extensive. The fact that these were pursued, despite cost and changes to relatively new buildings, suggests that IWBs represent a significant change in pedagogy or are a desired and useful pedagogical tool.

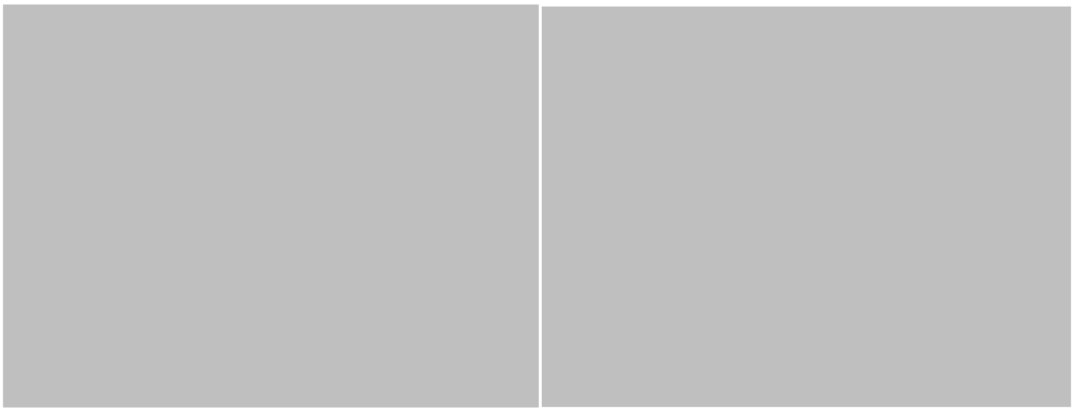
4.4.5 **Acoustic design and modifications**

Guidelines exist for the acoustic performance of South Australian classrooms (Section 2.3.5.4), however, rather than providing direction in the relevant acoustic physics, (e.g., Part IV in Grondzik et al. 2010), these policies suggest construction and materials that may help achieve acoustic needs, and a suggestion to engage specialist services.

All schools had obvious acoustic components included in classroom fabric, suggesting these policies are being enacted, though it is difficult to confirm whether specialist acoustic services were engaged in the design.[35] The newer schools showed some evidence of integrated acoustic design, while the two older schools, Red and Yellow, showed obvious building modifications to some classrooms that attempted to improve acoustics. The observed acoustic designs and modifications to fabric are shown in Table 4.16. Note that soft floor coverings provide some noise absorption, and all classrooms had carpet installed to approximately 90-100% of the floor. These, and other soft furnishings, are classified here as contributory acoustic components.

Similarly, wall insulation also provides acoustic noise ingress reduction in addition to thermal insulation; however, no evidence was available to suggest that specific noise insulation was specified over thermal insulation products. The presence or absence of solid core doors and acoustically isolating windows could not be determined from the available data, other than professional guesses, which have been omitted here.

Examples of observed acoustic elements are shown in Photograph 4.18, where two different acoustic ceiling types, both perforated. The left ceiling was observed to be corrugated perforated metal with likely material backing (similar to that specified in AUSCO1 in same school), whereas the right flat ceiling was observed to be perforated plasterboard.



Photograph 4.18: Two different acoustic ceiling strategies: left - corrugated perforated metal ceiling (Orange.5 DSCF7282_121025mod.JPG); right - suspended perforated plasterboard (Red.1 DSCF6820_120815mod.JPG)

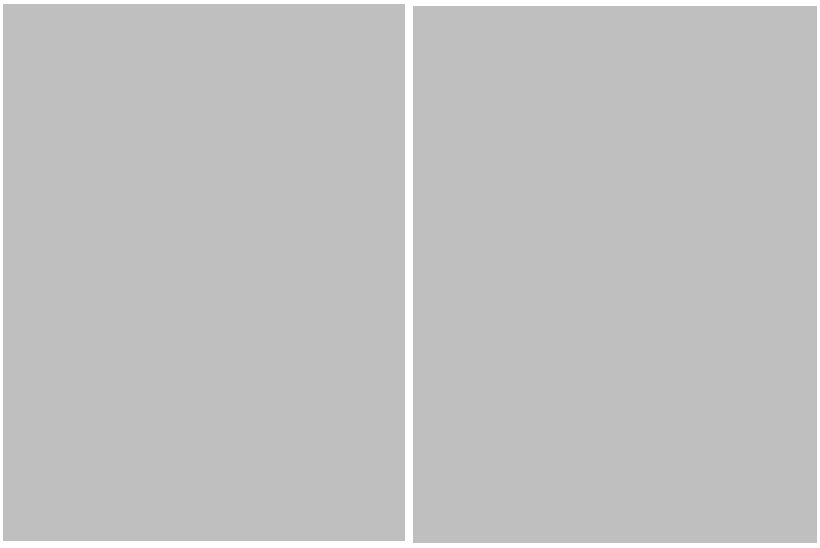
[35] From a professional perspective, Orange, White and Purple look like an acoustic consultant was involved. The retrofit of Red, particularly the bidirectional suspended acoustic panels looks like the work of a specific local consultant known to the author. The retrofit of Yellow does not look like an acoustic consultant was involved.

Photograph 4.19 shows two different acoustic retrofits to older classrooms. The left photograph shows Red.4 as an example of the retrofitting to all older rooms at Red School and demonstrates a strategy using suspended acoustic battens arrange at 90 degrees, i.e., placing a large amount of absorptive material in the space. To the right, Yellow School uses perforated plywood retrofitted to the ceiling.

Table 4.16: Observed acoustic elements and acoustic modifications to fabric

Classroom	Designed acoustic components	Acoustic modifications	Contributory acoustic components	Sources other than inspection (coded[a])
Yellow.1	Nil	Nil	Carpet on underlay; Pinboards	
Yellow.2	Nil	perforated plywood ceiling panels	Carpet; pinboards; soft furnishings (floor cushions)	
Yellow.3	Nil	perforated plywood ceiling panels; Electronic voice enhancement (microphone, amplifier and speaker)	Carpet; pinboards (area expanded during 2012)	
White.1	Suspended acoustic ceiling	Nil	Carpet; pinboards	DAIS2
White.2	Suspended acoustic ceiling	Nil	Carpet	
White.3	Suspended acoustic ceiling	Nil	Carpet; soft furnishings (sofa)	
White.4	Suspended acoustic ceiling	Nil	Carpet;	
White.5	Suspended acoustic ceiling	Nil	Carpet; soft furnishings (sofa)	
Orange.1	Perforated metal corrugated ceiling	Nil	Carpet with underlay; pinboards; rugs	SAS1
Orange.2	Perforated metal corrugated ceiling	Nil	Carpet with underlay; pinboards	DAIS1
Orange.3	Perforated metal corrugated ceiling	Nil	Carpet with underlay; pinboards	DAIS1
Orange.4	Perforated metal corrugated ceiling	Nil	Carpet with underlay; pinboards	DAIS1
Orange.5	Perforated metal corrugated ceiling	Nil	Carpet; pinboards; soft finish operable wall (kept open)	
Orange.6	Perforated metal corrugated ceiling; '2 layers of acoustic insulation to engineers design'	Nil	Carpet on underlay; pinboards; soft finish operable wall (kept closed)	AUSCO1
Orange.7	Perforated metal corrugated ceiling	Nil	Carpet with underlay; pinboards	DAIS1
Red.1	Nil	Suspended acoustic ceiling added; classroom volume reduced	Carpet; pinboards	DTEI1
Red.2	Suspended acoustic ceiling	Nil	Carpet; pinboards	DTEI1
Red.3	Nil	nil	Carpet; soft furnishings (bean bags)	DTEI2 DTEI3
Red.4	Nil	Suspended acoustic panels	Carpet; pinboards	DTEI3
Red.5	Nil	Suspended acoustic panels; 'acoustic treatment and baffling to dividing wall'	Carpet; pinboards; soft finish operable wall	DTEI2 DTEI3
Purple.1	Suspended acoustic ceiling	Nil	Carpet	
Purple.2	Unknown	Suspended acoustic ceiling; acoustic pinboard to full wall extent	Carpet	
Purple.3	Suspended acoustic ceiling; acoustic pinboard to full wall extent	Nil	Carpet	
Purple.4	Suspended acoustic ceiling; acoustic pinboard to full wall extent	Nil	Carpet; soft furnishings (upholstered benches)	

a. Coded due to participant privacy agreements. For examination purposes only see Appendix A.



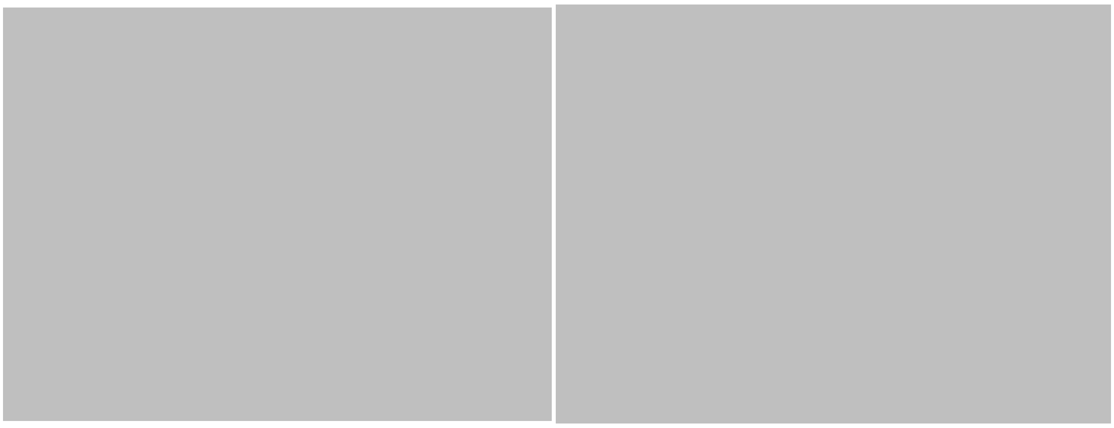
Photograph 4.19: Two different acoustic retrofit strategies: left - suspended acoustic panels (Red. 4 DSCF7055_121018mod.JPG); right - perforated plywood panels (Yellow.3 DSCF7450_121029mod.JPG)

During the study year, additional acoustic support was introduced to Yellow.3 in the form of electronic voice enhancement systems. Since there were two classes operating simultaneously in this space, two systems were installed and are shown in Photograph 4.20.

Photograph 4.20: Electronic voice enhancement speakers shown with red arrows in Yellow.3 (DSCF7414_121029mod.JPG)

4.4.6 Modifications to increase display opportunities

From the first visit, it was obvious that display of student work was extremely important for all schools and during the 2012 study year, some increases in display areas and options were observed. New catenary lines were observed to be installed in Red.3 and Red.4, together with additional pin boards in Red.4 and Yellow.3. The latter was also an attempt by the school to 'improve acoustics' (conversation with Y.c 26/3/12). These examples suggest that changes to facilities for pedagogical reasons are ongoing.



Photograph 4.21: Red.4 addition of catenary line for display in 2012. Left - 24 January (DSCF5741_120124mod.JPG). Right - 23 March (DSCF6016_120323mod.JPG)

4.5 Use of school space

The previous sections summarised inquiry-relevant observed building fabric configurations, observed internal environment components, and observed permanent modifications. The cost and permanence of these modifications, often across the school, are driven by school and education authority level decision making. This section provides observed use of school space that is driven by local decision making and is the transient use of the architecture described above.

4.5.1 Area per student

Previously, the Australian Government provided 'Advisory Area Ranges for Functional Spaces' as part of their federal administration function of capital grants (Australian Government 2008, p. 99). Furthermore, for Non-Government schools applying for block grants for building projects the Australian Government previously specified 'Commonwealth global area standards for school buildings are 6.13 m^2 per student for primary schools and 9.75m^2 per student for secondary schools' (Australian Government 2008, p. 97; c2000, pp. 58-63). These space allocations include non-teaching areas such as toilets, internal circulation, staff areas, and multipurpose areas, thus actual classroom area forms only a proportion of this allocation. No recommended classroom area per student was found.

Given the above, it was anticipated that the floor area per student (including circulation, storage and other room zones) should be similar in all schools. Referring to Table 4.17 below, this was indeed the case. Most rooms provided approximately 2m^2 per student of floor space. Those that were larger were either under populated (Yellow 2 was a double room with a single class) or had additional functional areas, such as a shared kitchen/wet area (White.2, Purple.2).

Of interest was the area per student in classrooms in older buildings, which retained their as-construction floor area. Of the five in the study (Red 1, Red 4, Red 5, Yellow 2 and Yellow 3), only

Yellow 2 and Yellow 3 retained their original classroom footprint, with Yellow 3 operating as a double class open space.

Table 4.17: Calculated areas per student in case study classrooms

classroom name	occupancy	Room type	students (desks in use)	floor area m^2 (to walls)	area/ student m^2	floor area source	Notes
Yellow.1	Resources	Multi-use	N/A	58	N/A	architectural drawings	
Yellow.2	Yr R-2	Open plan (2 classes)	29	108.8	3.75	architectural drawings	sink in room, school in start-up phase, single class in double class space.
Yellow.3*	Yr 4/5 south Yr 5/6/7 north	Open plan (2 classes)	56	113.3	2.02	architectural drawings	sink in room
White.1	Yr R-2	Open plan (3 classes)	65	229.1	3.52	architectural drawings	Note that this excludes 21m2 east end spaces
White.2	Yr 3	Single (internal door)	26	59.6	2.29	measure up	
White.3*	Yr 7	Single (internal door)	30	59.6	1.99	measure up	
White.4*	Yr 6/7	Single	28	59.6	2.13	measure up	
White.5*	Yr 7	Single (internal door)	28	59.6	2.13	measure up	no spots done in this room
Orange.1	Resources	Multi-use	N/A	273.2	N/A	architectural drawings	
Orange.2	Yr 2/3	Single (internal door)	28	58.9	2.10	architectural drawings	
Orange.3	Yr 3/4	Single (internal door)	27	58.8	2.18	architectural drawings	
Orange.4*	Yr 5/6	Single (internal door)	30	58.9	1.96	architectural drawings	
Orange.5*	Yr 6/7	Open plan (internal wall open)	54	127.9	2.37	measure up	2 sinks in room
Orange.6	Yr 2/3	Single (internal wall shut)	28	64.2	2.29	architectural drawings	sink in room
Orange.7	Yr 4/5	Single (internal door)	29	58.9	2.03	architectural drawings	
Red.1	JP	Single	28	54.2	1.94	architectural drawings	
Red.2	JP	Single (internal door)	28	55.8	1.99	architectural drawings	
Red.3	Resources	Multi-use		171	N/A	architectural drawings	
Red.4*	Yr 6/7	Single (with small internal permanent opening)	30	61.1	2.04	architectural drawings	
Red.5*	Yr 5/6	Single (internal wall shut)	30	55.6	1.85	architectural drawings	
Purple.1	Resources	Multi-use	N/A	165.6	N/A	measure up	
Purple.2	Yr R/1	Single (internal wall shut)	21	91.9	3.50	measure up	sink in room shared with adjacent room excluded
Purple.3	Yr 4/5	Single (internal wall shut)	26	72.8	2.80	measure up/arch drawings	includes alcove off main class space
Purple.4	Yr 6/7	Open plan (2 classes)	47	141.8	3.02	measure up/arch drawings	includes alcove off main class space
	Total Students		668				
	Total Class area (excl. resources)			1632			
	Average area per student				2.44		

*Students participated in survey

It must also be noted that during the time of the recommended areas (late 1990s through to 2008) ICT was evolving and becoming more portable and cost accessible (see Section 2.2.2.3), yet there was no change to the Commonwealth guidelines.

4.5.2 Sustainability education programmes

All schools were observed to have 'sustainability' elements, as defined by the South Australian Department of Education and Children's Services (DECS Asset Services 2009), integrated into their building fabric, either as designed or retrofitted (see Section 4.2.3), and all schools had food production gardens on their grounds (Table 4.2).

White School was the only school that included reference to the AuSSI program in their public communications (Newsletter) and explicitly stated that 'environmental sustainability' was part of their curriculum (Context statement 2012). Yellow school listed ESD elements in their 2012 context statement, but did not link this to curriculum.

Orange school mentioned their garden in newsletters, but all other schools reported their gardens in the context of curriculum activities. White school discussed their 2011 'Sustainable Gardening Grant' and 'biodiversity garden'. Yellow school discussed their weekly visits by a horticulturalist. Red School discussed their school kitchen grant funded by a 'land care grant'. Purple school discussed their community gardening project.

4.5.3 Classroom observations

The point of departure for this study was the expectation that people use buildings in ways that may not be anticipated and this section presents selected temporary changes and personalisation observed in classrooms. This section uses an unobtrusive ethnographic approach (Section 3.5) to study the occupied buildings, noting that it is the effect of occupants on buildings, not the occupants themselves that is the main focus of this section. Given the pedagogy discussed in Section 2.2.2, and the idealised expectation of a flexible school environment (Section 2.3), it was anticipated that the case study school would be observed to be dynamic in both use of floor and display space. These are reported below, together with other observations of spatial use where pertinent.

4.5.3.1 Dynamic space

Changes in floor layout were observed in most classrooms during visits. Each classroom observed had a range of fixed and loose furniture including but not limited to desks, chairs, shelves, cupboards (small and tall), mobile whiteboards, sofas and soft furniture. Noted observations of furniture locations were kept only for student desk layouts as the key indicators of pedagogical dynamic use of furniture.

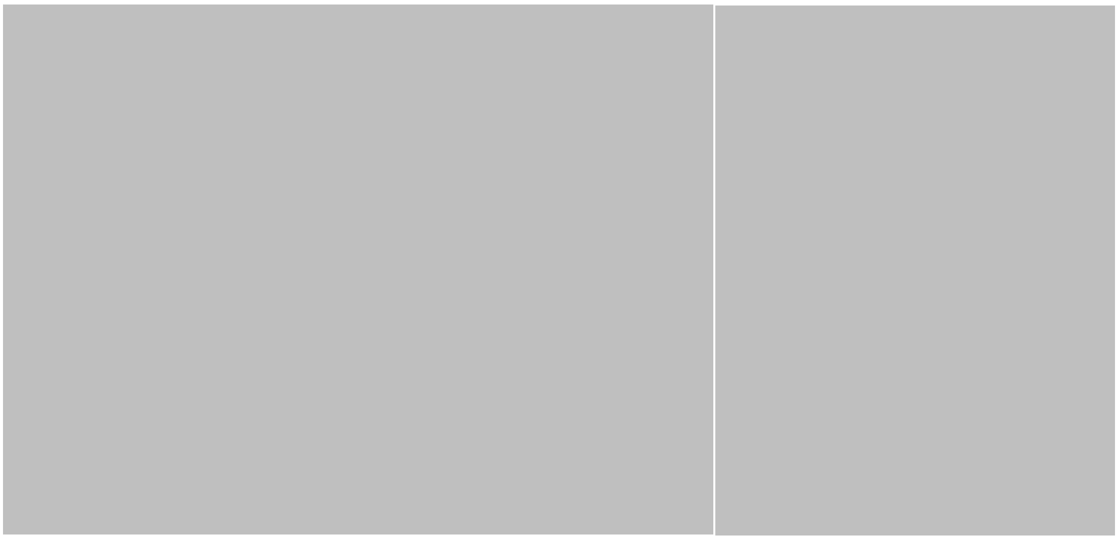
Desks were observed to be arranged so that they were away from walls. The desks were arranged in various configurations. The configurations observed could all be described as socially grouped, as opposed to rows facing the IWB. This latter configuration was observed in Orange.7, and Yellow.3, that latter being arranged in this way during the latter half of the year. Table 4.18 shows the number of desk rearrangements observed for each classroom. This sampling of desk layout does not give the exact number of desk layouts made during the year but does provide trends. For example, at least 67% of classes observed were rearranged at least once, suggesting that flexibility in layout is indeed being implemented by the majority of staff.

Observations were made at both the start and the end of the year so those with zero rearrangements are unlikely to have made changes throughout the year, unless it was to rearrange and then returned to the original layout in between research visits. Of those with zero rearrangements, two were libraries and four were optimised to provide a floor seating area (Red.2, White.2, White.3, White.5). Excluding the libraries, five created a dynamic environment with changing display rather than desk rearrangement (Red.2, White.2, White.3, White.4, White.5).

At the other extreme, those with observed desk rearrangements on nearly every visit did so for various reasons. Staff in Orange.6 (4/5 visits) expressed a preference for change (O.f 25/10/12). Yellow.1 (3/4 visits), which operated as both library and area for community group meetings, had folding tables on wheels and it was observed that these were rearranged easily. Yellow.2 (3/3 visits), while having fewer visits, had a high rate of change, in particular there was a major pedagogical change which was advertised to the community via a newsletter (YellowPD 2012c, Appendix A). Purple.4 was larger than most rooms so this may have made rearrangement easier, but no survey data was available to confirm this.

So, while desks are not strictly school architecture in the sense of being part of the fixed fabric of the building, they are important contributing components to the functionality of schools (Section 2.3.4.5). Thus, it is contended that their layout are indicators of occupant activity and have been used here in lieu of observation of people as an unobtrusive measure of activity.

Desks were arranged to create floor-seating areas in all classrooms except Yellow.3, White.4, and Orange.5. These areas were observed to be larger in junior primary than those in senior years due to the smaller age-appropriate furniture, with the exception of Red.4, which introduced a large floor seating area in term four (Photograph 4.22), with a dense seating area (not shown) created around the floor area.



Photograph 4.22: Red.4 desks arranged for no floor seating, left (DSCF6449_120802mod.JPG) and with floor seating, right (DSCF7055_121018mod.JPG)

Table 4.18: Observed desk mobility

Classroom	Number of observations	Desk rearrangements observed	Notes	floor area m² (to walls)	area/ student m²
Orange.2	6	4		58.9	2.10
Orange.6	5	4		64.2	2.29
Purple.4	5	4		141.8	3.02
Orange.3	7	3		58.8	2.18
Orange.4*	6	3		58.9	1.96
Purple.3	4	3		72.8	2.80
Yellow.1	4	3	library	58	N/A
Yellow.2	3	3		108.8	3.75
Orange.5*	4	2		127.9	2.37
Red.4*	4	2		61.1	2.04
Red.5*	5	2		55.6	1.85
White.1	5	2		229.1	3.52
Yellow.3*	5	2		113.3	2.02
Purple.1	3	1	library	165.6	N/A
Purple.2	3	1		91.9	3.50
Red.1	4	1		54.2	1.94
Orange.1	5	0	library	273.2	N/A
Orange.7	4	0		58.9	2.03
Red.2	5	0		55.8	1.99
Red.3	5	0	library	171	N/A
White.2	5	0		59.6	2.29
White.3*	6	0		59.6	1.99
White.4*	5	0		59.6	2.13
White.5*	2	0		59.6	2.13

Total classrooms	24
Total at least one change	16
% at least one change	***67%***

*Participated in survey

Another method of including spatial variety in the classroom is the use of internal partition flexibility using doors. These doors, where present, were either sliding doors or operable walls, the latter with or without swing doors. Observed internal doors and openings are listed in Table 4.19.

The significantly wider opening of internal doors, as compared to external swing doors, was intended to be used to change the pedagogical space by increasing the internal connection between two classrooms; however, all internal doors other than sliding doors were observed to take up floor space during operation. Their use, though limited only to observations at site visits, shows that there is a variety of use patterns. There is suggestion that slider doors are used more often than operable walls, though the sample is small.

It was also observed that internal doors were opened during times for indoor play, such as when students were kept inside due to inclement weather (Orange.3 29/11/12).

Table 4.19: Internal partition flexibility - observed used

Classroom	Opening type	Adjacent space	Observed use
Yellow.1	Accordion door	Multi-purpose teaching	Open and closed.
Yellow.2	Nil	Nil	
Yellow.3	Nil	Nil	
White.1	Nil	Nil	
White.2	Slider door - solid	Classroom	Permanently shut.
White.3	Slider door - solid	Classroom - Orange.5	Shut; partially open; fully open.
White.4	Nil	Nil	
Orange.1	Nil	Nil	
Orange.2	Slider door - solid	Classroom	Generally shut; no use observed
Orange.3	Slider door - solid	Classroom	Generally open; teacher observed to shut door on one visit
Orange.4	Slider door - solid	Classroom	Generally shut; observed part open on one visit.
Orange.5	Operable wall - solid	Classroom - Orange.5	Permanently open (two classes work together as Orange.5)
Orange.6	Operable wall - solid	Classroom	Permanently shut.
Orange.7	Slider door - solid	Classroom	Generally shut; observed part open on one visit.
Red.1	Nil	Nil	
Red.2	Nil	Nil	
Red.3	Nil	Nil	
Red.4	Permanent opening, no door	Classroom	Screened by portable blackboard
Red.5	Nil	Nil	
Purple.1	Nil	Nil	
Purple.2	Bi-fold door - glazed	Classroom	Shut; partially open; fully open.
Purple.3	Slider door - glazed	Multi-purpose teaching	Shut; partially open; fully open.
Purple.4	Slider door x2 - glazed	Multi-purpose teaching	Shut; partially open; fully open.

4.5.3.2 **Borrowed space**

It was observed that users 'borrow' space from the floor plan that designers might be considered to be allocated to other uses. This section presents three examples of this practice.

Circulation around doorways must provide appropriate access space for people with disabilities. This design practice is encoded in Australian Standard AS/NZS1428.1 and the direct approach case is sketched in Figure 4.10 for the 1998/2001 and 2009 editions. While buildings may have been designed before these circulation allowances were enforceable, equity for people with disabilities is a statutory requirement (Australian Human Rights Commission 2013). This is translated to percentage area of small and large single class classrooms with one or two doors in Table 4.20, which shows that, strictly, for the case of a small classroom with two doors, under current standards, 8% of the area should be assigned for circulation around doors. This is without allocating circulation through the classroom to desks, IWB, pinboards, shelves and other areas of student use.

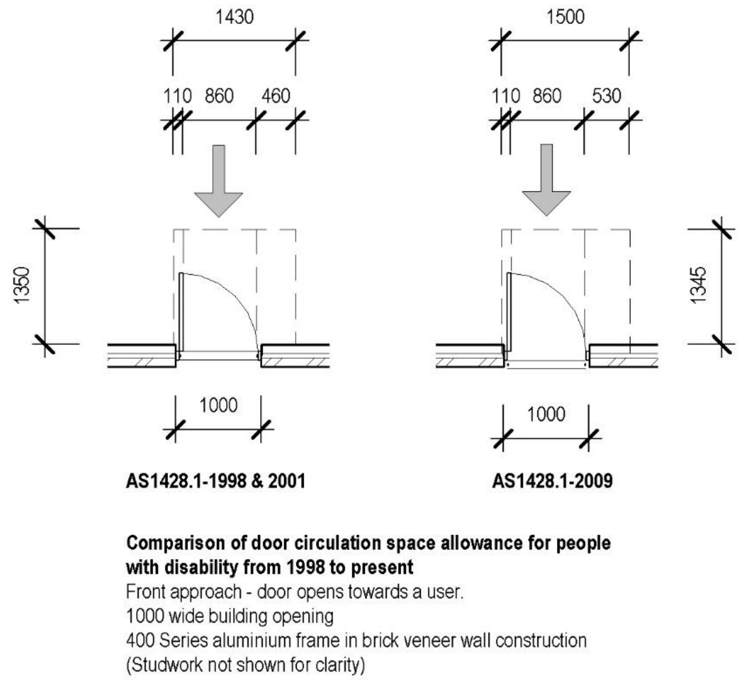
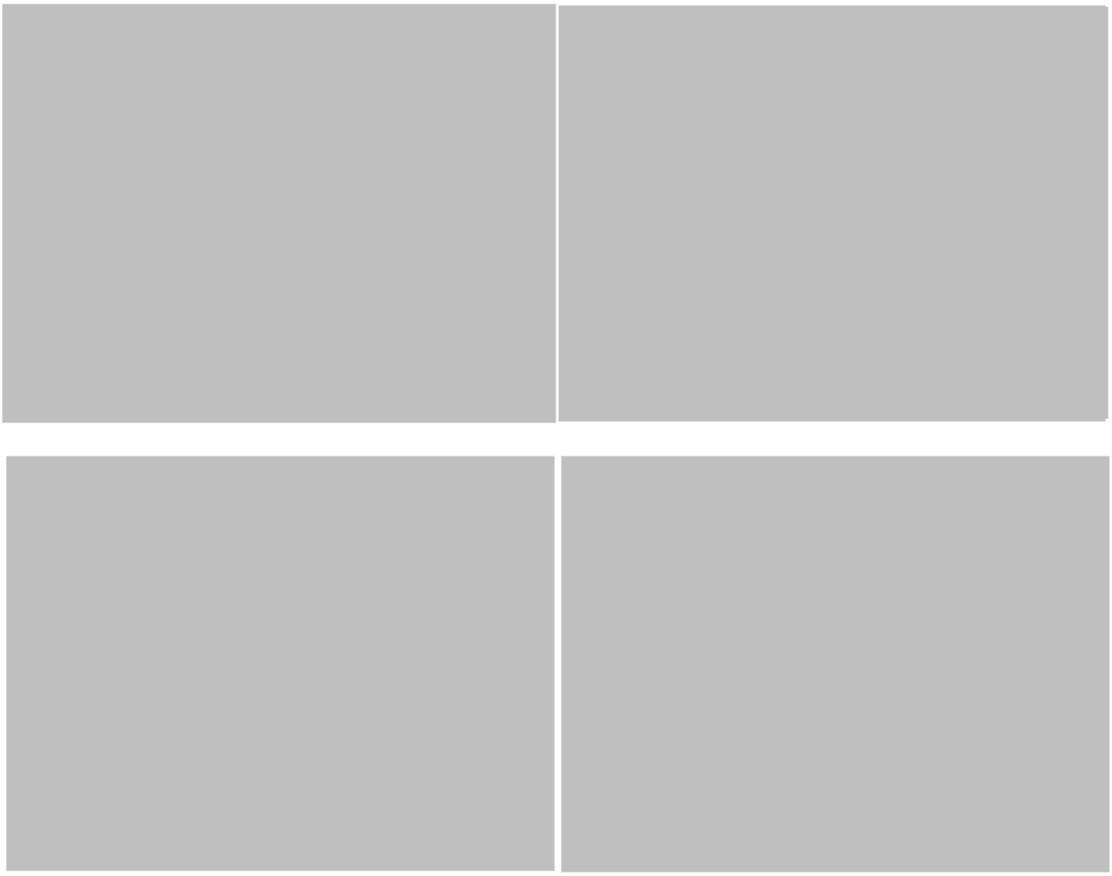


Figure 4.10: Comparison of AS1428.1 changes to circulation for people with disabilities to front approach to a swing door

Table 4.20: Percentage area of door circulation for people with disabilities in small and large single classrooms

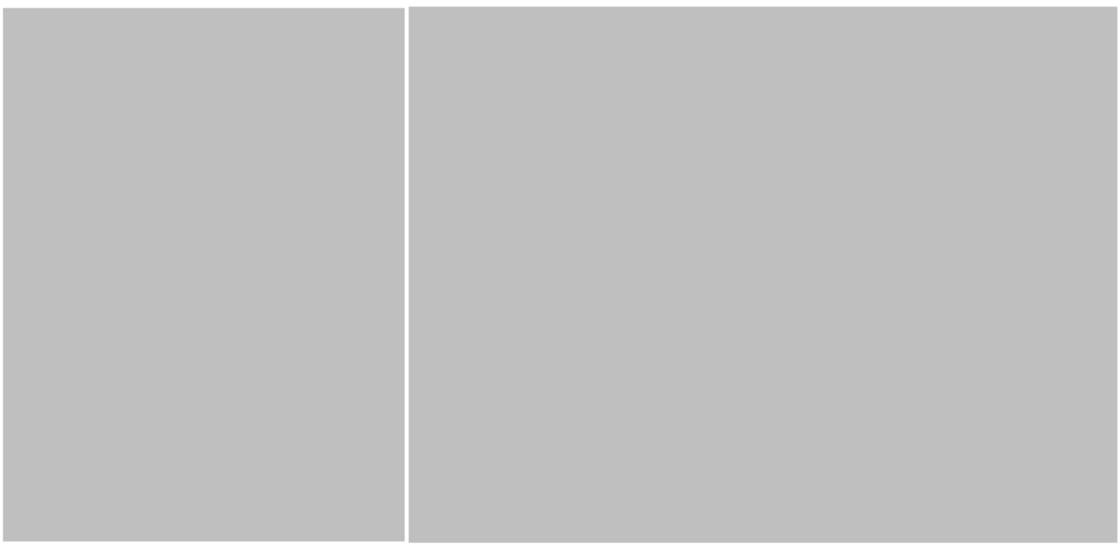
AS1428.1 Front approach door opens towards user		small single classroom 55 m²		larger single classroom 65 m²	
AS year	Door circulation area m²	% used with one door	% used with two doors	% used with one door	% used with two doors
2001	1.63	3.0%	5.9%	2.5%	5.0%
2009	2.23	4.1%	8.1%	3.4%	6.9%

It was observed that this door circulation space was encroached on with loose furniture, particularly items that needed their own circulation space for access, such as book cases, thus not only borrowing space, but creating conflicting circulation space. Examples of this practice are shown in Photograph 4.23, but is noted that this practice was not limited to these.

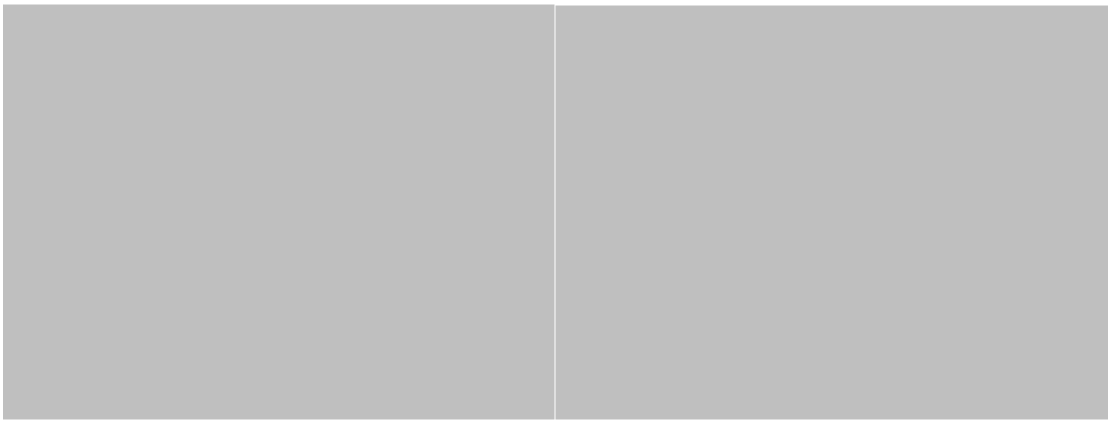


Photograph 4.23: Example of door circulation obstruction: Red.2 top (DSCF6418_120802mod.JPG, DSCF6423_120802mod.JPG), Orange.7, bottom left (DSCF6561_120803mod.JPG) and Yellow.3, bottom right (DSCF6325_120731mod.JPG)

Internal doors also offered possibilities for space borrowing. Where the sliding door or operable wall were kept predominantly closed, they offered additional display space in lieu of access (see Photograph 4.24 and Photograph 4.25 for comparison movable vs. fixed internal doors, within case study schools).



Photograph 4.24: Moveable internal partitions. White.3 (DSCF7813_121128mod.JPG) vs. White.2 (DSCF6273_120730mod.JPG)



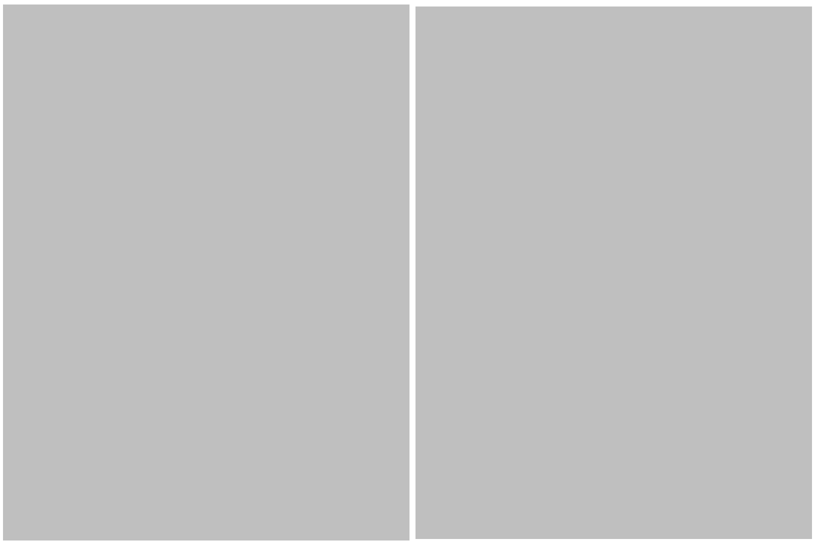
Photograph 4.25: Moveable internal partitions. Orange.3 (DSCF6202_120720mod.JPG) vs Orange.6 (DSCF6611_120803mod.JPG)

Daylight opportunities were also borrowed. It was observed that tall cupboards and shelves were placed in front of windows, suggesting storage took precedent over natural daylight (Photograph 4.26)

Photograph 4.26: Example of window obstruction Orange.5 (DSCF6858_140519mod.JPG)

Areas that were designed specifically as circulation were also colonised for other purposes (Photograph 4.27). In Yellow School the original 'hat and cloak room' from 1882 (COE1), while still being used to store bags and coats, was also used for single student to teacher learning support activities, as evidenced by the desks in the space and conversations with staff (Y.d 31/7/12).

Red school's circulation outside of Red.4 and Red.5 was originally part of a classroom, but had been modified prior to renovations in 2006 to be a circulation area. It was observed that that area was being used for lockers.



Photograph 4.27: Circulation as teaching space outside of Yellow.3 (DSCF8044_121207mod.JPG) and locker space outside of Red.5 (DSCF8069_121210mod.JPG)

The above examples of 'borrowed' space are presented as a sample only of how users use all space available for teaching or storage. This could be interpreted either as users using more physical teaching materials than necessary, or the teaching spaces are not matching pedagogical needs. This is a political and complex question, and this thesis will not attempt to answer this, other than to present observed spatial use and observed limitations.

4.5.3.3 **Display**

During initial spot measurements, it was noted that display extended beyond the installed pinboards to walls, cupboards and catenary lines overhead.[36] Under the principle of grounded theory method, this initial finding was reviewed and deemed to be of interest so additional data was collected in the form of notes and photographs at each spot measurement collection.

In addition to display location variation, the display varied in type (student work and teacher pedagogical materials) and, in some cases, changed throughout the year. Thus, the space was seen to be dynamic. This was further accentuated in those schools with catenary lines overhead, since the full class spatial volume also became a dynamic space.

The scope of this research did not extend to investigating the type and dynamism of the display, only the location. The emerging location typology and design implications are listed in Table 4.21 and observed display listed in Table 4.22.

[36] From the perspective of an education design architect, the extent of the display was a true surprise. It was felt that it was important to pursue this for professional purposes in addition to scholarly data collection. This also informs the data collection strategy described here.

Table 4.21: Display location typology

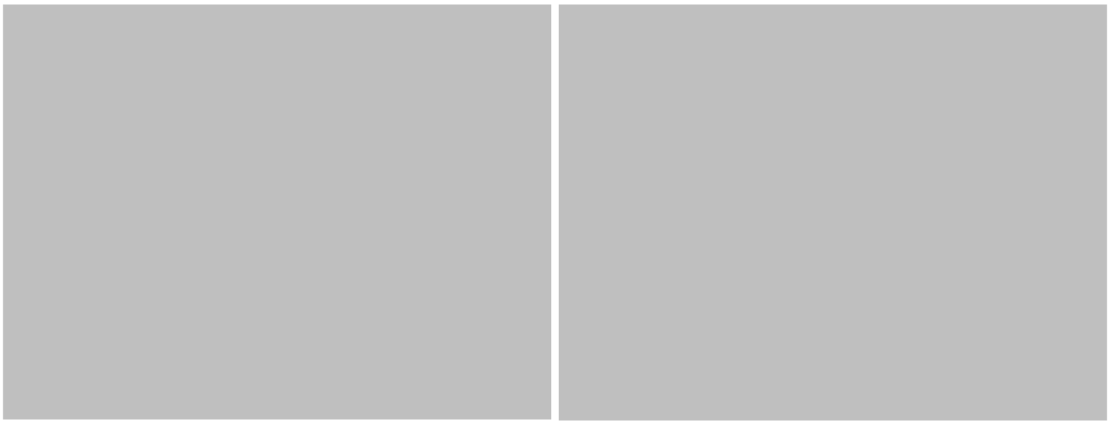
Display location	Description
Pinboard	Fixture to wall or wall treatment with dual pinboard/acoustic function
Wall	Variable wall types (skim plaster, plasterboard, timber dado) with painted finish
Window	Glazed component
Door / sidelight	Glazed and solid components (Sidelight refers to window adjacent door which acts as vision panel)
Catenary / ceiling	Overhead cables fixed to walls or ceiling and display fixed direct to ceilings
Cupboard / storage	Fixed or loose storage furniture
Luminaires	Light fittings, including suspension system.

Table 4.22: Observed display locations

Classroom	Pin board	Wall	Window	Door	Storage item	White board	Ceiling / catenary	Luminaires	Other
Yellow.1	■	■		■	■	Nil	Nil		Nil
Yellow.2	■	■	■	■	■	Nil	■	■	Window sills
Yellow.3	■	■		■		Nil	■	■	Window sills
White.1	■	■	■	■	■	Nil	■	Nil	Window sills; operable walls
White.2	■	■	■	■	■	Nil	■	■[a]	Nil
White.3	■	■	■	■	■	Nil	■	■[a]	Window sills
White.4	■	■	■	■	■	Nil	■	■[a]	Nil
White.5	■	■	■	■	■	Nil	■	■[a]	Nil
Orange.1	■	■	■	Nil	Nil	Nil	■	Nil	Nil
Orange.2	■	■	■	■	■	■	■	Nil	Nil
Orange.3	■	■	■	■	■	■	■	Nil	Nil
Orange.4	■	■	■	■	■	Nil	■	Nil	Nil
Orange.5	■	■	■	■	■	■	■	Nil	Nil
Orange.6	■	■	■	■	■	Nil	■	Nil	Nil
Orange.7	■	■	■	■	■	Nil	■	Nil	Nil
Red.1	■	■	■	Nil	■	■	Nil	■	Nil
Red.2	■	■	Nil	Nil	Nil	■	Nil	■	Nil
Red.3	■	Nil	Nil	■	Nil	Nil	■	■	Window sills
Red.4	■	■	■	Nil	Nil	Nil	■	Nil	Window sills; Suspended acoustic panels
Red.5	■	■	Nil	■	Nil	■	Nil	Nil	Window sills; Suspended acoustic panels
Purple.1	■	■	■	Nil	■	Nil	Nil	Nil	Nil
Purple.2	■	■	Nil	■	■	■	Nil	Nil	Nil
Purple.3	■	■	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Purple.4	■	■	Nil	■	■	Nil	Nil	Nil	Nil

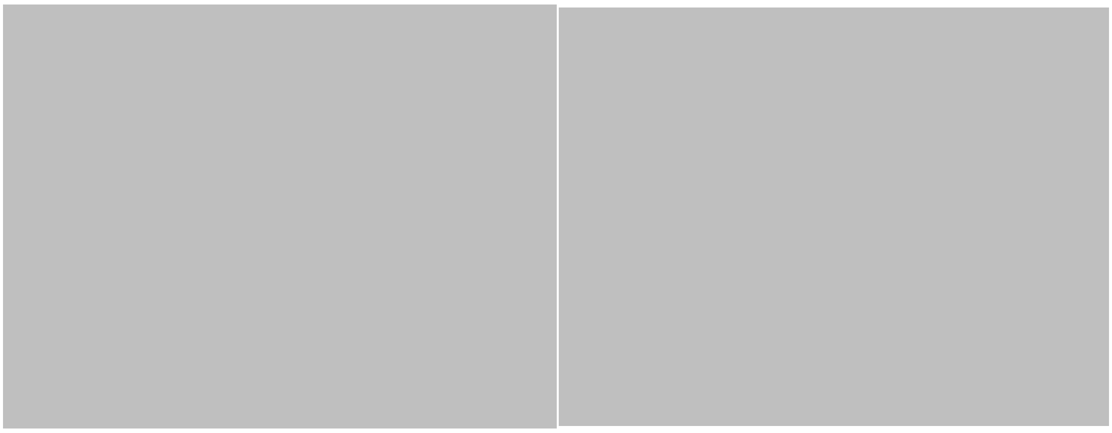
a. luminaires are located on cable trays suspended between walls

Photograph 4.28 shows examples of using the building fabric for personalisation and temporary installations. It suggests that users feel free to make the building fabric work to aid user activities. The buildings are not approached as spatially privileged. Rather, they are defined by users using areas that may not be specified to take display, such as walls or luminaires. The use of higher areas, as observed and as indicated by the presence of a ladder observed in classrooms, was not expected due to workplace safety issues.



Photograph 4.28: Display from luminaires. Left - Red.1 (DSCF6035_120323mod.JPG). Right - White.3 (DSCF6928_121016mod.JPG)

Display on windows, such as that observed in Photograph 4.29, was particularly intriguing, since it contradicted the notion that windows were to provide daylight in and views out. Window display was also observed to be directional, communicating into and out of the class. Some windows, however, were not used for display. These windows coincided with those with internal blinds, or deliberately obstructed by furniture. A summary of observations is given in Table 4.23.



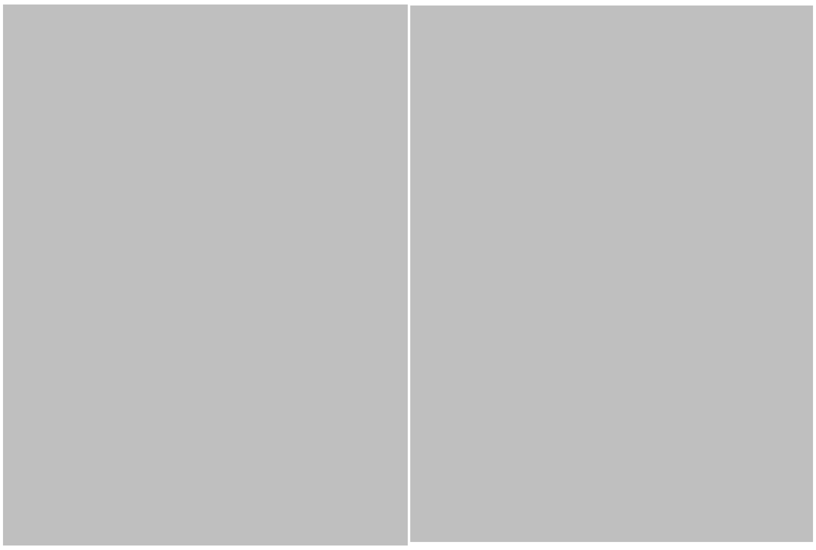
Photograph 4.29: Examples of display on glazing. Left Orange.4 (DSCF7377_121025mod.JPG). White.3 (DSCF6001_120320mod.JPG)

Table 4.23: Summary of external window display by case study classroom

Class	External windows	Display on window				Deliberate obstruction	Interior blinds	
	Direction	Observed	Greater than 50% glazing	Direction		Partial by..	Installed	Maximum coverage
				In	Out			
Yellow.1	N	Nil		Nil	Nil		■	100%
Yellow.2	N	Nil		Nil	Nil		■	100%
	E	■		■	■		■	100%
Yellow.3	N	Nil		Nil	Nil		■	100%
	E	Nil		Nil	Nil	Tall cupboard	■	100%
	S	Nil		Nil	Nil		■	100%
Orange.1	N	■		■	Nil		Nil	
	SE	Nil		Nil	Nil		Nil	
	NW	■		■	Nil		Nil	
Orange.2	S	■	■	■	Nil		Nil	
Orange.3	N	■	■	■	Nil		Nil	
Orange.4	N	■	■	■	Nil		Nil	
Orange.5	N	Nil		Nil	Nil	Tall cupboard	■	100%
	S	■	■	■	Nil		Nil	
Orange.6	E	Nil		Nil	Nil	Low cupboard	■	100%
	W	■	■	■	■		Nil	
Orange.7	S	■		■	■		Nil	
White.1	N	■		■	■		Nil	
	E	Nil		Nil	Nil	Opaque card	Nil	
	S	■		■	Nil		Nil	
White.2	N	■	■	■	■		■	60%
	S	■	■	■	Nil	Sill book stack	Nil	
	W	■		Nil	Nil		■	100%
White.3	N	■		■	■		■	60%
	S	■	■	Nil	■		Nil	
	W	Nil		Nil	Nil	Sill book stack	Nil	
White.4	N	■	■	Nil	■	Sill book stack	Nil	
	S	Nil		Nil	Nil	Sill book stack	Nil	
White.5	N	■	■	■	Nil	Sill book stack	■	60%
	S	■	■	Nil	■		Nil	
Red.1	N	■		■	■		■	80%
	E	■		Nil	■		■	80%
Red.2	N	Nil		Nil	Nil		■	100%
	E	Nil		Nil	Nil		■	100%
Red.3	N	Nil		Nil	Nil		■	70%
	S	Nil		Nil	Nil		Nil	
Red.4	N	■		■	■		■	70-80%
Red.5	N	Nil		Nil	Nil		Nil	
	E	Nil		Nil	Nil		■	80%
Purple.1	N	■		■	Nil		■	100%
	S	■		■	■		Nil	
Purple.2	N	Nil		Nil	Nil		Nil	
	S	Nil		Nil	Nil		Nil	
	W	Nil		Nil	Nil		Nil	
Purple.3	N	Nil		Nil	Nil		Nil	
Purple.4	N	Nil		Nil	Nil		Nil	
	S	Nil		Nil	Nil		Nil	

4.5.3.4 Computers

In addition to desktop computers observed in all classrooms, dedicated computer rooms were also available in Yellow, White, Orange, and Red Schools. Orange and Purple Schools were observed to use laptops, with examples of laptop charging docks shown in Photograph 4.30.



Photograph 4.30: Laptop charging docks (green box) in Orange.5, left (DSCF7847_121129mod.JPG) and Purple.2, right (DSCF7192_121019mod.JPG)

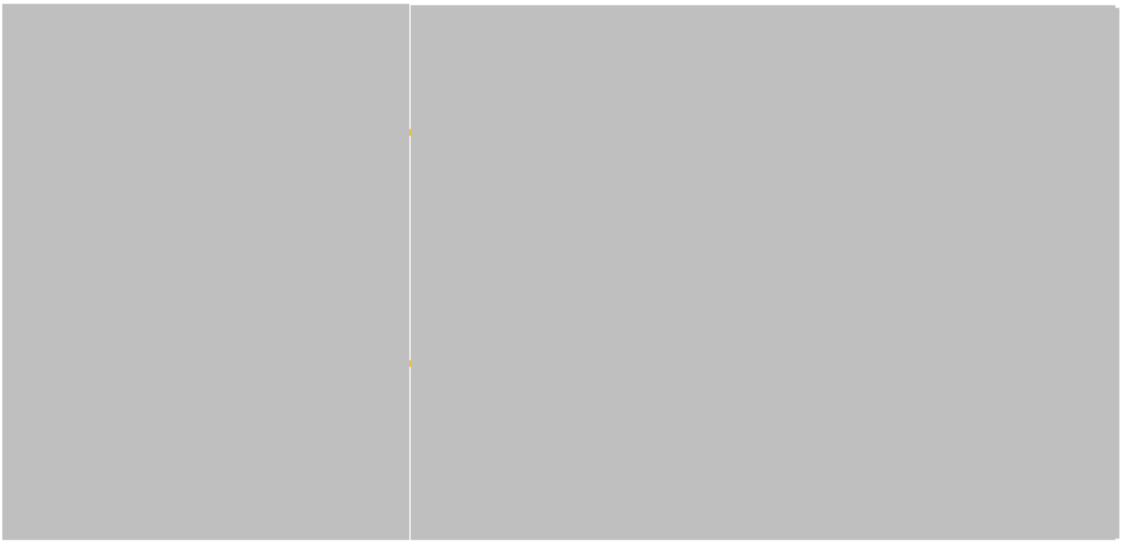
4.5.3.5 **View control**

Previously, windows were discussed for their capability to provide ventilation (Section 4.2.4), daylight (Section 4.2.5) and display space (Section 4.5.3.3). It might be assumed that users would want to see out of rooms, yet it was found that some windows were purposely obstructed, adding further to the conflicting functions of windows. This obstruction occurred on both internal and external windows. It is classified in this inquiry as five types of glazing modification based on observations in Table 4.24.

Table 4.24: Glazing obstruction typology

Glazing obstruction type	**Observed obstruction**	**Observed purpose**
Glare control	Reduce over-lighting to space through solid blinds, ad hoc internal blocking with plain cardboard, obstruction by furniture	Enable use ICT. Improve lighting conditions.
Display in	Directional display facing into the room.	Extension of pinboard type general display.
Display out	Directional display facing out of the room	Identity and artwork displayed to students outside of class
Bi-directional display	Display with no obvious direction; makes use of daylight	Exploration of translucency and transparency artefacts.
Obstruct view	Restrict view in and out.	Reduce distractions or increase security

While there were five types of glazing obstruction identified, obstruction by display also performed glare control and view obstruction. Furthermore, all reduced daylight and potential solar gains. Display examples were shown previously in Photograph 4.29. Examples of both exterior view and glare obstruction are shown in Photograph 4.31, where the exterior photograph is taken from a public footpath. Examples of display of work used to obstruct internal views are shown in Photograph 4.32, where two classrooms of similar layout in the same school are shown with full glazing and fully obstructed depending on user preference. This latter suggests that decision making about personalisation of view control is devolved to user level.



Photograph 4.31: Examples of external window glazing obstruction: White 1 inside (DSCF7657_121128mod.JPG) and outside (DSCF6245_120730mod.JPG)

Photograph 4.32: Example of internal window glazing obstruction (windows have dashed line around them): Left - no obstruction in Orange.3 (DSCF6205_120720mod.JPG). Right - fully obstructed in Orange.7 (DSCF6566_120803mod.JPG)

4.5.3.6 Other personalisation

Other personalisation observed, but not limited to, included the use of songs in lieu of sirens ("Star Wars" theme at Orange School and "Don't worry be happy" at Purple, 3/4/12), sofas (White.3 and White.5), a soft cubby house (Yellow.2), lounge chairs (Orange.4) and pinboards covered by loose material with boarders (White.1, White.3, White.5), or with personalised borders only (Orange.2, Orange.4). Streamers from supply air vents (White.1) as way of 'seeing' air movement (Heschong 1979, p. 25).

4.5.3.7 Maintenance, dirt, mess and cleaning up

One example of facilities maintenance were observed. A noise in the evaporative cooling of Orange.1 was observed on the logger installation visit (3/2/12) and gone at the next visit, apparently requiring two different trades to resolve the issue (O.d 28/3/12).

Though not anticipated, it was observed that some building elements were difficult to keep clean and two examples are discussed here. The inclusion of wall vents for passive fresh air ventilation were seen as innovative designs that lead to lower energy use (see Table 4.9 for design narratives). Orange and White Schools both include these in their permanent buildings using the construction as observed in Figure 4.11 and images shown in Photograph 4.33 and Photograph 4.34. It was noted that both constructions collected dirt on the exterior grilles. Orange construction differed in that it had an easily removable panel on the interior for cleaning, whereas the White interior panels seemed difficult to remove. Though difficult to show in the photographs, the carpet in the cavity of the White vent system, between the interior and exterior grilles was observed to very dirty, suggesting it had not been cleaned recently, if ever. This might detract from indoor air quality, though no air particle tests were performed to test this.

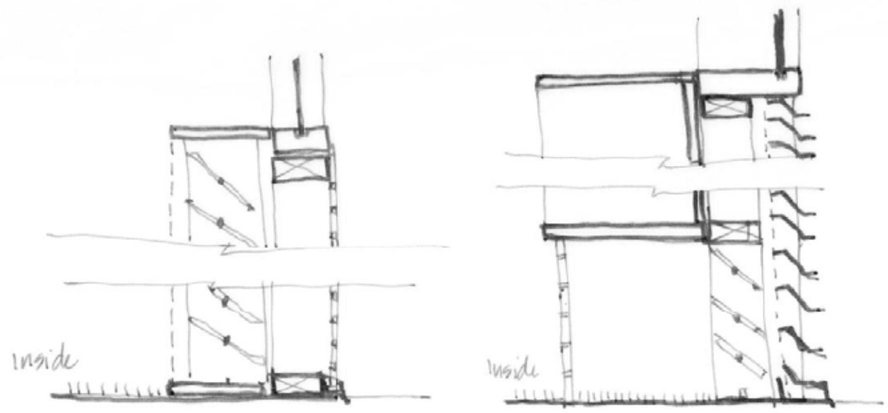
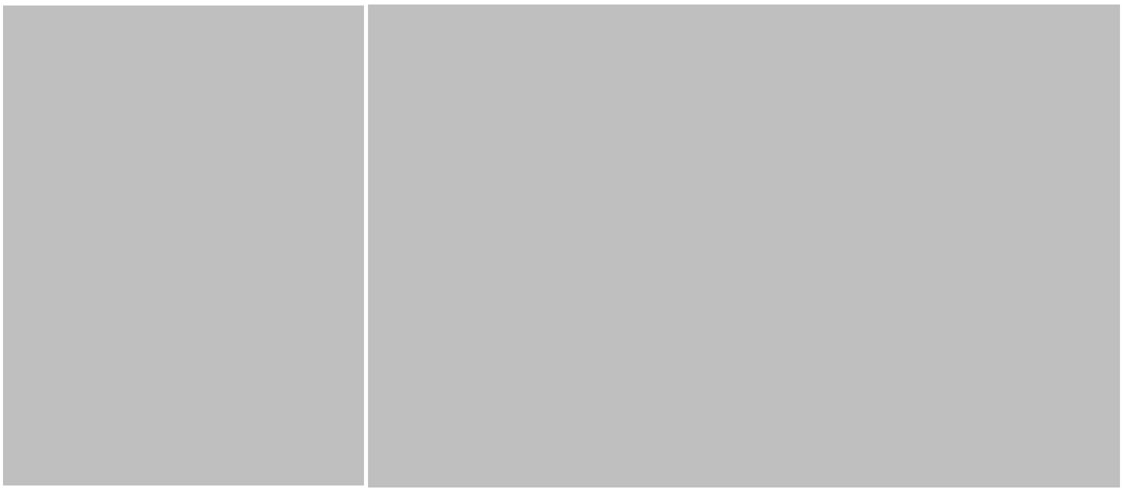


Figure 4.11: Observed section detail sketch of Orange (left) and White (right) wall vent constructions (wall structure inferred)

Photograph 4.33: Wall vents external and internal dirt example: White.4 left (DSCF7775_121128mod.JPG), middle (DSCF5442_111118mod.JPG) right (DSCF6920_121016mod.JPG)

Photograph 4.34: Wall vents external and internal dirt example: Orange.2 (DSCF6105_120328mod.JPG, DSCF6106_120328mod.JPG, DSCF6100_120328mod.JPG)

Interior mess was particularly obvious on dark coloured carpets with little colour variation. Photograph 4.35 shows mess on the background of dark blue carpet in Purple school, together with the vacuum cleaner that was observed being used during class time. Other vacuum cleaner[37] use was observed in Orange.4 (hand vacuum, 29/11/12).



Photograph 4.35: On the go clean up: vacuum cleaner in Purple.3 (DSCF7920_121206mod.JPG and detail)

4.5.3.8 **Storage**

All rooms were observed to have a storage from both fixed and loose components. The observed storage is listed in Table 4.25. Storage joinery included open shelves and closed cupboards. Shelf stripping is listed as separate below to show that it was not always used where installed.

Examples of shelf stripping and its use are shown in Photograph 4.36.

[37] Vacuum cleaner is the generic 'hoover' known to UK readers.

Photograph 4.36: Shelf stripping used as library stack in Orange.1 (DSCF6087_120328mod.JPG), and part view to right of logger in White.4 (DSCF6925_121016mod.JPG)

Table 4.25: Storage installed, retrofitted and used

Classroom	**Storage joinery**		**Shelf stripping**		**Other loose storage observed**
	Installed	**Used**	**Installed**	**Used**	
Yellow.1	■	■	Nil		Bookshelves
Yellow.2	■	■	Nil		Bookshelves; Filing cabinets; student drawers; cupboards
Yellow.3	■	■	Nil		Bookshelves; Filing cabinets; cupboards
White.1	■[b]	■	■		Bookshelves; Cupboards; Filing cabinets; student drawers
White.2	■	■	■		Bookshelves; student drawers
White.3	■	■	■		Bookshelves; student drawers
White.4	■	■	■	■	Bookshelves; student drawers; filing cabinets
White.5	■	■	■	■	Bookshelves; student drawers; filing cabinets
Orange.1	Nil		■	■	Bookshelves
Orange.2	■	■	Nil		Bookshelves; student drawers
Orange.3	■	■	Nil		Filing cabinet; Bookshelves; student drawers
Orange.4	■	■	Nil		Filing cabinet; Bookshelves; student drawers
Orange.5	■	■	Nil		Bookshelves; Cupboards; Filing cabinets; student drawers
Orange.6	■	■	Nil		Bookshelves; Cupboards; Filing cabinets; student drawers
Orange.7	■	■	Nil		Filing cabinet; Bookshelves; student drawers
Red.1	■	■	■		Filing cabinet; Bookshelves; student drawers
Red.2	■	■	■		Filing cabinet; Bookshelves; student drawers
Red.3[a]	Nil		■	■	Bookshelves
Red.4	■	■	■		Filing cabinet; student drawers
Red.5	■	■	■		Filing cabinet; student drawers; bookshelves
Purple.1	■	■	Nil		Bookshelves;
Purple.2	■	■	Nil		Bookshelves; student drawers; filing cabinets
Purple.3	■	■	Nil		filing cabinets
Purple.4	■	■	Nil		filing cabinets

a. Shelves on shelf stripping protected by vertical board on both sides of protruding shelves

b. Some joinery removed for IWB installation

4.5.4 Toilets

Staff and student toilets were all single gender, except accessible toilets (toilets for people with disabilities, AS1428.1), which were unisex. Since the focus was on teaching spaces, and due to student protection concerns, student toilets[38] were not observed at each visit, and no staff male toilets were visited. Toilets listed in Table 4.26 were visited briefly to determine layout and finishes, and note any obvious occupation effects.

Table 4.26: Visited toilets by school

School	Student toilets		Staff toilets	
	Visited	Description	Visited	Description
Yellow	Girls	Lightweight extension, with fixed windows. Finishes < 10 years old. Toilets - S bend visible	Access	Lightweight extension, with fixed windows. Finishes < 10 years old. Toilets - S bend visible
White	Girls, Boys, Access	Brick veneer, in classroom block with no windows, mechanical ventilation. Finishes < 10 years old. Toilets - S bend visible	Female	Brick veneer, in administration block with no windows, mechanical ventilation. Finishes <10 years old. Toilets - S bend visible
Orange	Girls	Rammed earth standalone block with operable windows, exterior doors left open, Finishes > 10 years old Transportable building, individual cubicles. Toilets - S bend visible	Female	Rammed earth/stud plasterboard, in Admin, fixed windows, mechanical ventilation. Finishes > 10 years old Toilets - S bend visible
Red	Girls	Brick veneer standalone block with skylights, no windows, roof vents. Finishes > 10 years old Toilets - S bend visible	Female	Brick veneer, off staff room, fixed windows, mechanical ventilation. Finishes < 10 years old Toilets - S bend visible

Photograph 4.37: Student toilets: Red School female students with paper on floor (DSCF8049_121210mod.JPG) and dead insects in skylight (DSCF8052_121210mod.JPG); Orange School female students with rubbish on floor (DSCF6656_120803mod.JPG)

All toilets inspected were found to use fixture and finishes contemporary to the last 15 years.[39] In the student toilets visited, paper and rubbish[40] on the floor was common. The junction between the wall and floor was commonly observed to be discoloured on tiles and grouting, as was exposed S-

[38] For non-Australian readers 'Toilets' refers to the bathroom space that includes pans, basins and hand dryers. In North America, these would be referred to as 'Restrooms'.

[39] This is based on the author's professional experience with education facility toilet design.

[40] Trash, garbage

bends, suggesting cleaning problems.

Based on observed toilet numbers, and considering the case of toilets available for female staff, it was calculated that staff would likely experience significant queuing problems during teaching breaks (Appendix G).

4.6 Summary

To provide context for the user perspectives (research questions 2 and 3), this section presented observed architectural fabric and building services, observed permanent modifications and a selection of use patterns. The case study schools offer a range of site, design, age, and construction materials. The participating schools range from small enclosed sites (Yellow School) to large dual campus configurations open to the public (White School). Building architecture varies according to age and design strategy. Older buildings in Yellow School and Red School are typical of late 1800s public school architecture. White School and Orange School are contemporary to the beginning of the 21st century, with 'sustainability' design features informing form, but different materiality (mixed lightweight and brick veneer, and rammed earth, respectively). All schools used lightweight relocatable buildings, thus, all students are exposed to a variety of building construction types.

Commentary of the case studies was sought from architectural publications and school publications. Architectural writing from architects and jury citations from architectural awards was found to be positive in claims of architectural determinism and the relationship between school design and learning benefits, however discussion of school infrastructure was found to be minimal in school publications. This lack of reflection by school communities on their architecture provides justification for the site observations.

The observed permanent modifications are presented as examples of the need for fabric change in response to changing pedagogical needs. These included changes to the buildings to control interior light, retrofitting of 'sustainability appliances', retrofitting of interactive whiteboards, and retrofitted components intended to change acoustics. In some cases examples of these occurred soon after buildings were completed suggesting issues with foresight and robustness to change.

The discussion of space use, including the transitory classroom changes, are included to provide a picture of use patterns needed for current pedagogy in South Australia. The classroom floor area per student was found to be consistent across all classrooms, except for one 'open' style classroom which offered larger area per student. Classrooms were found to be dynamic in their desk arrangement and pedagogical display. This latter element, which includes teaching materials and student work, was found to extend beyond the installed pinboards and included walls, cupboards, and doors. Cables were observed to be installed between walls so that display was hung over the heads of the students. Display was also installed on the window glazing, both obstructing the view, and exploiting the daylight in translucent student work.

Toilets were observed to be adequate in that they were designed to be functional, with security taking precedent over ventilation. Discolouration of skirting tiles was observed, together with paper on the floor, suggesting that daily maintenance might be problematic.

Schools and their use are complex. The fabric elements and their use patterns have been selected and presented here to provide context for interpretation of, first, the environmental monitoring of participant classrooms (Chapter 5), and users' perspectives (Chapter 6).

5 Environmental results

5.1 Introduction

The previous section provided an architectural context using selected observations of the sites and architecture, permanent modifications, and transient use of internal fabric. This section presents the findings from the indoor environmental monitoring and spot measurements taken in case study school classrooms and compares them to available regulations and guidelines, as mapped in Figure 5.1.

Temperature and humidity measurements are presented here first, followed by light, which is discussed in the context of prior window display use discussions. This section finishes with noise and sound measurements. The results are interpreted at the classroom unit of analysis, but, where appropriate, they are discussed at the school level of analysis. This, together with the previous chapter, create the context for interpreting the user perspectives in Section 6.

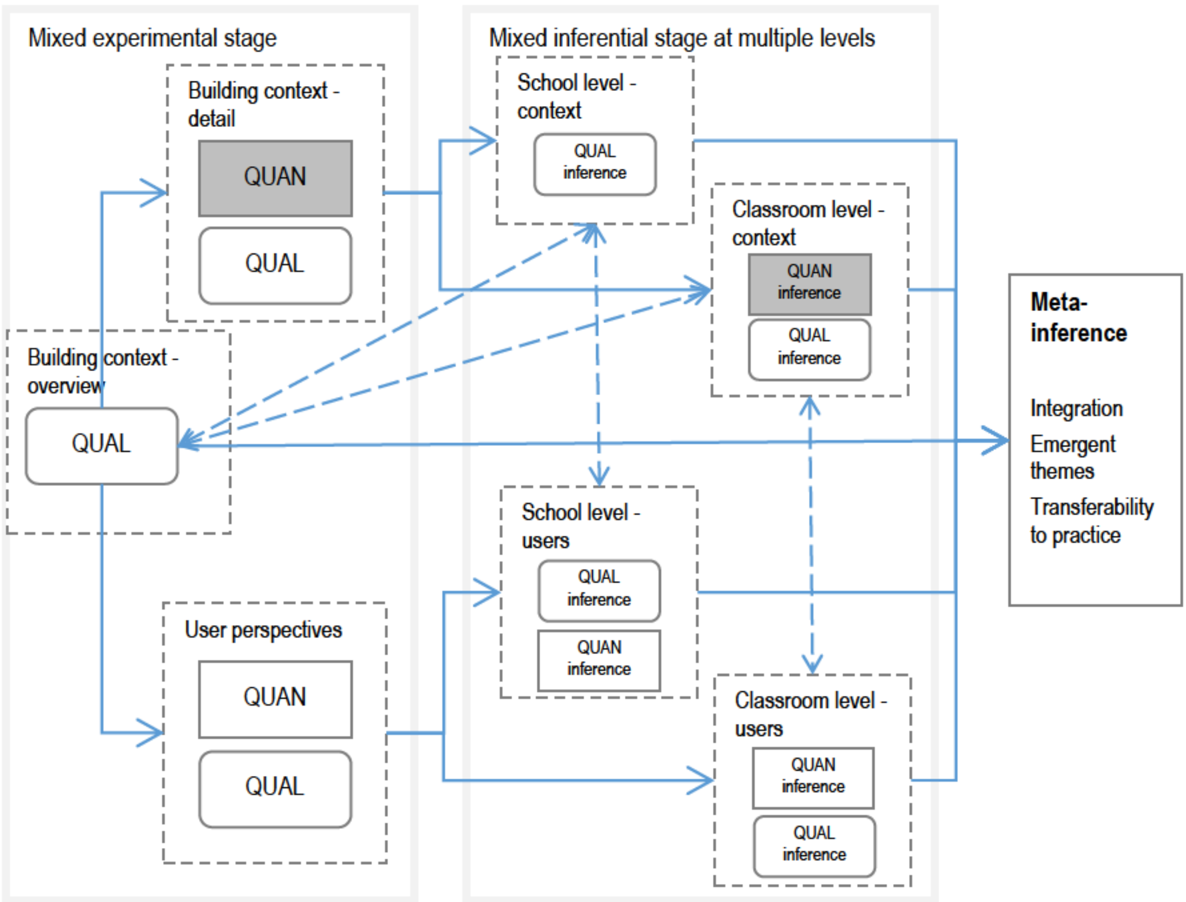


Figure 5.1: Mixed method research map for environmental results

5.1.1 Environmental data sampling

All data presented below are discrete point samples of analogue conditions. Loggers were set to sample the environmental conditions at half hour intervals. To avoid disturbance of loggers during everyday use of classrooms, the loggers were installed in the walls (see Section 3.5.5.1). The collected data was 'cleaned' to remove known and deduced data collection errors (Section 3.5.5.2) and different data sets were created (Appendix H.3.2). The core hours data set used most is DS-C-OL-A, which indicates all valid data collected during core hours, including uncompromised outliers.

These measurements were supplemented with 'spot measurements' from hand held instruments during site visits. Spot measurements were taken away from the walls on randomly selected on student desks so as to provide additional confirmation of local environmental conditions within a room (see Section 3.5.6).

5.2 Temperature and humidity

Temperature and humidity measurements were collected to provide physical data for interpreting comfort perspectives collected during the survey of users. The survey was delivered only once (Section 3.5.7), so perspectives are historical, and not equivalent to comfort studies (see 2.4.1.5). Regardless, the data collected offers a physical indicator of building performance, as compared to the temperature guidelines and standards for primary schools in South Australia, as summarised in Section 5.2.1. This is used to review the temperatures recorded by the environmental loggers (5.2.2) and hand held instruments (5.2.3). Unexpected observations are discussed in Section 5.2.4, followed by humidity (5.2.5).

5.2.1 Temperature guidelines and regulations for schools

A selection[41] of the design guidelines, standards and statutory inputs in operation at 2012 are listed in Table 5.1. It was not possible to confirm the design inputs used during the construction or renovation of each building. Rather, these standard and guidelines are presented as stated indoor environment temperatures expected by the education authority[42] responsible for procurement and operation of schools at the time of data collection, so were used as a benchmark for expected building performance.

All schools were observed to have some form of timing restrictions on HVAC through either local

[41] This list is a small selection of resources, and should not be used a reflection of local professional mechanical engineering design practices. The author's professional observation is that Adelaide professional mechanical engineers are fully informed of ASHRAE, AIRAH and other technical sources.

[42] It is noted that later versions of ASHRAE Standard 55 exist at the time of writing (ASHRAE 2004, 2013b), yet these were not prescribed by the Department of Education and Children's Services as of 2012, i.e., the year of data collection.

timers or automatic control systems (see Table 4.5) and, so, complied with control recommendations for installed plant.

Table 5.1: Selected temperature design guidelines and standards, and statutory inputs

Design input	Input type	Input description	Level or prescriptive standard
NCC BCA 2014 J5 Air-conditioning and Ventilation systems	Statutory	Energy efficiency Deemed-to-Satisfy Provisions	Prescriptive sizes of HVAC components and use of timers.
'Facilities Design Standards and Guidelines' (DECS Capital Programs & Asset Services 2010)	Standard	Refers reader to 'Air conditioning' policy	
"'Air Conditioning' (Ventilation, Heating and Cooling)" (DECS Asset Services 2008)	Standard	For design temps 6.5 / 37 C indoor temperature range	20 - 26 C
		Refers to ASHRAE 55-1992 Thermal Environmental Conditions for Human Occupancy	Assumed 10% dissatisfaction at comfort conditions for 20 - 26 C
		Green Building Council of Australia	Green Star 5 star
		Maximum room noise from HVAC plant	45 dBA
		Control	0-2 hour timer for heat/cool Motion sensor for ventilation
		Appendix B: Base common data to be used in life cycle analysis for a typical general learning area located in Adelaide.	GLA floor area 54m^2 School hours 08:30 - 15:00 Design temps 6.5 / 37 C Cooling set point 25 C Heating set point 21 C

5.2.2 Temperature monitored by environmental loggers

The recorded averages using all data collected during core hours (DS-C-OL-A) are available in Appendix H.5. These are presented graphically for the whole 2012 school year (Figure 5.2), Term 1 (February – April, Figure 5.3), Term 2 (April to June, Figure 5.4), Term 3 (July to September, Figure 5.5), and Term 4 (October to December, Figure 5.6). These figures use the Australian Bureau of Meteorology (BOM) station at Kent Town, South Australia for the outdoor air temperature reference.

During core school hours, the outdoor temperature was found to lie between the design temperature 99.5% of the time, i.e., six and half hours were outside of the 6.5 / 37°C design temperatures (DECS Asset Services 2008). This BOM site is located within the urban area the weather station is sited away from buildings and paved ground, so it is likely that this is a conservative estimate of design temperature compliance, since there are likely to be local microclimates within the urban canopy-layer (Erell et al. 2011, pp. 16-17).

These figures show that White School classrooms tended to operate in a smaller temperature range than others, particularly in the term 1. All schools tended to operate below the lower recommended set point during the cooler months. Since loggers were installed on walls, these measurements could be conservative due to local radiation effects of mass, although this was not observed during prototype testing prior to installation (Section 3.5.5.1), Furthermore, differences with spot temperature measurements do not support this (Section 5.2.3).

Orange.5 and Orange.6 recorded larger standard deviations during the cooler months relative to the others, which is consistent with their lightweight portable construction. Red.2 tended to be warmer in the cooler months, with a larger standard deviation, both relative to other Red School classrooms. This is consistent with its permanent (as opposed to transportable) lightweight construction and large single glazed northern façade.

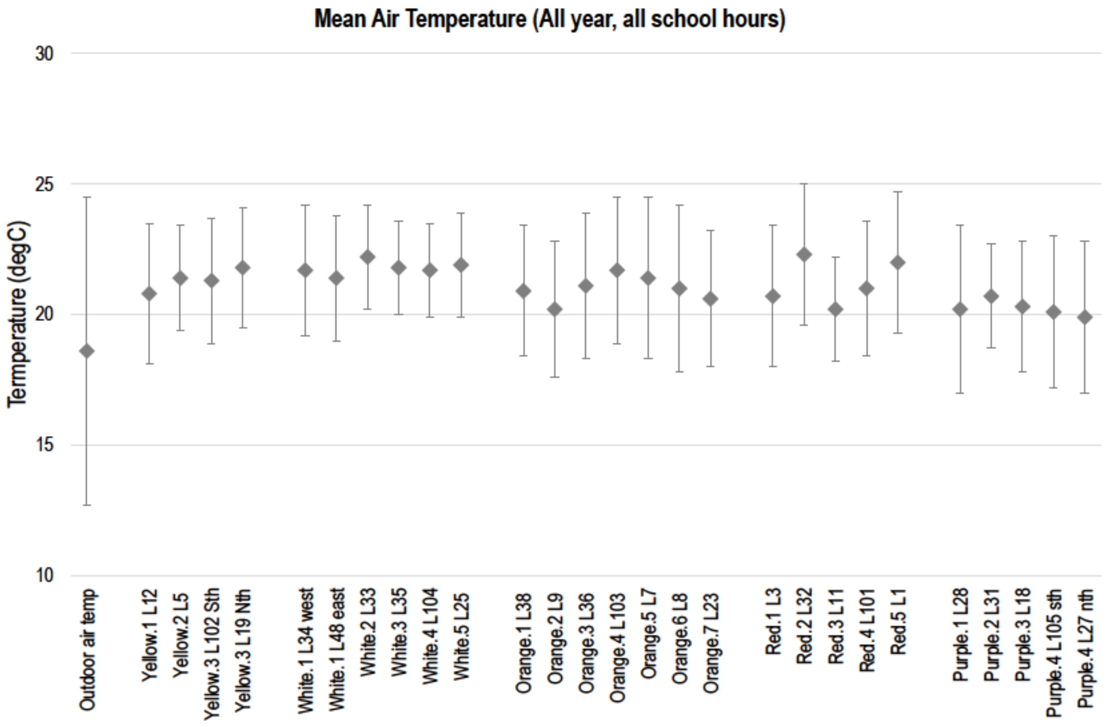


Figure 5.2: Mean Air Temperature for the school year during school hours (DS-C-OL-A)

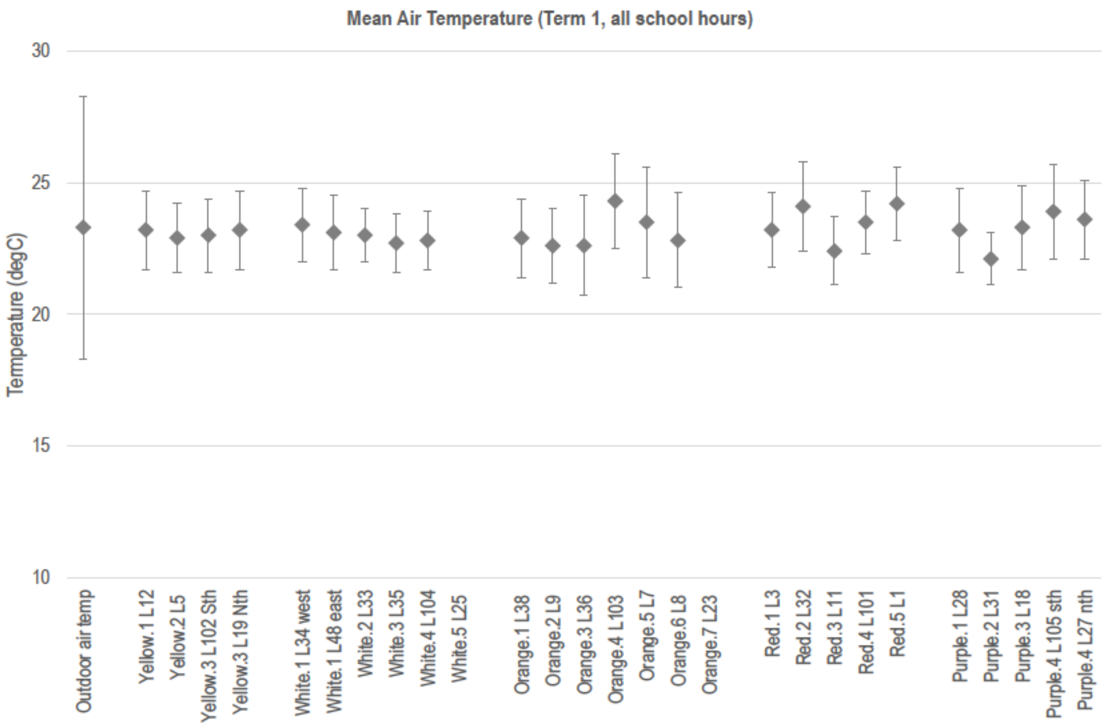


Figure 5.3: Mean Air Temperature for Term 1 (February – April 2012) during school hours (DS-C-OL-A)

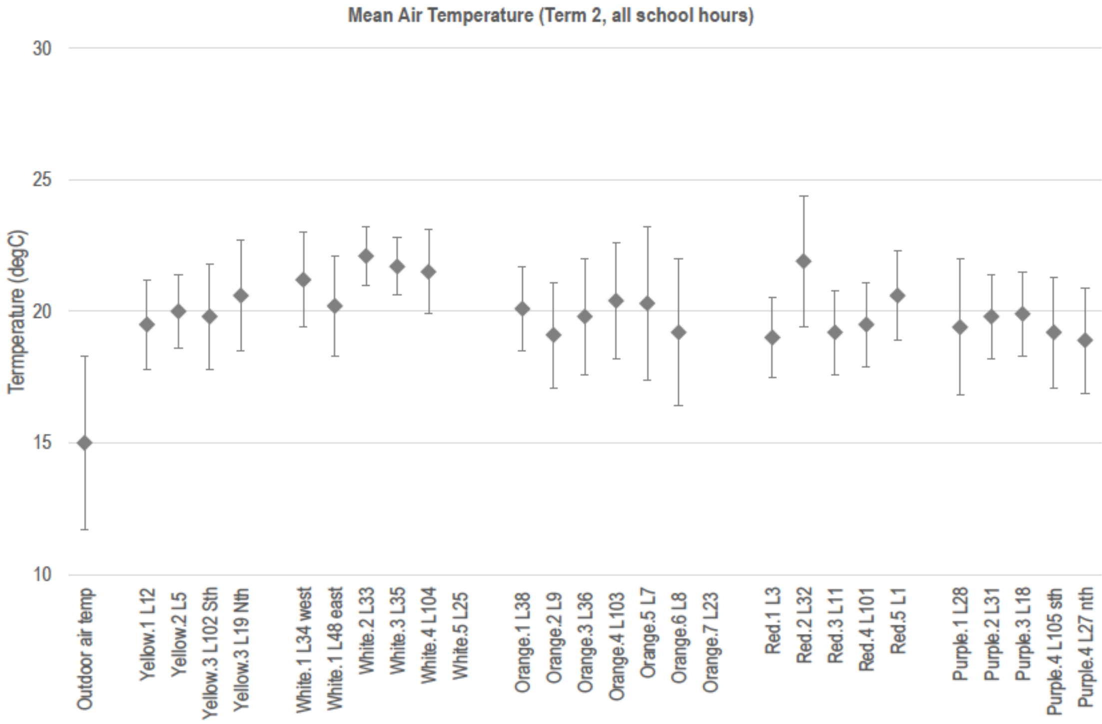


Figure 5.4: Mean Air Temperature for Term 2 (April – June 2012) during school hours (DS-C-OL-A)

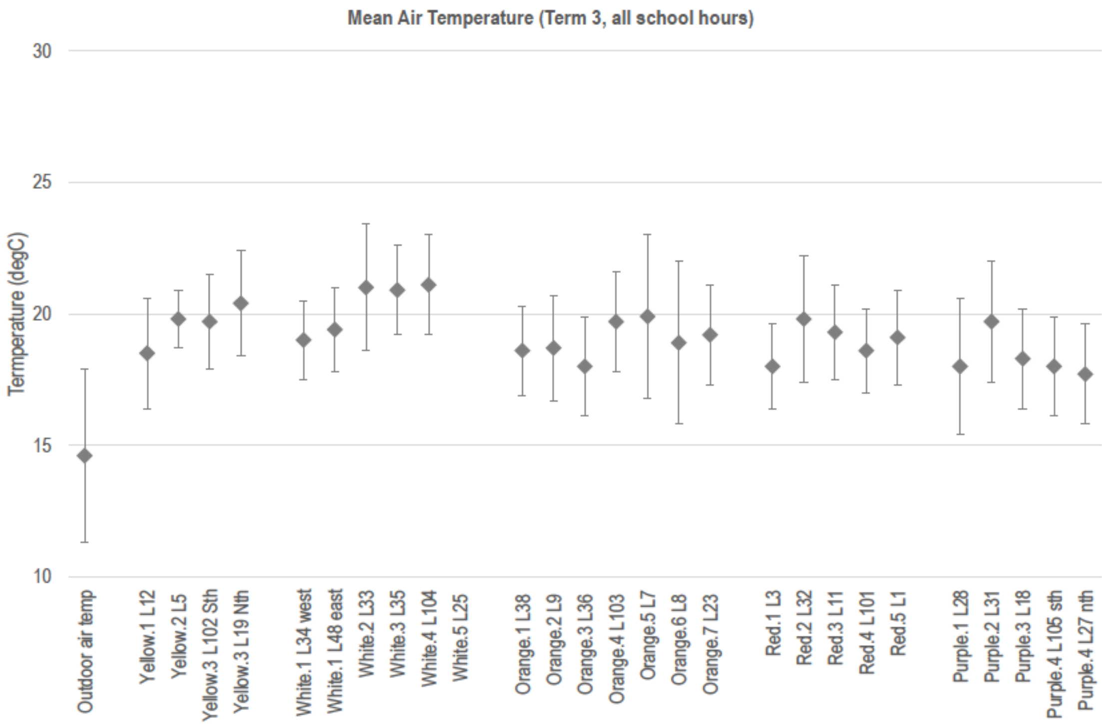


Figure 5.5 Mean Air Temperature for Term 3 (July to September 2012) during school hours (DS-C-OL-A)

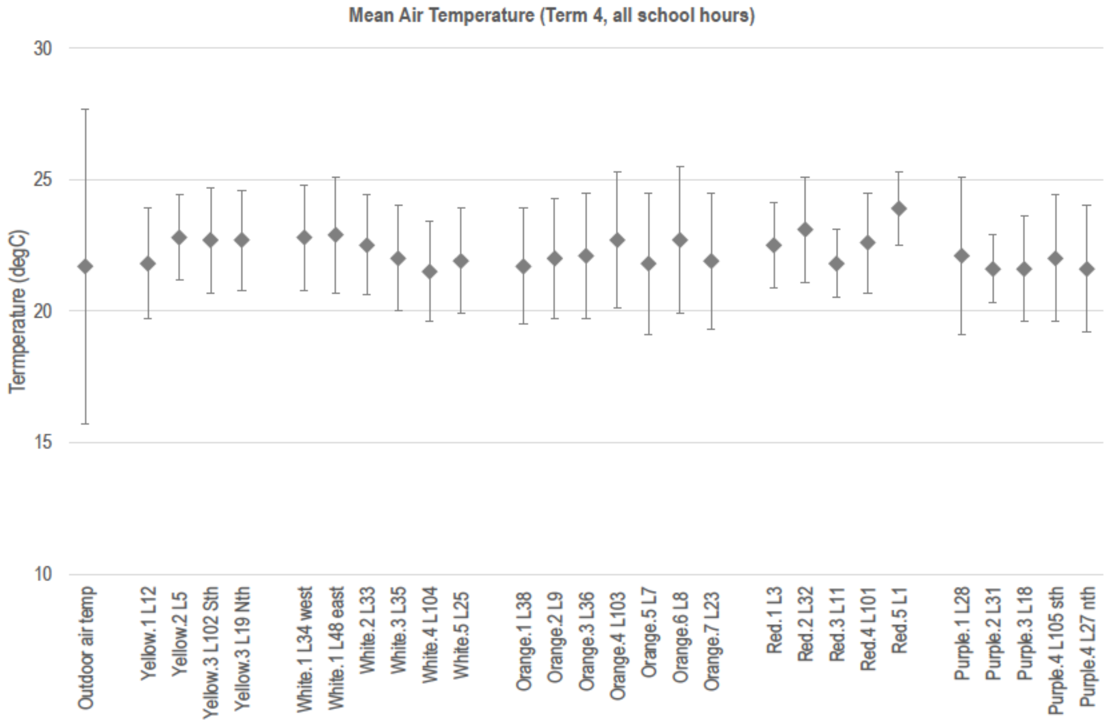


Figure 5.6 Mean Air Temperature for Term 4 (October to December 2012) during school hours (DS-C-OL-A)

The monitored indoor air temperatures are plotted against the outdoor temperatures in scatter plots available in Appendix H.8. These show use of heating and cooling in all schools, with a consistent 'bend' in the plot around 22 degrees Celsius. The suffix 'AC' represents loggers placed near air conditioner vents to capture and confirm AC use. These are responsible for outliers in White.3, Yellow.1, and Purple.2. Outliers at high outdoor temperatures, such as in Red School or Orange School, could be explained by the inconsistent occupation of rooms and the two hour timers turning off the cooling. Similarly, this also explains low indoor temperatures, particularly in the lightweight construction transportables Orange.5 and Orange.6.

Using the comfort range 20 - 26°C prescribed by the education authority (DECS Asset Services 2008), the percentage of temperature logged outside deemed comfort temperatures are shown in Table 5.2. The largest non-compliance for each school is shown in bold. Orange.2 is a south-facing classroom, with the south wall consisting of approximately 60% glazing and fibre cement cladding, the latter without insulation in the assembly, suggesting the HVAC system is not compensating for low resistance walls. Purple.4 also had significant glazing, with full height glazing to both north and south elevations.

White.1 is a multi-class classroom and had two classes near the logger. It was also located distally from HVAC plant. Notably, White.2 and White.3 were the most compliant.

Yellow.1 was a library, as was Red.3. Since occupation was varied, it is difficult to critique the performance.

Table 5.2: Percentage of core hours observations OUTSIDE of the prescribed comfort range during core hours

Yellow	%	White	%	Orange	%	Red	%	Purple	%
Yellow.1 L12	**35.2**	White.1 L34 west	27.4	Orange.1 L38	35.7	Red.1 L3	41.0	Purple.1 L28	45.6
Yellow.2 L5	27.2	White.1 L48 east	**31.4**	Orange.2 L9	**50.8**	Red.2 L32	**20.8**	Purple.2 L31	**32.4**
Yellow.3 L102 Sth	**19.8**	White.2 L33	**11.4**	Orange.3 L36	36.4	Red.3 L11	**44.7**	Purple.3 L18	44.3
Yellow.3 L19 Nth*	30.5	White.3 L35*	11.9	Orange.4 L103*	27.2	Red.4 L101*	39.9	Purple.4 L27nth	**54.8**
		White.4 L104*	15.2	Orange.5 L7*	**25.1**	Red.5 L1*	25.7	Purple.4 L105sth	53.5
		White.5 L25*	15.9	Orange.6 L8	34.1				
				Orange.7 L23	42.6				

Kent Town Bureau of Meteorology air temperature outside of prescribed comfort range for 64.2% of core hours
Lowest and highest values by school in ***bold****.*
**classes participating in survey*

Core hours temperature data was compared with after school hours (3.30-5.30pm) (Appendix H.5.2), school weeknights (6pm to 8am) (Appendix H.5.3), and weekends and holidays (Appendix H.5.4). Differences between these times were tested as an indicator of use beyond the core school hours, where it was assumed that operation of HVAC systems was an indicator of room use. Excluding known HVAC operation problems (discussed later in Section 5.2.4) it was found that eight classrooms had similar after core hours temperatures to the core hours, suggesting after school activities, and that five classrooms were used on the weekends (Appendix H.6).

5.2.3 Temperature measured by portable instruments

The spot measurements taken at desk level in classrooms are presented in Appendix H.7 as overlays onto box plots of the core school hours environmental monitoring data collected, presented by school term. It was not possible to take spot measurements in all terms. Additionally, access to classrooms varied during site visits, so some classrooms have more points than others do.

Both surface and air temperatures measured were consistent with the logged temperatures, suggesting that the logged temperatures provide a reasonable indication of the temperature in the central teaching areas despite their wall installation.

Surface temperatures on desks were measured as being higher than air temperatures on the same day. All desks appeared to be metal frame with particleboard and 'laminate' (also known as 'formica') finish surfaces[43], some with under desk tubs. Desk colours were observed to light blues, greys and creams and slightly textured. The infrared thermometer used had a fixed emissivity setting of 0.95, i.e., for use on non-metal surfaces, i.e., appropriate for use on formica (ε=0.937 at 27°C (Kaplan, p. 150)). Thus, the discrepancy could either be an error in instrument calibration, or thermal lag from remnant heat storage due to recent use.

[43] Desks were observed to be similar to tub desks http://www.woodsfurniture.com.au/products/tub-desks/adjusta-4-leg-double/. Professionally, it is observed that Woods are a common supplier to South Australian schools.

5.2.4 Unexpected monitored temperature data

There two main visual patterns in the temperature data from the environmental loggers. The first was a diurnal pattern that followed the external temperature, while the second was a zigzag pattern that occurred during school hours and was consistent with school occupation. Assuming these were evidence of 'normal' HVAC operation, there were other patterns observed. Two of these are discussed below.

The first was the reduced, or lack of diurnal variation regardless of time of day, or day of the week. For the first part of 2012, this was evident in White.3, as shown in Figure 5.7 where the White.3 measurements are restricted to a narrow band, and show no diurnal variation over the weekend of 6 and 7 May. This suggests that the HVAC was operating over the weekend within narrow set points.

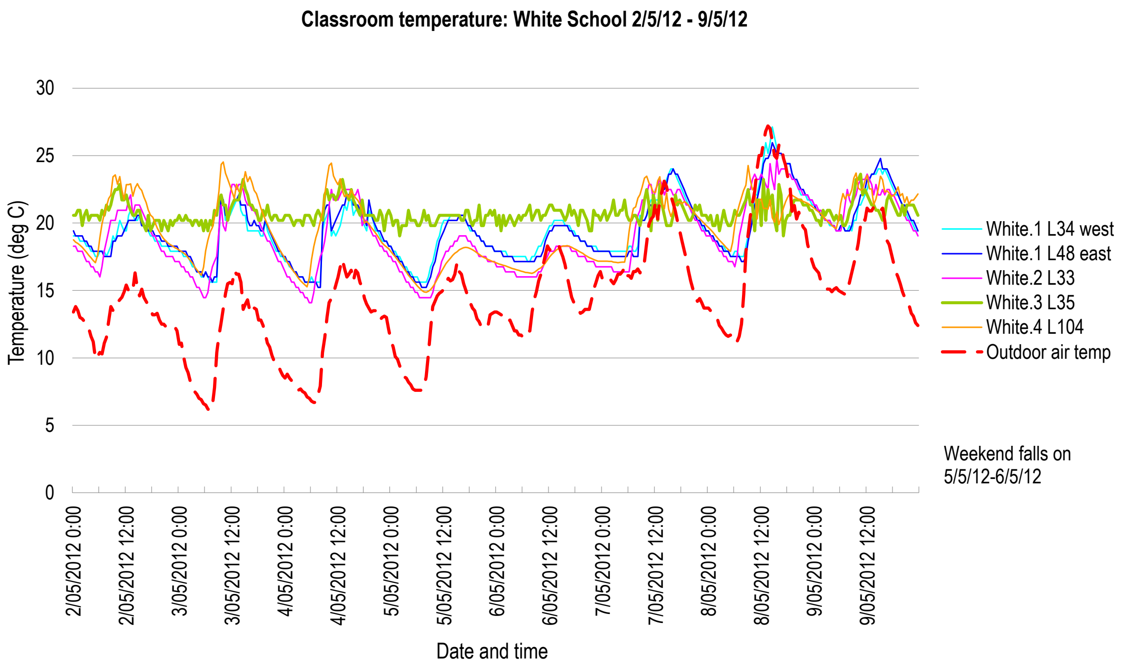


Figure 5.7: Different set points - White School Wednesday 2/5/12 to Wednesday 9/5/12

Different set points for different classrooms at White School are also evident in July (Figure 5.8), together with an adjustment in set points captured in the data. This adjustment was consistent with a conversation with staff, where a staff member described a lack of access to the BMS to adjust set points at the term start (16 July 2012) and the need to liaise with an outside party to have it adjusted (W.g 30/7/2012). From the data below, this took a week for this to be resolved.

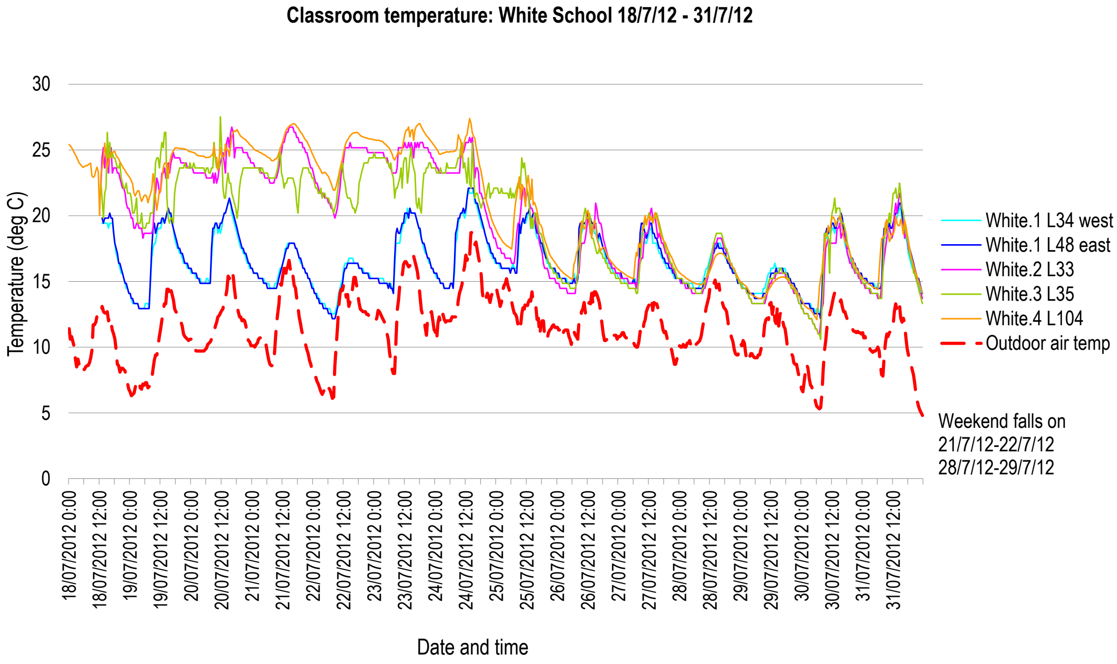


Figure 5.8: Different set points - White School Wednesday 18/7/12 to Tuesday 31/5/12

Schools were reported to be used after core school hours (Section 6.3.3). Yellow School operated language class on the Saturdays, and this was evident in temperature patterns. Figure 5.9 and Figure 5.10 show similar temperature patterns on Saturdays to weekday school patterns, which is consistent with known non-school hours occupation.

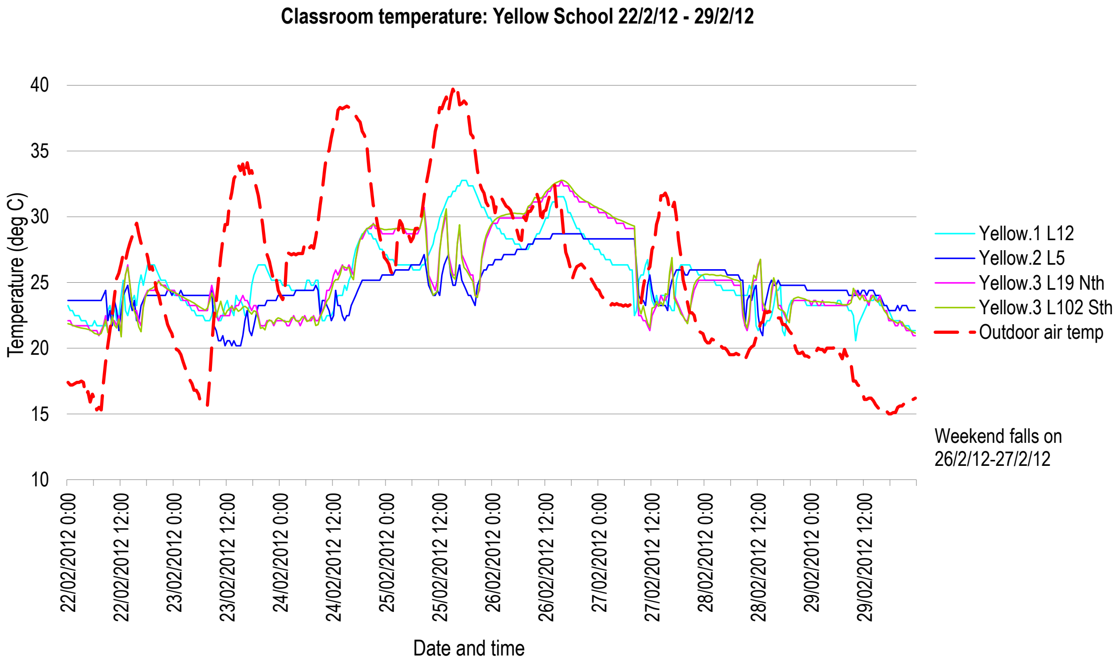


Figure 5.9: Saturday use: Yellow School Wednesday 22/2/12 to Wednesday 29/2/12 with use on Saturday 25/2/12

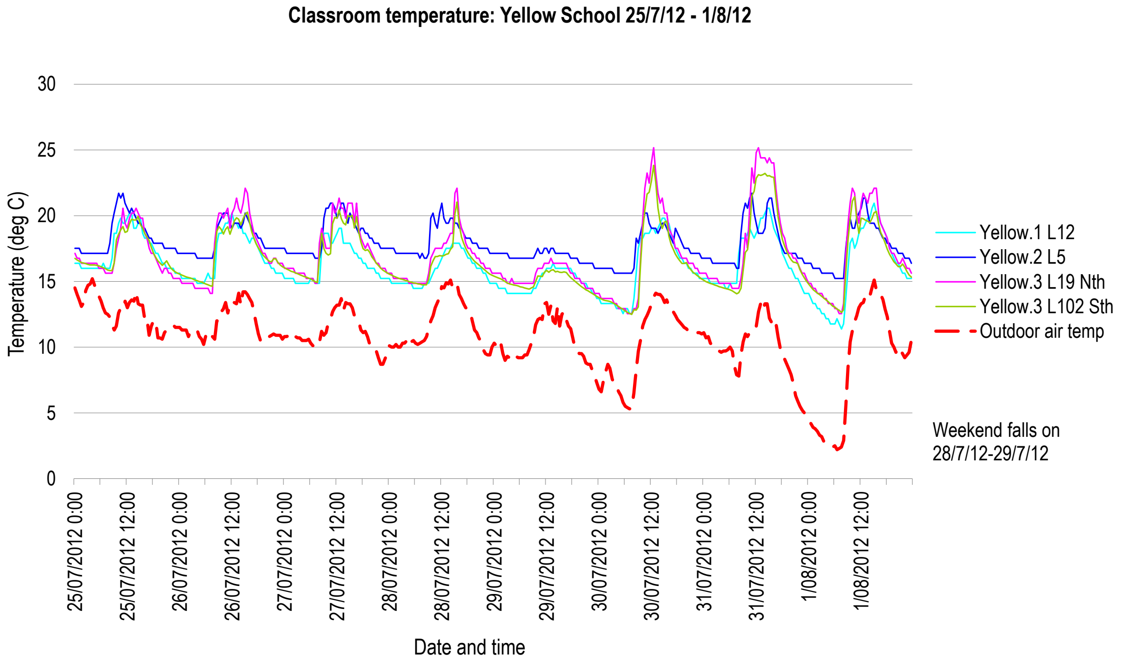


Figure 5.10: Saturday use: Yellow School Wednesday 25/7/12 to Wednesday 1/8/12 with use on Saturday 28/7/12

5.2.5 Temperature and humidity

South Australian education authority guidelines refer to ASHRAE standard 55 1992 for acceptable ranges of operative temperature and humidity (Table 5.1). Regardless of previously noted complications with applying adult comfort principles to children (Section 2.3.5.2), as an approximation[44], for comparison, the operative temperatures from a more recent standard (ASHRAE 2013b) were mapped onto psychrometric charts of the monitored temperature and humidity data (Appendix H.9, with selected charts repeated below). For simplicity the different clothing levels (0.5-1.0 clo) for 80% occupant acceptability for seated office activities is shown as merged into a single region to cover the summer and winter environmental monitoring.

The charts show only the core school hours, i.e., 8.30am to 3pm. It is interesting to that all classrooms tended towards being on the low temperature side of 'acceptability' during winter. Furthermore, the psychrometric profiles of all monitored classrooms were similar regardless of construction and environmental system. For example, Orange.4, with its solid mass walls and mixed mode environmental system (Figure 5.11), exhibited a similar profile to Orange.6, a recently built lightweight transportable with an inverter system and operable windows that were never observed to be used (Figure 5.12). White.2, a permanent mixed lightweight and brick veneer construction with mixed mode environmental system and similar orientation to Orange.4, was

[44] The 1992 version of operative temperatures refers to summer and winter seasons, not clothing level, and a variable humidity ratio (see Figure 1 in de Dear & Schiller Brager 2001). The operative temperature has been replaced by dry-bulb temperature as is precedent elsewhere (Jones 2001, pp. 90-91). The distinction in temperatures is noted as introducing inaccuracies, yet it is argued that in the context of this qualitative inquiry this is acceptable.

similarly cooler than 'acceptable' (Figure 5.13).

Based on the measurements above, a student who is sedentary might feel cold in all case study classrooms. Plastic chairs were observed to be used by all students and, when compared to a standard office chair (0.10 Clo), it was concluded that these chairs would provide similar poor insulation in the order of wooden stools (0.01 Clo in ASHRAE 2013b), thus not offsetting the low temperatures.

In contrast to this additional insulation may be available through standard clothing. All participant schools required students to wear uniforms, with long trousers available to both genders. The total clo value for a typical winter uniform of underwear, long socks, shoes, long-sleeve sweatshirt, thick long trousers and a long-sleeve jumper was calculated to be 1.14 Clo (ASHRAE 2013b, p. 7). These are 0.14 warmer than 1.0 Clo range reported in the ASHRAE standard 55-2013 Graphic Comfort Zone Method (ASHRAE 2013b, p. 9). This is equivalent to students wearing an additional 'thin sleeveless vest' (ASHRAE 2013b, p. 7). Satisfaction with classroom temperatures is discussed in Section 6.4.4.1.

All classrooms were typically below 70% relative humidity, except Orange.1, which was recorded as being above 70% on warmer days (Figure 5.14). This is consistent with the room having evaporative cooling.

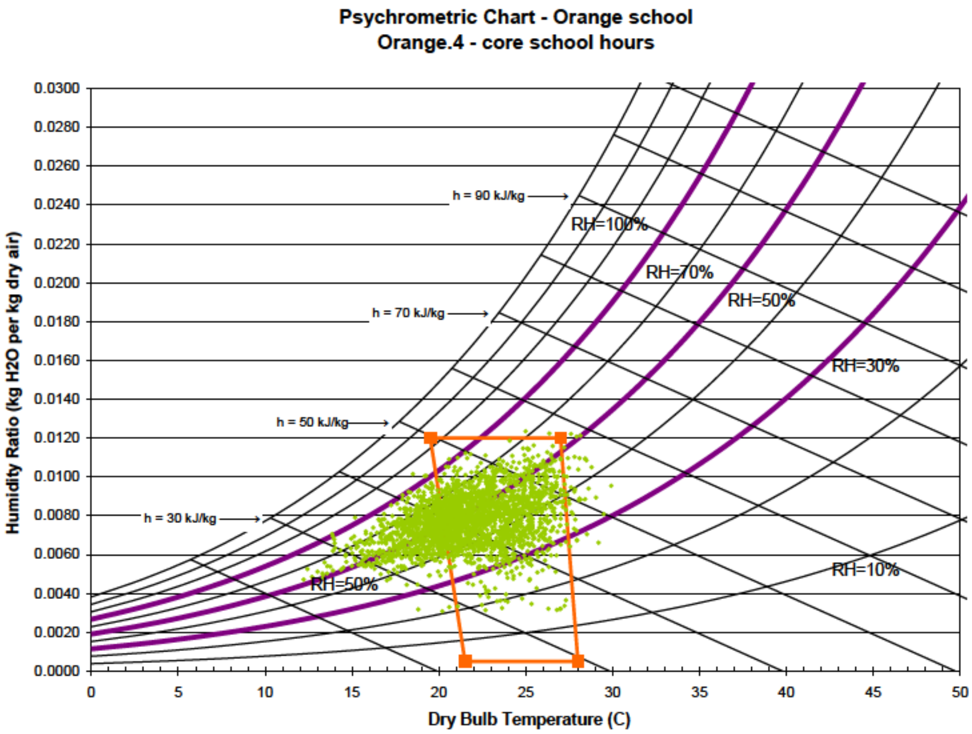


Figure 5.11: Psychrometric chart for core school hours: Orange.4 - Mass walls (DS-C-OL-A)

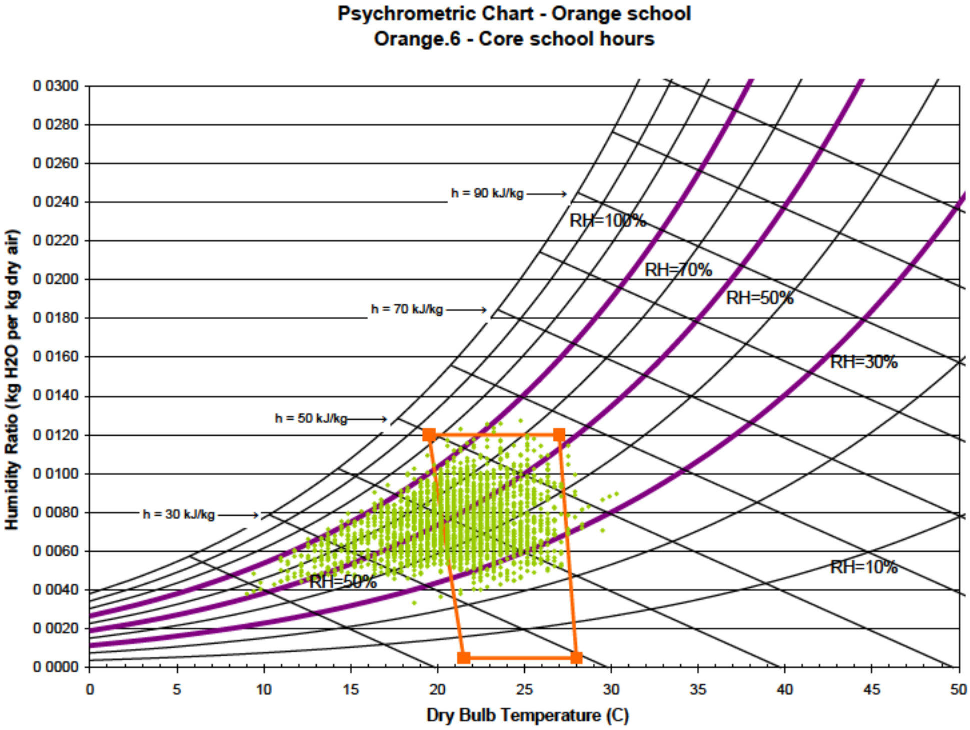


Figure 5.12: Psychrometric chart for core school hours: Orange.6 - lightweight transportable building (DS-C-OL-A)

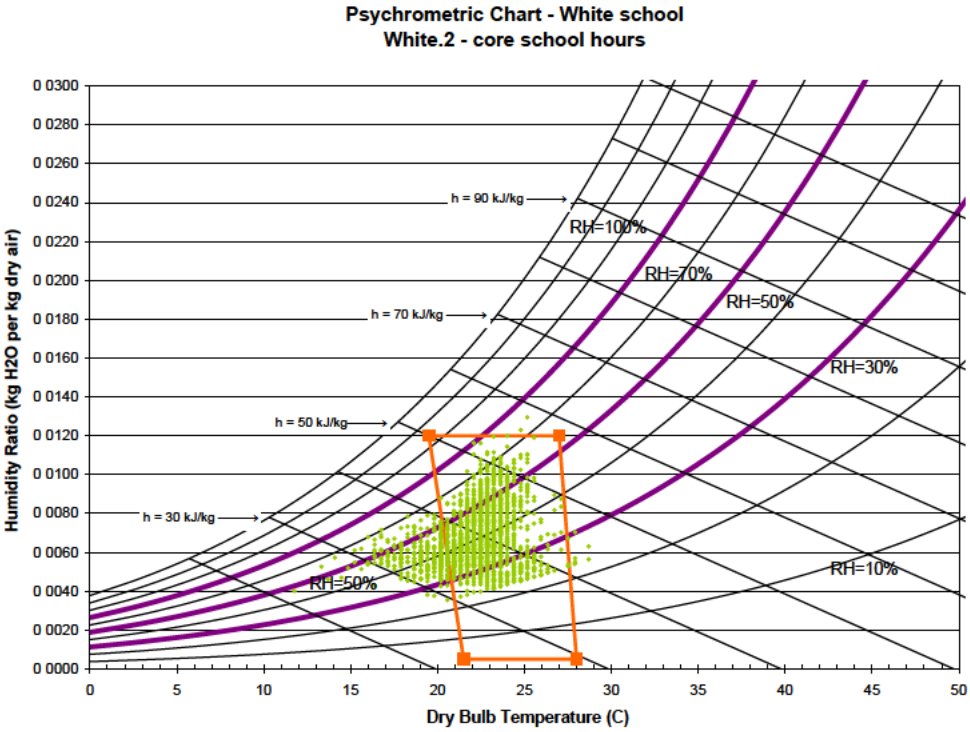


Figure 5.13: Psychrometric chart for core school hours: White.2 – mixed lightweight and brick veneer permanent construction (DS-C-OL-A)

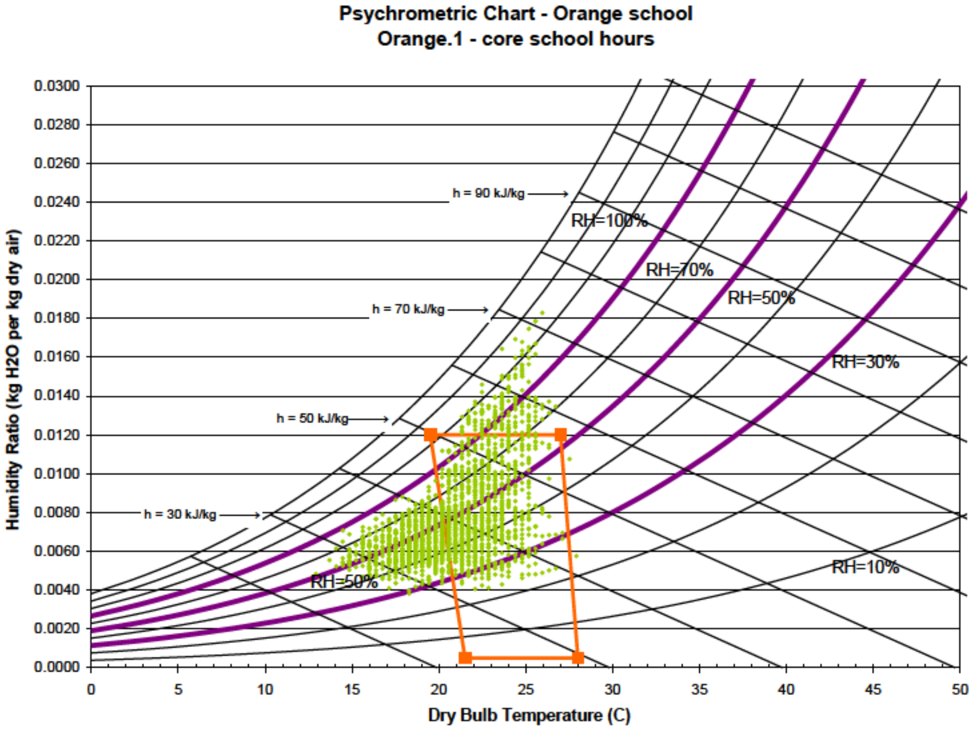


Figure 5.14: Psychrometric chart for core school hours: Orange.1 – Mass walls with evaporative cooling (DS-C-OL-A)

5.3 Light

This Section presents the expected light design deduced through lighting guidelines and regulation for school buildings in South Australia. These are then contrasted with what was measured in the case study classrooms.

5.3.1 Lighting guidelines and regulations for schools

There are two sources of design inputs for school lighting depending on whether the source of the light is daylight or artificial. With the objective of minimising the use of artificial light, daylight is encouraged with focus on use of appropriate shading and skylights to control glare and contrast (DECS Capital Programs & Asset Services 2010). However, the selected BCA requirements in Table 5.3 provide only proportional design guidelines, i.e., size of window, not quality of light, and there are not Australian Standards referenced. Thus, provision of daylight, both quality and quantity relies on the architectural design.

Table 5.3: Selected day lighting design guidelines and standards, and statutory inputs

Design input	Input type	Lighting purpose	Level or prescriptive standard
NCC BCA 2014 F4.1 (d)	Statutory	Provision of natural light	To all general purpose classrooms
NCC BCA 2014 F4.2 (a)(i)	Statutory	Methods and extent of natural light	Windows not less than 10% of the floor area and open to sky

Artificial lighting design in schools is driven by a range of standards and statutory inputs and falls into the design realm of electrical engineers. A selection of standards and statutory regulations applicable to artificial lighting design for South Australian schools is presented in Table 5.4. This list does not claim to be definitive or for professional use. Rather it is presented as a sample of design inputs to demonstrate the ambiguity of artificial light design. The design inputs do not refer to each other clearly, so that the DECS capital programs refers to a standard for offices without referring to the specific education lighting standard. The BCA refers to the lighting standard suite of documents, but the educational lighting standard is written such that more than one illuminance level could be applied to a primary school classroom due to the range of activities.

Table 5.4: Selected artificial lighting design guidelines and standards, and statutory inputs

Design input	Input type	Lighting purpose	Level or prescriptive standard
NCC BCA 2014 F4.4	Statutory	Lighting to class 9 buildings[45]	AS 1680.0. (no year listed)
NCC BCA 2014 J6 TableJ6.2a	Statutory	School - general purpose learning area	8 W/m^2 MAXIMUM illumination power density
NCC BCA 2014 J6.3	Statutory	Lighting and power control	Timers or motion sensors required
AS/NZS 1680.2.2:2008 Table E1	Standards	Office and screen based tasks	General task 320 lx Screen-based task areas 160 lx
AS/NZS 1680.2.3:2008 Table D1	Standards	Specific applications - Educational and training facilities	Classroom general use 240 lx Computer rooms refer AS1680.2.2 Art activities 400-800 lx
(DECS Capital Programs & Asset Services 2010)	Standards	General	Prescribes lamp wattage (36W) and luminaire height.
(DECS Capital Programs & Asset Services 2010)	Standards	'rooms dedicated to the use of computers'	AS1680.2.2 (no year listed)

While current regulations, both for daylight and artificial light, are applicable only to new building work, these regulations and standards will be used as indicator and reference of what is currently considered best practice. This is justified since all classrooms under study had been either built or renovated within the last fifteen years, so the lighting levels should be designed to provide uniform lighting levels to Australian Standards regardless of the age of the building. Thus, all rooms should achieve a minimum light level at all locations in the room if artificial lights are on, i.e., location of measurement should not matter. However, given the range of activities that occur in a contemporary classroom (screen work, general learning, artwork), it is difficult to nominate a single appropriate illuminance level.

5.3.2 Measured light levels

Light levels were collected by those illumination level loggers with light sensors and supplemented with spot measurements using a handheld light meter during site visits (Section 3.5.5). The two sets of measurements need to be interpreted and compared with care due to the different orientations used on the environmental loggers and lux meter. The environmental loggers were

[45] The ABCB classification for public buildings is Class 9. Specifically, schools are Class 9B. Table F4.4 also covers all non-residential buildings.

installed on the walls for practical reasons, leading to the light sensors being oriented vertically (refer to Section 3.5.5.1 and Photograph 3.3). This is in contrast to the portable lux meter, which was placed horizontally on vacant spaces on student desks, i.e., between 560mm and 720mm AFL. Thus, there are discrepancies between light measurements on the same day at the same time in the same room. Due to this wide range of illuminance levels measured, these are presented below box plots and spot measurements, rather than as averages.

The full range of logger measured illuminance box plots and spot measurements are presented in Appendix H.10. A sample is presented in Figure 5.16 to Figure 5.19 using the late spring and early summer conditions of Term 4, with all vertical axis scales set to 2000 lux for comparison. All logged illuminance levels tended to be lower than recorded lux meter measurements. While this could be due to site visits taking place on sunnier days, it is more consistent with the fixed wall installation location and vertical orientation of the environmental loggers as compared to results from a horizontal lux meter placed on centrally located student desks.

The logged illuminance levels tended to have between 25 - 75% of measurements below 200 lux, i.e., only suitable for screen based tasks adjacent walls, except Purple.4 (skylights), White.1 (three class space with clerestories), Red.2 (large north glazing and north and east clerestories) and Red.4 (tall north windows without shade devices). Moving away from walls, illuminance measured by the hand held devices showed a large variation, with some classes measured at more than the 800lux level recommended for artificial lighting for art activities, as in Purple.1, Purple.3, Purple.4, Orange.4, Orange.7, White.1, Red.2, and Red.4.

In between these extremes of uses, there was a variation of observed illuminance levels ranging between 200 and 800 lux. Orange School (except Orange.4 and Orange.7), showed the least variation, which is likely due to the glazing modification (film) and obstruction (display and furniture) as described in Section 4.2.5, and the consequent reliance on artificial lighting.

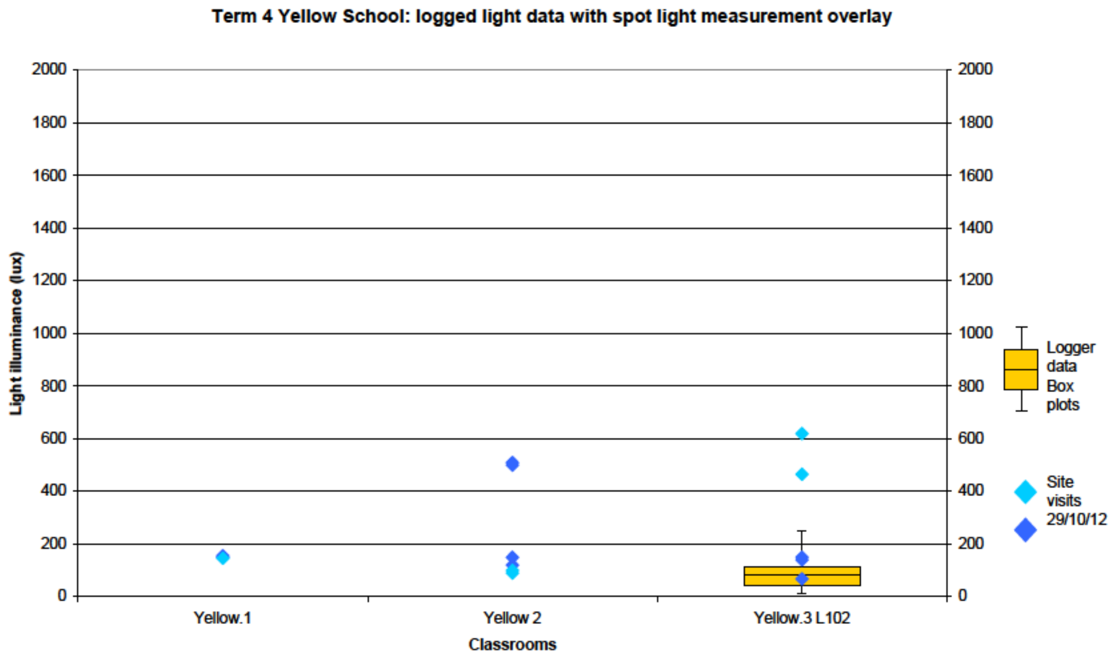


Figure 5.15: Term 4 Measured illuminance: Yellow School (no box plot means no illuminance-capable logger used in room) (DS-C-OL-A)

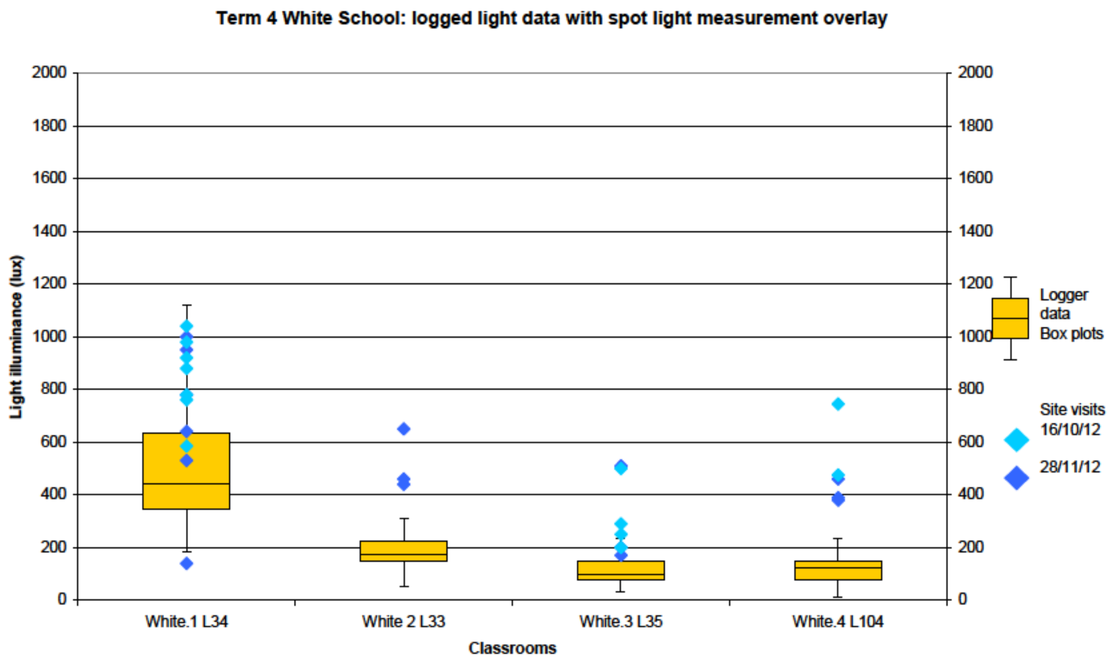


Figure 5.16: Term 4 Measured illuminance: White School (no box plot means no illuminance-capable logger used in room) (DS-C-OL-A)

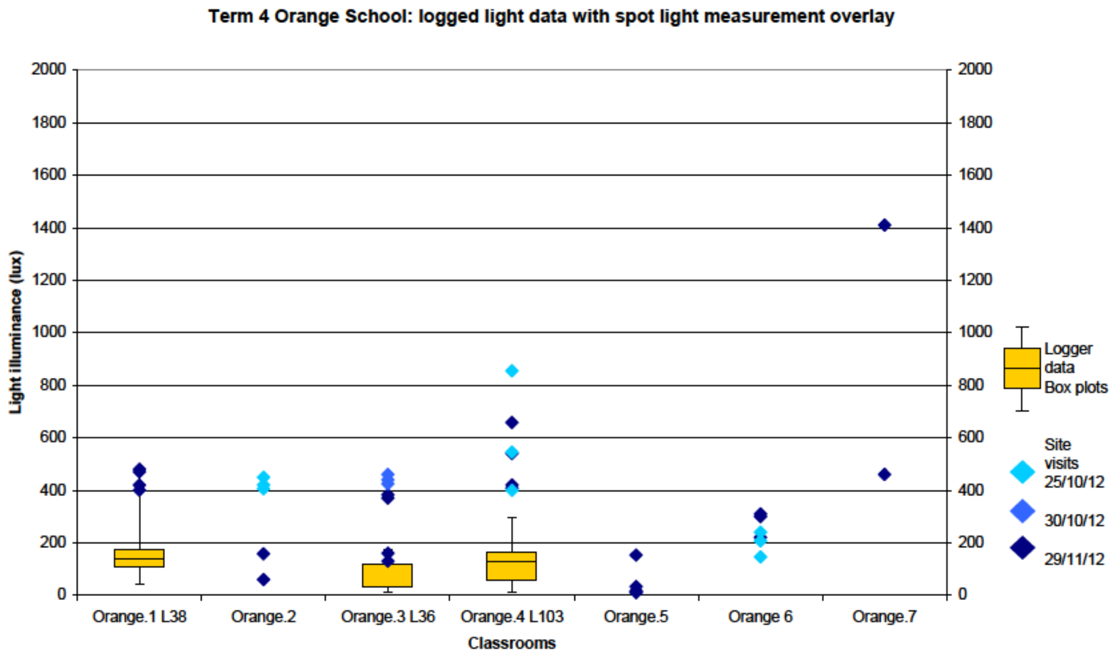


Figure 5.17: Term 4 Measured illuminance: Orange School (no box plot means no illuminance-capable logger used in room) (DS-C-OL-A)

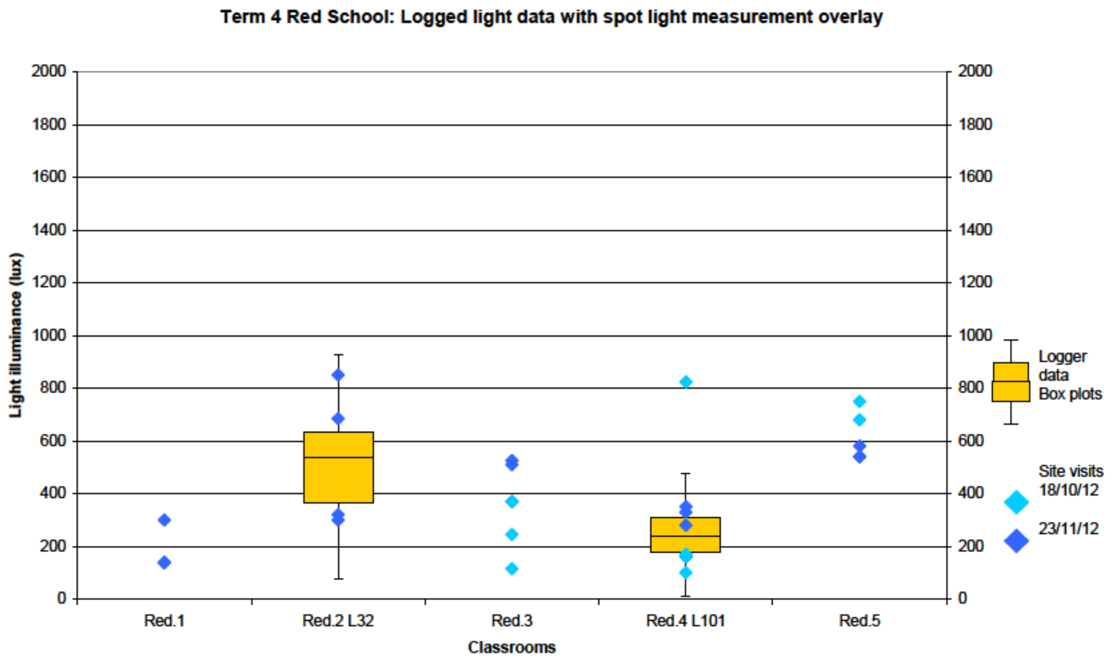


Figure 5.18: Term 4 Measured illuminance: Red School (no box plot means no illuminance-capable logger used in room) (DS-C-OL-A)

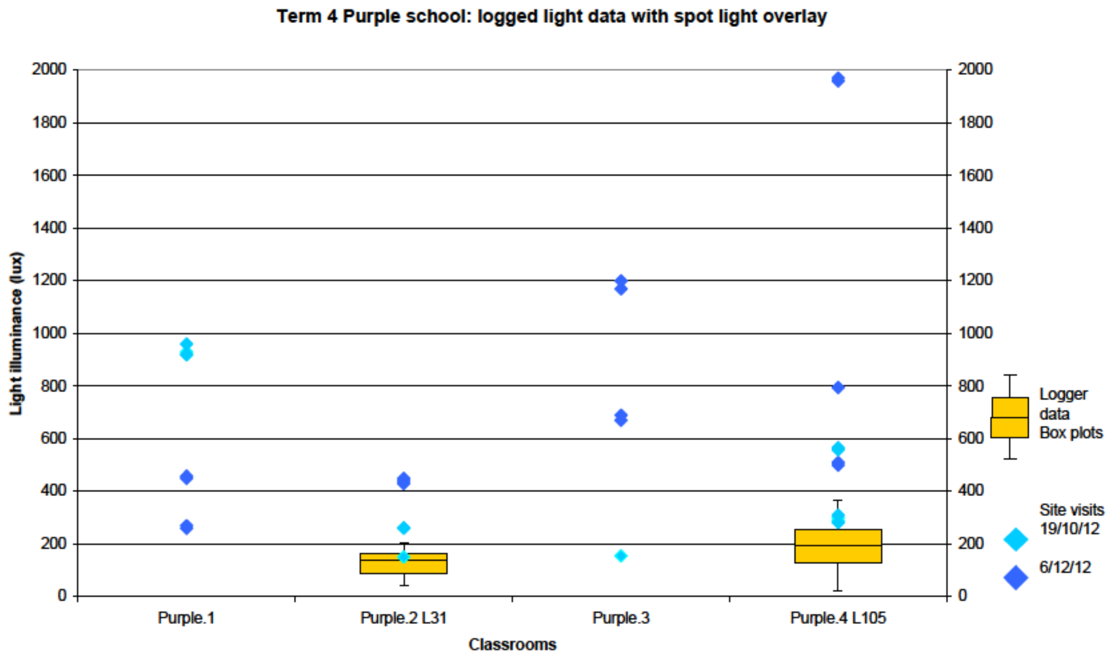
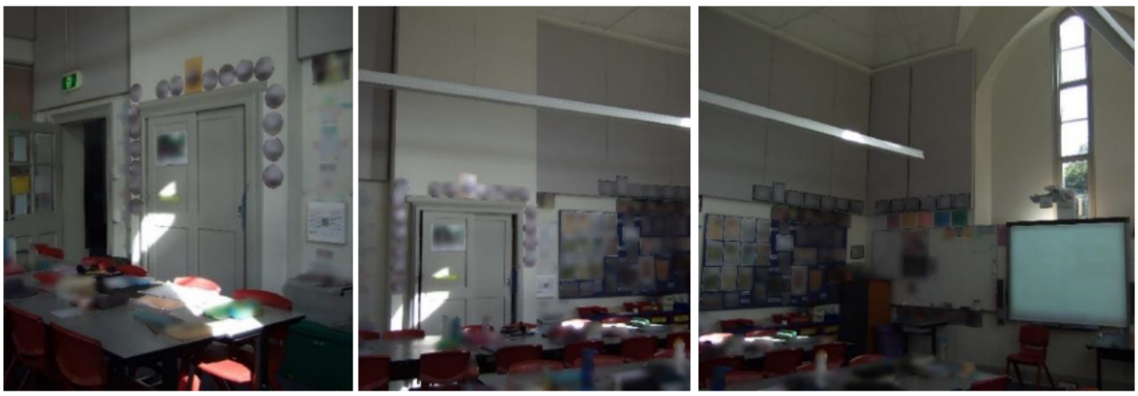


Figure 5.19: Term 4 Measured illuminance: Purple School (no box plot means no illuminance-capable logger used in room) (DS-C-OL-A)

Overall, there was a wide range of lighting conditions observed, as suggested by the measurements. Though difficult to photograph, two examples are provided below. On a visit in August, some obvious glare was observed in Red.5, in the form of direct sunlight on desks and walls from a north window (see tall, narrow window in Photograph 5.1). This window had no exterior shade device in its original design and its heritage listing prevented retrofitting.



Photograph 5.1: Morning glare from north window onto west wall Red.5 in August (DSCF6397_120802mod.JPG, DSCF6408_120802mod.JPG, DSCF6407_120802mod.JPG)

The clerestory and ceiling geometry in White.2, White.3 and White.4 was observed to create very different lighting conditions and zones within each room. Photograph 5.2 attempts to show this with a panorama of photos of the west wall. The camera was set on auto flash and the flash went off on the first (along the south wall), and the last (towards the north wall) where there were windows with blinds. The centre photos show the transition from well-lit, over the IWB, towards the darker northwest corner, where the environmental logger was placed.

Photograph 5.2: Differing daylight on west wall in White.3 in November, with camera on auto flash. (DSCF7816_121128mod.JPG flash, DSCF7817_121128mod.JPG no flash, DSCF7818_121128mod.JPG no flash, DSCF7819_121128mod.JPG flash)

5.4 Noise and Sound

Using the words 'noise' and 'sound' needs care and the point at which sound (wanted) evolves into noise (unwanted) is subjective and not definitive. Despite this complexity the objective of architectural acoustics is to design 'to meet hearing needs' (Grondzik et al. 2010, pp. 737-740). A summary of educational acoustic literature was presented in Section 2.3.5.4, and acoustic modifications observed in the case studies are discussed in Section 4.4.5.

Measuring the success of an acoustic treatment is a specialist area[46] and is beyond the scope of the current project. Rather, the intention of the sound measurements was to provide an indicative measure of the current acoustic treatment of classrooms and the sound levels experienced under current pedagogies, and as comparison between classrooms. It did not intend to measure the composition or quality of sound within the classrooms, though it is acknowledged that this is a critical aspect of occupant experience. This latter deficiency was due to lack of access and time, but is noted for future work. Despite this, the dBA measurements (Grondzik et al. 2010, pp. 757-758) made were considered an adequate starting point both in themselves to judge current problem-based learning sound levels and the sound durability of both old and recent buildings, and their modifications, under current noise stresses. The next section summarises acoustic guidelines and standards used in South Australian primary schools, which is then followed by the noise measurements taken in the case study schools.

[46] The researcher has worked with specialists Marshall Day Acoustics on aircraft noise rectification projects (http://marshallday.com/project/st-george-greek-orthodox-church-thebarton-south-australia) and, having witnessed their expertise, does not claim to have acoustic knowledge to this professional level.

5.4.1 Noise and sound guidelines and regulations for schools

Like environmental comfort and light, acoustic design has a range of inputs and a selection of these are given in Table 5.5. Again, these vary between standards and offer conflicting inputs, such as a maximum class background noise of 40dBA allowed by an acoustic standard, conflicting with a HVAC plant allowable noise of 45dBA.

Table 5.5: Selected acoustic design guidelines and standards, and statutory inputs

Design input	Input type	Acoustic purpose	Level or prescriptive standard
NCC BCA 2014 F5	Statutory	Only for class 2 or 3 or 9c buildings, i.e., not schools	nil
AS/NZS 2107:2000 Table 1	Standards	Design sound levels	Primary schools Max unoccupied sound level = 45 dBA Reverb time = 0.4 to 0.5 s (2/3 occupancy)
AS/NZS 2021:2000	Standards	Aircraft noise intrusion - construction depends on Australian Noise Exposure Forecast (ANEF) adjacent any airport	Indoor design sound level for aircraft noise for 'teaching areas' = 55 dBA
(DECS Asset Services 2008)	Standards	Maximum room noise from HVAC plant	45 dBA
(DECS Capital Programs & Asset Services 2010)	Standards	General notes about acoustic separation and reduction of reverberation time and referral to CP001.	Prescriptive use of acoustic surfaces. 35-40 dB separation. 'attention to detail ...to avoid sound paths'
(DECS Asset Policy & Capital Programs 2008)	Standards	Acoustic performance standards Notes that DECS standards higher than AS/NZS 2107	Classrooms, primary: Max unoccupied sound level = 40 dBA Reverb time = 0.4 to 0.5 s (2/3 occupancy)

5.4.2 Measured noise levels

The noise measurements made during this study are presented below (Figure 5.23 to Figure 5.20), together with the presence or absence of students at each measurement. Where learning activities were in progress a maximum and minimum reading was taken to observe variation.

Measurements in empty rooms were generally below the lower limit of the sound meter, i.e., 35dBA or less. Since HVAC plant was observed to be operating in all cases during the measurement, this suggests that HVAC noise limits typically met the relevant standards.

Some classrooms were observed to experience noise ingress. This noise ingress came from three sources - noise from adjacent classes, student noise outside the building and non-school noises outside the building. Figure 5.23 provides an example of the first two types of noise. Red.2 experienced noise ingress without occupants on the 2/8/12 and, since it is a single room, the noise source was student activity in the adjacent playground. Note that this noise entered the room despite all windows and external doors being shut. Red.4 also experienced noise ingress into the teaching space despite being empty of occupants. This room is connected to an adjacent teaching space by a wall opening and the noise from the adjacent space was measured at 50 dBA. HVAC noise was measured above the 45dBA guideline in White.1.

Maximum sound levels were rarely measured above 75dBA and, where measured, occurred in both multi-class classrooms (Purple.4) and single class rooms (Purple.3), suggesting that noise levels are not necessarily related to number of students. Nor was it related to age of students since junior primary classes (Yellow.2) were as loud as senior primary classes (Red.5) in similarly constructed buildings, or different acoustic treatments - see Photograph 4.19 for similar school treatments in Yellow.3 and Red.4.

During the measurements it was observed that different activities led (logically) to different sound levels, such as reading and discussion was far quieter than project construction activities. Given this, the small sample of noise measurements provide only trends towards lower and upper limits of observed activities, for use in comparison against the later survey responses.

The noise and sound guidelines listed in Section 5.4.1 provide only sound levels as design criteria so it is considered appropriate to measure sound levels to provide comparative analysis within the scope of this study; however, given the above findings, it is appropriate to note that these guidelines seem inadequate. Based on the similarities of measurements in occupied classroom of different construction, sound level measurement, though simple, does not provide an appropriate measure of acoustic quality. While it would have been interesting to extend measurements beyond test guideline compliance, measures associated with speech intelligibility were not undertaken due to lack of test equipment and available time to become knowledgeable in the highly specialist area of acoustic design.

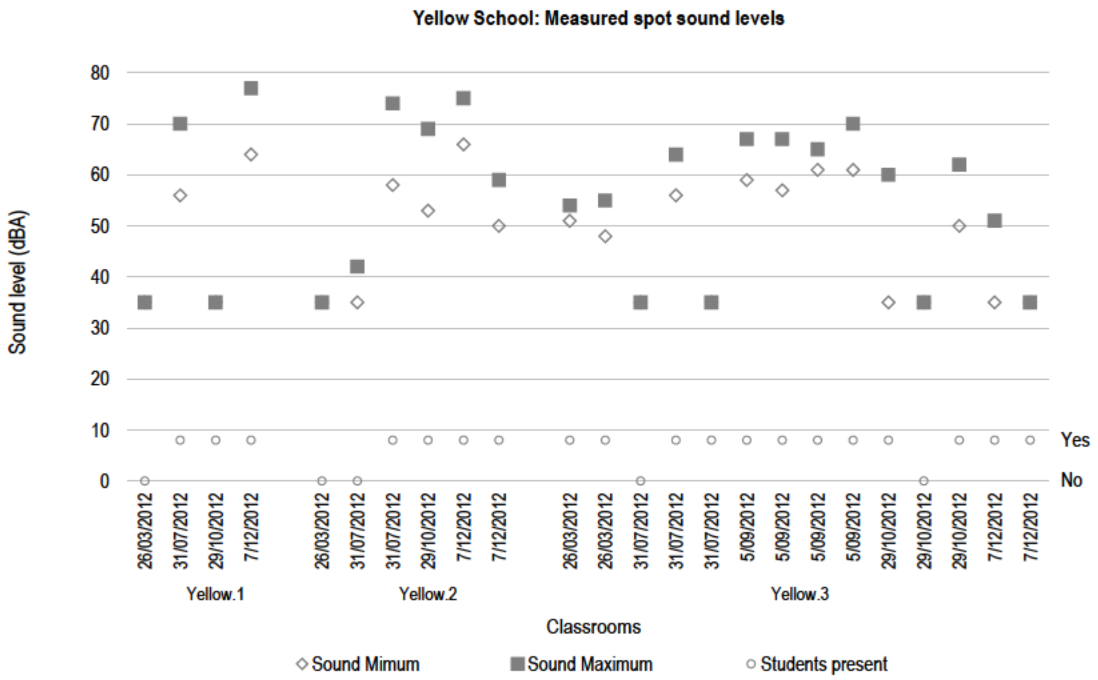


Figure 5.20: Measured spot sound levels – Yellow School

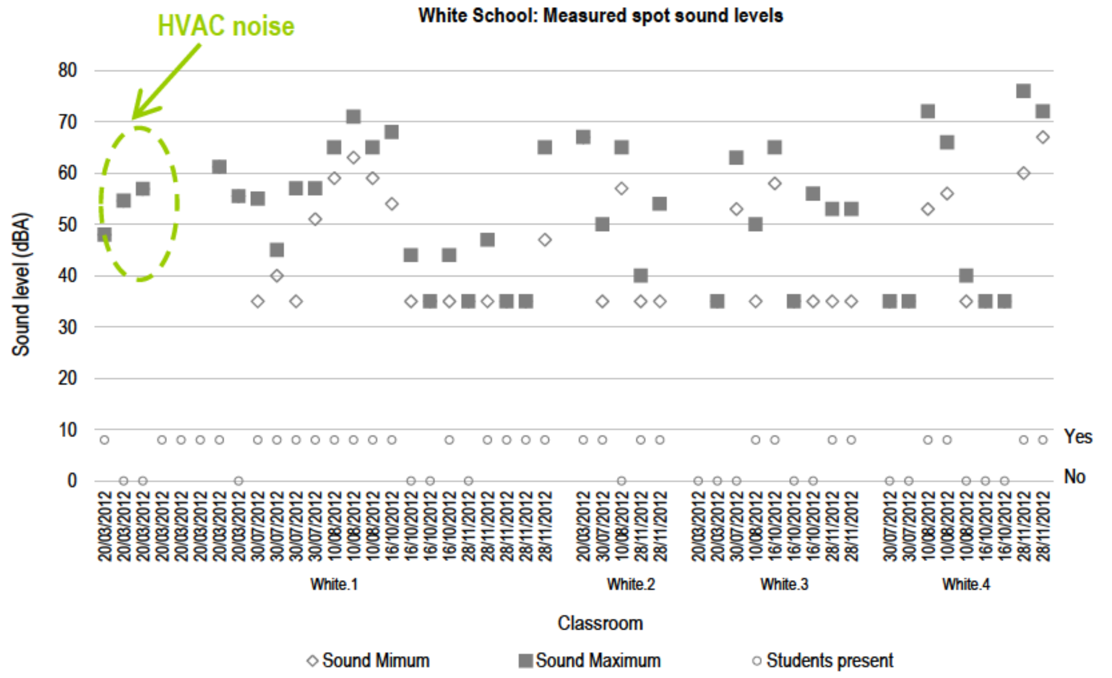


Figure 5.21: Measured spot sound levels – White School

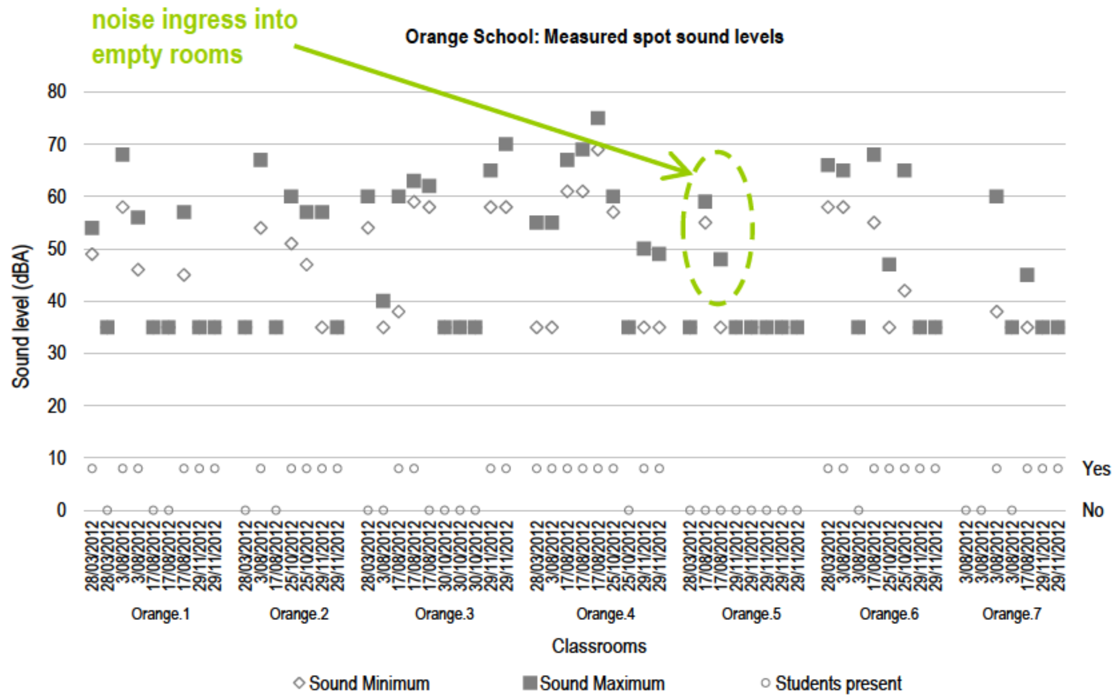


Figure 5.22: Measured spot sound levels – Orange School

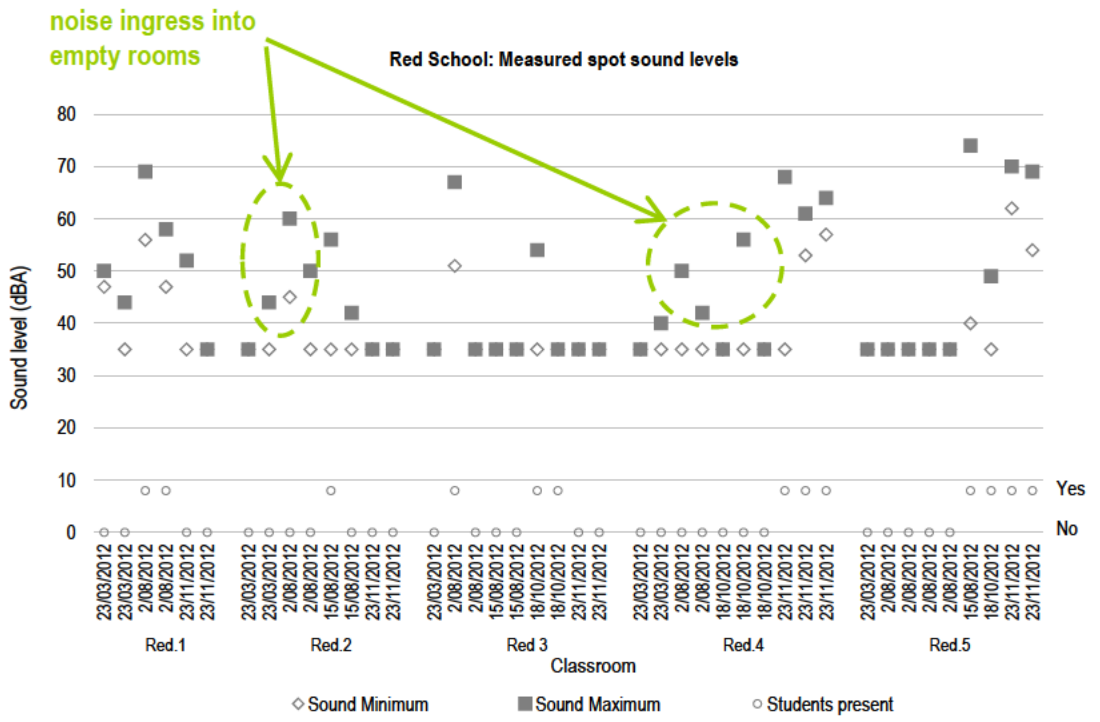


Figure 5.23: Measured spot sound levels – Red School

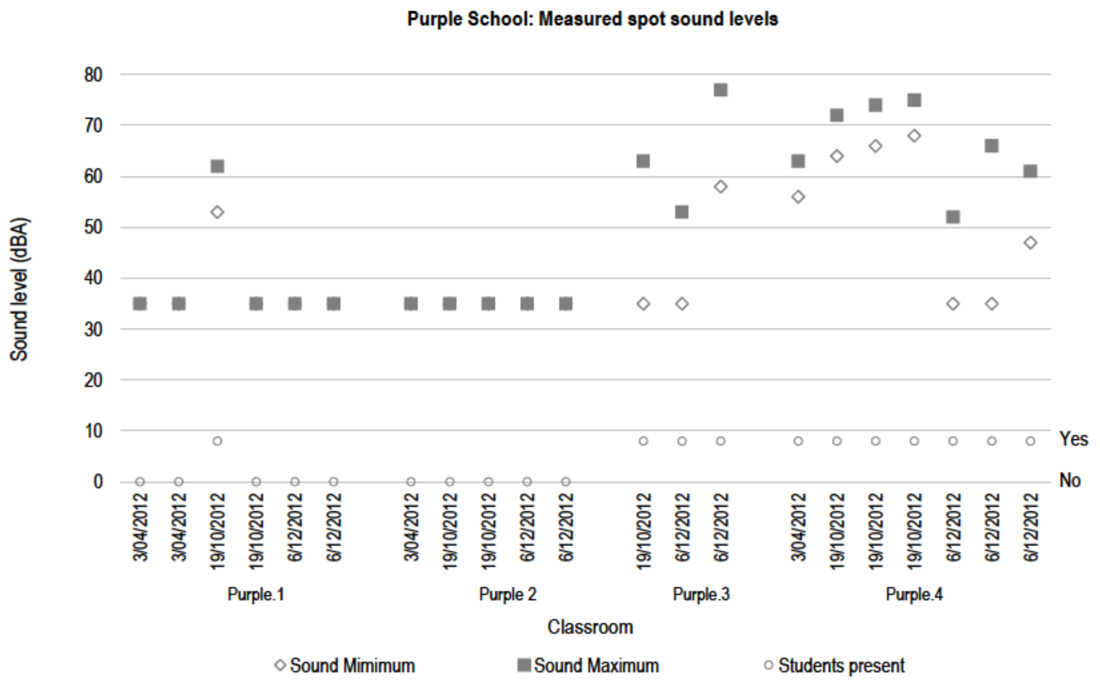


Figure 5.24: Measured spot sound levels – Purple School

Noise from sources other than school activities were noted but not included in the above formal spot measurements. Light aircraft noise was heard in White.3 with operable windows open on 16/10/12 (not measured), and measured at 67dBA in White.2 on 30/7/12 with the door propped open (despite the outdoor winter temperatures). Bus noise was noted at 53dBA in Yellow.2 on 31/7/12 with windows shut (no operating external door). These were consistent with adjacent infrastructure (airfield near White.2 and busy bus route near Yellow.2) and, though only observed three times in this study, are likely to be a regular occurrence in the noise landscape of both schools.

5.5 Summary

This chapter presented measured aspects of the physical classroom environment (as compared to the general classroom environment – see Section 1.3.3). These were compared to the relevant design guidelines and standards to confirm conformance, or otherwise, and to provide context for later participant survey responses. This chapter contributed to developing a context for user perspectives as required by research questions 2 and 3.

The aspects measured were temperature, relative humidity, sound, and light, using two methods. First, classrooms were monitored using environmental loggers installed on walls (see Section 3.5.5.1 for the installation method). Since the objective was to compare the later survey data to the physical environment, the environmental data from occupied school hours , or 'core hours', was of most interest, so was separated and the results were presented in this section.

The second data collection method used hand held instruments to collect spot data away from the walls and on student desks (see Section 3.5.6.1 for the collection method). This was done to supplement the monitored data and collect sound level data not available from the environmental loggers.

During core school hours, it was found that classrooms were not operating within the local education authority's (DECD) temperature guidelines, particularly during the cooler months. It was conjectured that this might be due to occupation influences, such as variable occupation of the classrooms, or where doors and windows were opened to improve ventilation. The other alternative is that the measured cooler temperatures during winter were due to ineffective architectural and mechanical design. Three schools studied used classrooms in buildings with significant thermal mass walls, so the small proportion of the day in which they were occupied (approximately one third of a twenty four hour day), and an ineffective mechanical design, may not have been sufficient to overcome the time lag of the stone and rammed earth. This cooling effect of rammed earth walls during winter was particularly evident in the psychrometric charts.

Light levels were measured as variable and did not always meet the guidelines and standards for artificial lighting levels in a general use classroom. The variability suggests spaces were lit with daylight rather than constant artificial light. This was consistent with what was observed. It is acknowledged that the environmental logger position might also have underestimate the light; however, measured levels were consistent with other occupation variability, such as the use of windows for display materials, and consequent reduction in daylight. The large variability between wall and spot measurements also suggests that that glare might be an issue if doing screen based tasks on laptops or tablets on student desks away from the walls, as was found to be typical (Section 4.5.3.1), rather than on surfaces adjacent walls.

Sound levels in empty classrooms with HVAC operating was not measured above 35dBA except in White.1 early in the year, thus meeting design guidelines. When students were present, sound was rarely measured above 75 dBA, despite the variable spatial acoustic treatment or number of students present. Although a sound meter is simple and inexpensive to use when compared to other speech intelligibility tests, the results do not provide a good picture of the true nature of the space acoustics.

In summary, the classrooms were measured to be generally cool during winter months. The light was measured to be both over and under guidelines, and this depended on the architecture of the room and together how occupants responded to this with temporary modifications, suggesting that there was the potential for both glare and poor light conditions. The classrooms generally met design objectives for background sound, although noise ingress from adjacent activities, and one example of HVAC noise was observed.

The next chapter presents the results of the user surveys. These physical environment measurements provide context for interpretation of user perceptions and preferences. These are discussed and staff and student perceptions of their physical environment is discussed and contrasted in Section 6.4.4.

6 User perspectives

6.1 Introduction

Having previously provided the built environment context in chapter 4, and monitored environmental context in chapter 5, this chapter introduces the voices of case study occupants and their perspectives[47].

Four schools (White, Orange, Red, and Yellow) chose to participate in the survey (Section 3.5.7). The survey was designed to provide three response options, open ended questions, multiple response multiple choice, and five point scale questions, to cater for different capabilities and enthusiasm (Section 3.5.7.1). The survey code tables are available in Appendix I. For convenience, this chapter uses descriptive words to summarise the questions, and cross-references the question to its question number in the code table.

This chapter commences with a summary of the characteristics of the student and staff participants (Section 6.2), followed by their perspectives about their school built environment as a whole (Section 6.3), i.e., at school level of analysis (Section 3.2.3). Perspectives about classrooms and workplaces are presented (Section 6.4) followed by spaces other than classrooms (Section 6.5). Finally, quantitative factor analysis is applied to student scale responses to reveal underlying constructs in Section 6.6, and discussed in context of previous analysis.

6.2 Student and staff participant characteristics

Before presenting the participant responses, this section presents demographic characteristics of the case study participants, followed by their satisfaction with their time at school as either learner or staff member.

6.2.1 Response rate and demographics

A total of 147 students and 44 staff responses were received from the four participating schools. The students were from years five, six, and seven, and aged between nine and thirteen years old. Based on the total enrolment in the participant schools the response rate for students was 28.7% (Appendix J.1), however, not all students at each school were invited to participate. The response rate by participating monitored classroom was 51.4%, with the breakdown by participating class shown in Table 6.1. Participation rates were higher when the survey was completed in class,

[47] 'Perspective' is used to avoid confusion with the technical meanings of the term 'perception' in disciplines such as environmental psychology (Gifford 2014, p. 543) and cognitive neuroscience (Purves et al. 2013).

rather than as a take-home exercise.

Table 6.1: Student survey participant sample rates by classroom

Classroom	Class occupancy	Class enrolment	Student participants	%	Survey delivery method
Yellow.1	Resources				
Yellow.2	Yr R	29			
Yellow.3	Yr 4/5 south Yr 5/6/7 north (26)	**56**	**23**	41.1%	By researcher – in class
White.1	Yr R-2	65			
White.2	Yr 3	26			
White.3	Yr 7	**30**	**13**	43.3%	By teacher – take home
White.4	Yr 6/7	**28**	**25**	89.3%	By teacher – in class
White.5	Yr 7	**28**	**14**	50.0%	By teacher – taken home
Orange.1	Resources				
Orange.2	Yr 2/3	28			
Orange.3	Yr 3/4	27			
Orange.4	Yr 5/6	**30**	**7**	23.3%	By teacher – take home
Orange.5	Yr 6/7	**54**	**40**	74.1%	By researcher – in class
Orange.6	Yr 2/3	28			
Orange.7	Yr 4/5	29			
Red.1	Yr R/1	28			
Red.2	Yr 1/2	28			
Red.3	Resources				
Red.4	Yr 6/7	**30**	**8**	26.7%	By teacher – take home
Red.5	Yr 5/6	**30**	**17**	56.7%	By researcher – in class
Purple.1	Resources				
Purple.2	Yr R/1	21			
Purple.3	Yr 4/5	26			
Purple.4	Yr 6/7	47			
	Sampled classrooms total	***286***	***147***	***51.4%***	

All surveys were distributed to staff via the principals at participating schools; with the total response rate of staff at participant schools was 27% (Appendix J.2). This varied by schools with the highest response rate of 44% from White School. Yellow School returned the lowest response at 20%.

Of the staff participants, just under 60% had both worked in the education sector for more than 20 years and were full time employees (Appendix J.3). Approximately 56% of the staff participants had been at their school for more than five years. Fifteen percent had worked in the same room for more than five years. Thus, participants brought experience in both their work and their environment.

The gender of respondents (Figure 6.1, Appendix J.4) was nearly equal for students, but biased towards female for staff. This latter bias is consistent with the predominantly (75.5%) female workforce in the primary and secondary school education sector (Department for Education and Child Development 2012).

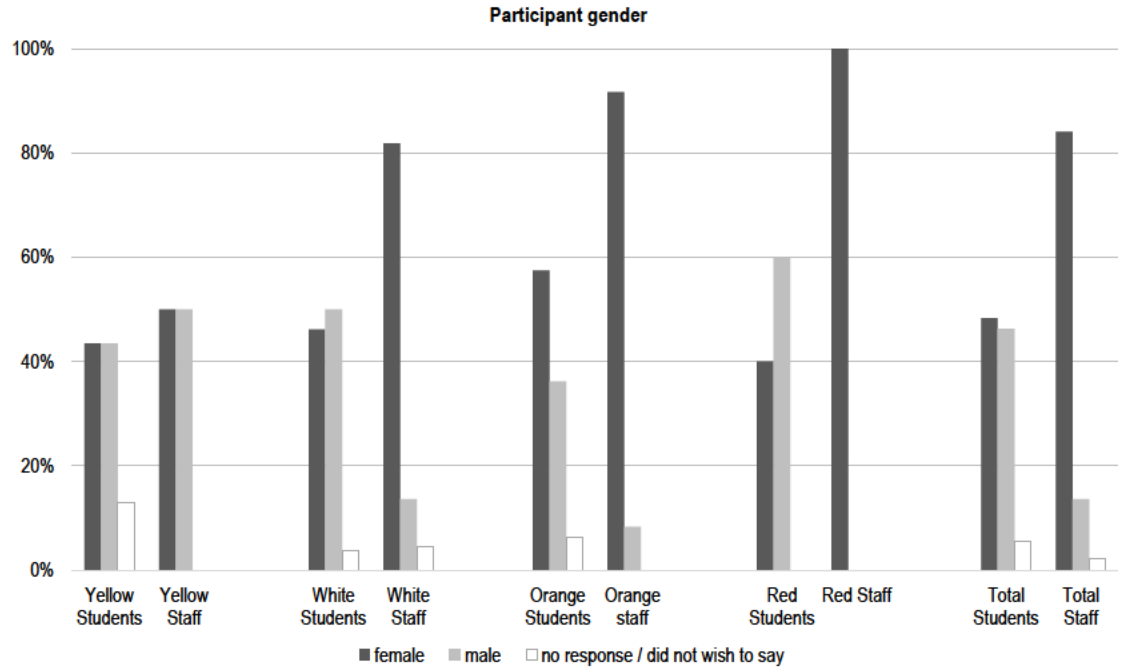


Figure 6.1: Participant gender by school – staff and students

6.2.2 Satisfaction with school and work

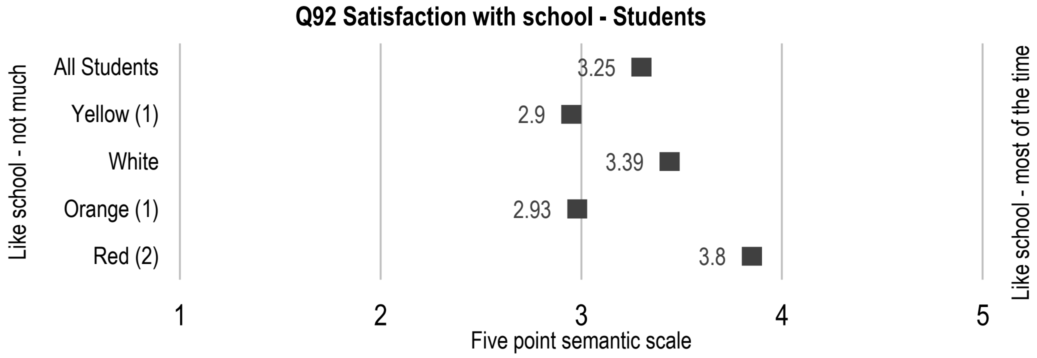
Since work is not always a positive activity for some people (Wilson & Rosenfeld 1990, pp. 55-61), and some students experience negative emotions, such as anxiety (Hattie 2009, pp. 49-50) about going to school, there was concern that any dissatisfaction with school participation may influence the survey results. Exploring emotions was beyond the scope of expertise of the researcher and provided no beneficence (National Health and Medical Research Council et al. 2007, pp. 55-57). As a compromise, this research tool asked students whether they liked school and staff whether they were satisfied with their job (both five point scales, Q82) and, knowing that there may be obedience to researcher authority and cultural differences[48], the option for non-obedience was made explicit by providing a tick box to show participants that it was acceptable not to respond. Despite this, both students and staff responded at high rates (Appendix K.30).

Student satisfaction with, or 'liking', school was above average overall (Figure 6.2), but differed significantly across the four schools[49]. When adjusted for unequal sample size[50], significant post-hoc homogenous subsets were indicated such that Red School students expressed higher satisfaction with school than Orange School (confirming the original unweighted test), and also Yellow School (see Appendix K.30.1 for post hoc tests).

[48] In adults, this is complex and dramatically documented by researchers such as (Milgram 1963) and (Hofstede 1980).

[49] Q92 Students one-way ANOVA $F(3,133) = 3.059$, $p = 0.031$. Tukey post-hoc comparisons of the four groups indicate that Red School ($M = 3.8$, 95% CI[3.24, 4.36]) liked school more than Orange School ($M = 2.93$, 95% CI[2.50, 3.36]), $p = 0.042$. Comparison of these schools with, and between White ($M = 3.39$, 95% CI[3.05, 3.73]) and Yellow ($M = 2.90$, 95% CI[2.33, 3.48]), were not statistically significant at $p < 0.05$

[50] All post-hoc tests used Tukey's Honestly Significant Different text (HSD) (Cramer & Howitt 2004, p. 172; Pallant 2011, p. 211), with additional harmonic mean weightings to adjust for unequal sample sizes (IBM Corporation 2013, p. 22).



(1), (2) = different groups with significance difference by schools within student cohorts, adjusted for sample size.

Figure 6.2: Q92 Student satisfaction with school – semantic scale by school

Staff participants responded that they found their job satisfactory (*M* = 4.00) (Appendix K.30.2), and a one-way ANOVA found no significance difference between schools ($F(3, 47) = 1.035$, $p = 0.388$).

Figure 6.3: Q92 Staff satisfaction with job – semantic scale by school

Stepwise multiple linear regression on all variables found significant models predicting for both cohorts (Table 6.2). The regression models indicate that responses to a question about students perspectives of their school buildings as boring or interesting, and natural light as suitable, predict their response to whether they like school.

The possibility that students confused the question about school buildings being boring or interesting with the later question about their satisfaction with attending school was considered. Results addressing the perspectives of school buildings as place (Section 6.3.2.2) are supportive of the proposition that school buildings and school satisfaction are, indeed, separate in the minds of students. Regardless of the constructs, a correlation was found between satisfaction and school buildings as interesting.

Stepwise linear regression for staff satisfaction found that staff preference for a louder workplace, pride in buildings, and calming views, predicted job satisfaction ($R^2 = 0.55$). Preference for a louder work place might suggest that job satisfaction is higher in those who are less perturbed by noise, have some pride in their school buildings and have calmer views, in this response cohort.

Table 6.2: Q92 Satisfaction with school / job – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Student satisfaction with school	0.40	*F*(2,93) = 30.72	School buildings are interesting (Q15)	0.49	< 0.0005
		p < 0.0005	Daylight suitable (Q54)	0.31	< 0.0005
Staff participants					
Staff satisfaction with job	0.55	*F*(3,25) = 10.18	Prefer overall noise louder (Q35)	0.65	< 0.0005
		p < 0.0005	Proud of school buildings (Q20)	0.46	0.002
			Views are calming (Q65)	-0.39	0.010

6.3 Perspectives of the school built environment

This section presents the survey results to questions about the school unit of analysis. Referring to the mixed methods research map in Figure 6.4, this section presents the analysis and inference of user perspectives collected using quantitative and qualitative methods in each case study school, in the context of analysis presented in Sections 4 and 5. It looks first at the school uniqueness, then buildings and grounds, the school as a community asset, and finishes with perspectives about school sustainability.

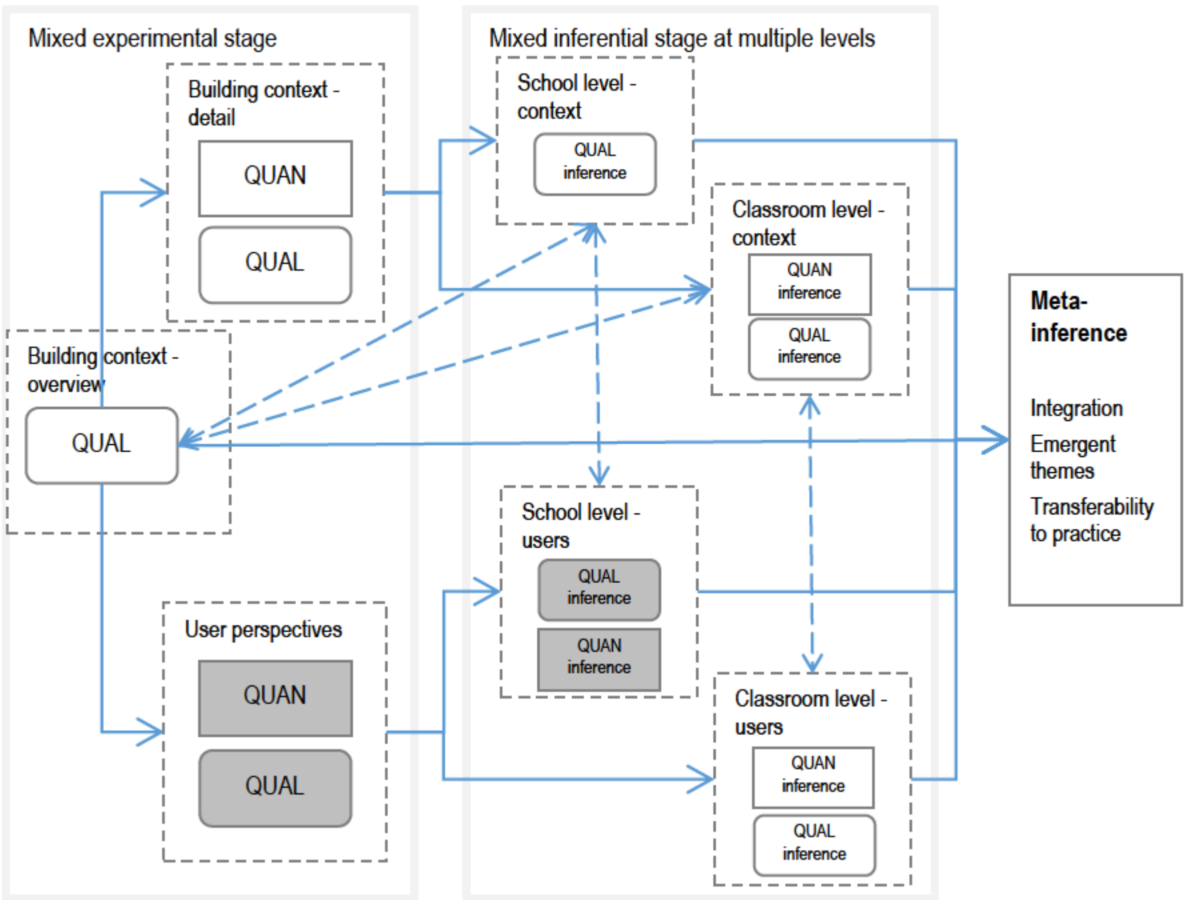


Figure 6.4: Mixed methods research map for user perspectives at school level

6.3.1 Perspectives of school uniqueness

Staff and students were asked to state what was special or unique about their school. This was intended to create a rich context for interpreting school data, and to identify specific trends in perceived uniqueness, such as physical facilities or other non-physical aspects. The question was posed as an open question and nearly 80% of students and 100% of staff responded (Appendix L.2.1).

Responses were post-coded so that themes, or code categories, were designated according to time (history and historical narratives), principal activities (teaching and learning), visual observations (size, buildings, grounds, other visual responses), technology, and connection to wider context (community and planning), with the remaining categorised as culture, which refers to reported relationships, activities, values and artefacts (Schein 1985). Though all of the former categories can be considered as part of this latter culture model, they have been separated out in this instance according to their usefulness to this current architectural inquiry.

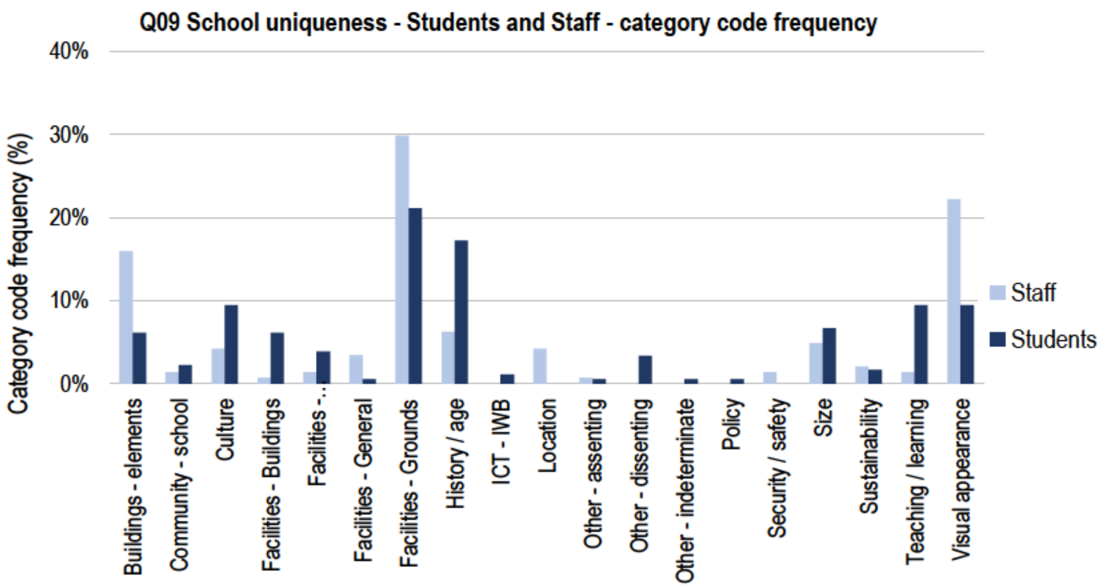


Figure 6.5: Q09 School uniqueness – Students and Staff – open question category code frequency

Referring to the code category summary in Figure 6.5, both physical facilities and non-physical school aspects made schools unique to participants. Students responded that buildings, building elements and grounds made the school unique, but also identified the aspects of school culture, history and teaching / learning also made the school special. A small proportion stated that they did not consider their school to be unique or special (six students), thus refuting the premise of the question.

Staff focussed more on building elements, grounds and visual appearance. This difference could be due to staff interpreting their responses in their anticipated context of the survey (architecture), but also be due to the different experiences of schools, i.e. schools as learning place vs. schools as work place.

These code categories are not uniformly distributed across case study schools. Table 6.3 and Table 6.4 shows the breakdown of the detail code with coding greater than or equal to six for student and staff responses respectfully (refer to Appendix L.2 for the full lists).

Table 6.3: Q09 School uniqueness – Student – detail code frequencies ≥ 6

Category code – detail code	Yellow	White	Orange	Red	**Total**
Facilities - Grounds - ecosystem	0	**18**	0	1	**19**
History / age - "old"	**15**	0	0	2	**17**
Facilities - Grounds - site plan	0	**7**	6	0	**13**
History / age - History	5	0	0	**6**	**11**
Culture - people described positively	1	**3**	**3**	0	**7**
Facilities - Buildings - Gym	0	2	**5**	0	**7**
Visual appearance - shape	0	**6**	1	0	**7**
Other - dissenting	0	2	**4**	0	**6**
Size - large	0	2	**4**	0	**6**
Size - small - good	1	0	0	**5**	**6**
Teaching / learning - teachers described positively	1	2	**3**	0	**6**

Table 6.4: Q09 School uniqueness – Staff – detail code frequencies ≥ 4

Category code – detail code	Yellow	White	Orange	Red	**Total**
Facilities - Grounds - site plan - different campuses	0	**13**	6	0	**19**
Facilities - Grounds - ecosystem	0	**18**	0	0	**18**
Buildings - elements - materials	0	0	**7**	0	**7**
Buildings - elements - Heritage / old	2	0	0	**5**	**7**
History / age - History	1	0	0	**6**	**7**
Location - close to community & facilities	**2**	2	0	**2**	**6**
Size - large	0	**3**	**3**	0	**6**

Site plan layout and ecosystem aspects of grounds were reported by White school students and staff as making their school unique. This is consistent with the observed site plan and its distinct zones and bisection with a large ecosystem feature (Figure 4.4). Students and staff at White School and Orange school noted that the schools were large, which is again consistent with the observed site plans. Red School students noted that their school was small, as indicated by the site plan and enrolment, but they indicated that this was a positive feature. Staff also identified the relation of their school to the wider community location.

Orange students noted that there was a variety of buildings. Architecturally, it was observed there was a variety of building designs on all sites, but the variation may be more noticeable because Orange School used approximately 50% transportable buildings for classrooms, and these were visually distinct from the permanent buildings in their materiality (Photograph 4.3, Photograph 4.4). Though all schools participating in the survey had new gyms or halls built in the last five years (Building the Education Revolution Implementation Taskforce 2011), only White and Orange students reported their new gyms as making their schools special or unique. This could be because in both cases the gyms/halls are large and used regularly as suggested by the comment such as '...a big gym' (W.Stu50), '...and also how we have a massive gym we can play in' (W.Stu25), and '[w]e have great places like our big gym' (O.Stu87).

Building shape was reported by White School students, which is consistent with the observed form of skillion roofline and chimney vents (Photograph 4.2). From this, and the previous paragraph, school uniqueness perspectives of students might be influenced by size, shape and materiality of building stock, particularly when viewed from outdoor play areas.

Staff at different schools identified building materials specific to their school such as building materials (Orange school, Red School) and passive ventilation strategies (Orange school) unique to their school.

School uniqueness is not, however, restricted to facilities. White, Orange and, to a lesser extent, Yellow students, all reported culture, teachers and other people as making their school special or unique:

> Our school has a great history and is such a great place to be. We welcome our student teachers, we love them... (Y.Stu23);
>
> Our school is unique because everyone is helping each other, they're nice to each other and the teachers are really helpful... (W.Stu28);
>
> It has mixed colours of peoples skin (W.Stu74);
>
> That we all get along and we show respect to our pupils and following teachers. We help each other out and we are all role models. (O.Stu84);

White School staff also noted that their school was multicultural. Students also identified their teachers and learning as being unique, but this was not identified as special or unique by staff.

Staff and students from the older schools identified the school age as making their school special or unique. Yellow school students consider their school as 'old' yet Red school student report aspects of heritage as school uniqueness, though in smaller numbers. Again, both of these are consistent with age, apparent heritage-looking construction, and heritage listings of school buildings within both schools.

Where there were heritage-looking buildings these were clearly part of school identity:

> Our school is unique and special because of the history of our school and the old memories it has. (Y.Stu6);
>
> Because it is so old but still lives (Y.Stu22);

> It is old and I think it looks good ['looks good' underlined] (Y.Stu14);
>
> I think the school is special because it is very old and we only have a small community (R.Stu146).

The response to this open and unstructured question (Section 3.5.7.1) suggests that the uniqueness or specialness of a school is more complex than staff and student perspectives of their facilities. Where facilities uniqueness is reported, it is consistent with what was observed at the school, thus, suggesting suggests that staff and students actually do notice their built environment. The student participants showed they hold definite opinions about their school's uniqueness, be it either lacking distinguishing features, or having a wide range of physical and cultural features, suggesting that they have capacity to articulate on their built environment.

6.3.2 Perspectives of school buildings and grounds

This section presents the user perspectives of their buildings and grounds at school level unit of analysis and are findings from questions about school as place, functional space, and quality of space, together with perspectives about the contribution of buildings and grounds towards teaching and learning. They are also discussed in the context of the observed built environment and the perspectives of the uniqueness of the school. Convergence and non-convergence of data is reported by topic and case study school.

6.3.2.1 School buildings as contributing to teaching and learning

Design advice assumes a deterministic relationship between school buildings and teaching and learning (Section 2.3). To investigate expectations about the school built environment, staff were asked about their views on how buildings and grounds contribute to teaching and learning, with the intention to hear from those responsible for education. Staff responded with an 89% response rate (Appendix L.14.1).

Participants provided diverse responses suggesting that school buildings and grounds mean different things to different staff, as seen by the category coding of the open question responses (Figure 6.6). Responses with 5% or more category codes were about culture as well as the physical environment (circulation, design, learning environment, size, space). Staff also noted that acoustics, environmental comfort, grounds, the site plan and the actual teaching were important (around 4% each of responses).

Low response and absences were also notable. Few participants responded that security and safety were important. This suggests either that schools are currently safe and secure, or that this is not a concern in South Australian culture. Building views were not mentioned. Technology and IWBs were mentioned either by few people or not at all. This suggests that either technology is either not important, implicitly integrated, or seen as separate from the built environment so not appropriate for response to this question.

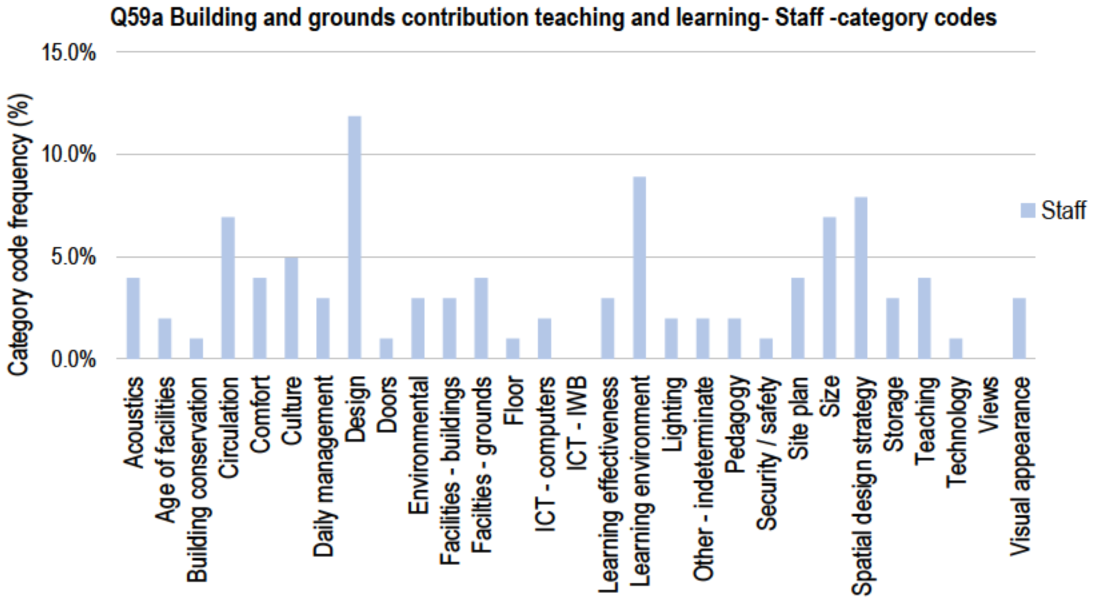


Figure 6.6: Q59a Buildings and grounds contribution to teaching and learning – Staff – open question category code frequencies

Detail codes show that responses were reasonable distributed across schools (Table 6.5, full table in Appendix L.14), suggesting that there are some common beliefs between school staff, such as the need for variety in learning environments. There were also school specific responses, such as the need to be able close off a double classroom in Orange School, which is consistent with the observed operable walls and sliding doors between class spaces.

Table 6.5: Q59a Buildings and grounds contribution to teaching and learning – staff – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Learning environment - need variety of space for group and individual learning	2	0	3	3	8
Design - classrooms feel comfortable, 'cosy', not sterile, pleasant, peaceful	0	2	4	1	7
Size - large learning spaces give flexibility	1	0	2	4	7
Teaching - facilitate team teaching	0	0	3	1	4
Circulation - equitable, convenient exits	0	2	0	1	3
Comfort - must have fresh air	0	1	2	0	3
Culture - contributes to school pride	0	2	1	0	3
Daily management - must be clean	0	1	2	0	3
Environmental - facilities, factors, opportunities	0	3	0	0	3
Learning effectiveness - improved by design which relaxes students	0	0	3	0	3
Spatial design strategy - need ability to close off double classroom	0	0	3	0	3
Spatial design strategy - need flexibility	2	1	0	0	3
Storage - good	0	2	1	0	3

The above suggests that perspectives of what aspects of school buildings and ground contribute to teaching and learning have both common aspects, such as providing flexible, comfortable spaces that enhance contemporary teaching delivery, and more personal aspects about specific design preferences. Variety of learning environments was reported before pure space considerations such as flexibility. Unlike the architect claims in public documents (Table 4.9), what is absent is a single narrative about what school buildings and grounds should contribute to teaching and learning. Designing 'new century' learning, or 'flexible interior spaces' (Section 2.3.1), does not encapsulate the user perspectives. Expectations from education specialists are far more complex.

6.3.2.2 School buildings as place and architecture

Since schools can be considered as a place-based community asset (Green & Haines 2012, p. 6), as a landmark with '...a concentration of association' (Lynch 1960, p. 101), or a phenomenological sense connected with cognitive processes (Lengen & Kistemann 2012), questions were included to identify the importance to users of case study schools as locations, i.e., as landmark places.

6.3.2.2.1 School buildings as attractive

As context for this visual section, participants were asked about how important it was for school buildings to look attractive (Q28). The mean response from students was 3.98 on a five-point scale, and 4.30 from staff (Appendix K.19). No differences in sample means were found between student and staff cohorts as a whole (Appendix K.2) or between case study schools within student and staff cohorts[51], suggesting that all participants considered that it was important that school buildings look attractive (Figure 6.7).

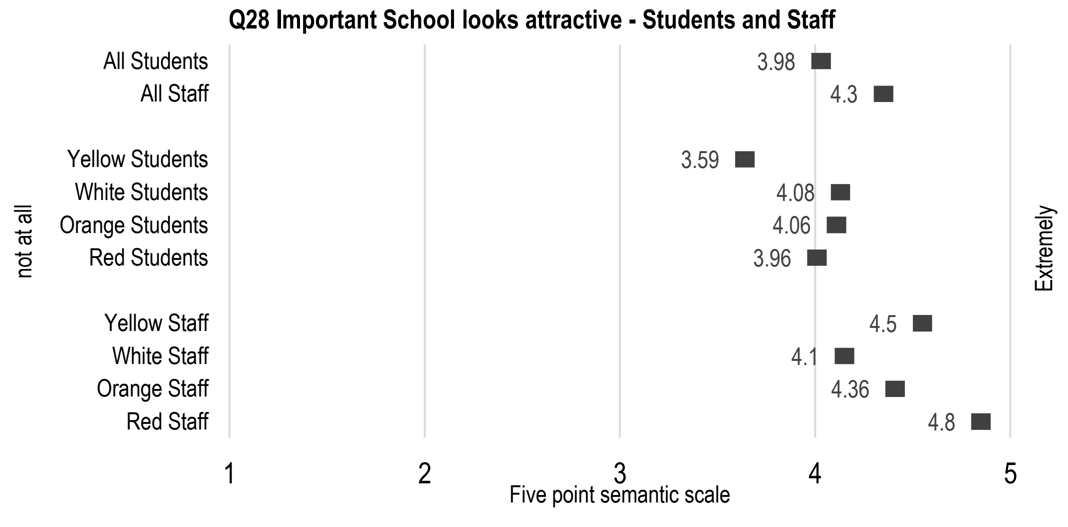


Figure 6.7: Q28 Important school looks attractive – Students and Staff – semantic scale by school

Linear regression was used to test for variables that may predict attitudes about whether schools should look attractive, with models found from both student and staff responses (Table 6.6). The student model is predicted by the perspective that buildings are well maintained (Q16), but its predictive contribution was limited (R^2=0.09). It is noted that visual variables are omitted as predictors, suggesting that student participants may differentiate between visual attractiveness

[51] One-way ANOVA by school: Students $F(3, 140) = 1.464$, $p = 0.227$), and staff $F(3, 36) = 1.676$, $p = 0.189$)

and visual cleanliness. In contrast, staff responses that their current school buildings as 'interesting' (Q15) predict that the school should look attractive, suggesting that there is an aesthetic visual influence between currently interesting buildings and perspectives that it is important to look attractive.

Table 6.6: Q28 Important school looks attractive – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Important school looks attractive	0.09	F(1,94) = 9.500 p = 0.003	Buildings well maintained (Q16)	0.30	0.003
Staff participants					
Important school looks attractive	0.21	F(1,27) = 7.164 p = 0.012	School buildings are interesting (Q15)	0.46	0.012

6.3.2.2.2 School buildings as landmarks

Participants were asked about their perspectives of school buildings as landmarks or otherwise. Students responded with a mean of 2.97 on a five point scale, i.e., just below the neutral score on the 'ordinary' side, and staff responded with a mean of 3.76 on a five point scale (Figure 6.8, Appendix K.4). Testing between student and staff cohort sample means could not support the null hypothesis, suggesting that there is a significant difference between cohorts (Appendix K.2).

Students' perspectives of their schools as landmarks also differed significantly[52], such that Red School students perceived their school as more of a landmark than students from White School and Orange School.

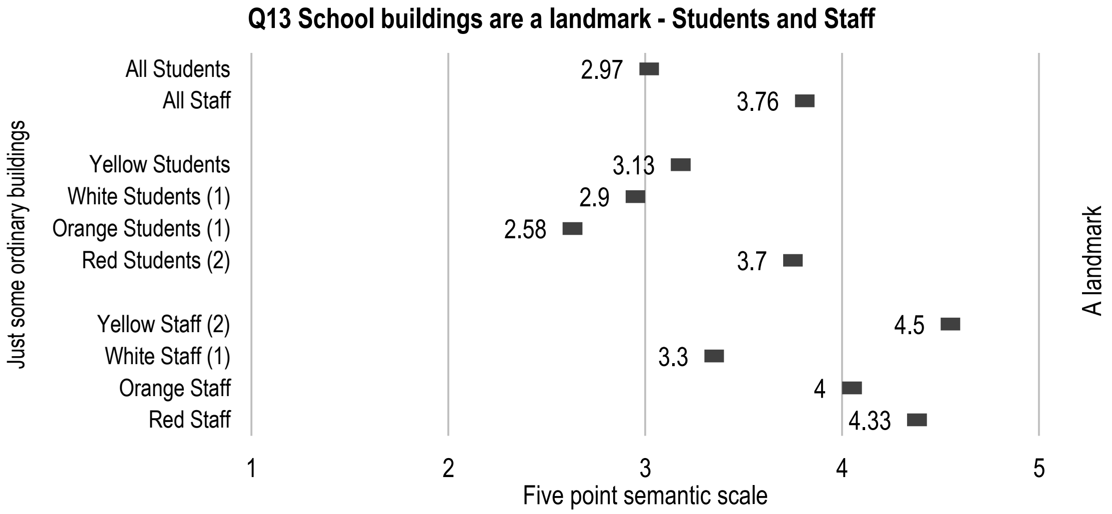
Similarly, staff perspectives differed significantly by school[53]. Staff from White School perceived their school as more ordinary than staff from Yellow School and Red School in the ANOVA test, but the significance in perception difference between White and Red Schools was not apparent when adjusting for unequal sample sizes in post-hoc tests (Appendix K.4).

The term 'landmark' has specific connotations in built environment theory (Section 2.3.2) and it was included in the survey to investigate applicability to non-professional participants. The nearly neutral means could be due to lack of understanding of the term, or genuine lack of strong perspectives about the 'landmark-ness' of the school buildings, however, the mean differences by schools and their correspondence with site plans and construction suggest that there is some understanding by students of the notion of 'landmark'. Students and staff scored Red School and

[52] One-way ANOVA $F(3,137) = 5.265$, $p = 0.002$. Tukey post-hoc comparisons of the four groups indicate that Red School ($M = 3.7$, 95% CI[3.17, 4.22]) students perceived their school as significantly more of a landmark than White School ($M = 2.90$, 95% CI[2.63, 3.18]), $p = 0.026$, and Orange School ($M = 2.58$, 95% CI[2.20, 2.96]), $p = 0.001$, but comparison with Yellow ($M = 3.13$, 95% CI[2.71, 3.55]), was not statistically significant at $p <$ 0.05

[53] $F(3,38) = 5.107$, $p = 0.005$. Tukey post-hoc comparisons of the four groups indicate that White School staff ($M = 3.30$, 95% CI[2.99, 3.61]) perceived their school as more ordinary than Yellow ($M = 4.5$, 95% CI[2.91, 6.09]), $p = 0.034$, and more ordinary than Red School ($M = 4.33$, 95% CI[3.48, 5.19]), $p = 0.031$. Comparison of Orange School ($M = 4.00$, 95% CI[3.46, 4.54]) with other schools was not statistically significant at $p <$ 0.05

Yellow School as more of landmark than other schools, but only the Red School student responses were statistically significantly higher, suggesting that these perspectives are not necessarily due to the older heritage-looking fabric of these school. It is noted that the site plans and construction of all schools are quite different. Red school is located on a corner with buildings adjacent the road (Photograph 4.5) and Yellow school is a two storey building located adjacent to the road (Photograph 4.6), whereas Orange and White schools are set back from their main entrances. Alternatively, the description of landmark might be more applicable to Red and Yellow schools, than Orange and White, due to the formers' aged construction.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.8: Q13 School buildings are a landmark – Students and Staff – semantic scale

Stepwise multiple linear regression produced significant models for buildings as landmarks, with small predictive contribution for students, and much larger contribution for staff participants (Table 6.7). Both models identified only one independent variable, the perspective of school buildings are interesting (Q15), as contributing to the model. While the mean responses by school hint at the older schools being more visually interesting, the ANOVA results do not support this conclusion.

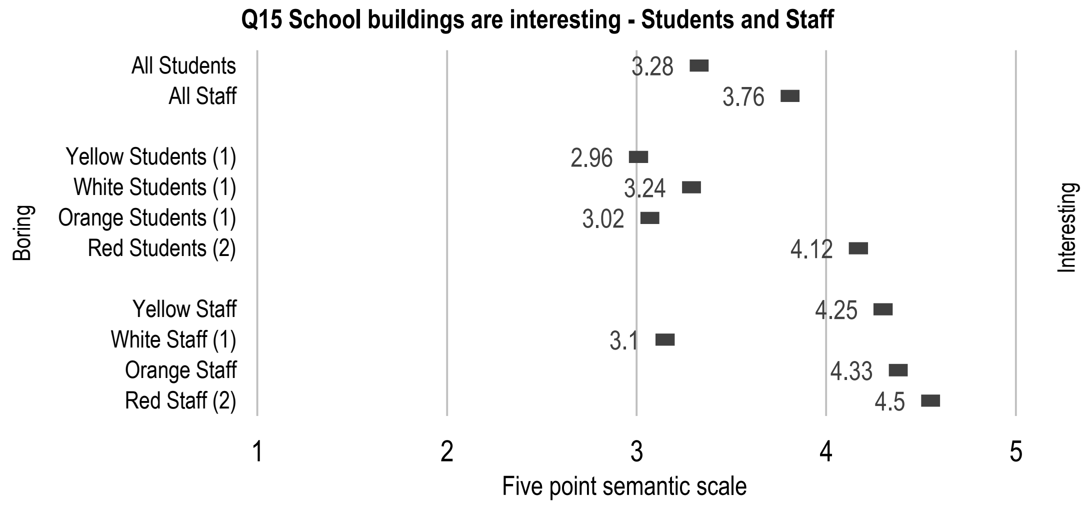
Table 6.7: Q13 School buildings are a landmark – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
School buildings are a landmark	0.17	$F(1,94) = 18.75$ $p < 0.0005$	School buildings are interesting (Q15)	0.41	< 0.0005
Staff participants					
School buildings are a landmark	0.52	$F(1, 27) = 29.43$ $p < 0.0005$	School buildings are interesting (Q15)	0.72	< 0.0005

6.3.2.2.3 **School buildings as interesting**

An alternative, possibly simpler, question about the presence of school buildings is to ask whether they can be rated as boring or interesting. The student cohort as a whole rated their school buildings as just above neutral and staff rated their schools as slightly more interesting (Figure 6.9, Appendix K.5), with no significant difference found between the cohort sample means (Appendix K.2).

Significant differences between schools were found in both the student cohort[54] and staff cohort[55] responses. Red School students indicated that they found their Red School buildings significantly more interesting than all other case study school students found their own buildings. Similarly, after adjustment for uneven sample sizes (Appendix K.5), Red School staff also found their own buildings more interesting than perspectives reported by White School Staff. Again, this hints at a heritage-looking school being considered more interesting, but without the statistical inclusion of the Yellow School cohort with the Red School cohort this conclusion is difficult to support, from the perspective of a quantitative analysis.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.9: Q15 School buildings are interesting – Students and Staff – semantic scale

Stepwise linear regression found significant models to predict participants' responses about whether their schools were boring or interesting (Table 6.8). Following on from the previous variable investigation, the perspectives of the school being a landmark, together with perspectives about maintenance, contributed to staff respondents perspectives of whether school buildings

[54] One-way ANOVA $F(3,140) = 6.361$, $p < 0.0005$. Tukey post-hoc comparisons of the four groups indicate that students at Red School (M = 4.12, 95% CI[3.65, 4.59]) perceived their school buildings as being more interesting than Yellow School (M = 2.96, 95% CI[2.48, 3.44]), p = 0.002, White School (M = 3.24, 95% CI[2.92, 3.55]), p= 0.007, and Orange School (M = 3.02, 95% CI[2.71, 3.34]), p = 0.001.

[55] One-way ANOVA $F(3, 38) = 6.544$, $p = 0.001$. Tukey post-hoc comparisons of the four groups indicate that staff at White School (M = 3.10, 95% CI[2.62, 3.58]) perceive their buildings as less interesting that staff at Orange School (M = 4.33, 95% CI[3.77, 4.90]), p = 0.004, and Red School (M = 4.50, 95% CI[3.93, 5.07]), p = 0.013. Comparison of all schools with Yellow School (M = 4.25, 95% CI[2.73, 5.77]), were not statistically significant at $p < 0.05$.

were interesting, i.e., perspectives about visual aesthetics and fabric quality.

Perspectives about buildings being landmarks did not appear as contributing to students' perspectives about school buildings being boring or interesting, however other emotional type variables about pride in school and liking school did, together with noise ingress from adjacent rooms. This suggests that awareness of school buildings as aesthetically interesting is not fully comprehended by students in the adult sense, but that there are emotional aspects contributing to this perspective.

Table 6.8: Q15 School buildings are interesting – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
School buildings are interesting	0.50	F(3, 92)=30.72 p < 0.0005	Proud of school buildings (Q20) Student satisfaction with school (Q92) Loud noise from adjacent room (Q32)	0.42 0.38 -0.19	< 0.0005 < 0.0005 0.011
Staff participants					
School buildings are interesting	0.68	F(2, 26) = 27.20 p < 0.0005	School buildings are a landmark (Q13) Buildings well maintained (Q16)	0.49 0.46	0.001 0.002

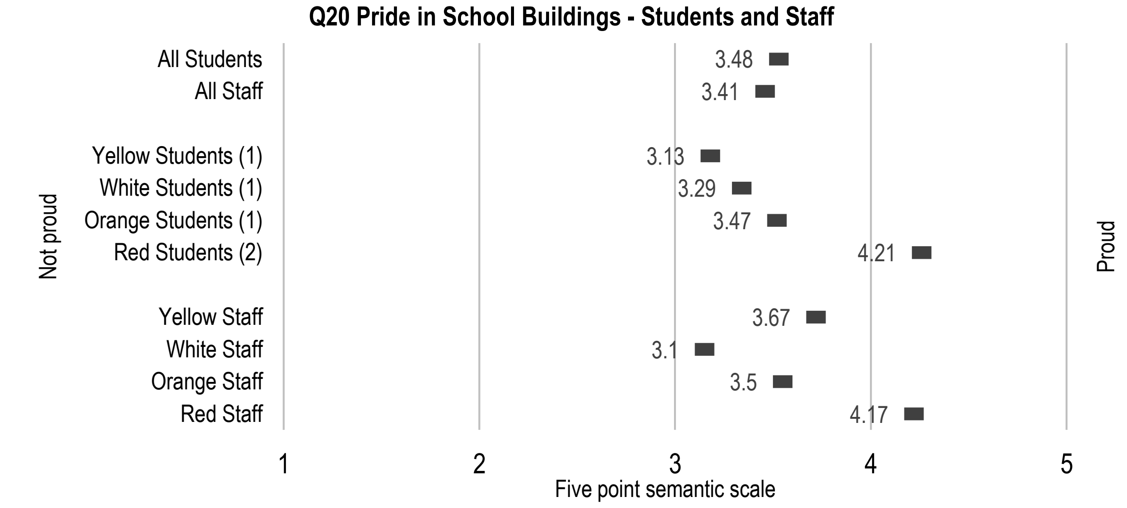
6.3.2.2.4 **Pride in school buildings**

A third approach to investigating the presence or importance of school buildings in a user's awareness was through investigating the sense of ownership and identification, as explored through pride in school buildings.

Overall both students and staff responded that they were above neutral in scaling their pride in their school buildings (Figure 6.10, Appendix K.15), with no significant difference found between the cohorts (Appendix K.2). It was found that students at Red School scaled their pride in their school buildings significantly higher than other schools[56]. No difference between staff responses across case study schools was found[57].

[56] One-way ANOVA *F*(3,139) = 5.064, *p* = 0.002. Tukey post-hoc comparisons of the four groups indicate that Red School students (*M* = 4.21, 95% CI[3.78, 4.64]) expressed higher pride ratings for their school more than Yellow (*M* = 3.13, 95% CI[2.64, 3.62]), *p* = 0.004, White (*M* = 3.29, 95% CI[3.01, 3.58]), *p* = 0.004, and Orange School (*M* = 3.47, 95% CI[3.14, 3.80]), *p* = 0.0.34

[57] One-way ANOVA *F*(3, 37) = 1.505, *p* = 0.229.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.10: Q20 Pride in school buildings – Students and Staff – semantic scale

Stepwise multiple linear regression on student responses for six possible models to predict pride in buildings with explanatory contribution of up to 50%. The fourth model is presented here since the fifth and sixth models were rejected due to not all coefficients being significant at $p < 0.05$ (Table 6.9). For students, pride has visual (interesting, calming views), quality (clean), and functional predictors (good for learning), i.e., is not solely visual.

Stepwise multiple linear regression on staff responses was found to be mathematically indeterminate in this group of staff responses.

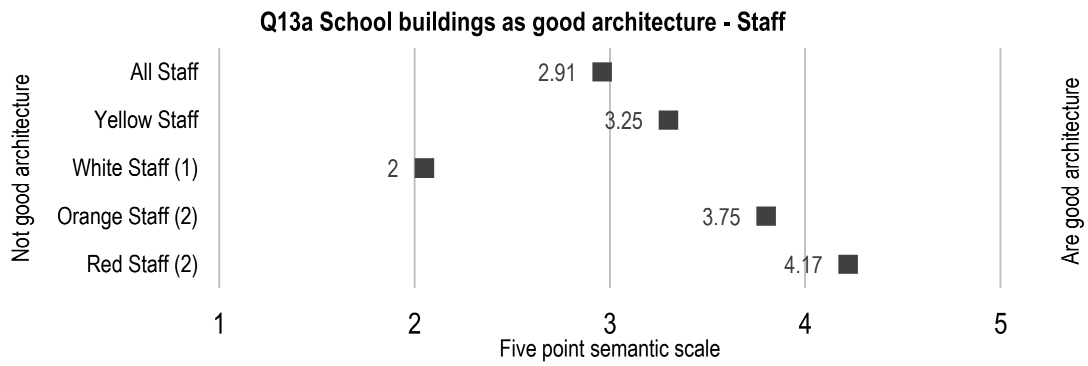
Table 6.9: Q20 Proud of school buildings – Students – multiple linear regression on all variables

Dependent variables	R^2	*F*, *p*	Coefficients	Beta	*p*
Student participants					
Proud of school buildings	0.48	$F(4,91) = 21.25$	School buildings are interesting (Q15)	0.35	< 0.0005
		$p < 0.0005$	Buildings good for learning (Q18)	0.20	0.036
			Views are calming (Q65)	0.21	0.010
			Buildings are clean (Q14)	0.21	0.019
Staff participants					
No stepwise MLR solution possible					

6.3.2.2.5 School buildings as architecture

Staff were assumed to have some understanding of 'architecture', so were asked to scale their school as bad or good architecture. Their overall mean response was just under neutral at 2.91 on a five-point scale (Figure 6.11, Appendix K.5). The responses from White School staff were found to be significantly lower than other schools[58].

[58] One-way ANOVA $F(3, 39) = 11.682$, $p < 0.0005$. Tukey post-hoc comparisons of the four groups indicate that White School staff ($M = 2.00$, 95% CI[1.54, 2.46]) judged the school architecture as less 'good' than Orange School staff ($M = 3.75$, 95% CI[3.14, 4.36]), $p < 0.0005$, and Red School ($M = 4.17$, 95% CI[3.13, 5.20]), $p < 0.0005$. Comparison of these schools with, Yellow ($M = 3.25$, 95% CI[1.25, 5.25]), were not statistically significant at $p < 0.05$



(1), (2) = different groups with significance difference by schools within staff cohorts, adjusted for sample size.

Figure 6.11: Q13a Buildings are good architecture – Staff – semantic scale

Stepwise multiple linear regression was not possible for Q13aBadArchVsGoodArch as a dependent variable due to collinearity.

Of all the above scales, Red School, the only school that has not been recognised with an architectural award, was consistently judged more positively by both students and staff, whereas White School was judged as less positively by occupants, despite its success in architectural awards. Red School is, however, recognised as contributing to cultural heritage through its age, suggesting that contemporary architectural awards are not a predictor of positive user judgement. The possible influence of cultural significance towards a positive user judgement is also logically suggested here.

To test whether participants see and identify individual architectural forms, all participants were asked to choose quickly applicable description for their school from architecture typologies or to provide their own description in multiple choice question group Q23-Q27, with 95% of students and staff selecting at least one architecture typology from the given list. Since schools had more than one style of architecture, the options presented allowed for more than one response to these groups, hence, interpretation of the table below cannot be as mutually exclusive categorical variables.

Table 6.10: Q23-27 School architecture typology multiple choice – Students and Staff – response frequencies

Q23-27 attempted	**Students**		**Staff**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
one response only	110	74.8%	41	93.2%
two responses	27	18.4%	1	2.3%
three responses	3	2.0%		
attempted question group	*140*	*95.2%*	*42*	*95.5%*
Total surveys collected	*147*		*44*	

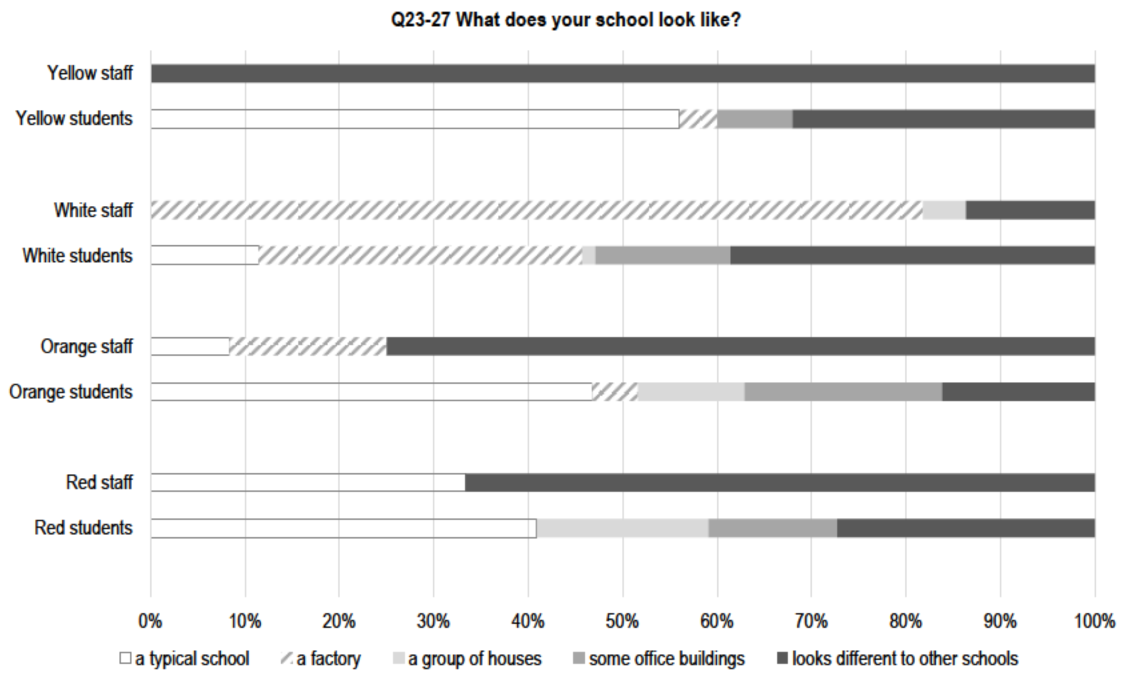


Figure 6.12: Q23-27 percentage response to 'what does your school look like' – students and staff

Figure 6.12 presents the percentage responses from both students and staff, with the complete contingency tables found in Appendices L.5.1 and L.5.2, respectively. Few participants identified their schools as looking like 'a group of houses', suggesting that the case study schools were seen as different for local residential development forms. There is a variety of school architecture in Adelaide (Section 2.3.3), yet in all cases, a greater proportion of students than staff identified their schools as 'typical'. This suggests that students have a more limited awareness of other school architecture, which is consistent their age and likely architectural experience.

Orange school consists of a number of buildings of four-classroom groups and some transportable classrooms that are distributed over the site, with a range of forms and building materials. Orange school students interpreted these differently, considering it to be typical, but also like 'office buildings', whereas staff reported that it looked different to other schools.

White school was seen as 'different' and like 'a factory' by students, with staff reporting the school as 'like a factory.' Given the building forms and site plan, these impressions are consistent with observations, since White school's triangular room massing could be described (possibly unkindly) as factory-like (Photograph 4.2).

Red, Orange and White were also seen as having some residential characteristics, but Yellow was definitely not, possibly because its main building is two storey with a comparatively large building footprint (Photograph 4.6), whereas Adelaide vernacular residential architecture tends to be single storey single dwellings (Pikusa in Forward, Persse & Rose 1994).

Participants from all schools indicated that their schools looked different to other schools, with a third of student participants, and less than half of staff participants, provided further explanation to how they perceived this. White students and Orange staff being the most vocal on paper (Appendix L.6.1).

When describing how their school looks different, category coding showed that student respondents wrote most about their grounds and visual aspects as differentiators from other schools, whereas staff wrote most about age of buildings, specific elements and visual appearance (Figure 6.13).

The detail coding of student responses showed that responses were distributed between aspects relating to individual schools (Table 6.11, full list in Appendix L.6.2). White and Orange students remarked on the size and different districts within their schools (using Lynch's term, cited in Thomas 2002), which is consistent with the large sites. Yellow and Red students explained that the age of their buildings made their schools different to other schools, which is consistent with the observed construction ages, heritage-looking exterior fabric and obvious internal modifications. These older schools also prompted descriptive responses such as 'lovely' and 'friendly', suggesting an emotional response.

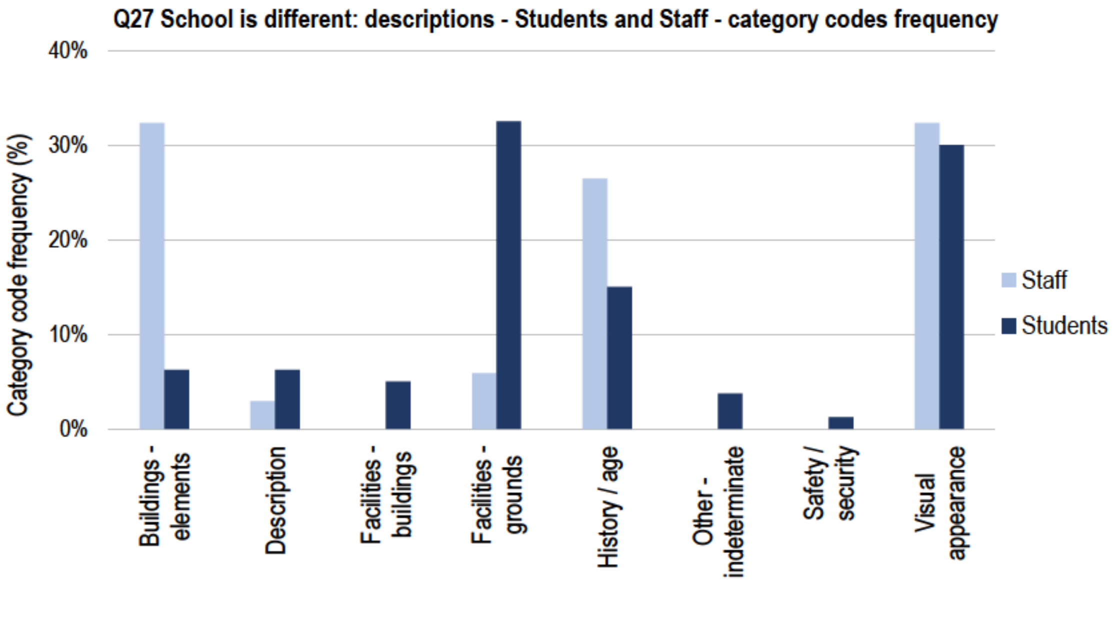


Figure 6.13: Q27 How school looks different – Students and Staff – open question category code frequency

Staff responses did not identify grounds as being different from other schools. Rather, they focussed on buildings and identified aspects according to school, such as age of buildings in the older Red and Yellow schools, materials in Orange school, and form in White School (Table 6.12, Appendix L.6.3).

Table 6.11: Q27 How school looks different – Students – detail code frequency ≥ 5

Category code – detail code	Yellow	White	Orange	Red	Total
History / age - old	6	0	0	5	11
Facilities - grounds - districts	0	5	4	0	9
Visual appearance - "odd", "odd shaped", "weird shapes", "different", "strange"	0	7	0	1	8
Facilities - grounds - large	0	4	2	0	6
Visual appearance - "factory", "triangular", "slanted"	0	6	0	0	6
Description - "lovely", "charm", "nice", "looks friendly", "good atmosphere"	1	0	0	4	5
Facilities - grounds - ecosystem	0	5	0	0	5
visual appearance - "modern"	1	3	0	1	5

Table 6.12: Q27 How school looks different – Staff – detail code frequency ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
History / age - old	3	0	0	4	7
Buildings - elements - materials	1	0	4	0	5
Buildings - elements - roof vents	0	0	5	0	5
Visual appearance - "factory", "triangular", "slanted"	0	1	2	0	3
Visual appearance - old	1	0	0	2	3

No participant mentioned sustainability, "green" or "eco" in his or her responses. Identification of sustainability elements might have been expected in White and Orange schools since they have a number of visible passive and energy efficient features. However, the form of White school was remarked upon using words such as ‘odd’, ‘weird’, ‘triangular’, and ‘modern’, suggesting that the students notice the steeply raked roofline that encases the stack chimneys but do not identify them with a particular function. The Orange school also has stack chimneys but no students noted these as making the school different to other schools.

From this series of questions, it can be concluded that occupants have some awareness of the basic forms and typologies of their buildings, with some sophisticated interpretations emerging in the qualitative responses. This is heartening. While architectural notions, such as landmark, may not be appropriate or understandable, the fact that occupants are able to identify the basic forms of their buildings suggests that design is noticed, if not at the forefront of recognition and recall.

6.3.2.2.6 What is liked about school buildings

In Q29, staff and students were asked what aspects of the exterior of their school they liked. This question was posed as an open question to determine if any unanticipated component was put forward. Students responded far more enthusiastically to this question than to Q27 asking about what school looks like, with 86% providing comments about what they like about their school's exterior, in addition to a strong response from staff participants (Appendix L.7.1).

Category coding showed that students commented mostly about aspects of their grounds that they use, such as playgrounds and ovals, whereas staff responded that they liked the visual appearance and building elements (Figure 6.14).

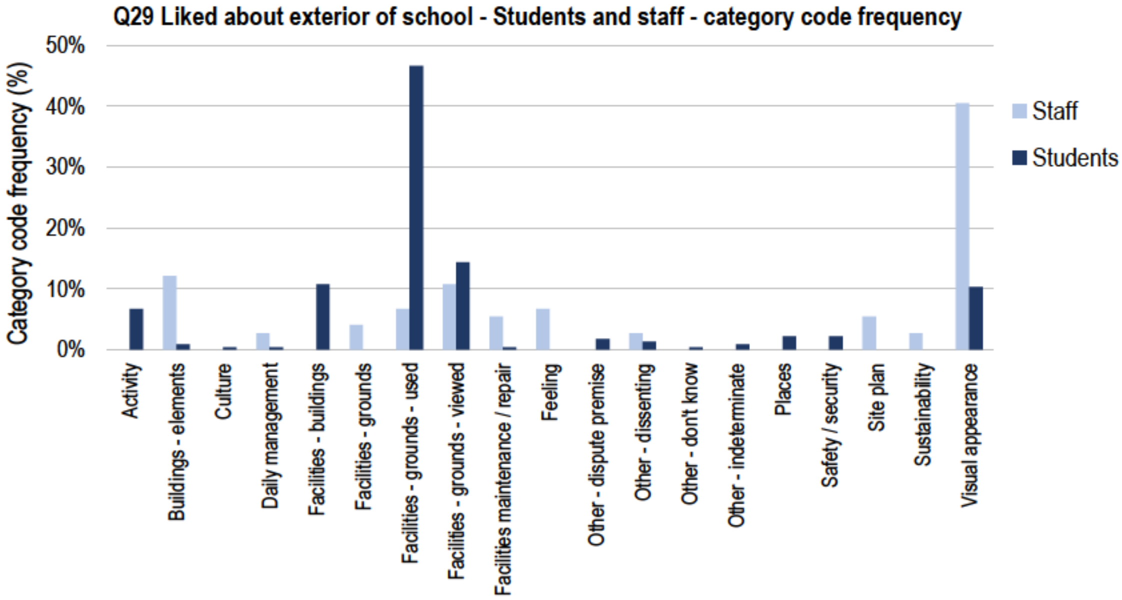


Figure 6.14: Q29 Liked about exterior – Staff and Students – open question category code frequency

Detailed post-coding led to a large variety of codes (Appendix L.6.3), with higher frequency codes shown in Table 6.13 for student response coding, in Table 6.14 for staff response coding. Students from the larger White and Orange Schools were enthusiastic about their playgrounds, ovals and soft landscapes. Size was important and the opportunity for different social groups to have their own 'places'.

The term 'gardens' was difficult to interpret since a small number specifically mentioned gardens that they tend themselves, so 'gardens' may in fact be food production. Artificial grass was also reported as liked by students with comments such as:

> The fake-grass area is pretty groovy (Y.Stu7)
>
> ...The fake grass area looks nice to the eye and is a nice place to be. (Y.Stu23)

The new gyms and halls were liked by the student participants. Given students' preference for their active outdoor areas, this could be due to a general and genuine liking of their gyms and halls. However, all of these were built during 2009-2011 (see Section 6.3.1), so students would have likely seen them being built, and the buildings would feel relatively new when compared to their classrooms and libraries. Whether this likeability continues after this cohort has moved on would be interesting to pursue for inter-generational building appreciation.

Some students returned responses about what they did not like, thus, disputing the premise of the question:

> Nothing Really, Real Bad, Boring white buildings (W.Stu59)

No student mentioned any sustainability demonstration elements, such as rainwater tanks or photovoltaic panels, nor did they mention any 'sustainability' elements of their buildings, such as wall vents or stack chimneys. Students liked what they use most outside, what they had seen built and soft landscape or, as one student expressed it:

> I LOVE the exterior of this school. its so perfectly done and makes connecting with nature a breeze. when you open a classroom door, you step into a courtyard full of green and fresh air. (W.Stu27)

Staff indicated that they liked visual aspects of the buildings (age, form, colour, materials, design), and grounds (trees, plants, non-productive gardens). These were consistent with observed infrastructure, such as Yellow and Red Staff liking the visual appearance of the older, heritage-looking buildings, whereas Orange staff like the unusual building materials.

Table 6.13: Q29 Liked about exterior – Students – detail code frequency ≥ 8

Category code – detail code	Yellow	White	Orange	Red	Total
Facilities - grounds - Playgrounds, play area	0	**26**	10	4	**40**
Facilities - grounds - trees, plants, non-productive gardens	3	4	**9**	7	**23**
Facilities - buildings - hall / gym	3	**7**	6	1	**17**
Facilities - grounds - ovals	0	**8**	6	1	**15**
Visual appearance - 'design', style, 'look'	1	3	3	**4**	**11**
Facilities - grounds - grass, grass areas	2	**6**	0	2	**10**
Facilities - grounds - fake grass	**9**	0	0	0	**9**
Facilities - grounds - large school	0	2	**4**	3	**9**
Activity - fun	0	3	**5**	0	**8**

Table 6.14: Q29 Liked about exterior – Staff – detail code frequency ≥ 4

code detail	Yellow	White	Orange	Red	Total
Visual appearance - old	**4**	0	0	**4**	**8**
Visual appearance - the form and colour	0	1	**5**	2	**8**
Buildings - elements - wall material	1	0	**4**	2	**7**
Facilities - grounds - trees, plants, non-productive gardens	0	2	**5**	0	**7**
Facilities maintenance / repair - good	0	1	**3**	0	**4**
Visual appearance - 'design', style, 'look'	0	0	**2**	**2**	**4**
Visual appearance - 'different', 'unique'	0	**3**	1	0	**4**

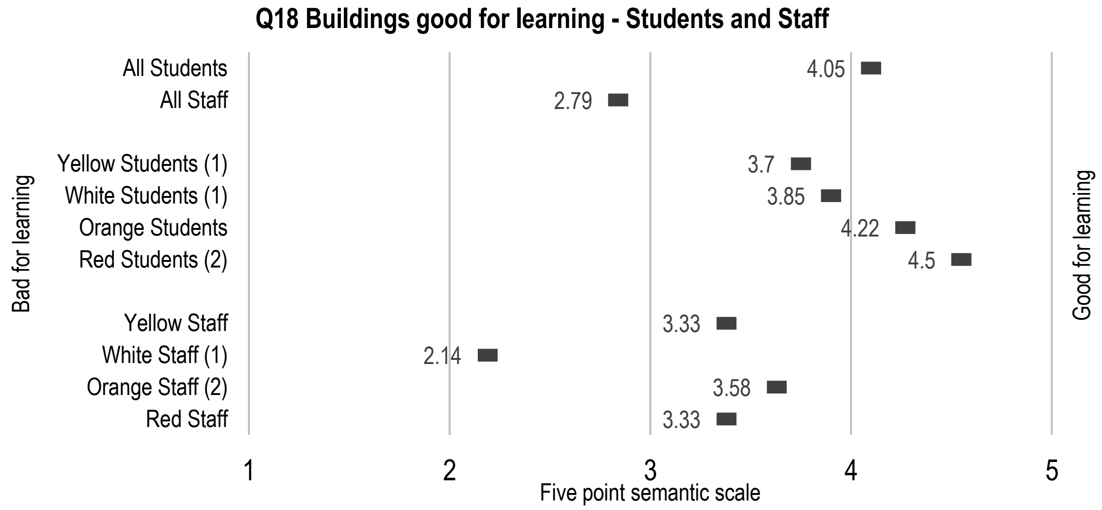
6.3.2.2.7 **Place summary**

The section presented user perspectives of school buildings as place. It investigated user perspectives of building as landmark, interesting, pride in school buildings, and good architecture (staff only). It tested how schools related to contemporary local architectural typology and forms, and asked users what they like about their buildings and grounds to seek what delighted users the most in their wider school built environment. Students tended to judge their buildings as less of landmark and interesting than staff, and both had similar pride in their school buildings. Staff did not judge their school buildings as excellent architecture. All judge their buildings as looking like a variety of building typologies, including factory, residential and office, but also noticed form and age of the buildings. When asked what they liked about their buildings, staff listed more about buildings whereas students listed more about their grounds, suggesting that preferences depend on the scope of use of the different populations.

6.3.2.3 School buildings as functional space

School buildings and grounds must provide appropriate functional space for teaching and learning (Section 2.3.4.1). In Section 4.4, observed building modifications were described, suggesting that the original fabric has had to be adjusted to meet occupant needs. This section outlines user perspectives of school buildings as functional places for learning and working, i.e., places that meet the needs of occupant activity purpose.

When asked whether school buildings were good or bad for learning (Q18) students responded positively (M = 4.05), but staff responded with less enthusiasm (M = 2.79) (Figure 6.15, Appendix K.11). Testing between cohort sample means could not support the null hypothesis, suggesting that this difference is statistically significant (Appendix K.2).



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.15: Q18 Buildings good for learning – Students and Staff – semantic scale

Student perspectives were found to differ across schools[59], where Red School students scaled their school as significantly better for learning that both Yellow School and White School students. Similarly, staff perspectives were also found to differ across schools[60], where Orange School staff

[59] One-way ANOVA $F(3, 141) = 5.086$, $p = 0.002$. Tukey post-hoc comparisons of the four groups indicate that Red School (M = 4.50, 95% CI[4.19, 4.81]) was significantly perceived as being better for learning than Yellow (M = 3.70, 95% CI[3.32, 4.07]), $p = 0.009$, and White (M = 3.85, 95% CI[3.62, 4.07]), $p = 0.013$. Comparison of these schools with, and between, Orange School (M = 4.22, 95% CI[3.93, 4.50]) were not statistically significant at $p < 0.05$.

[60] One-way ANOVA $F(3, 39) = 7.608$, $p < 0.0005$. Tukey post-hoc comparisons of the four groups indicate that White (M = 2.14, 95% CI[1.74, 2.53]) was significantly perceived as being worse for learning than Orange School (M = 3.58, 95% CI[3.01, 4.16]), $p = 0.001$, and Red School (M = 3.33, 95% CI[2.48, 4.19]), $p = 0.038$. Comparison of these schools with, and between, Yellow (M = 3.33, 95% CI[-0.46, 7.13]) were not statistically significant at $p < 0.05$.

rated their school as better for learning that White School staff.

White School is the most recent greenfield school, yet it was rated with the lowest score by staff (*N* = 22). The low sample *N* of other case study staff may have resulted in more optimistic responses relative to White School, due to self-selection of participants.

Using student responses, stepwise regression on all other scale variables proposed four significant models, with the model with the highest predictive strength ($R^2 = 0.55$) listed in Table 6.15. This model uses a mixture of environmental and non-environmental aspects as predictors, i.e., healthy, safe, proud and clean appear to be small but significant predictors as opposed to other architectural or sustainability perspectives.

Stepwise multiple linear regression on staff responses found that the perspective of buildings being good for learning was predicted by perspectives of buildings as healthy, and as being good for teaching. This latter variable was collected only from staff as an indicator of their workplace activities, as opposed to student learning activities.

Both of these models identify a perspective of buildings as healthy as being a predictor of a perspective of buildings as good for learning. This suggests that there is a perspective of quality of workplace health or public health that is important to space quality.

Table 6.15: Q18 Buildings good for learning – Students and Staff - multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Buildings good for learning	0.55	$F(4,91) = 28.13$ $p < 0.0005$	School buildings are healthy (Q19)	0.35	< 0.0005
			Buildings are safe (Q17)	0.25	0.005
			Proud of school buildings (Q20)	0.21	0.011
			Winter air smells dirty (Q44)	-0.17	0.028
Staff participants					
Buildings good for learning	0.83	$F(2, 26) = 65.53$ $p < 0.0005$	Buildings good for teaching (Q18a)	0.65	< 0.0005
			School buildings are healthy (Q19)	0.32	0.010

To investigate the building as workplace, staff were asked additional questions about whether they considered their buildings good for teaching (Q18a) and whether buildings matched the pedagogy (Q18b). On average staff responded that buildings reduced their teaching effectiveness (*M* = 2.71, Figure 6.16, Appendix K.12) and were neutral about whether the buildings matched their pedagogy (*M* = 2.98, Figure 6.17, Appendix K.13).

While differences in staff perspectives about whether buildings reduce or enhance teaching effectiveness were found such that Orange School staff scaled their buildings as enhancing teaching more than White School staff[61], when adjusted for sample size these disappeared (Appendix K.13).

Staff perspectives of whether buildings match pedagogy found perspectives were not statically significant at $p < 0.05$ across the four schools, ($F(3, 37) = 0.983$, $p = 0.411$).

Based on architectural design intents to match pedagogy, or improve teaching flexibility, as intended by architect public narratives (Table 4.9), these responses are lower than might have been expected. These user perspectives might be lower than expected due to low response rates from Yellow and Red School, or self-selected responses in Orange and White Schools where response rates were higher.

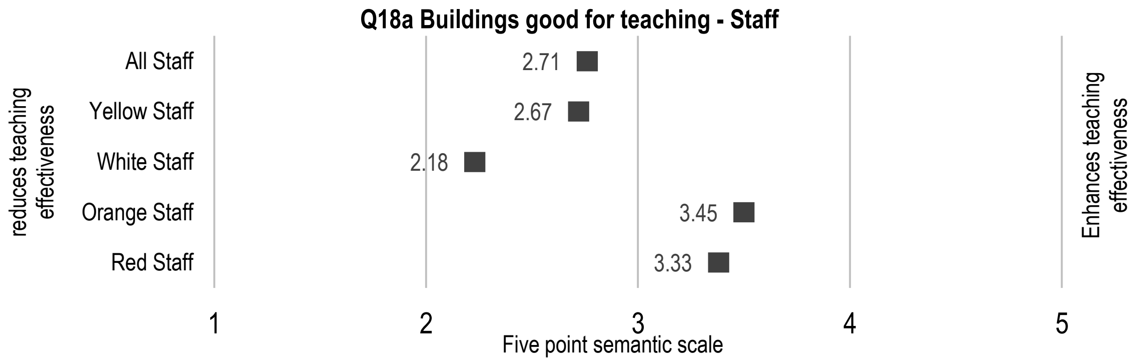


Figure 6.16: Q18a Buildings good for teaching – Staff – semantic scale

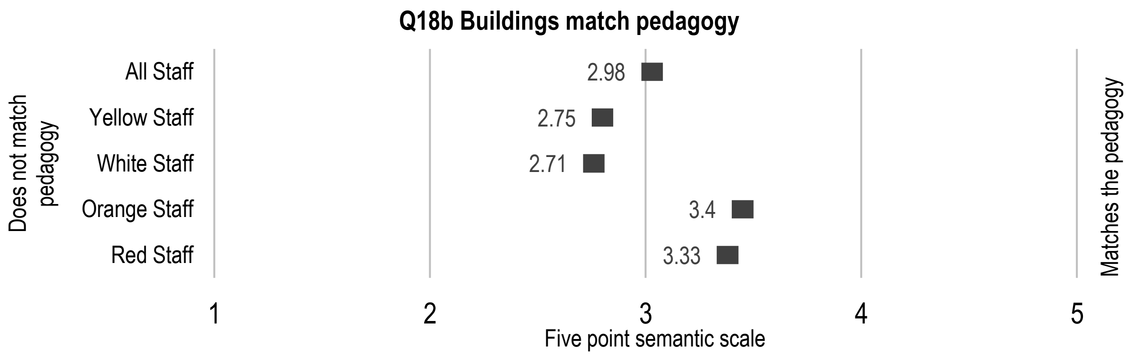


Figure 6.17: Q18b Buildings match pedagogy – Staff – semantic scale

Stepwise multiple linear regression using all variables found models to predict buildings as good for teaching (18a), and buildings as matching pedagogy (18b) (Table 6.16). Buildings that were perceived as being good for teaching depended on perspectives of them as being good for learning, matched to pedagogy, and that they facilitate speech clarity for students, whereas

[61] A one-way ANOVA was used to test staff perspectives of whether buildings reduces or enhances teaching effectiveness and found perspectives differed significantly across the four schools, $F(3, 38) = 4.857$, $p = 0.006$). Tukey post-hoc comparisons of the four groups indicate that Orange School ($M = 3.45$, 95% CI[2.90, 4.01]) was perceived to significantly enhanced teaching effectiveness when compared to White ($M = 2.18$, 95% CI[1.78, 2.58]), $p = 0.007$. Comparison of these schools with, and between Red School ($M = 3.33$, 95% CI[2.25, 4.42]) and Yellow ($M = 2.67$, 95% CI[-2.50, 7.84]), were not statistically significant at $p < 0.05$.

matching pedagogy was predicted only by the perception that buildings are good for teaching. Thus, the former is more complex and suggests some focus on students through their learning and their ability to understand, whereas the latter was more about work activities.

Table 6.16: Q18a Buildings good for teaching; Q18b Buildings match pedagogy – Staff – MLR on all variables

Dependent variables	R^2	*F*, *p*	Coefficients	Beta	*p*
Student participants					
Variables not in survey					
Staff participants					
Buildings good for teaching (Q18a)	0.86	$F(3, 25) = 52.40$ $p < 0.0005$	Buildings good for learning (Q18) Buildings match pedagogy (Q18b) Students understand speech (Q31a)	0.59 0.28 0.23	< 0.0005 0.005 0.021
Buildings match pedagogy (Q18b)	0.48	$F(1, 27) = 24.98$ $p < 0.005$	Buildings good for teaching (Q18a)	0.69	< 0.0005

This section has found that students tend to judge buildings as better for their learning than do staff. While architects intended to provide excellent teaching and learning spaces, participants judged that they are not excellent. Matching buildings to pedagogy is not the same as making school buildings good for learning and teaching. Teaching should be matched to students' learning style through a range of instructional modes (Marsh et al. 2014, p. 183), suggesting that pedagogy needs different space types for different instructional modes. Staff, themselves, also differ in preferences. Paraphrasing an incidental conversation during as site visit '...you need the right teacher for the right building' (O.e 3/8/12).

6.3.2.4 School buildings as healthy and safe space

6.3.2.4.1 Cleanliness

Participants were asked to rate other visually accessible quality aspects of their buildings, such as perspectives of maintenance and cleanliness. Students responded positively when asked whether they considered their buildings 'dirty' or 'clean' ($M = 3.63$) as did staff ($M = 3.55$) (Figure 6.18, Appendix K.6), with no significant difference between the cohorts (Appendix K.2).

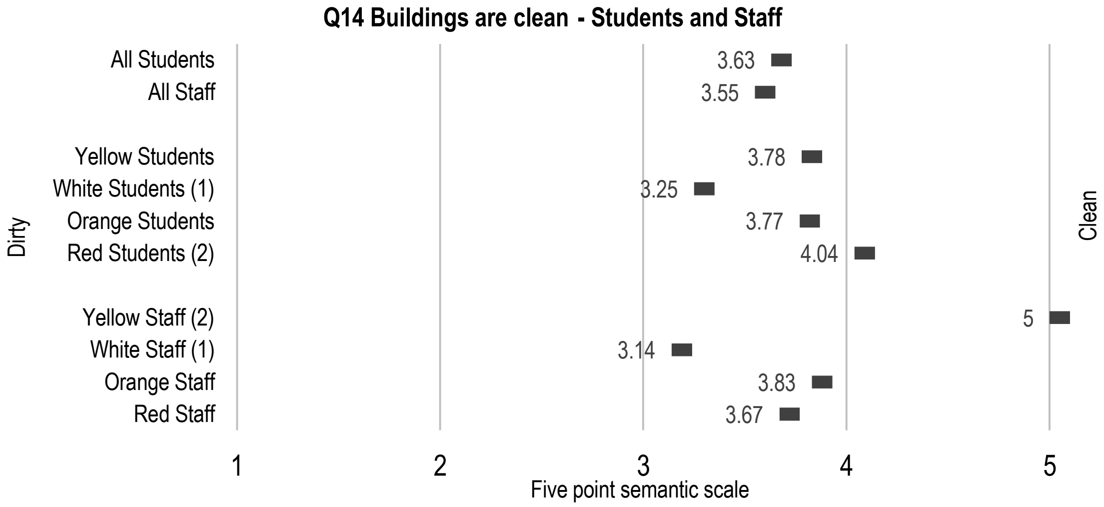
Student perspectives of cleanliness were found to differ across schools[62]. After adjustment for sample size (Appendix K.6), Red School students scaled their school cleaner than Orange School Students scaled their school.

Differences in staff perspectives of cleanliness were also found[63] such that Yellow School staff

[62] One-way ANOVA $F(3, 142) = 4.913$, $p = 0.003$. Tukey post-hoc comparisons of the four groups indicate that students at White School ($M = 3.25$, 95% CI[3.01, 3.49]) judged their buildings to be less clean than Orange School ($M = 3.77$, 95% CI[3.44, 4.09]), p = 0.035, and Red School ($M = 4.04$, 95% CI[3.72, 4.36]), $p = 0.005$. Comparison of these schools with Yellow ($M = 3.78$, 95% CI[3.39, 4.17]), were not statistically significant at $p < 0.05$

[63] One-way ANOVA $F(3, 38) = 3.652$, $p = 0.021$. As with the student case above, Tukey post-hoc comparisons of the four groups indicate that staff at White School ($M = 3.14$, 95% CI[2.73, 3.56]), $p = 0.022$, perceive their school less clean when compared to Yellow School Staff ($M = 5.00$, 95% CI[5.00, 5.00]). Comparison of these schools with Orange School ($M = 3.83$, 95% CI[3.13, 4.54]) and Red School ($M = 3.67$, 95% CI[2.4, 4.94]) were not statistically significant at $p < 0.05$

scaled their school as very clean; however, it must be noted that this statistical result is likely due to the small sample rate of Yellow School (*N* = 3).



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.18: Q14 Buildings are clean – Students and Staff – semantic scale

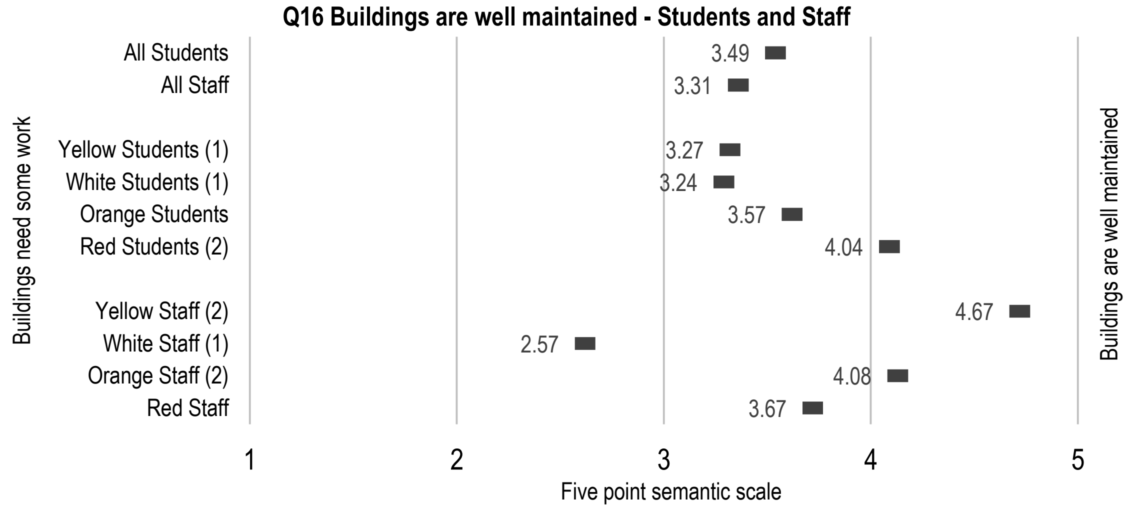
Stepwise regression on all other scale variables found models for perspectives of cleanliness for both staff and student participants, with moderate predictive capability for the student cohort (Table 6.17). In both cohorts, the perspective of buildings as healthy is a predictor. The student model includes the perspective of 'pride', i.e., an emotion component, whereas the staff model is also predicted by time to fix building problems, i.e., more functional.

Table 6.17: Q14 Buildings are clean – Students and Staff - multiple linear regression on all variables

Dependent variables	R^2	*F*, *p*	Coefficients	Beta	*p*
Student participants					
Buildings are clean	0.37	F(2, 93) = 27.55	School buildings are healthy (Q19)	0.47	< 0.0005
		p < 0.0005	Proud of school buildings (Q20)	0.23	0.017
Staff participants					
Buildings are clean	0.61	F(2, 26) = 20.11	School buildings are healthy (Q19)	0.55	< 0.0005
		p < 0.0005	Building problems fixed (Q16a)	0.36	0.015

6.3.2.4.2 **Maintenance**

Users were asked about perceived maintenance of their buildings. Students responded with a mean of 3.46 (*SD* = 1.05, *N* = 142), and staff with a mean of 3.31 (Figure 6.19, Appendix K.8), with no significant difference between the cohorts (Appendix K.2). It was also assumed that staff would have experience with the maintenance process, so they were asked about the response rate for maintenance. Staff responded below neutral with a mean of 2.79 (Figure 6.20, Appendix K.9).



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.19: Q16 Buildings are well maintained – Students and Staff – semantic scale

Students perspectives about school building maintenance were found to differ significantly across schools[64]. After adjusting for sample size (Appendix K.8), students from Red School scaled their buildings as cleaner than Yellow School students' perspectives of their buildings.

Staff perspectives of school building maintenance also differed across schools[65], such that White School staff scaled their buildings as having poorer maintenance than Yellow School and Orange School staff indicated about their respective schools.

Differences were found in staff perspectives of how quickly building problems were fixed[66]. White School staff indicated that building problems took longer to fix than staff perspectives of Yellow School and Orange School. The low mean score of White School staff perspectives is indicative of maintenance issues, and taken with the neutral score of perspectives of cleanliness, this suggests White School has other 'maintenance' issues and 'building problems'.

[64] One-way ANOVA $F(3,138) = 3.752$, $p = 0.013$. Tukey post-hoc comparisons of the four groups indicate that Red School ($M = 4.04$, 95% CI[3.72, 4.36]) was significantly perceived as being better maintained than White School ($M = 3.24$, 95% CI[2.95, 3.53]), $p = 0.010$. Comparison of these schools with, and between, Orange School ($M = 3.57$, 95% CI[3.22, 3.71]), and Yellow School ($M = 3.27$, 95% CI[2.84, 3.71]), were not statistically significant at $p < 0.05$.

[65] One-way ANOVA $F(3, 38) = 8.753$, $p < 0.0005$. Tukey post-hoc comparisons of the four groups indicate that White School ($M = 2.57$, 95% CI[2.13, 3.02]) was significantly perceived as being more poorly maintained than Yellow School ($M = 4.67$, 95% CI[3.23, 6.10]), $p = 0.007$, and Orange School ($M = 4.08$, 95% CI[3.51, 4.66]), $p = 0.001$. Comparisons of these schools with Red School ($M = 3.67$, 95% CI[2.40, 3.69]), were not statistically significant at $p < 0.05$.

[66] One-way ANOVA $F(3, 38) = 8.672$, $p < 0.0005$. Tukey post-hoc comparisons of the four groups indicate that White School ($M = 2.00$, 95% CI[1.52, 2.48]) was significantly perceived as having a longer time for building problems to be fixed than Yellow School ($M = 4.33$, 95% CI[1.46, 7.20]), $p = 0007$, and Orange School ($M = 3.75$, 95% CI[3.08, 4.42]), $p < 0.0005$. Comparisons of these schools with Red School ($M = 2.83$, 95% CI[1.44, 4.23]), were not statistically significant at $p < 0.05$.

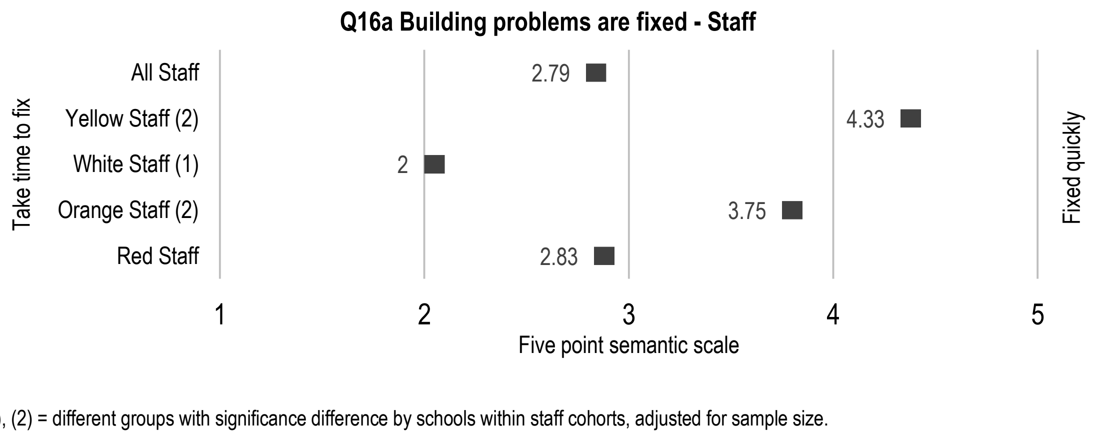


Figure 6.20: Q16a Building problems fixed – Staff – semantic scale

Stepwise multiple linear regression was undertaken on Q16 and Q16a using all other variables to investigate predictive influences of other variables (Table 6.18). Student responses predicting maintenance perspectives resulted in a complex model that included visual, noise, lighting and other fabric quality perspectives. This suggests that either the variation between schools prevents the regression of a simple and logically consistent model. Alternatively, it might also suggest that while maintenance, per se, is not well defined, it is predicted by holistic feelings that emanate from a quality of built environment fabric that is constructed to look and feel healthy and safe.

Regression on staff data also identified feeling healthy as predicting perspectives of good maintenance, and this was combined with the knowledge of timing of maintenance, as identified by the corollary regression on 16a.

Table 6.18: Q16, Q16a Buildings well maintained, problems fixed – Students and Staff – MLR on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Buildings well maintained (Q16)	0.55	$F(6, 89) = 18.12$	School buildings are healthy (Q19)	0.235	0.009
		$p < 0.0005$	Loud noise from adjacent room (Q32)	-0.250	0.001
			Views are attractive (Q64)	0.198	0.012
			Important school looks attractive (Q28)	0.080	0.016
			Buildings are safe (Q17)	0.222	0.012
			Lighting helps learning (Q53)	0.185	0.016
Staff participants					
Buildings well maintained (Q16)	0.67	$F(2, 26) = 27.10$	Building problems fixed (Q16a)	0.508	< 0.0005
		$p < 0.0005$	School buildings are healthy (Q19)	0.459	0.001
Building problems fixed (Q16a)	0.51	$F(1, 27) = 27.68$ $p < 0.0005$	Buildings well maintained (Q16)	0.712	< 0.0005

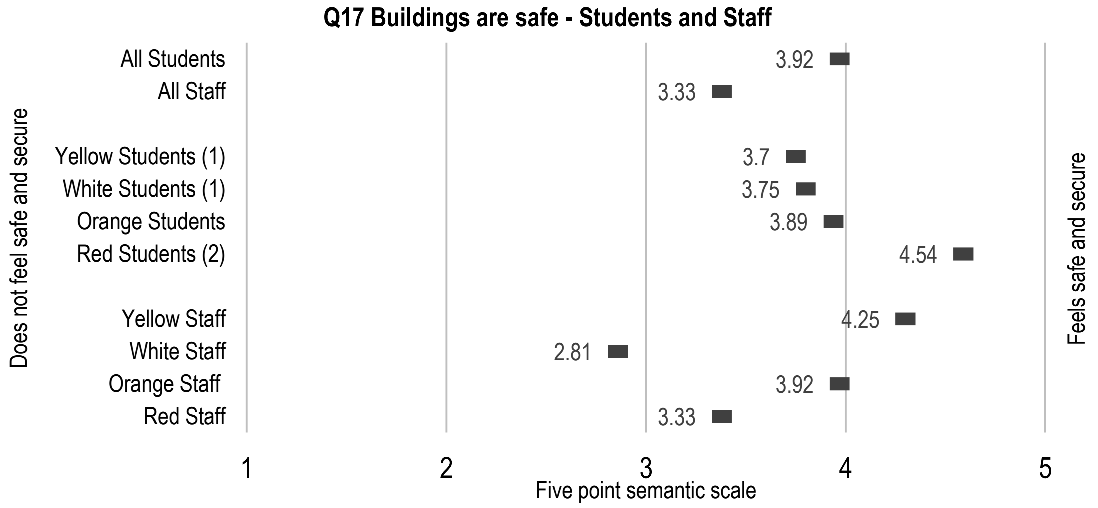
6.3.2.4.3 **Safety**

Students responded positively when asked whether they considered their buildings to feel safe (*M* = 3.92). Staff reported positively, but at a lower mean (*M* = 3.33) (Figure 6.21, Appendix K.10). Difference testing between means found that the null hypothesis could not be supported suggesting that there is a significant difference between the cohorts (Appendix K.2).

Differences in student responses were found[67], such that Red School students scaled their school as safer than student perspectives of the safety of Yellow School and White School. It is noted that there is a police station opposite the Red School site.

Differences in staff perspectives about school safety were also found[68] between Orange School and White School; however, when adjusted for sample size (Appendix K.10) these differences were not apparent. Despite this, it should be noted that the site plans for the larger Orange and White Schools are very different. Orange School (Figure 4.3) buildings have car parks and ovals as buffers between adjacent roads, and the school is fully fenced, while White School (Figure 4.4) has buildings located adjacent to roads and the school is open to the public at all times of the day to provide local amenity. This may contribute to the higher rating of Orange School staff for safety.

Similarly, the mean responses of students also indicate Orange Students feel safer, although White School students do not indicate that they feel unsafe. Notably, the responses of Orange School Students were not significantly different to those of Red School Students, despite the police station located opposite that latter. This feeling safety did not translate to Red School staff, although they still responded above neutral.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.21: Q17 Buildings are safe – Students and Staff – semantic scale

Stepwise regression for safety on all other variables generated a number of models that might be considered illogical. Two models are presented for both staff and student cohorts, one each with all significant coefficients generated, and one each with 'logical' coefficients (Table 6.19). The

[67] One-way ANOVA $F(3, 39) = 3.417$, $p = 0.027$. Tukey post-hoc comparisons of the four groups indicate that staff at Orange School ($M = 3.92$, 95% CI[3.28, 4.55]) felt their school was significantly safer than White ($M = 2.81$, 95% CI[2.26, 3.36]), $p = 0.049$. Comparison of these schools with, and between, Red School ($M = 3.33$, 95% CI[2.06, 4.60]) and Yellow ($M = 4.25$, 95% CI[2.73, 5.77]), were not statistically significant at $p < 0.05$.

[68] One-way ANOVA $F(3, 39) = 3.417$, $p = 0.027$. Tukey post-hoc comparisons of the four groups indicate that staff at Orange School ($M = 3.92$, 95% CI[3.28, 4.55]) felt their school was significantly safer than White ($M = 2.81$, 95% CI[2.26, 3.36]), $p = 0.049$. Comparison of these schools with, and between, Red School ($M = 3.33$, 95% CI[2.06, 4.60]) and Yellow ($M = 4.25$, 95% CI[2.73, 5.77]), were not statistically significant at $p < 0.05$.

more 'logical' coefficient models suggest that perspectives about maintenance being good predicts perspectives about school buildings being safe for both students and staff, with students perspectives about buildings being good for learning also a predictor.

The regressions with more coefficients suggest that safety is predicted by a range of perspectives, either suggesting it is complex, or this result is anomalous due to this particular data cohort.

Table 6.19: Q17 Buildings are safe – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Buildings are safe	0.49	F(5, 90) = 17.55 p< 0.0005	Buildings good for learning (Q18) Buildings well maintained (Q16) ICT important now (Q66) Classroom too big (Q62) Easy to save water (Q22)	0.31 0.22 0.25 0.20 0.20	0.001 0.019 0.002 0.017 0.024
Buildings are safe	0.39	F(2,93) = 30.17 p< 0.0005	Buildings good for learning (Q18) Buildings well maintained (Q16)	0.43 0.29	< 0.0005 0.004
Staff participants					
Buildings are safe	0.44	F(2,26) = 10.35 p < 0.0005	Buildings well maintained (Q16) Too hot in winter for students (Q41a)	0.68 -0.41	< 0.0005 0.014
Buildings are safe	0.29	F(1,26) = 11.22 p = 0.002	Buildings well maintained (Q16)	0.54	0.002

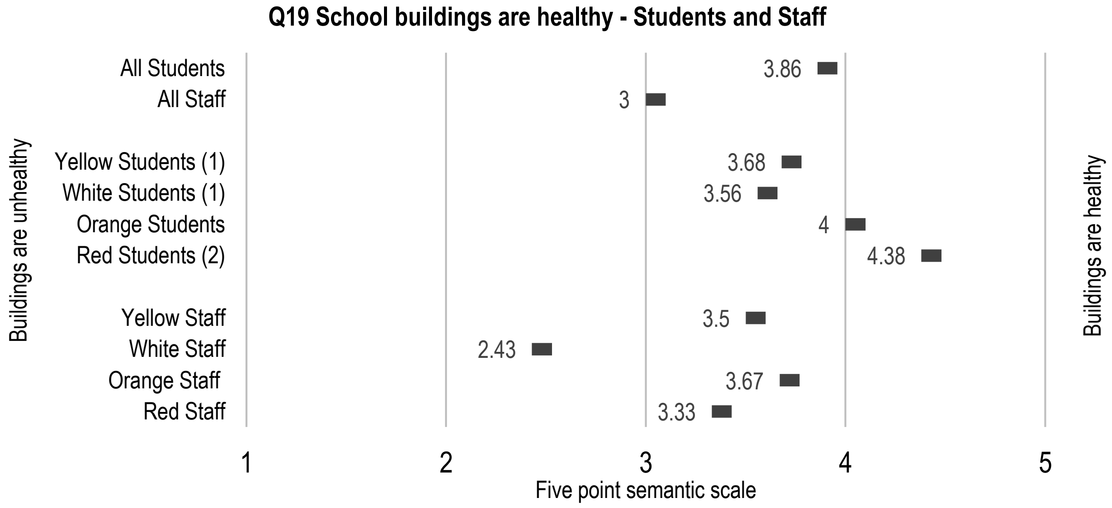
6.3.2.4.4 **Healthy buildings**

Students responded positively when asked whether they considered their buildings 'healthy' (*M* = 3.86), whereas staff were neutral overall (*M* = 3.00), (Figure 6.22, Appendix K.14). Testing between sample cohort means could not support the null hypothesis, suggesting that there is significant difference between the cohort perspectives (Appendix K.2).

Students at Red School scaled their perspectives of buildings as healthy to be higher than student perspectives of Yellow School and White School[69]. Staff at Orange School scaled their perspectives of buildings as healthy to be higher than staff perspectives at White School[70]. When adjusted for sample size (Appendix K.14), this difference between group perspectives was not supported.

[69] One-way ANOVA $F(3, 137) = 5.876$, $p = 0.001$. Tukey post-hoc comparisons of the four groups indicate that students at Red School (*M* = 4.38, 95% CI[4.07, 4.68]) significantly perceived their school buildings to be healthier than Yellow School (*M* = 3.68, 95% CI[3.34, 4.03]), $p = 0.030$, and White School (*M* = 3.56, 95% CI[3.32, 3.80]), $p = 0.001$. Comparison of these schools with Orange School (*M* = 4.00, 95% CI[3.73, 4.27]) were not statistically significant at $p < 0.05$.

[70] One-way ANOVA $F(3, 39) = 4.275$, $p = 0.011$. Tukey post-hoc comparisons of the four groups indicate that staff at Orange School (*M* = 3.67, 95% CI[3.04, 4.29]) significantly perceived their school buildings to be healthier than White School (*M* = 2.43, 95% CI[1.96, 2.9]), $p = 0.011$. Comparison of these schools with, and between, Red School (*M* =3.33, 95% CI[2.06, 4.60]) and Yellow School (*M* = 3.5, 95% CI[1.91, 5.09]) were not statistically significant at $p < 0.05$.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.22: Q19 School buildings are healthy – Students and Staff – semantic scale

Stepwise multiple linear regression on all variables found that, for the student cohort, school buildings perceived as healthy were predicted well by perspectives of cleanliness and good maintenance, as being good for learning, as well as a perception that water saving was easy (Table 6.20).

Staff responses also found that the perspectives of school buildings being good for learning and clean predicted the perspective of buildings as healthy, in addition to experience of low glare and the preference for quieter workplaces. These last two are suggestive of workplace annoyance connection (Section 2.2.2.5), making them consistent with perspectives of health workplaces. The inclusion of the perception that buildings are healthy if they are good for learning by both students and staff suggests a more complex perception and interaction than purely clean air or thermal comfort.

Table 6.20: Q19 School buildings are healthy – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	***F, p***	**Coefficients**	**Beta**	***p***
Student participants					
School buildings are healthy	0.56	$F(4,95) = 29.40$	Buildings good for learning (Q18)	0.32	0.001
		$p < 0.0005$	Buildings are clean (Q14)	0.31	< 0.0005
			Easy to save water (Q22)	0.17	0.033
			Buildings well maintained (Q16)	0.18	0.035
Staff participants					
School buildings are healthy	0.82	$F(4,24) = 27.26$	Buildings good for learning (Q18)	0.54	< 0.0005
		$p < 0.0005$	Buildings are clean (Q14)	0.37	0.002
			Glare occurs (Q55)	-0.26	0.014
			Prefer overall noise louder (Q35)	-0.19	0.049

6.3.2.4.5 Healthy and safe building summary

In this section, the results of scale questions associated with health and safety were presented. Schools were seen by students and staff as moderately clean, maintained, safe, and healthy. Staff varied with perspectives about timing for building problems to be fixed. Regressions found that these were sometimes predicted by non-obvious variables that may suggest that perspectives of quality of space are more complex and emotional than purely visual observations.

6.3.2.5 School redesign preferences

This inquiry was interested in what aspects of school architecture were not working robustly or as planned, however, after discussions with management staff, it was decided that this would be inappropriate to ask this directly (Section 3.5.7.1). The alternative question 'If you could redesign the outside or inside of your classroom what would you change or improve?' was considered to be more positive and respectful and would allow the same information to be drawn out using the logic that if there is something not working it would be identified as a target for redesign or change. Both students and staff responded well (78% and 86%, respectively) to this open question (Appendix L.20.1).

Category code frequencies of staff and student responses are summarised in Figure 6.23. Both staff and students expressed a desire to redesign an aspect of grounds and visual appearance, in addition to expressing that no changes were necessary. Staff also expressed a desire to redesign the exterior to make it more suitable for outdoor teaching and learning, make it safer and change to site plan.

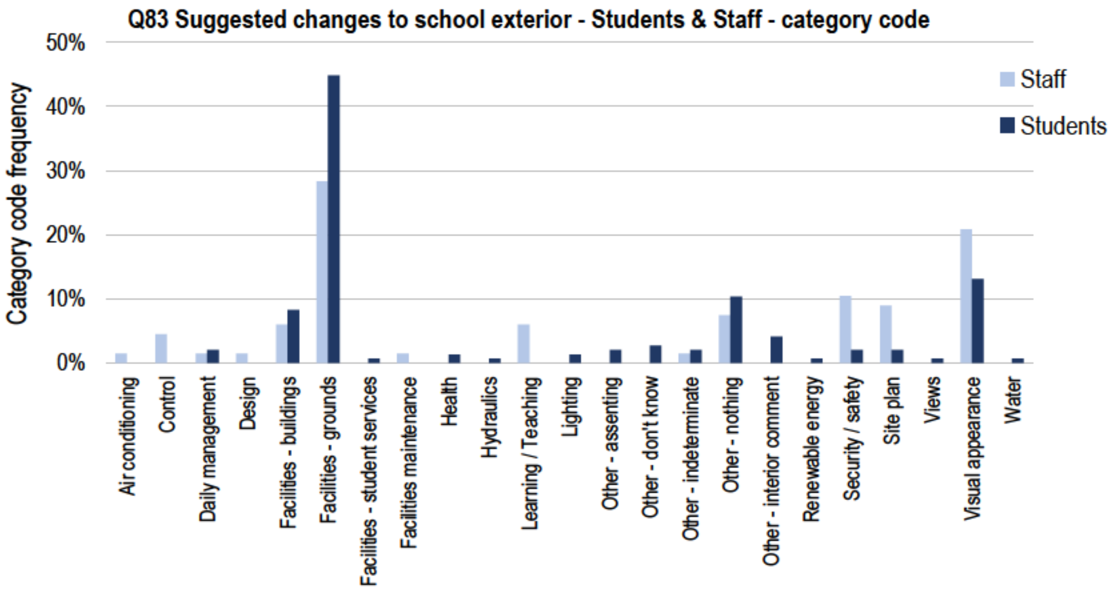


Figure 6.23: Q83 Suggested changes to exterior – Students and Staff – open question category code frequency

The highest detail code frequencies are shown by school in Table 6.21 and Table 6.22, with the full tables available in Appendix L.20. Some staff and students did not want to make changes. Students wanted changes to landscape ('I would change the plants, some more trees out the front of our school would be nice', Y.Stu23), but staff stated they would change aspects to improve site and outdoor functionality ('Staffroom more central. More Seating / tables - for older students...', O.Sta29; 'More play areas. Better surfaces to play on. More thought to thoroughfares', W.Sta5). This was also expressed during site visits, particularly for outdoor learning during winter, where it was explained that courtyards were '...intended as "learning streets" but more like "wind tunnels"' (paraphrased W.j 18/7/12).

There were many opinions about aspects of school building architecture. Some staff and students liked their buildings as they were. Others wanted to change the look of the buildings, such as the heritage fabrics ('Bricks - they are a bit run-down...', R.Stu141), or the ventilation elements ('the chimney things', W.Stu58). Some students wanted uniform architecture ('I would make it more modern .... I would also have all the buildings the same style', O.Stu97), and staff expressed dislike of the different styles ('New [building] - doesn't match our existing buildings', R.Sta44). Other students found the newer schools too architecturally conservative ('the whole thing, more modern style to make it standout', W.Stu49; 'I would make every classroom different and wild with excitement', O.Stu108).

Table 6.21: Q83 Suggested changes to exterior – Students – detail code frequency ≥ 6

Category code – detail code	Yellow	White	Orange	Red	Total
Facilities - grounds - more or redesigned soft landscape	6	0	**7**	3	**16**
Other - nothing	2	3	**5**	**5**	**15**
Facilities - grounds - oval, larger, upgraded	0	4	**5**	0	**9**
Facilities - grounds - playground different location or ages	2	0	2	**4**	**8**
Visual appearance - more interesting, exciting, colourful	0	**6**	1	0	**7**
Facilities - grounds - playground - change not specified	2	1	**3**	0	**6**
Facilities - grounds - more sports courts / fields	0	**3**	2	1	**6**
Response about interior	1	**4**	1	0	**6**

Table 6.22: Q83 Suggested changes to exterior – Staff – detail code frequency ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Visual appearance - more interesting, exciting, colourful, less ugly	0	**7**	1	0	**8**
Other - nothing, no change	2	0	0	**3**	**5**
Security / safety - add / change perimeter fence	0	**5**	0	0	**5**
Learning / Teaching - outdoor areas more appropriate for learning	0	**2**	1	1	**4**
Facilities - grounds - more seating	0	0	**3**	0	**3**
Facilities - grounds - more / larger play areas	1	**2**	0	0	**3**

White School staff and students expressed concerns about fencing, consistent with both scale responses and the observed open plan of the site, though fencing was not mentioned by students. White School staff and students also indicated that they would change the appearance of their buildings.

Notably, cleanliness, health, and maintenance did not appear as in responses as needing to be redesigned. This suggests that 'design' of the school exterior is not associated with these, that there are higher priorities for redesign, or they confirm the positive responses in Section 6.3.2.4.

Overall, staff and students were interested in changing functionality of the outdoor spaces either for play and sport functions (students), or for learning and teaching (staff), together with changes to planting. The newer schools White and Orange, also prompted more comments about their visual appearance and fabric, suggesting that contemporary architecture is not as satisfactory to users as the older, heritage-looking architecture; however, without an older building that is not associated with heritage in the study, it is difficult to conclude that older buildings are preferred over contemporary buildings – it could simply be the stone facade.

6.3.3 School as community asset

In order to judge the community perception of schools as assets, staff were asked about use or perspectives of their school as a community asset (response rate 77%, Appendix L.23). Responses show that staff identified that schools were used for a range of activities for the general public as well as including parents specifically (Figure 6.24).

Detail coding (Table 6.23, with full frequency list available in Appendix L.23.2) shows that the largest schools, White and Orange, were used for community sport, and the open school, White, provides public amenity. All schools were mentioned as hosting community activities, and were described as a meeting place for community, in general, and parents, specifically. Red School age was identified as contributing to the community. Thus, the internal view of the staff was that schools contributed to the community in amenity and function. After hours use also conflicts with assumed occupancy profiles (Table 2g, Australian Building Codes Board 2012).

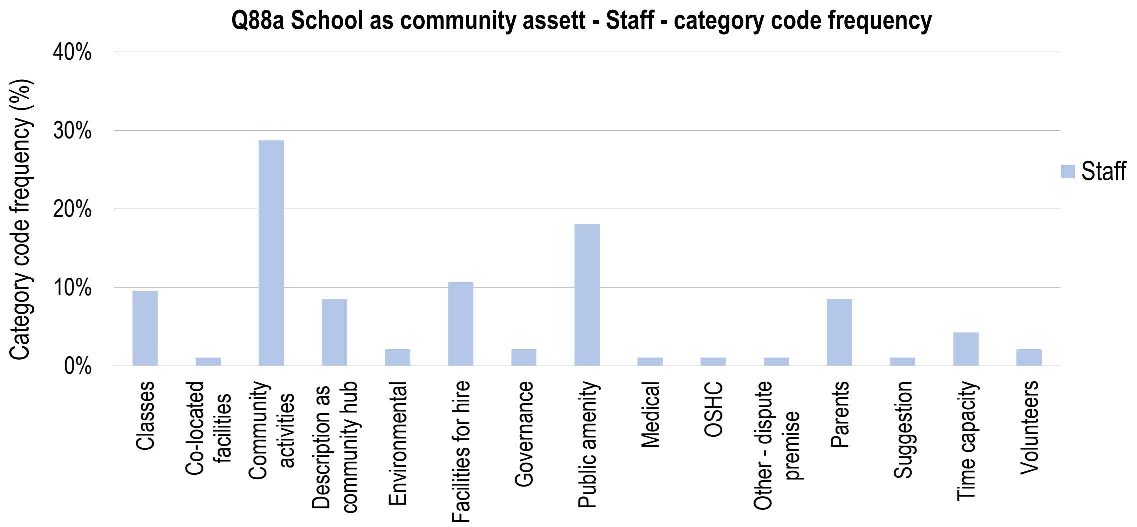


Figure 6.24: Q88a importance to, or use by. community of school – Staff – open question category code frequency

Table 6.23: Q88a importance to, or use by, community of school – Staff – detail code frequency ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Community – sports	1	**8**	**8**	1	**18**
Public amenity - grounds open	0	**10**	1	1	**12**
Community - activities - not specified, various	2	**4**	1	2	**9**
Parents - meeting place, social gathering	2	0	**5**	1	**8**
Facilities for hire - gym / hall	1	2	**3**	1	**7**
Description - meeting place	**2**	0	1	0	**3**
Public amenity - history	0	0	0	**3**	**3**

6.3.4 Perspectives of school sustainability

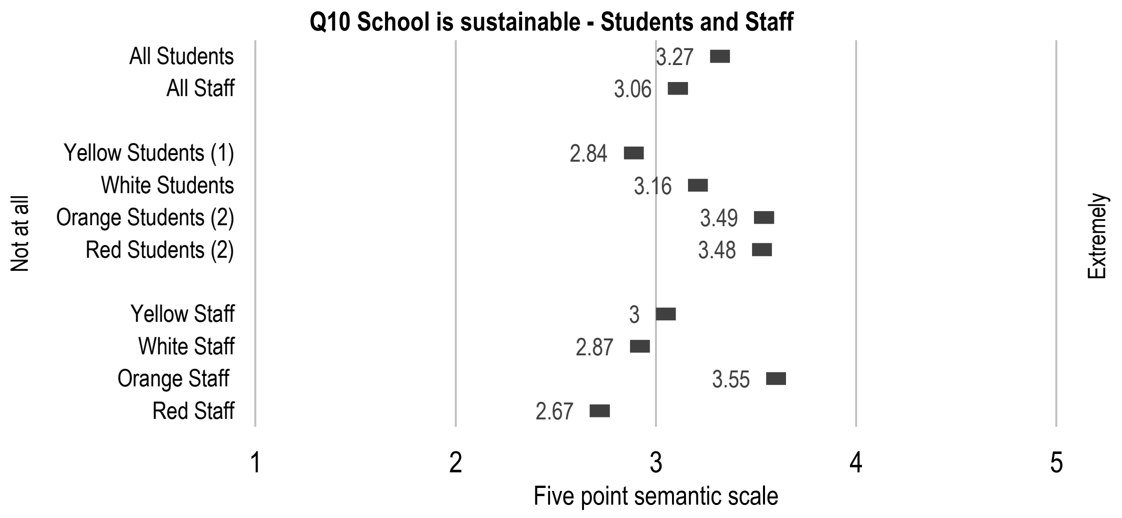
Since building sustainability is a significant concern of architects, occupants were given a variety of options to express their expectations and observations of school and school building sustainability.

The scale question asking whether staff and students considered their school sustainable (Q10), found that students responded with a perception slightly above neutral (M = 3.27), whereas staff had a neutral perception of school sustainability (M = 3.06), (Figure 6.25, Appendix K.3), with no significant difference detected between cohorts (Appendix K.2).

Both groups were tested for differences between schools. Student perspectives differed[71] such that students from Yellow School scaled their school as being less sustainable than the perspectives of Orange School and Red School students had about their respective schools. For staff responses, a one-way ANOVA found perspectives of school sustainability were not significantly different across schools (F(3, 31) = 1.777, p = 0.172).

Given that Orange and White Schools have specific building elements that are intended to indicate sustainability, such as ventilation chimneys, it was expected that sustainability might have scored higher with these schools. Though not significant, Orange School staff and student response means are higher than other schools, but White School is not scored as sustainable by its staff. Student perception of Yellow School as less 'sustainable' is difficult to interpret. When compared to the other schools their demonstration photovoltaic panels were the most visually accessible to students (Photograph 4.10).

[71] Both student and staff response cohort failed the Levene test for homogeneity of variances (Student, p = 0.009; Staff, p < 0.0005), however, only student responses also failed the stricter Welsh (p = 0.004), and Brown-Forsythe (p = 0.008) robustness tests. For completeness, one-way ANOVA F(3, 130) = 3.434, p = 0.019. Tukey post-hoc comparisons of the four groups indicate that Yellow School (M = 2.84, 95% CI[2.55, 3.13]) was considered statistically less sustainable than Orange School (M = 3.49, 95% CI[3.18, 3.80]), p = 0.029. Comparison of these schools with, and between White (M = 3.16, 95% CI[2.92, 3.40]) and Red School (M = 3.48, 95% CI[3.22, 3.73]), were not statistically significant at p < 0.05.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.25: Q10 School is sustainable – Students and Staff – semantic scale

Stepwise multiple linear regression was undertaken on all variables to find predictive variables for the perspective of school sustainability. The staff regression could not be mathematically resolved. The student model with the highest contribution to variance, and with all coefficients significant, is given in Table 6.24, where it shows that student perspectives are predicted by perspectives of energy saving devices. This is consistent with the presences of form of energy use restriction at all schools, such as timers or automatic HVAC control, suggesting that these do, indeed, act predicatively towards perspectives of sustainability. Sustainability perspectives were also predicted by visual aspects such as maintenance and the functionality of light.

Table 6.24: Q10 School is sustainable – Students – multiple linear regression using all variables

Dependent variables	R^2	***F, p***	**Coefficients**	**Beta**	***p***
Student participants					
School is sustainable	0.26	F(3,92) = 10.96	Buildings well maintained (Q16)	0.22	0.033
		P < 0.0005	Easy to save energy (Q21)	0.28	0.004
			Lighting helps learning (Q53)	0.23	0.022
Staff participants					
No mathematical solution using all variables					

Using open response form, Question 11 asked directly how participants expected their school to be sustainable and Question 12 asked participants what they perceived as sustainable at their school. Of the student participants just over half attempted Q11 (52%) but more attempted Q12 (66%), i.e., more reported what was present rather than what they expect. Similarly staff also reported what was present (90%), not what was expected (66%), suggesting that expectation of sustainability has a low awareness or importance in both cohorts. For the complete response rates to Q11 and Q12 by school refer to Appendix L.3.1 and Appendix L.4.1.

The category code frequencies are shown graphically for expectations (Q11, dashed bar) and observations (Q12, solid bar) in Figure 6.26. Students responded with expectations about building elements, daily management, energy use, water and recycling, and described observed sustainability as building elements, energy, buildings, grounds, and recycling. They also described observed student activities as being present far more than expected, and daily management as being present far less than expected. Staff had more expectations about, energy, water and recycling, and observed more sustainability aspects in building elements than expected.

The highest frequency student and student detail codes for expectations (Q11) are given in Table 6.25 and Table 6.26, respectively, and observations (Q12) of school sustainability in Table 6.27 and Table 6.28, with full detail code listings in Appendices L.3 and L.4.

When responding to the question about expectations of school sustainability student responses did not strictly conform to the question since 14% of coded responses were observations about their own buildings rather than expectations. Given the age range, the (unintended) complex subtlety of the question, the intention to empower and respect students, and the question asking specifically about what is at the school, this research will retain and interpret observations and suggestions for change as indicators towards what is expected by students.

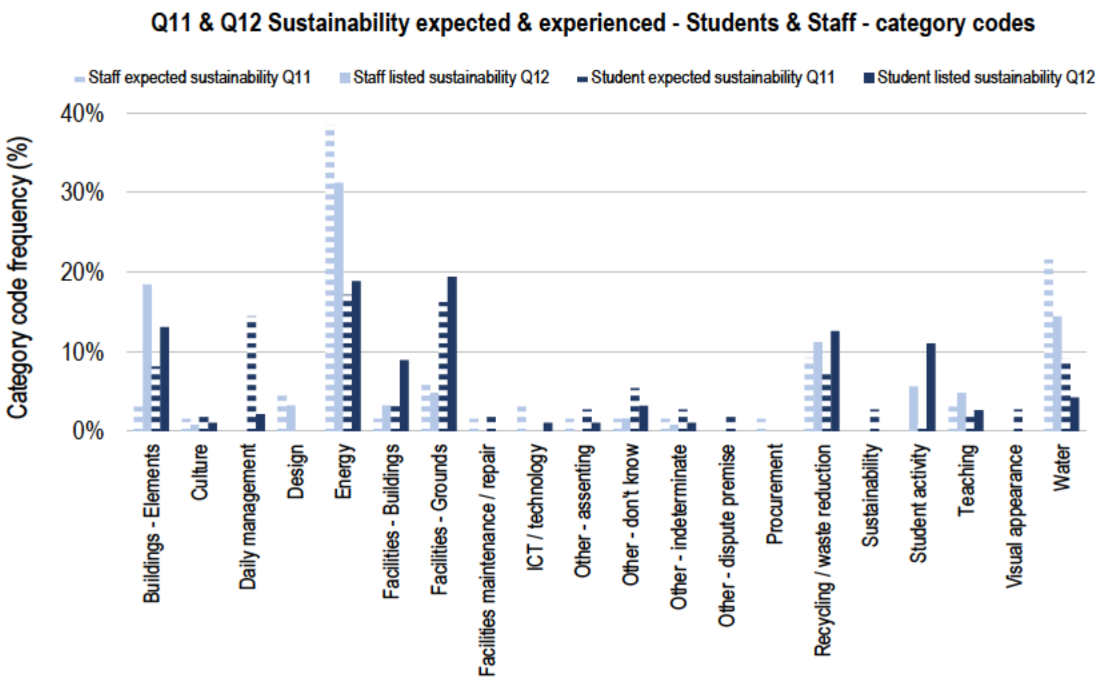


Figure 6.26: Q11 & 12 School sustainability expectations and listed – Students and Staff – open question category code frequency

Referring to Table 6.25, students expected sustainability to be in the form of daily management activities, recycling, energy and water savings, inclusion of ecosystems, and listed a mix of passive sustainability (not controlled by students) and active sustainability (controlled by students). Visually, they expected items such as photovoltaic panels and gardens. Students indicated that they observed integrated energy saving and water saving building elements, but reported most participatory sustainability, such as recycling (Table 6.27).

Staff expected specific sustainability elements, such as energy saving, efficient and renewable energy devices, and recycling activities (Table 6.26), and recorded that they did observe these (Table 6.28).

Comparing the different cohorts, students expected and observed sustainability aspects in their grounds, whereas staff were slightly more focused on building elements and design, suggesting, again the influence of the different territory of occupation.

Table 6.25: Q11 School sustainability expectations - Students - detail codes ≥6

response type code	Category code – Detail code	Yellow	White	Orange	Red	Total
expectation	Daily Management - to be clean, no litter	0	8	0	3	11
expectation	Energy - Photovoltaic panels	2	2	3	4	11
expectation	Energy - Saving (non-PV)	3	0	1	4	8
expectation	Recycling / waste reduction	3	1	0	4	8
observation	Facilities - Grounds - outdoor ecosystem	0	7	0	0	7
unclear	Other - don't know	1	1	4	0	6

Table 6.26: Q11 School sustainability expectations - Staff - detail codes ≥6

response type code	Category code – Detail code	Yellow	White	Orange	Red	Total
expectation	Energy - Saving (non-PV)	0	3	3	3	9
expectation	Energy - energy efficiency	1	5	0	0	6
expectation	Recycling / waste reduction	1	3	1	1	6
expectation	Water - save / reduce use / turn off taps	0	2	3	1	6

Table 6.27: Q12 Listed school sustainability – Students – detail codes ≥ 6

Category code – Detail code	Yellow	White	Orange	Red	Total
Recycling / waste reduction	0	14	0	10	24
Energy - lights - timers / automatic	0	1	7	5	13
Buildings - Elements - windows / skylights / nat light	1	4	6	1	12
Energy - PV	2	2	3	4	11
Student activity - composting / gardening	0	3	0	8	11
Facilities - Grounds - gardens / plants	1	5	0	4	10
Facilities - Grounds - ecosystem	0	9	0	0	9
Student activity - clean up	1	6	0	2	9
Facilities - Grounds - playground / equipment / furniture	1	1	6	0	8
Energy - AC - timers / automatic	0	4	0	3	7
Facilities - Buildings - Gym / Hall	1	2	4	0	7
Buildings - Elements - windows automatic	0	6	0	0	6
Other - don't know	2	1	2	1	6

Table 6.28: Q12 Listed school sustainability – Staff – detail codes ≥ 6

Category code – Detail code	Yellow	White	Orange	Red	Total
Energy - PV	2	**6**	**6**	2	**16**
Recycling / waste reduction	2	**7**	1	4	**14**
Energy - AC - timers / automatic	0	5	**6**	2	**13**
Water - recycled	0	**10**	0	2	**12**
Energy - lights - timers / automatic	0	1	**4**	**4**	**9**
Buildings - Elements - Ventilation	0	1	**5**	0	**6**
Buildings - Elements - materials	0	0	**6**	0	**6**

While there were some suggestion of occupant activity contributing to a school being 'sustainable' there were few responses to this question that specifically addressed social aspects of sustainability (apart from a reference to culture and heritage) and none for economic sustainability. Thus, it could be concluded that either 'sustainable' is perceived as being of the physical realm, or the participants censored themselves due to restrict responses to perceived architectural relevance. Alternatively, staff also noted actions of students, as did students, suggesting sustainability action is 'done' by people other than staff participants. Students also expected the daily management of the school, such as cleaning, to done, but again done by someone else. This suggests that sustainability is a systemic action that is both observed as physical devices, and as actions, often by people other than participants.

Students and staff were asked to rate their buildings for ease of saving energy (Q21, Figure 6.27 and Appendix K.16), and easy of saving water (Q22, Figure 6.28 and Appendix K.17). Students responded that they perceived their buildings were just above neutral on a five point scale for both making energy saving easy ($M = 3.29$) and water saving easy ($M = 3.30$). Staff responded with less than neutral ratings for energy saving ($M = 2.56$) and water saving ($M = 2.74$). In both cases, testing between sample cohort means could not support the null hypothesis, suggesting that significant differences existed between cohorts (Appendix K.2).

One-way ANOVA on student and staff responses to Q21 and Q22 found that no schools differed significantly in their perspectives of buildings saving energy for student responses ($F(3, 114) = 1.70$, $p = 0.171$) or saving water for both students and staff (students, $F(3, 112) = 1.87$, $p = 0.139$; staff, $F(3, 35) = 0.547$, $p = 0.653$). Staff response of energy saving were found to differ significantly across schools[72]; however, after adjustment for unequal sample size, no significant post hoc homogenous subsets were also indicated. Despite this, the perspectives from White School staff are consistent with the expectations and observations reported in questions 11 and 12 discussed above, and at conflict with design expectations for White School (Table 4.9).

[72] One-way ANOVA ($F(3, 37) = 3.74$, $p = 0.019$). Tukey post-hoc comparisons of the four groups indicate that staff at White School ($M = 2.15$, 95% CI[1.69, 2.61]) is significantly perceived that their buildings make energy saving more difficult than Orange School ($M = 3.33$, 95% CI[2.71, 3.96]), p = 0.011. Comparison of these schools with, and between, Red School ($M = 2.50$, 95% CI[1.40, 3.60]), and Yellow ($M = 2.33$, 95% CI[0.90, 3.77]), were not statistically significant at $p < 0.05$.

Stepwise linear regression was undertaken on both Q21 and Q22 using all other variables for both student and staff participants, but the models found were not convincing due to the large number of independent variables included in models (Appendix K.18)

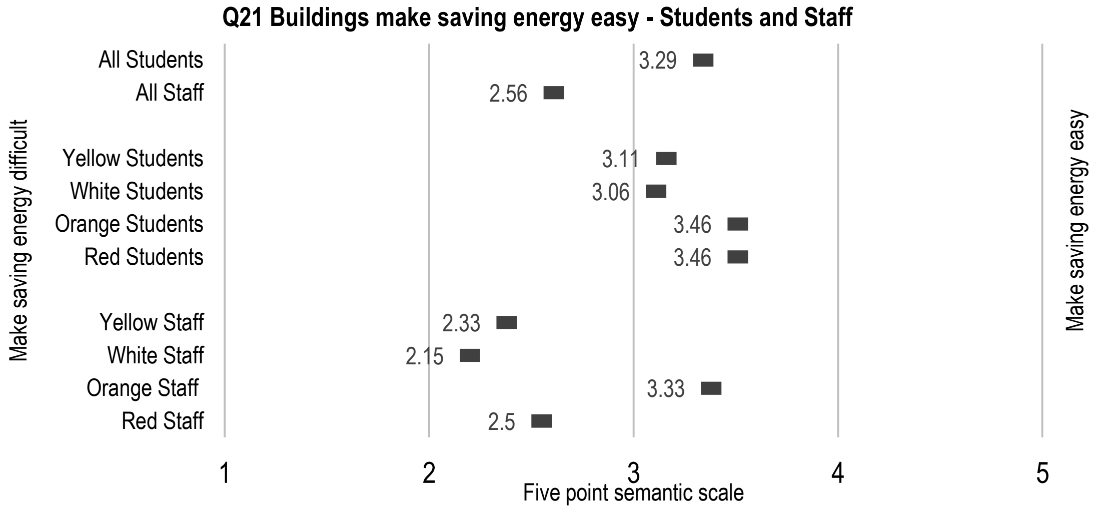


Figure 6.27: Q21 Building make it easy to save energy – Students and Staff – semantic scale

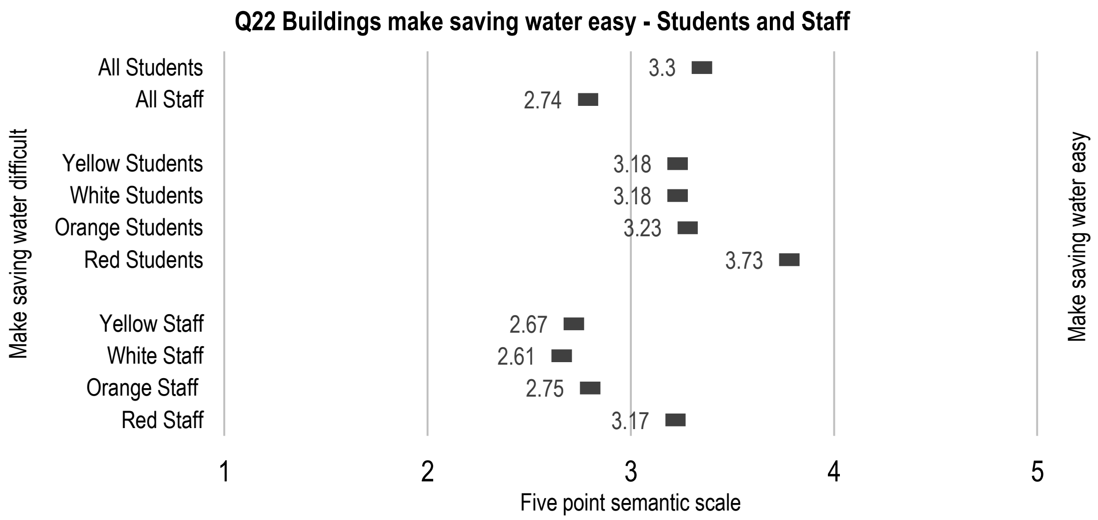


Figure 6.28: Q22 Buildings make it easy to save water – Students and Staff – semantic scale

A multiple-choice question was posed to capture recall about what sustainability and built environment elements were discussed in class (Figure 6.29, Appendix L.17). Overall, students and staff largely agreed with each other about what was discussed in lesson.

Items identified with 'ecologically sustainable design' (DECS Asset Services 2009) such as walls and roof, building materials, rainwater tanks and photovoltaic panels, were reported, but there were differences consistent with school configurations. Though a small response overall, responses from the Orange and Red schools for discussing 'the walls and roof' were slightly higher and consistent with relatively higher responses in discussing building materials, suggesting that their non-typical construction (rammed earth and random rubble stone wall, as compared to masonry brick cladding typical of local residential) were discussed in some form during lessons. Rainwater tanks had only a small indication of class discussion (0 - 5% of total responses) despite their presence. Photovoltaic panels were discussed slightly more, but only between 4-8% of total responses. According to (DECS Asset Services 2009) these latter two could be considered demonstration items. The low discussion responses might be indicative that sustainability discussions are a small part of curriculum, or student awareness is low.

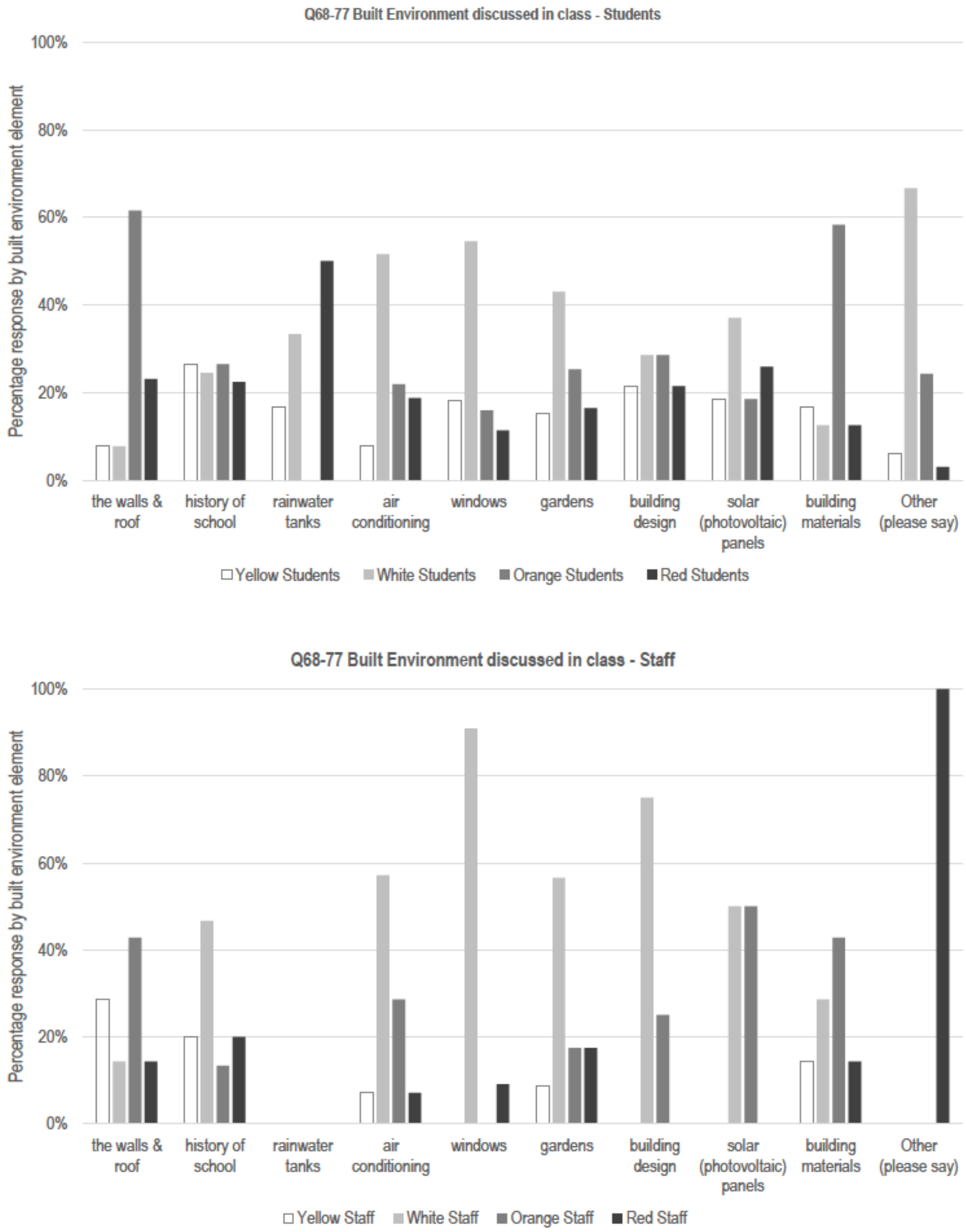


Figure 6.29: Q68-77 Built environment discussed in class – Students and Staff – percentage response by element

White School staff and students reported air conditioning and windows at a higher proportion than other schools. This is consistent with the reported poor control of these elements are discussed in Section 6.4.4.4.

Gardens were discussed in the lessons in all case studies (50 - 75%, normalised). Since all schools had some form of garden, regardless of the site size, this higher proportion of response suggests that when compared to, say, photovoltaic panels, the act of participating in gardening may increase student awareness and may offer more value to learning than demonstration items that are not maintained by students.

Staff made only two comments about 'other things that were discussed in class', both from Red School. One response noted that they talked about cellars and the other did not specify what was discussed. The open section of student responses was coded, with the category codes presented graphically in Figure 6.30, showing that students identified grounds facilities as being discussed in lessons.

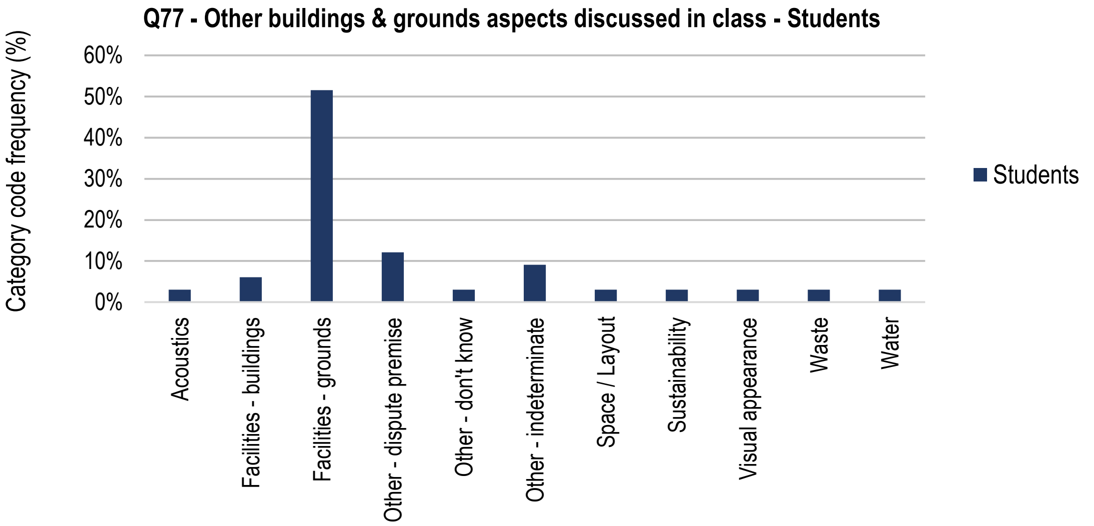


Figure 6.30: Q77 Other buildings and grounds aspects discussed in class – Student – open question category code frequencies

The detail coding and school breakdown (Appendix L.18), shows that White School students provided the most responses to the open section of the question identifying that they discuss outdoor facilities. These refer to an ecological learning section in the centre of the White School's site plan, and a bridge that is the main circulation between two school campuses.

6.4 Perspectives of the classroom built environment

Having presented participants' perspectives of their school built environment, attention is now turned to the classroom built environment. This section addresses the region of the mixed method inference map (Figure 6.31), in which participants' survey data is analysed using quantitative and qualitative methods, and triangulated with contextual architectural and environmental data to create case-by-case inferences. This section commences with perspectives of how a classroom is expected to facilitate teaching and learning (Section 6.4.1), classroom design perspectives (Section 6.4.2), perspectives of the dynamic features and use of classrooms (Section 6.4.3), selected environmental perceptions (Section 6.4.4), and perspectives of how current classrooms should be changes (Section 6.4.5).

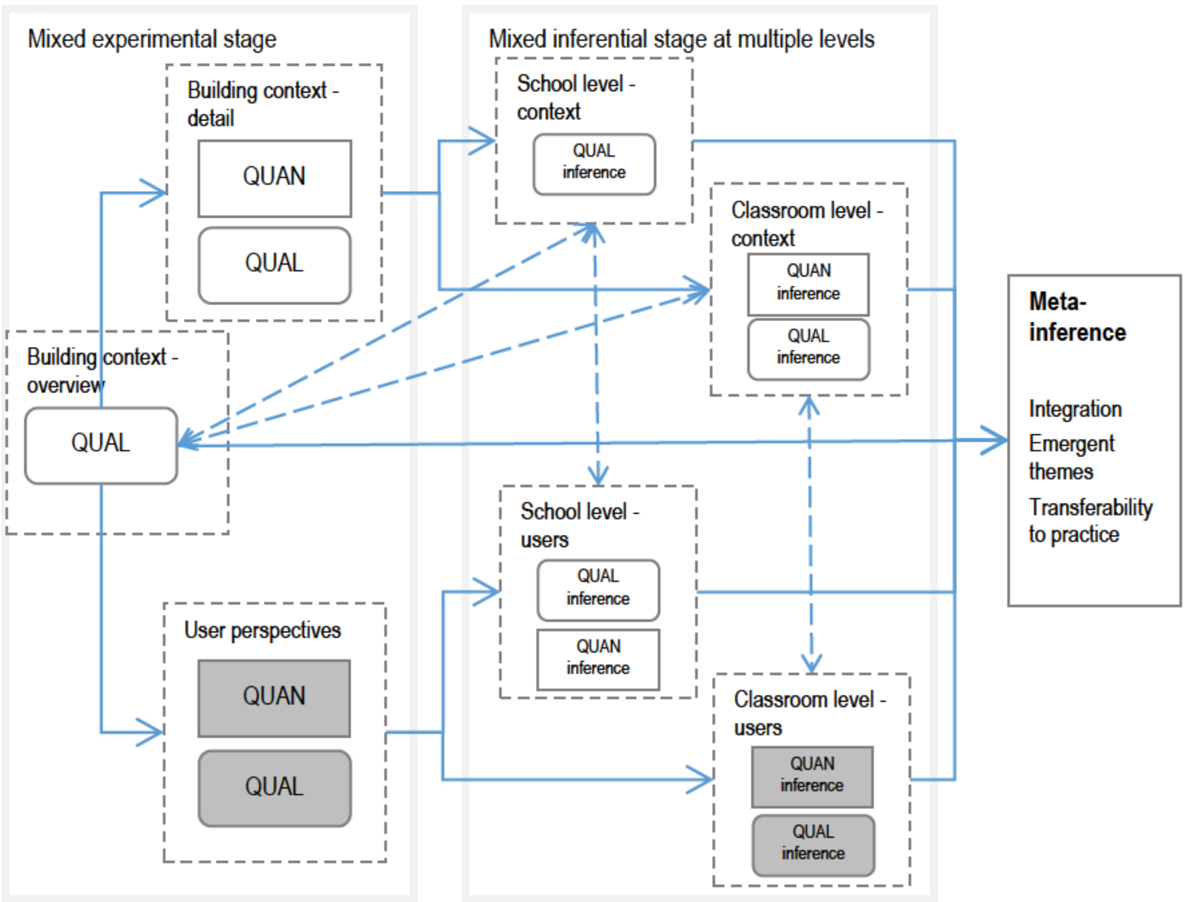


Figure 6.31: Mixed methods research map for user perspectives at classroom level

6.4.1 Teaching and learning in the classroom space

This section presents user perspectives of the classroom in terms learning and teaching activities. First, user perspectives on pedagogy and learning activities are presented. Next user perspectives of how classrooms contribute to learning and teaching, and perspectives on shape and the preferred floor plan for teaching are presented. Finally, ICT in learning and teaching is discussed.

6.4.1.1 Pedagogy and learning activities

Staff and students were asked about their pedagogy and learning activities with the intention of establishing current practices that may be driven by, or drive, spatial configurations. Staff were offered an open question to summarise their intended teaching and learning methods from which differences and commonalities were identified. To simplify this topic for students, they were asked to indicate the three most frequent locations for learning activities.

Despite changes in pedagogy, trends and intentions (Section 2.2.2.1), Figure 6.32 shows that students tended to work at their desks, working either alone or in groups (full crosstabulation in Appendix L.1.1). It is unknown whether this is teacher lead or due to restricted flexibility of available space (lack of space or furniture that is difficult to move), but it is noted that the reported incidence of floor work was low. This was consistent with the observation that floor seating areas in the older years was smaller than areas observed in younger years (Section 4.5.3.1), suggesting that student size is not reflected in available classroom space.

Computer use occurs at both classroom desk and elsewhere and is consistent with the computing configuration observed with some schools having access to laptops (Orange) and all schools relying on a combination of two to four desktops in their rooms and dedicated computing rooms (Section 4.5.3.4).

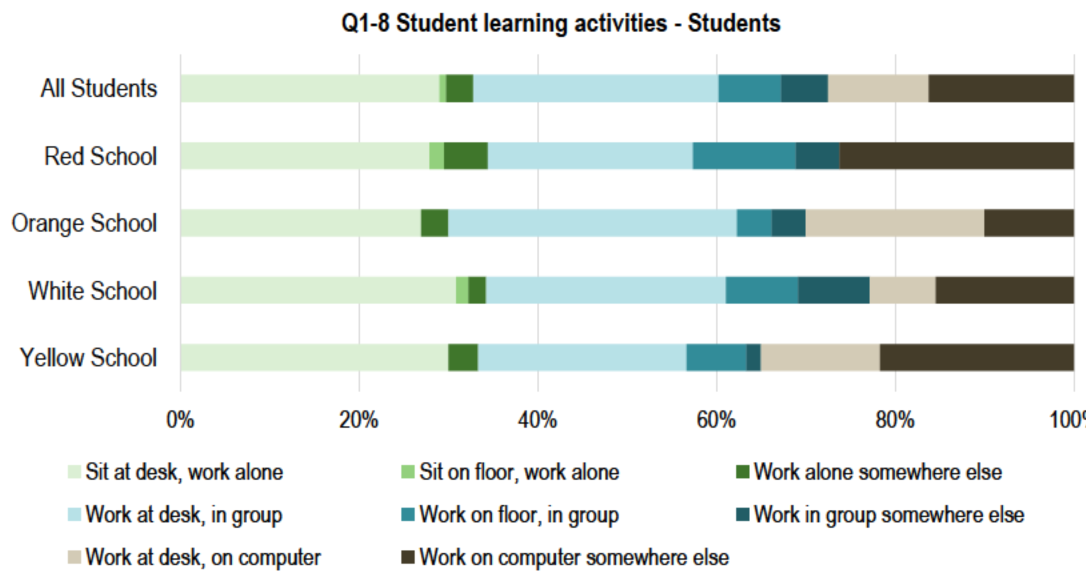


Figure 6.32: Q1-8 Student percentages by school to top three learning activities

The staff response rate about pedagogy was robust (Appendix L.1.2), with category coding frequency of responses in shown graphically in Figure 6.33. Teachers described various technical teaching instructional modes (Marsh et al. 2014, p. 183) which are indicated by the 'Teaching-...' codes. Additionally pedagogy was described variously as being 'student-centred', group and collaborative learning, early years learning, and constructivist approaches. These have been separated out as more strategic approaches, and can be found in architects' descriptions of strategic intentions for buildings (see Table 4.9), but may overlap between them and also fall under instructional modes. Additionally, staff also used this question to comment on their school building architecture and how it supports or changes their teaching approaches.

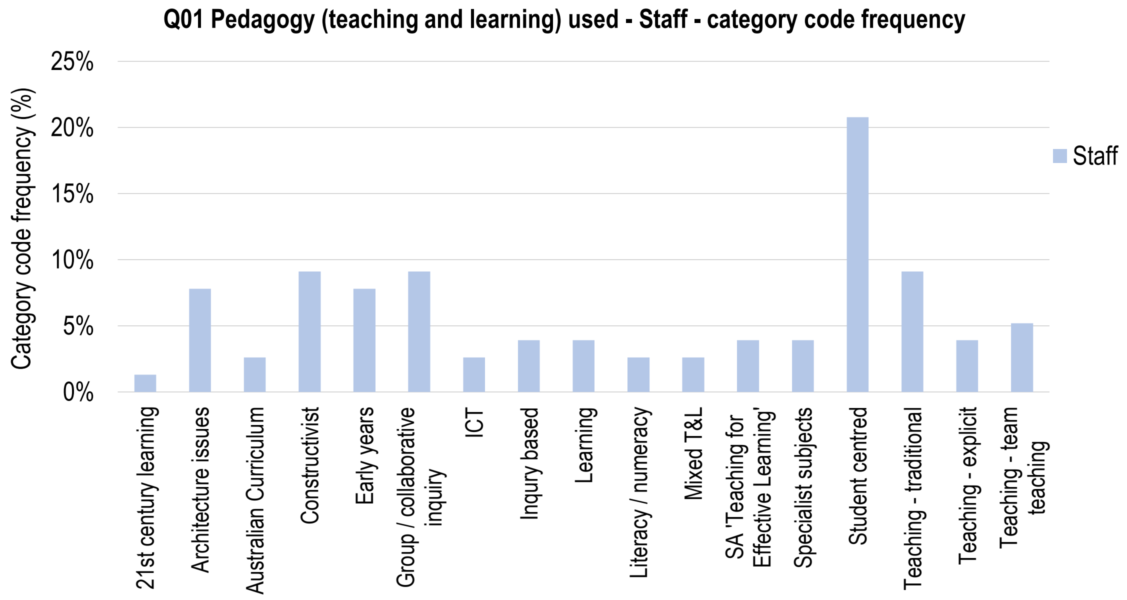


Figure 6.33: Q01 Reported pedagogy – Staff – open question category code frequencies

The largest detail code frequencies by school are presented in Table 6.29, with the complete list available in Appendix L.1.3. The detail codes are distributed across the schools, except for 'Early Years' appearing solely from White School staff responses, and 'team teaching' appears, as observed, in Orange School.

White School staff also reported 'group work' more than other schools, and that the architecture did not match the pedagogy. This is consistent with the student reported learning locations, in which White School students reported a higher proportion of learning activities as in groups, and in places other than the classrooms.

Table 6.29: Q01 reported pedagogy – Staff – detail codes ≥ 4

Category code – detail Code	Yellow	White	Orange	Red	**Total**
Constructivist	1	1	**3**	2	**7**
Group / collaborative inquiry	0	**5**	2	0	**7**
Student centred - inquiry	**3**	0	2	2	**7**
Student Centred - whole child, start from where they are	0	1	2	**4**	**7**
Early years	0	**6**	0	0	**6**
Teaching - whole class / 'traditional' / large classes	1	**4**	0	0	**5**
Architecture - does not match pedagogy	0	4	0	0	**4**
Teaching - Team teaching / composite classes	0	0	**4**	0	**4**

6.4.1.2 Classroom contribution to teaching and learning

Staff were asked earlier about how buildings and grounds contributed to teaching and learning (Section 6.3.2.1). To focus on expectations for the classroom, students and staff were also asked what parts of the classroom helped most with learning and teaching, with response rates of 84% and 73% respectively (Appendix L.13.1).

The category code summary comparing student and staff responses is shown in Figure 6.34. Both students and staff identified fixtures and furniture as helping with teaching and learning. Staff responded that the lighting, space and layout, and teaching process itself help with learning. Additionally, the floor was noted as contributing with learning, yet this was not reported as a high frequency location for learning by the student cohort in Figure 6.32. Staff also identified the IWB as important, but students responded at double the rate to staff. This suggests that what is identified as important is what is most used by different user cohorts.

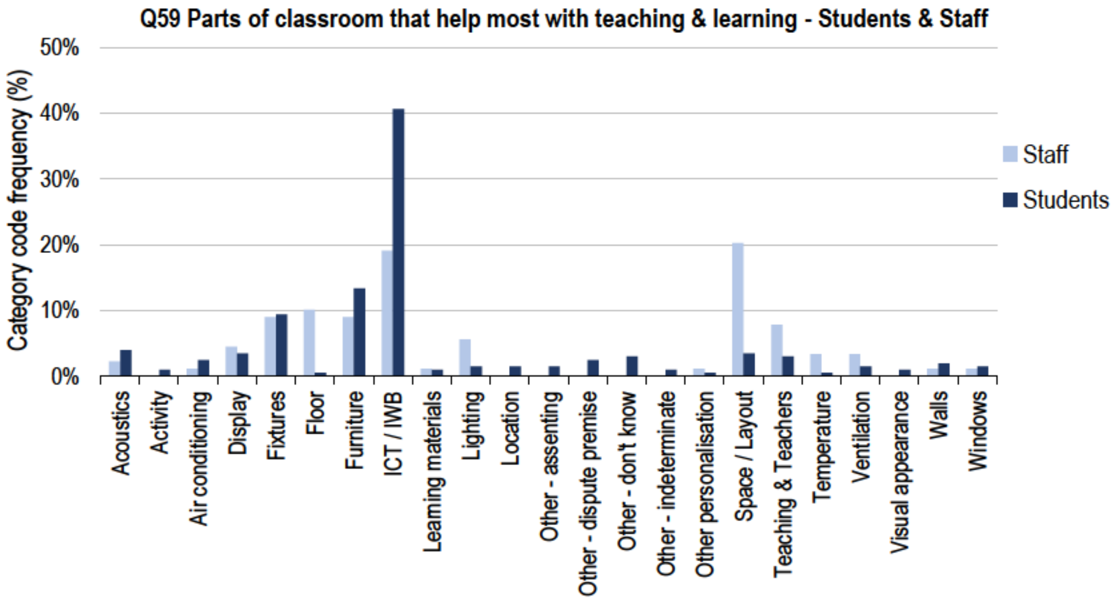


Figure 6.34: Q59 Parts of classroom that help with learning – Students and Staff – open question category code frequency

The highest detail coding frequencies by school are presented for students (Table 6.30), and staff (Table 6.31) below, with the complete lists in Appendix L.13. Students and staff listed interactive white boards as most helpful to learning, but not uniformly across schools. This is perhaps a logical expectation if interactive white boards are the main tool for teaching delivery. It should be noted that the low frequency in Yellow is possibly due to their particular installations in which white boards are used with fixed projectors and without interactivity (Section 4.4.4). Students and staff also listed display, furniture, and teaching/teachers as helping with learning.

Functional architecture, such as use of space/layout and acoustics, were considered by both students and staff to be important. Staff also noted that the floor and floor seating was very important. Visual appearance was, however, not identified as contributing to teaching and learning.

Some students said nothing in the classroom helped, while others listed their teachers as the most important part of the classroom, suggesting that perhaps 'classroom' is systemic (Section 2.2.2.1), and includes people as well as fabric.

Table 6.30: Q59 Parts of classroom help with learning – Students – detail codes ≥ 6

Category code – detail code	Yellow	White	Orange	Red	**Total**
ICT / IWB - interactive white boards	1	**28**	23	10	**62**
Furniture - desks	6	3	**8**	5	**22**
ICT / IWB - computers	1	**11**	8	0	**20**
Fixtures - whiteboard	6	**8**	2	2	**18**
Display- on walls	1	1	3	2	**7**
Other - don't know	1	**2**	**2**	1	**6**
Teachers	1	1	**4**	0	**6**

Table 6.31: Q59 Parts of classroom help with learning and teaching – Staff – detail codes ≥ 4

Category code – detail code	Yellow	White	Orange	Red	**Total**
ICT / IWB - interactive white boards	0	5	**6**	3	**14**
Floor - floor seating	0	**3**	1	**3**	**7**
Space / Layout - variety of spaces / student groups	1	0	**3**	2	**6**
Furniture - desks	0	**3**	1	1	**5**
Display	0	1	**2**	1	**4**
Space / Layout - large space	0	1	1	**2**	**4**
Space / Layout	0	**3**	1	0	**4**
Teaching & learning - pedagogy	**3**	1	0	0	**4**

During site visits incidental conversations with staff included comments about more cupboards to be installed in the classroom in the following year (paraphrased, R.a 10/12/14). Break sirens were also noted as being harsh, so, at Orange School, the siren music was selected by the staff and changed regularly (O.I 20/7/12).

6.4.1.3 **Teaching and classroom shape**

Given the interest in changing floor plan shape of classrooms (Section 2.3.3), staff were asked what shape classroom they currently teach in, and what shape they prefer to teach in (Figure 6.36, with full crosstabulation in Appendix L.29.2). Responses were prompted using the image in Figure 2.1, which presents five shapes, all with the same area. Shapes A and D, square and rectangle, were coded as rectilinear. Shape B was coded as circular. Shape C is based on an 'L-shape' classroom, while shape D, based on an amalgamation of L-shape and non-rectilinear floor plan, was offered as an extreme 'irregular' shape.

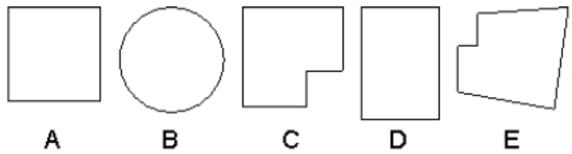


Figure 6.35: Classroom shape options in survey

The responses to current classroom floor plan shapes were consistent with the observed geometry. Few classrooms were observed to be truly square, but some classrooms in White, Orange and Red were closer to square than rectangular. The classrooms in Yellow were more rectangular than square, but with double classes in them, the footprint for a single class might be considered square. Some multi-class rooms in White could be considered as L-shaped, or irregular, when considered as a whole. Orange School also had one building that is best described as irregular, as reported by responses, and one room in Red school could have been described as either L-shaped or irregular. Thus, staff were aware of their rooms as either rectilinear or non-rectilinear, and White, Orange and Red Schools had both types of teaching spaces on-site that could be available for comparison by staff. Also, note that no staff indicated their current classroom was circular.

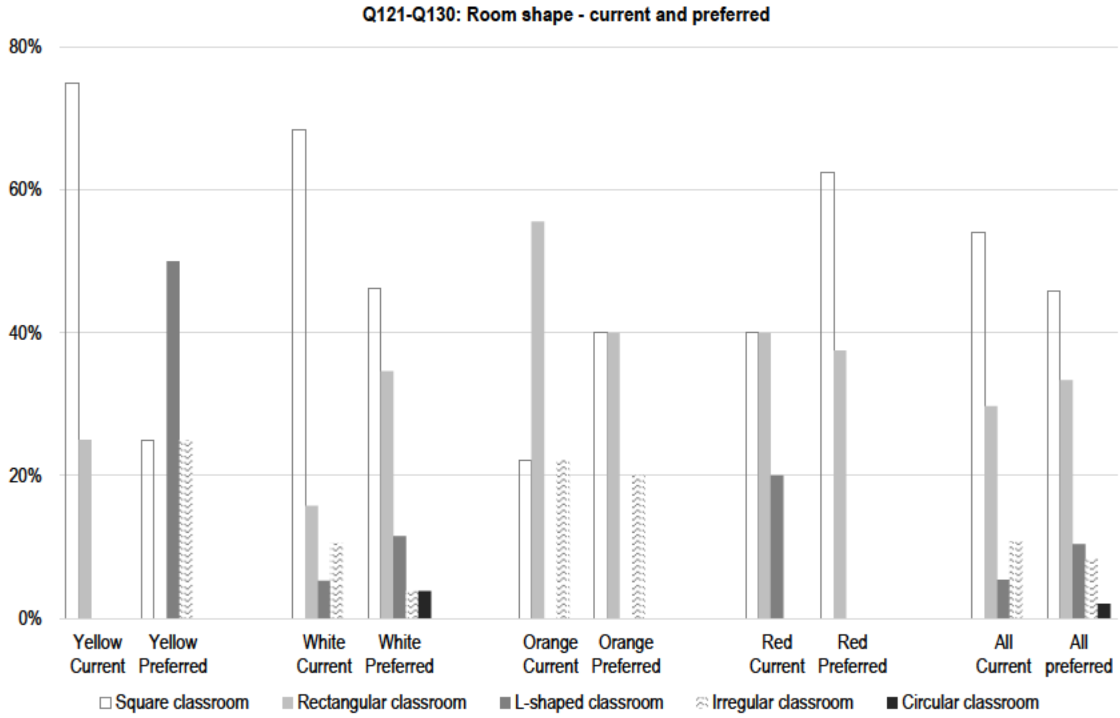


Figure 6.36: Q121-Q130 Preferred and current classrooms, percentages by school

Red, White and Orange staff indicated that they preferred to teach in square and rectangular classrooms. Yellow School staff indicated that they preferred L-shape or Irregular shaped classrooms; however, the low response rate should be noted. A sole respondent nominated a circular classroom. Thus, overall preference, within this cohort, is for a traditional rectilinear shape.

Staff were given the opportunity to say why they preferred specific shapes. They responded at a rate of 70.5% (Appendix L.30) and category coding frequencies in Figure 6.37.

Reasons for preferred classroom shape included the perspectives about change (flexibility, reconfiguration), space and its efficient use, specific areas and furniture, and the need to have good visibility of students and by students.

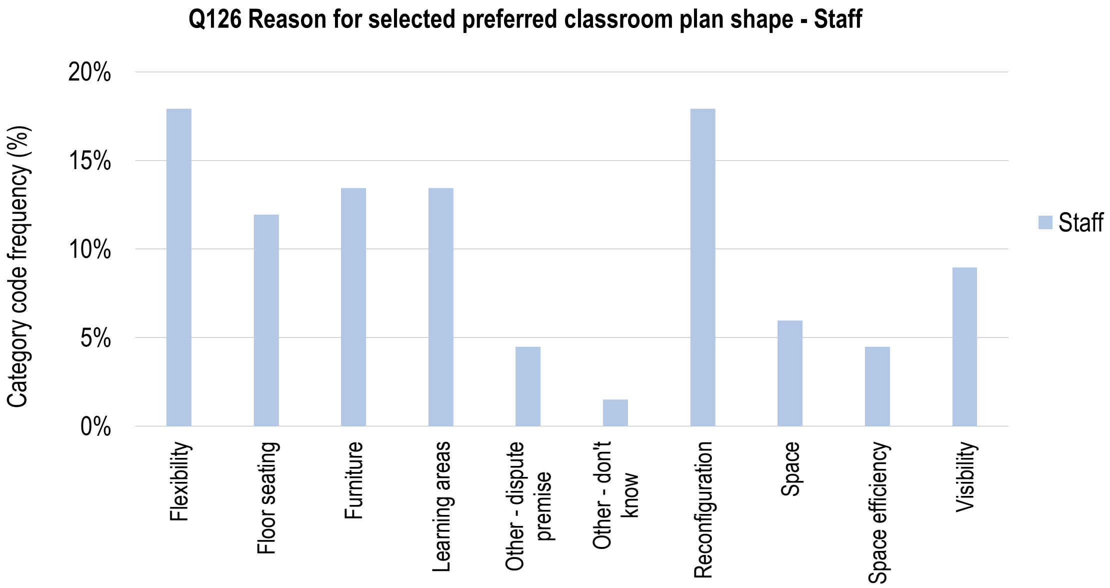


Figure 6.37: Q126 Preferred classroom shape reasons – Staff – open question category code frequencies

These perspectives were seen across all preferred shapes. Referring to the highest frequency detail coding in Table 6.32, and full list in Appendix L.30, all shapes except circular were seen as flexible. This is at odds with some design advice that advises that non-rectilinear shapes provide more options (Section 2.3.3.3). Rectangular, L-shaped, and irregular shaped classrooms were seen as providing opportunity to create different zones or learning areas. Square, irregular and rectangular were seen as providing good visibility both ways. Some staff preferred a rectangular room or irregular room because there were corners, whereas another preferred a circular room because there no corners. This range of classroom shape preference is consistent with the range of learning and teaching activities that staff responded with in Section 6.4.1.

Table 6.32: Q126 Preferred classroom shape reason – Staff – detail codes ≥ 4

Preferred shape	Category code – detail code	Yellow	White	Orange	Red	Total
Square	Reconfiguration - easy	0	3	1	3	7
Square	Flexibility - generally, best, easy	1	4	0	1	6
Rectangular	Floor seating - easier	0	2	2	1	5
Square	Furniture - space use depends on furniture size / shape	0	3	1	1	5
Rectangular	Reconfiguration - easy	0	4	0	1	5
Rectangular	Furniture - space use depends on furniture size / shape	0	2	1	1	4
Square	Visibility - supervision and IWB	0	0	3	1	4

6.4.1.4 ICT in the classroom

Information and communications technology are integral to contemporary society, and are seen by some as leading new teaching and learning innovation (Section 2.2.2.3). ICT was observed as an infrastructure service within the building fabric of all schools (Section 4.4.4).

Students and staff were asked their perspectives of ICT, with predictable results. Students indicated that computers were important in their current learning (M = 4.30, Appendix K.28) and staff indicated that ICT was important in current teaching and learning (M = 4.78, Appendix K.28). Additionally, students expected computers to be more important in the future (M = 4.54, Appendix K.29), as did staff (M = 4.95, Appendix K.29). In both cases the differences between staff and student responses was found to be significant (Appendix K.2), although it is noted that both means are strongly positive.

A one-way ANOVA was used to test perspectives of importance of computers and ICT in current learning and found that there were no statically significant difference between schools in both student responses ($F(3, 122) = 0.960$, $p = 0.414$) and staff responses ($F(3, 37) = 0.039$, $p = 0.990$, at $p < 0.05$). Similarly no difference between schools was found for responses about the future importance of ICT between schools in both student responses ($F(3, 120) = 1.495$, $p = 0.219$) and staff responses ($F(3, 36) = 0.600$, $p = 0.619$).

Referring to Figure 6.34, both students and staff had identified that information and communication technology, generally, and interactive whiteboards, specifically, helped with teaching and learning, however this was reported at a higher frequency by students (40% of codes), than staff (19%). Students also nominated the ICT/IWB in the classroom as the item within their classroom that they liked (22% of codes), whereas staff preferred other spatial and fabric aspects, and only 4% indicated that they liked the ICT / IWB (Figure 6.42). Thus, students both found technology important and liked, but staff found it only important functionally. Both of these perspectives are consistent with the means presented above.

Similarly, pedagogy, as expressed by staff in Figure 6.33, was not defined in terms of ICT / IWB, but this does not mean that the described pedagogy is not facilitated by good technology. The importance of ICT / IWB was implied during incidental conversations about the desire and problems of retrofitting buildings with wireless networks (R.b 2/8/12), how the deflection in transportable floors causes the IWB to going out alignment and need re-aligning daily (O.f 29/11/12), and how the growing size of ICT servers and the need for support stuff were conflicting with existing buildings and their space limitations (Y.f 19/7/12). Furthermore, the introduction of ICT in classrooms, rather than in specialist computer rooms has changed the daylight requirements to the point where Orange School retrofitted glazing film to reduce daylight (O.l

20/7/12), despite glare control being part of the original design intention (Table 4.9).

6.4.2 Classroom design

Whereas the previous section outlined user perspectives of the classroom as it applies to teaching and learning, this section looks at perspectives of specific aspects of classroom design. The expected importance of a well-designed classroom is discussed, followed by classroom size, views, and what is liked about classrooms.

6.4.2.1 The importance of a well-designed classroom

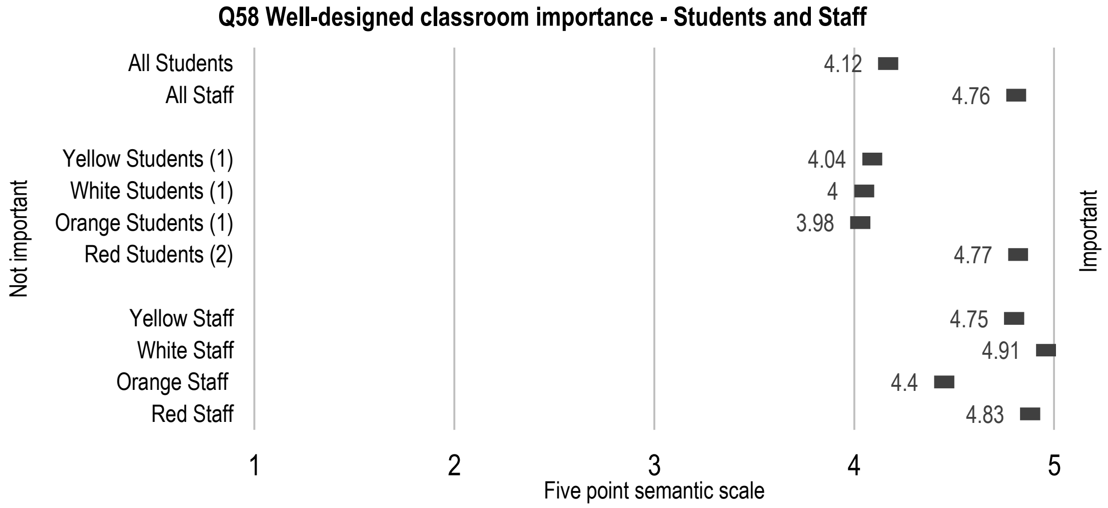
Students and staff were asked to indicate how important they perceived that a well-designed classroom was to their learning. The overall sample was positive, with students responding with a mean of 4.12, whereas staff were more emphatic with a mean of 4.76 (Figure 6.38, Appendix K.23). The difference between student and staff responses was found to be significant (Appendix K.2), but, again, it is noted that both are strongly positive.

It was found that students perspectives about the importance of a well-designed classroom differed significantly across the four schools[73] and, after adjustment for sample size, Red School students scaled this question significantly higher than other schools. The awareness of students at Red School was not expected since Red School had been recognised for its architectural heritage value rather than its architectural design. However, the classrooms have obvious contemporary retrofitted features, such as the large acoustic absorption panels, which are a significant modification to the older style school building fabric (see Photograph 4.19), and which were reported by students as helping with their learning (Table 6.30). Additionally, some Red School students would have observed the retrofitting of catenary display cables during the year (Section 4.4.6). These obvious building fabric modifications may have contributed to awareness of classroom design as important.

Differences were also found between White School and Orange School staff participants[74]; however, these were not indicated after adjustment for unequal sample sizes (Appendix K.23)

[73] One-way ANOVA $F(3, 140) = 3.633$, $p = 0.015$. Tukey post-hoc comparisons of the four groups indicate that Red School students ($M = 4.77$, 95% CI[4.54, 5.01]) significantly perceived a well-designed classroom as more important than students at White School ($M = 4.00$, 95% CI[3.74, 4.26]), $p = 0.017$, and Orange School ($M = 3.98$, 95% CI[3.63, 4.33]), $p = 0.015$. Comparison of these schools with, Yellow ($M = 4.04$, 95% CI[3.55, 4.54]), were not statistically significant at $p < 0.05$.

[74] One-way ANOVA $F(3, 38) = 2.951$, $p = 0.045$). Tukey post-hoc comparisons of the four groups indicate that White School ($M = 4.91$, 95% CI[4.78, 5.04]) significantly perceived a well-designed classroom as more important than Orange School ($M = 4.40$, 95% CI[3.90, 4.90]), $p = 0.027$. Comparison of these schools with, and between, Red School ($M = 4.83$, 95% CI[4.40, 5.26]) and Yellow School ($M = 4.75$, 95% CI[3.95, 5.55]), were not statistically significant at $p < 0.05$.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.38: Q58 Well-designed classroom importance – Students and Staff – semantic scale

There were no significant correlations greater than 0.3 with other variables in the student cohort, suggesting that there was minimal association of the perception of good classroom design with any other scale variable investigated. Despite this lack of correlation, stepwise multiple linear regression on all variables found small signification regression models. The best model showed that the perspective that it is important that classrooms be well designed is predicted by the perspective of pride, the school as a whole should look attractive, and the perceptive that their school is not sustainable (Table 6.33).

Stepwise regression on all variables in the staff cohort provided, again, model with low influence, but was solely predicted by time working in the education sector, i.e., the more education experience staff have, the more the belief that a well-designed classroom is important.

Table 6.33: Q58 Well-designed classroom important – Students and Staff – multiple linear regression on all variables

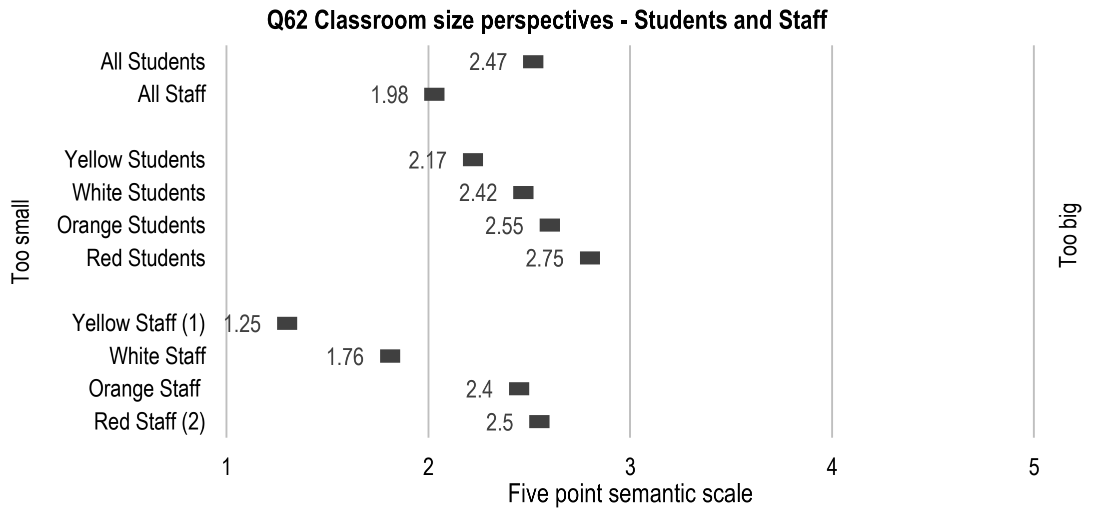
Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Well-designed classroom important	0.16	$F(3, 92) = 5.80$ $p = 0.001$	Proud of school buildings (Q20)	0.31	0.003
			Important school looks attractive (Q28)	0.26	0.010
			School is sustainable (Q10)	-0.23	0.027
Staff participants					
Well-designed classroom important	0.25	$F(1, 27) = 8.79$ $p = 0.006$	Job Experience (Q95)	0.50	0.006

6.4.2.2 **Classroom size**

Students and staff were asked about their floor area space and its functionality. Both students and staff scaled their classrooms as being small ($M = 2.47$ and $M = 1.98$, respectively; Figure 6.39, Appendix K.24). Testing between means could not support the null hypothesis, suggesting that significant differences existed between the cohorts (Appendix K.2).

Referring to Table 4.17, floor area per student (wall to wall area including space occupied by furniture and fixtures) varied from 1.9 to 2.4 m^2, i.e., a difference from smallest to largest of $0.5m^2$, or a class space of approximately 700mm by 700mm per student. Despite this difference in area per student, students responses did not differ across schools (one-way ANOVA, $F(3, 138) = 1.791$, $p = 0.152$).

Staff perspectives of room size did differ significantly across the four schools ($F(3, 37) = 3.286$, $p = 0.031$). Tukey post-hoc multiple comparisons by school were not significant at $p < 0.05$; however, significant post hoc homogenous subsets were indicated when adjusted for unequal sample size, with Yellow School perceived as smaller than Red School. Staff participation included staff not attached to the case study classrooms, so not all area per student data was collected. However, in Section 4.5.1, it is noted that observed Yellow School rooms were found to be of the same order in size as Red School.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.39: Q62 Classroom size perspectives – Students and Staff – semantic scale

Concerns about classroom size were supported by responses to other questions (Q149, Appendix L.34), and incidental conversations with staff during site visits where concerns about classroom size were further explained. Paraphrasing these latter sources, it was felt that larger children need more space generally, and that there is a safety issue with students pulling out their chairs onto teachers' toes (O.c 25/10/12). In addition to the main teacher of a class, learning support officers are used for one-on-one individual support. Their need for a quiet, distraction-free, space is often overlooked and they find that they use corridors for individual support, which are distracting due to noise and passing foot traffic (Y.d 31/7/12).

The classroom size variable was set as a dependent variable in a stepwise multiple linear regression on all other scale variables for both staff and student response groups (Table 6.34). The best model from the student responses suggested the perspective that a classroom was too small was predicted by perspectives that furniture is not easy to move, the school building do not feel safe and computers are important. The involvement of perspectives about ability to move furniture was as anticipated, and the association with safety was not unexpected since small spaces may increase possibility for bump injury described by staff above. Similarly, computers take up floor space within classrooms, either through PC stations or laptop charging racks, thus, making this a logically congruent finding.

Stepwise multiple linear regression on the staff response group found that inability for students to understand staff is a predictor for the classroom being too small. This is suggestive of issues with overcrowding of classroom space.

Table 6.34: Q62 Classroom too big – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F*, *p*	Coefficients	Beta	*p*
Student participants					
Classroom too big	0.29	$F(3, 92) = 12.77$	Furniture moves easily (Q63)	0.37	< 0.0005
		$p < 0.0005$	Buildings are safe (Q17)	0.33	< 0.0005
			ICT important now (Q66)	-0.30	0.001
Staff participants					
Classroom too big	0.30	$F(1, 27) = 11.77$	Students understand speech (Q31a)	0.55	0.002
		$p = 0.002$			

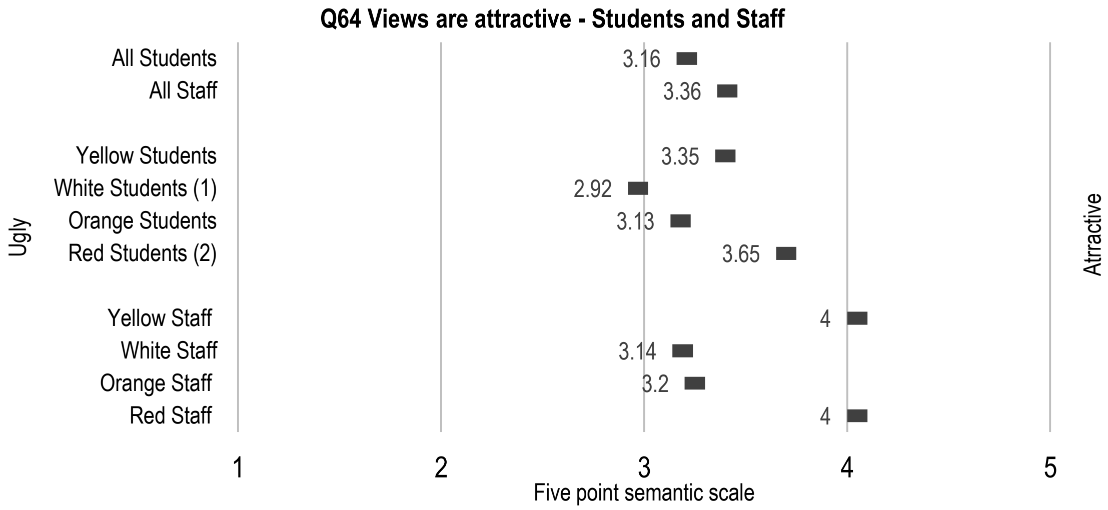
6.4.2.3 **Classroom views**

Design advice recommends good views as important to learning (Section 2.3.5.3). Students and staff were asked to rate views out of their classroom as being ugly or attractive, and distracting or calming. Response difference between cohorts to both questions were found not to be significant (Appendix K.2). Students perceived their view out as neither attractive nor ugly (Q64, $M = 3.16$), as did staff ($M = 3.36$) (Figure 6.40, Appendix K.26). Students found views more calm than distracting (Q65, $M = 3.42$), but staff were neutral ($M = 2.98$) (Figure 6.41, Appendix K.27). This less than definitive judgment about views is possibly due to views being reduced by architecture, such as high sill heights in Yellow School and Red School (e.g., Photograph 4.9) and occupant use of windows for display (e.g., Photograph 4.29).

Student perspectives of views as attractive differed by school[75]. On the available evidence, it is difficult to identify possible reasons for these differences in student perspectives of view

[75] One-way ANOVA $F(3, 136) = 2.922$, $p = 0.036$. Tukey post-hoc comparisons of the four groups indicate that Red School ($M = 3.65$, 95% CI[3.24, 4.06]) judged significantly that their views were more attractive than White School ($M = 2.92$, 95% CI[2.62, 3.22]), $p = 0.030$. Comparison of these schools with, and between, Orange School ($M = 3.13$, 95% CI[2.83, 3.43]) and Yellow School ($M = 3.35$, 95% CI[2.97, 3.73]), were not statistically significant at $p < 0.05$.

attractiveness. The sill heights are comparable in Red and White Schools and both schools had views of trees. Red School windows had minimal display obstruction, but views were obstructed with blinds, whereas White School windows were used for student display. Both schools had blinds, dark opaque at White School on the windows towards the trees, and white translucent blinds on Red School windows.



(1), (2) = different groups with significance difference by schools within student and staff cohorts, adjusted for sample size.

Figure 6.40: Q64 Views are attractive – Students and Staff – semantic scale

No differences were found between groups for staff perspectives of view attractiveness (Q64, $F(3, 38) = 1.718$, $p = 0.180$). Similarly, perspectives of views as calming or distracting were found not to differ significantly across schools for both student perspectives (Q65, $F(3, 134) = 0.29$, $p = 0.993$), and staff perspectives (Q65, $F(3, 36) = 1.569$, $p = 0.214$).

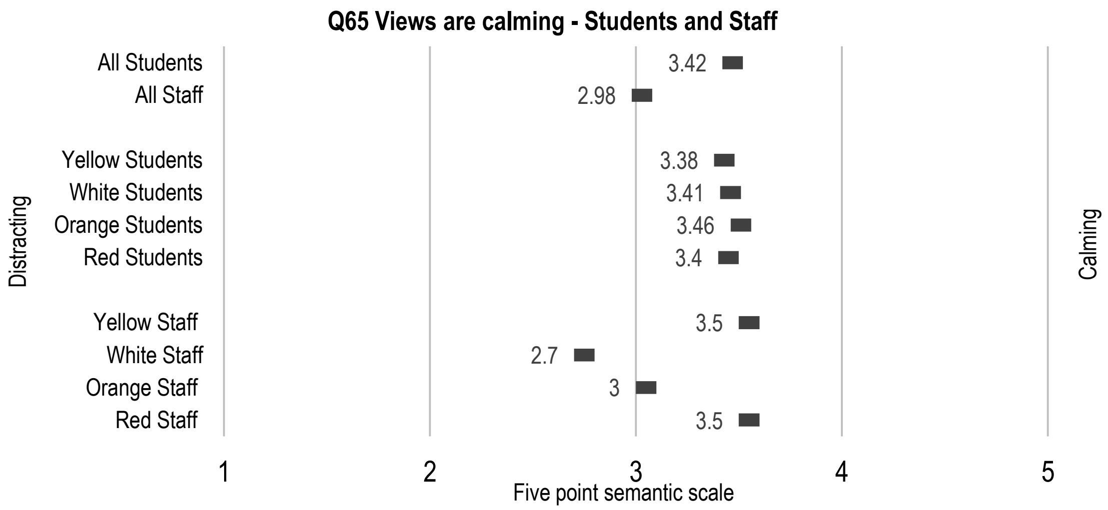


Figure 6.41: Q65 Views are calming – Students and Staff – semantic scale

Stepwise multiple linear regression was undertaken to find predictive models for both view variables and both student and staff response groups. Models with significant coefficients are summarised in Table 6.35. Both students and staff perspectives of views as attractive were predicted by perspectives of views as calming.

For students, a visual perception of an attractive view is predicted by the visual perception of good maintenance, the olfactory perception of fresh air, the judgement that views are calming, and being a female student. Note that gender is only just within the 95% significance confidence interval so should be judged as a predictor with care.

Similarly, both student and staff perspectives of views as calming were predicted by views as attractive. However, students perspectives were also predicted by low glare, higher school year and sense of pride, so, a calming view is predicted by the visual perception that the view is attractive, the visual quality perception that glare is not problematic, a positive attitude towards school buildings, and being older.

For staff perspectives of an attractive view were also predicted by winter temperatures judged as cold, which could be related to glazing area available. Staff perspectives of view as calming were also predicted by buildings considered interesting, suggesting a visual judgement of views as calming.

In all regressions of view variables, there are notable omissions about teaching and learning, suggesting that, for this cohort, views out of classrooms are not associated directly with classroom activities and productivity, as might be expected. This does not preclude indirect influences through other mechanisms of wellbeing associated with pleasant views.

Table 6.35: Q64 Views are attractive and Q65 Views are calming – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	***F, p***	**Coefficients**	**Beta**	***p***
Student participants					
Views are attractive (Q64)	0.42	F(4, 91) = 16.63 p < 0.0005	Views are calming (Q65) Buildings well maintained (Q16) Summer air stale (Q39) Gender (Q93)	0.40 0.25 0.20 -0.16	< 0.0005 0.004 0.017 0.046
Views are calming (Q65)	0.44	F(4, 91) = 17.85 p < 0.0005	Views are attractive (Q64) Glare occurs (Q55) Years in current room (Q90) Proud of school buildings (Q20)	0.42 -0.25 0.21 0.21	< 0.0005 0.003 0.008 0.018
Staff participants					
Views are attractive (Q64)	0.37	F(2, 26) = 7.460 p = 0.003	Views are calming (Q65) Winter temp is hot (Q41)	0.54 -0.35	0.002 0.045
Views are calming (Q65)	0.44	F(2, 26) = 10.30 p = 0.001	School buildings are interesting (Q15) Views are attractive (Q64)	0.44 0.42	0.007 0.009

6.4.2.4 What occupants like

In addition to what helps with learning and teaching (Figure 6.34), staff and students also asked in an open question what they liked about the interior of their classroom. Response rates were 75% and 77% for students and staff, respectively (Appendix L.15.1).

Student and staff category code frequencies are presented graphically in Figure 6.42. Both students and staff liked the display, and visual appearance. Staff liked the fixtures, space/layout and windows, whereas students liked the furniture and furniture. In both cohorts, some disputed the premise that there was anything to like, with student responses relatively higher.

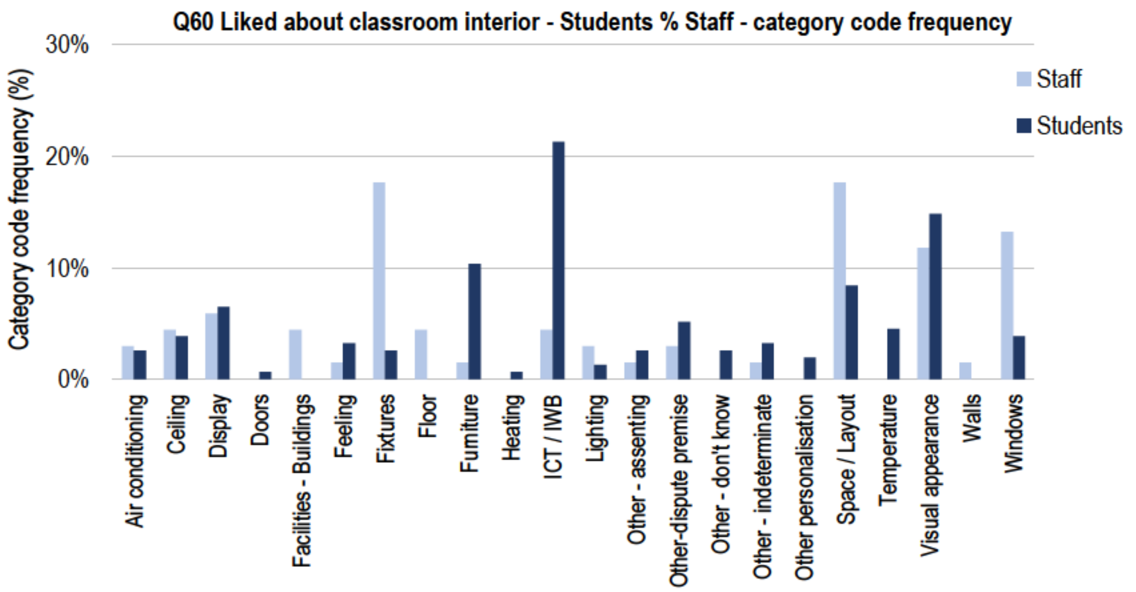


Figure 6.42: Q60 Liked about interior of classroom – Students and Staff – open question category code frequency

Detail coding showed that students liked a variety of classroom elements, with the highest frequency codes given in Table 6.36, followed by highest staff detail codes in Table 6.37, with all detail coding available in Appendix L.15. The strongest responses about what students liked in their classrooms came from White school students, with their appreciation of IWBs. Both White students and staff liked the interior wall colours, though the latter could include the personalisation and decoration of the class itself, as observed in Section 4.5.3.3. Contrary to this, the third highest detail score where students liked nothing had a higher proportion of White school students. This might suggest that the interior treatment of White classrooms provoked a dichotomous reaction.

Students, particularly Orange School, also liked their desks and chairs and the space or layout of their classrooms, i.e., used and modifiable aspects. Students also reported feelings about the classrooms, which may be a reflection of the built environment or the friendliness of the classroom social environment.

Staff, particularly Orange Staff, liked wet areas, and this is consistent with the observed installations by school (Table 4.17). Windows and daylight were also liked by staff, particularly Red School staff, which is consistent with the large windows observed in all rooms.

Table 6.36: Q60 Liked about interior of classroom – Students – detail codes ≥ 5

Category code – detail code	Yellow	White	Orange	Red	Total
ICT / IWB - IWB and WB/projector	1	15	9	4	29
Visual appearance - colour, non-white, decorated	0	12	0	2	14
Other - dispute premise - nothing	0	5	3	0	8
Furniture - desks, their arrangement	4	0	3	0	7
Furniture - swivel chairs	0	7	0	0	7
Visual appearance - design; positive about style or look	1	2	2	2	7
Space / Layout - good size	1	0	4	1	6
Display - student work, colourful	2	0	2	1	5
Feeling - friendly, welcoming, calm, good environment	0	3	0	2	5
Other - indeterminate	2	1	1	1	5

Table 6.37: Q60 Liked about interior of classroom – Staff – detail code ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Visual appearance - colour, non-white, decorated	0	4	1	2	7
Windows - daylight	1	0	2	3	6
Fixtures - wet area	1	1	3	0	5
Fixtures - pin boards	0	2	1	0	3
Fixtures - storage	0	0	3	0	3
Floor - carpeted	0	2	1	0	3
Space / Layout - good size	0	0	2	1	3
Space / Layout - floor seating area	0	1	2	0	3
Space / Layout - double classroom; open space	1	1	1	0	3

6.4.3 Classrooms as dynamic space

As discussed in Section 2.3.4.3, and deduced from architect intentions with their reference to flexibility and group work (Table 4.9), it was expected that the classroom space would be dynamic. This section presents user responses to questions about the anticipated flexible use of space, and relates them back to the space changes observed throughout the year. Questions were asked about how users changed the room to help with teaching and learning, use of elements that control large-scale space changes such as operable walls, and use of elements for pedagogical display.

6.4.3.1 Matching space with teaching and learning

Staff and students were asked, in an open question, how they change their classroom to help with teaching and learning. Staff responded at a far higher rate that students (71%, Appendix L.16.1). Due to the moderate student rate (38%), their responses have been coded so that category and detail coding are combined, however staff coding used the summary and detail coding procedure.

Figure 6.43 presents the final staff and student summary coding graphically. Some students did not respond to the question asked and, instead, made suggestions about what should change.

Since a question about future or imaginary changes was asked later in the survey, responses about what should change in this question were coded as 'other - indeterminate.' Some students responded that they changed groups, desks and computers, but some were unsure. Staff responded that furniture, generally, and desks, specifically, together with students, were moved around. Some students noted that change did not happen and staff noted that they were restricted in options. Thus, change the classroom, where possible, seemed to be focussed on moving people or desks.

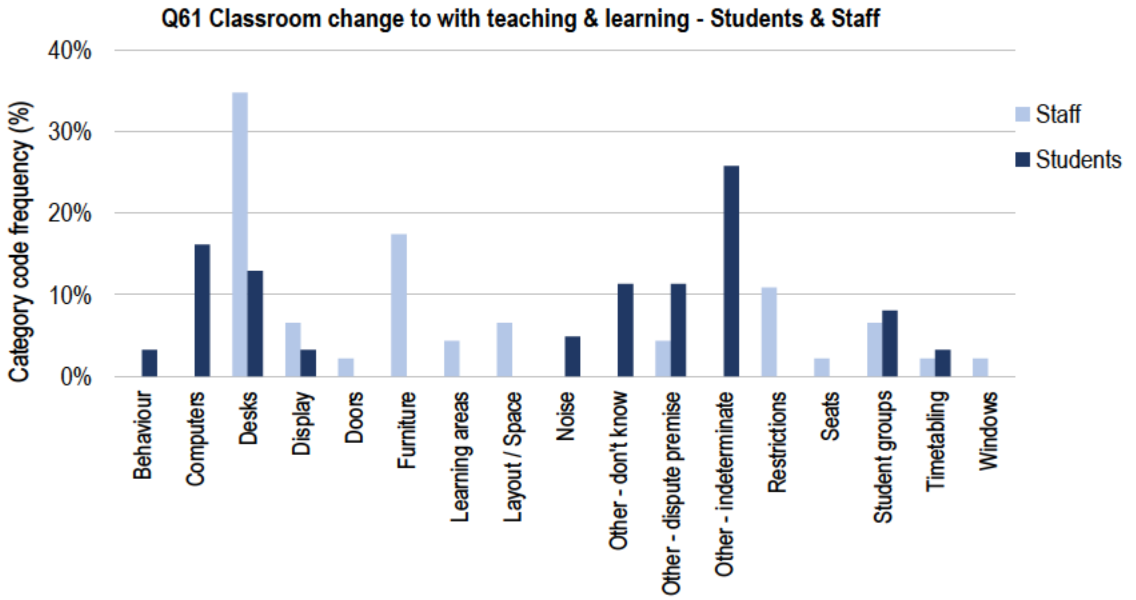


Figure 6.43: Q61 Change classroom to help with learning – Students and Staff – open question Category/Detail code frequency

The highest detail code frequencies by school are presented students in Table 6.38, and staff in Table 6.39, with complete tables in Appendix L.16. Students in White and Orange Schools did not answer the question posed. Both of these schools were observed to have fixed classroom layouts, or only minor changes during the inquiry year, so it is possible that students did not understand the question in the context of stationary room layouts. After computers, which were available on trolleys, students nominated how they rearranged desks, but only for national NAPLAN testing (Section 2.2.1.3), which is, again, consistent with the context of stationary room layouts observed. Students did respond that they moved around the desks to different seats, and changed student groups, which was confirmed by staff. Students also noted changes such as behaviour and noise.

Staff reported changes to configuration of space, such as grouping of desks, creation of floor spaces, group work spaces. Some also noted that they used furniture to change the atmosphere (soft furnishings).

Unexpectedly, changing display of pedagogical materials and student work was not mentioned by staff, and students recalled display change with very low frequency. Given the predominance of the pedagogical display observed this seemed to be not considered as variable, or the notion of 'classroom' is restricted to the floor plan.

Table 6.38: Q61 Change classroom to help with learning – Students – detail codes ≥ 5

Category code – detail code	Yellow	White	Orange	Red	Total
Other - indeterminate - don't answer question	1	9	6	0	**16**
Computers	2	6	2	0	**10**
Desks - rearrange; only for NAPLAN	1	1	4	2	**8**
Other - don't know	2	3	2	0	**7**
Other - dispute premise - no changes	0	2	4	1	**7**
Seats - move around	2	1	2	0	**5**

Table 6.39: Q61 Change classroom to help with learning – Staff – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Desks - rearranged regularly	1	2	2	3	**8**
Furniture - rearranged	1	4	2	0	**7**
Desks - rearranged to create floor space	0	4	0	1	**5**
Restrictions - due to lack of space	1	2	0	2	**5**
Display	0	1	2	0	**3**
Student groups - group work spaces	0	1	2	0	**3**

6.4.3.2 **Moving furniture**

Students and staff were asked specifically whether they could move their furniture as required. Students responded neutrally (*M* = 3.04), and staff responding just above neutral (*M* = 3.28) (Figure 6.44, Appendix K.25). The differences between the cohorts were found not to be significant (Appendix K.2). No significant differences across schools were found when one way ANOVAs were performed on perspectives about ability to move furniture in both the student responses ($F(3, 130) = 0.139$, $p = 0.937$), and staff responses ($F(3, 36) = 0.791$, $p = 0.501$).

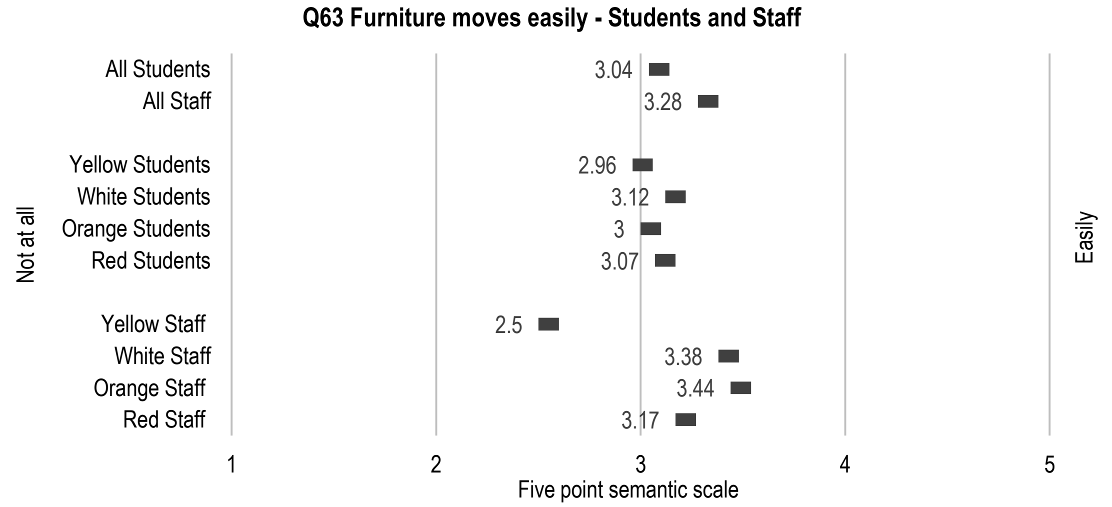


Figure 6.44: Q63 Furniture moves easily – Students and Staff – semantic scale

When planning this question it was assumed that furniture was moved as part of contemporary pedagogy so it would provide a complementary active measure for the perception of classrooms being too big or small, particularly for reporting by student participants. It was observed that furniture was rearranged throughout the year (Section 4.5.3.1); however, the amount of rearrangement varied from class to class, and the observed rearrangements to be low in the classes with students participating in the survey. Where classrooms were not reconfigured during the year, this may be part of an intended pedagogy or it may be because it was just too difficult to move classrooms around. Either way, self-reporting of furniture moving as neutral and no difference between classes is consistent with observed student experience of reasonably stable room arrangements.

In contrast to this, one teacher noted during an incidental conversation that since it was her first year in the room she likes to move furniture around to 'try things out' and 'freshen things up' (O.f 25/10/12). This suggests that teaching staff take time to learn about the space possibilities within their rooms, and use the space flexibility to maintain interest. Flexibility of teaching groups was thought to be better facilitated by using mobile desk/chair units, but the cost of this specialist furniture was acknowledged (R.b 2/8/12, O.c 12/12/12).

6.4.3.3 **Internal doors and operable walls**

One method of providing space flexibility is to design building fabric with internal doors that can open and join spaces, such the sliding doors and operable walls observed in Section 4.5.3.1. White, Orange and Red staff responded that they had access to both operable walls and large sliding doors to change space configuration, but only 50% used them daily. Rather, they tended to be either always open, or always shut or opened occasionally (Figure 6.45, with full crosstabulations in Appendices L.33.1 and L.33.2).

Four staff participants added comments about their internal doors. White School staff clarified their local situation. One added that they used a smaller door. Another noted that there was no door in their operable wall, which is consistent with the moveable panels in the open space teaching areas in the east campus, e.g., White.1. The final White School participant said that the operable walls were unsafe so were not moved. An Orange School participant clarified that his or her operable wall had a swing door in it.

During a site visit, in an incidental conversation, one staff member noted that '...sliding doors are easier to use than operable walls...' (paraphrased, O.6 29/11/12), which is consistent with observed lack of movement of operable walls during the inquiry.

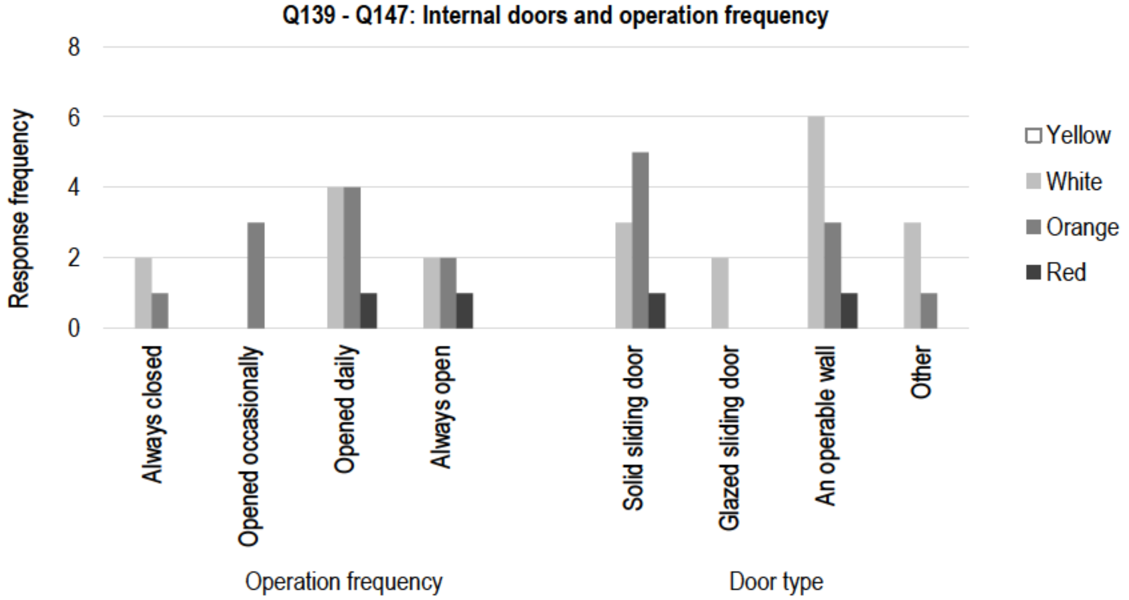


Figure 6.45: Q139-Q147: Internal door types and operation frequency by school

6.4.3.4 Dynamic display

Early observations noted that display of pedagogical materials and student work extended beyond pinboards (Section 4.5.3.3). As a sequential mixed method research design response, staff were asked to confirm, via a multiple-choice question, what classroom elements they use for display. All schools confirmed that in addition to pinboards, doors, walls, windows and overhead display was used (Figure 6.46, with full crosstabulation in Appendix L.31). Additionally, six staff participants reported using other locations for display (Q137). Three wrote that they use 'wires', 'ropes' and 'lines' across the room. This was intended to be classified under 'ceiling / overhead', but these responses suggest that the hanging mechanisms were important to users. Two wrote that they used hallways, i.e., the space outside of the classroom was claimed for display, and one wrote that they used cupboards and trolleys. All of these suggest that the pinboard space alone is not sufficient for user needs. Furthermore, staff take the initiative to use all classroom elements available for personalisation regardless of the intended primary purpose of the element. This is consistent with observations such as use of luminaires identified previously (Photograph 4.28).

Within architectural science, the intended purpose of window glazing is to allow natural light and controlled solar radiation into a room, and allow views out of a room (Szokolay 2008). Since it was observed that windows were used for display, and that this may affect their primary intended purpose, staff were asked to say why windows were useful for display. Responses were collected from all schools except Yellow school (Appendix L.32.1), which was consistent with the minor amount of window display observed in this school.

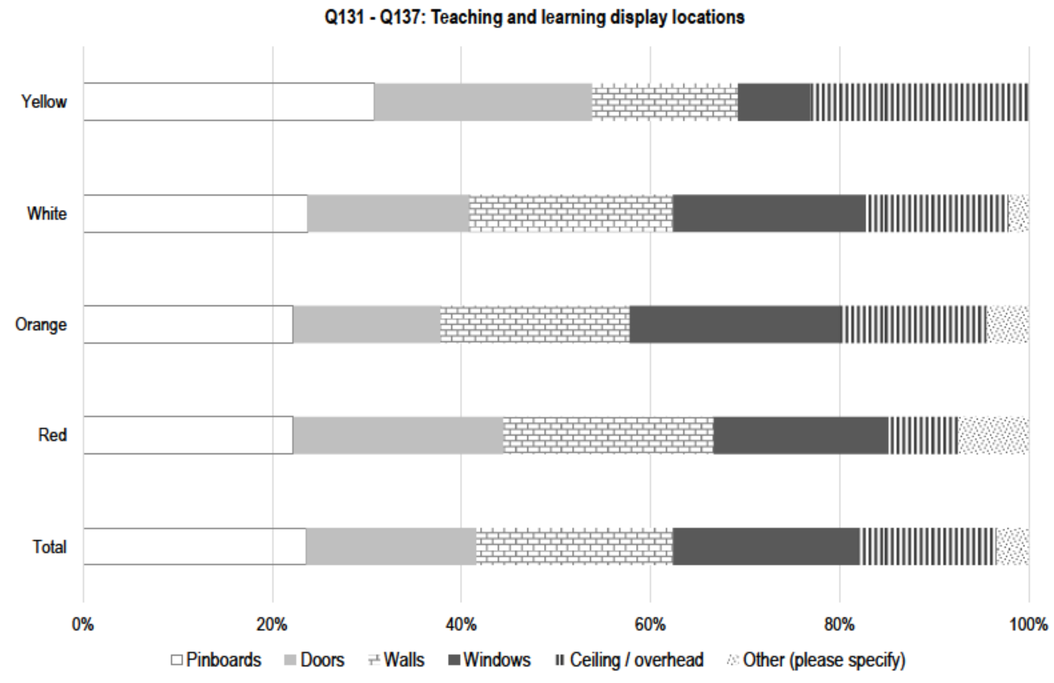


Figure 6.46: Q131 - Q137: Proportional teaching and display locations by school

Category coding of staff responses are shown graphically in Figure 6.47. There were four main reasons for use: communication to people beyond the classroom; the need for more display space; the nature of the display itself; and obstruction. This is consistent with the observed typology proposed in Table 4.21.

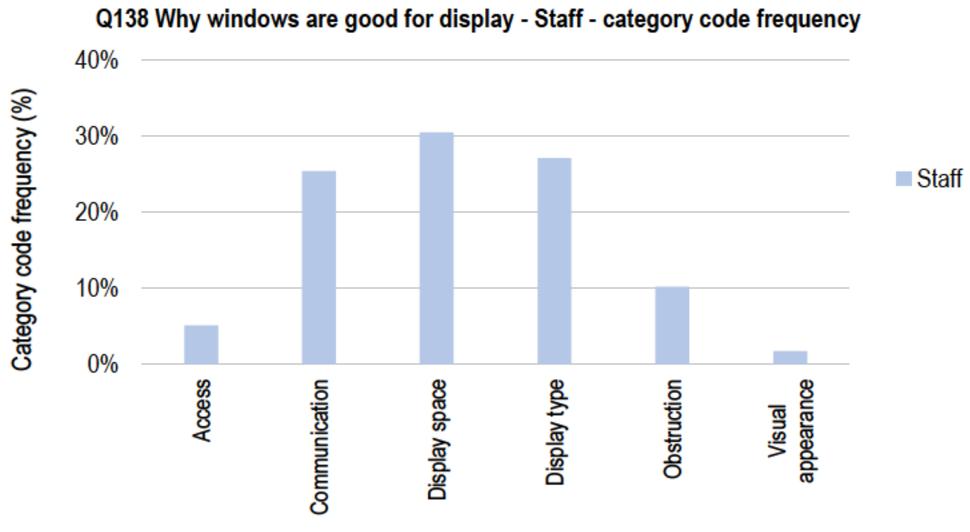


Figure 6.47: Q138 Reasons windows used for display – Staff – open question category code frequency

The detail coding of responses show that staff from the three responsive schools all used windows due to lack of space (Table 6.40, full list in Appendix L.32.2). Use of windows for student work that uses transparent or translucent materials was recalled specifically by Orange and Red School, but was also observed in White.2 during site visits.

Obstruction was described by White and Red School staff for three reasons – solar control, reduce distractions or a bad view, and privacy. This is consistent with the site plan of these schools since, both of these schools have east and west oriented glazing, and both are adjacent to passing public foot traffic. Though not mentioned in the survey responses, the there was also concern about passing foot traffic since, paraphrasing an incidental conversation with a White staff member, the campus has public access on the weekend so there should be no sensitive display on the windows (W.g 30/7/12).

During site visits, staff also discussed internal windows. Again, paraphrasing an incidental conversation during a site visit one staff member obstructed an internal window obstructed for two reasons – display and to obstruct view and stop 'fish bowel' feeling (O.g 25/10/12). This is consistent with observed window treatment in Photograph 4.32.

Table 6.40: Q138 Reason windows used for display – Staff – detail code ≥ 3

Category code – detail Code	Yellow	White	Orange	Red	**Total**
Display space - lacking, need more	0	**8**	5	4	**17**
Communication - to people outside of class	0	4	**5**	0	**9**
Communication - to people inside of class	0	2	**4**	0	**6**
Display type - transparent / translucent	0	0	**4**	2	**6**
Display type - student work	0	1	**4**	0	**5**
Display type - art work	0	1	**2**	0	**3**
Obstruction - solar control	0	**2**	0	1	**3**

6.4.4 Classroom thermal, light and aural environment

This section summarises the participants' perspectives about their indoor environment, where environment is used here to refer to selected physical aspects of the classroom rather than the educational environment, such as 'classroom climate' (Moos 1980). Temperature and ventilation are first discussed, followed by perspectives of light, and then sound. Finally, the section presents perspectives about the control of environment.

6.4.4.1 Perceived temperature and ventilation

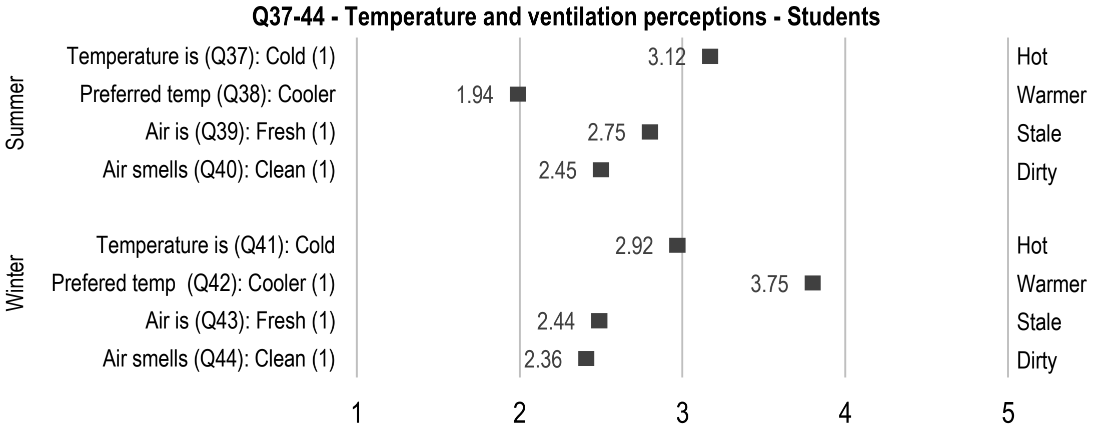
Staff and students were asked to respond to five point scale questions about their perceptions and preferences of summer and winter temperature, and their perceptions of air freshness and smell. Since the questions asked for memory of temperatures they cannot be compared directly to the immediate perception of comfort studies (see Section 2.4.1.5). Scale means are shown for students and staff in Figure 6.48 and Figure 6.49, respectively (full frequency tables in Appendix K.21.1), with significant differences between cohorts indicated (Appendix K.2).

Students recalled summer and winter classroom temperatures as nearly neutral. In winter, staff responded with similar temperature perceptions, but summer temperatures were perceived as significantly hotter than that recalled by students. The staff perceptions of indoor summer temperatures as hotter might be influenced by their active role in classrooms or different expectations of comfort.

Staff perceived that the temperature was tending towards being too hot for students in summer and a little cold for students in winter, which is consistent with the direction of preferences indicated by students, but possibly not as extreme as indicated by student scale preferences.

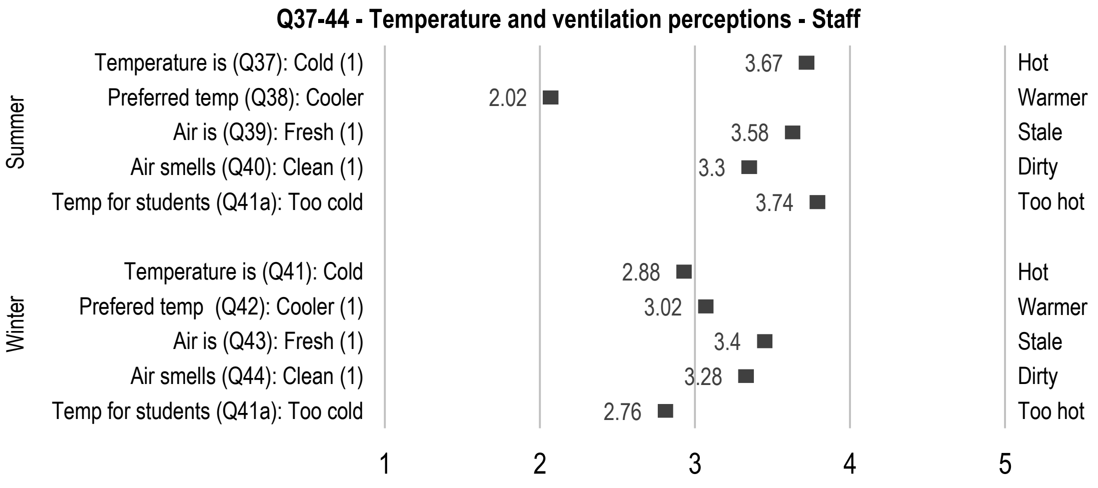
Both staff and students preferred it cooler in summer. In winter, staff reported neutral preferences, which was in contrast to students, who preferred it warmer.

Perceptions of air freshness were significantly different between staff and students. In both summer and winter, students were more positive than staff about the freshness and smell of the air. The differences in air freshness and smell suggests that students are less judgemental about air quality than their teachers are.



(1) significant difference between staff and student cohort

Figure 6.48: Students' classroom temperature perceptions: descriptive statistics of responses



(1) significant difference between staff and student cohort

Figure 6.49: Staff temperature perceptions: descriptive statistics of responses

One-way ANOVAs were undertaken on all temperature and air quality variables by school, with significant differences found between schools in the student responses (Table 6.41). Students at White School perceived that, during summer, their classrooms were significantly warmer than perceptions of students at Yellow and Orange School (Q37), and that their air was significantly staler than students at Red and Yellow School (Q39). This is consistent with the observed control problems with the automatic HVAC system, and the local attempts to mitigate lack of ventilation by propping the door open during class (Table 4.6). No significant differences between schools were found for staff responses (Appendix K.21.3).

Table 6.41: Temperature and air quality scale questions – Students – One-way ANOVA tests

Variable (all 5-points)	Levene test homogeneity of variances	One Way ANOVA	Homogeneous subsets (using Tukey HSD for unequal group sizes)				
			Group 1 (mean, *N*)		Group 2 (mean, *N*)		Harmonic Mean Sample Size
Summer temp is hot (Q37)	$p = 0.592$	$F(3, 143) = 7.33$ $p < 0.0005$	Yellow Orange Red	(2.65, 23) (2.70, 47) (3.16, 25)	Red White	(3.16, 25) (3.67, 52)	32.26
Prefer summer temp warmer (Q38)	$p = 0.578$	$F(3, 142) = 1.26$ $p = 0.290$	White Orange Red Yellow	(1.73, 51) (2.02, 47) (2.08, 25) (2.09, 23)			32.16
Summer air is stale (Q39)	$p = 0.399$	$F(3, 142) = 7.25$ $p < 0.0005$	Red Yellow Orange	(2.12, 25) (2.35, 23) (2.70, 47)	Orange White	(2.70, 47) (3.29, 51)	32.16
Summer air smells dirty (Q40)	$p = 0.119$	$F(3, 141) = 2.16$ $p = 0.095$	Red Yellow White Orange	(1.96, 25) (2.39, 23) (2.55, 51) (2.63, 46)			32.05
Winter temp is hot (Q41)	$p = 0.067$	$F(3, 139) = 0.80$ $p = 0.493$	White Yellow Orange Red	(2.71, 49) (3.00, 23) (3.02, 46) (3.04, 25)			31.84
Prefer Winter temp warmer (Q42)	$p = 0.387$	$F(3, 140) = 0.58$ $p = 0.628$	Yellow Red Orange White	(3.57, 23) (3.68, 25) (3.72, 46) (3.90, 50)			31.94
Winter air is stale (Q43)	$p = 0.438$	$F(3, 140) = 0.84$ $p = 0.472$	Red White Yellow Orange	(2.28, 25) (2.36, 50) (2.39, 23) (2.65, 46)			31.94
Winter air smells dirty (Q44)	$p = 0.010$ Welch $p = 0.554$	$F(3, 139) = 0.62$ $p = 0.601$	Yellow Red White Orange	(2.17, 23) (2.21, 24) (2.38, 50) (2.50, 46)			31.53

The student summer and winter temperature perspectives and preferences are not consistent with the measured classroom temperatures measured in term one (February – April) and term three (July – September), as presented visually in Figure 6.50 and Figure 6.51 (see Appendix K.21.1 for values). Across all participating classrooms in all schools, White.3 students recalled summer classroom temperatures as being the hottest, and wished it coolest, despite the environmental logger recording the lowest average temperature during school hours. Orange.4 students perceived their classroom as neutral despite it having the highest mean temperature, but this might be consistent with their preference for a cooler room. Yellow.3, Orange.5, and Red.4 classes reported their classrooms as being just below neutral (cooler), yet wanted it cooler.

The lack of consistency in reported perception of summer temperature cannot be explained with the data to hand, other than to speculate different adaptation, or that it is due to the effect of increased airflows (ASHRAE 2013a, pp. 9.12-19.13) that might be due to the using of a ceiling cassette in Orange.5, or ceiling fans in Red.4. The preference for a cooler room during summer is, however, consistent with comfort studies with student participants showing increased sensitivity to heat (Section 2.3.5.2).

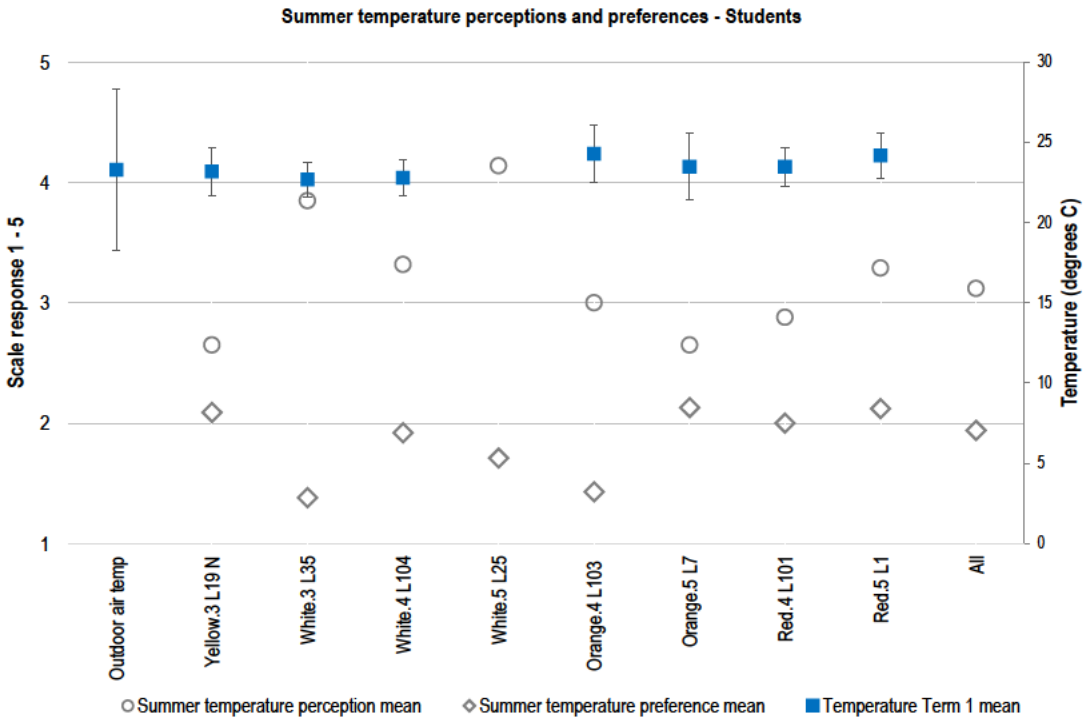


Figure 6.50: Student summer perceptions and preferences compared to mean Term 1 temperature (error bars = SD)

In winter, White.4 students recalled their class as the coldest despite it being measured by the environmental logger as the warmest across all schools in all participating classrooms. Furthermore, this room was maintained within the prescribed comfort range temperatures for 84% percentage of core hours during the year (Table 5.2). Red.4 was measured as the coolest room during the winter term, yet students perceived it as warmest. Again, the data to hand cannot explain the reason for this, other than to speculate that it might be due large, un-shaded, north-facing windows (Photograph 4.5, lower left) providing localised radiant warmth within the room, assuming equivalent activity and uniforms.

All students reported a preference for warmer classrooms. This preference for a warmer room is consistent with comfort studies with student participants showing increased sensitivity to cold during winter (Section 2.3.5.2).

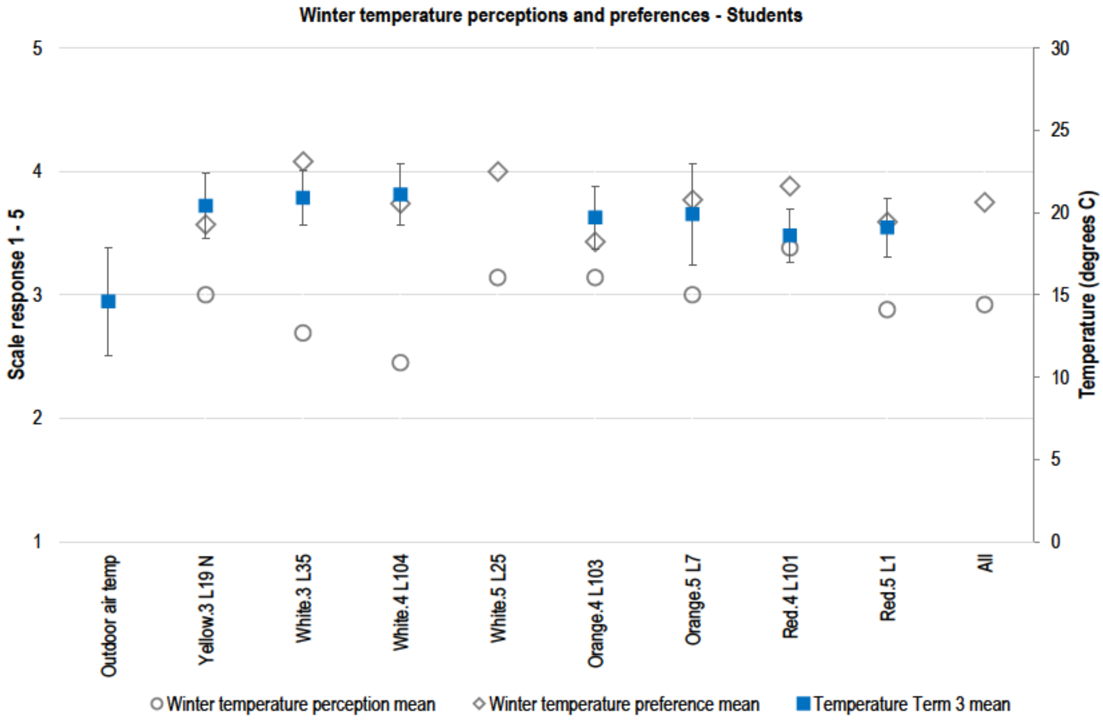


Figure 6.51: Student winter perceptions and preferences compared to mean Term 1 temperature (error bars = SD)

What is notable is that, given the low compliance with the prescribed comfort range (Table 5.2), and the tendency towards all classrooms to operate outside of the lower range of recommended acceptable range of operative temperature and humidity (ASHRAE 2013b, p. 9) (psychrometric graphs in Appendix H.9), both staff and students did not report classrooms to be colder than they have all indicated. If the 'acceptable range' is accepted as valid, this suggests that clo levels were high, or activity was more than sedentary. If the latter is true, and was present during the summer months, this would explain the preference for cooler classrooms despite all classrooms measured as operating within the upper acceptable range. The alternative interpretation is that the recall method does not provide accurate perceptions of temperature.

Stepwise regression was performed on all variables to investigate predictive models to describe temperature perceptions and preferences Table 6.42. Students' summer temperature perception was predicted by perceptions of summer air freshness together with perceptions of winter temperature and air quality, suggesting a year-round consistency. Summer temperature perceptions were also predicted by visual perspectives of school buildings, in this case a building considered ‘more ordinary’ predicted perception of cooler temperatures. Student preferences for summer temperatures was predicted by perceived temperature, but with only small variance contribution of 5%.

Students' winter temperature perceptions were predicted by summer temperature perceptions, again suggesting a year-round consistency, and again, a visual variable, in this case the attractive views predicted temperature perceived as warmer. Students' winter temperature preferences were predicted as moderate levels by variables associated with ability to move furniture, ability to save water and pride in school buildings. This suggests that winter temperature preferences are not obviously connected to other environmental variables.

Staff preferences for summer temperature was inversely predicted by perception of summer temperature. Similarly, winter temperature preferences were predicted inversely by perceptions of winter temperatures. These simple and obvious relationships are consistent with comfort literature.

It was not possible to resolve mathematically a stepwise multiple linear regression to create a predictive model for staff perceptions of summer temperatures. The perception of winter temperature was predicted by the staff perception of student experience of winter temperatures, and with a high model variance contribution. This is suggestive of the staff concern towards their students and their statutory role to provide duty of care towards students. It is also consistent with the neutral scale means in these variables (Figure 6.49), and may suggest that if comfort and preferences are satisfied then concern is turned towards others.

Table 6.42: Temperature perceptions and preferences – Students and Staff – multiple linear regression on all variables

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Summer temp is hot (Q37)	0.281	$F(3, 95) = 8.889$ $p < 0.0005$	Winter temp is hot (Q41) Summer air is stale (Q39) Winter air smells dirty (Q44) School buildings are a landmark (Q13)	-0.297 0.447 -0.274 0.227	0.002 < 0.0005 0.011 0.014
Prefer summer temp warmer (Q38)	0.053	$F(1, 94) = 5.224$ $p = 0.025$	Summer temp is hot (Q37)	-0.229	0.025
Winter temp is hot (Q41)	0.177	$F(3, 93) = 10.04$ $p < 0.0005$	Summer temp is hot (Q37) Views are attractive (Q64)	-0.325 0.261	0.001 0.007
Prefer Winter temp warmer (Q42)	0.245	$F(3, 95) = 9.926$ $p < 0.0005$	Furniture moves easily (Q63) Easy to save water (Q22) Proud of school buildings (Q20)	0.336 -0.417 0.275	< 0.0005 < 0.0005 0.006
Staff participants					
Summer temp is hot (Q37)	*No mathematically valid model*				
Prefer summer temp warmer (Q38)	0.600	$F(1, 27) = 40.55$ $p < 0.0005$	Summer temp is hot (Q37)	-0.775	< 0.0005
Winter temp is hot (Q41)	0.648	$F(1, 27) = 49.79$ $p < 0.0005$	Too hot in winter for students (Q41a)	0.805	< 0.0005
Prefer Winter temp warmer (Q42)	0.320	$F(1, 27) = 12.73$ $p = 0.001$	Winter temp is hot (Q41)	-0.566	0.001

Participants were offered space to provide any other comments about their thermal comfort. Of the students, 22% provided some form of response with Orange students responding at the highest rate, and a 41% response from staff participants (Appendix L.9.1).

Excluding general comments in the category code summary below (Figure 6.52), both staff and students commented at similar rates on air conditioning, air quality and temperature, together with how they adapted their behaviour. Students commented on their own preferences, while staff commented on control and ventilation, together with their concern for students.

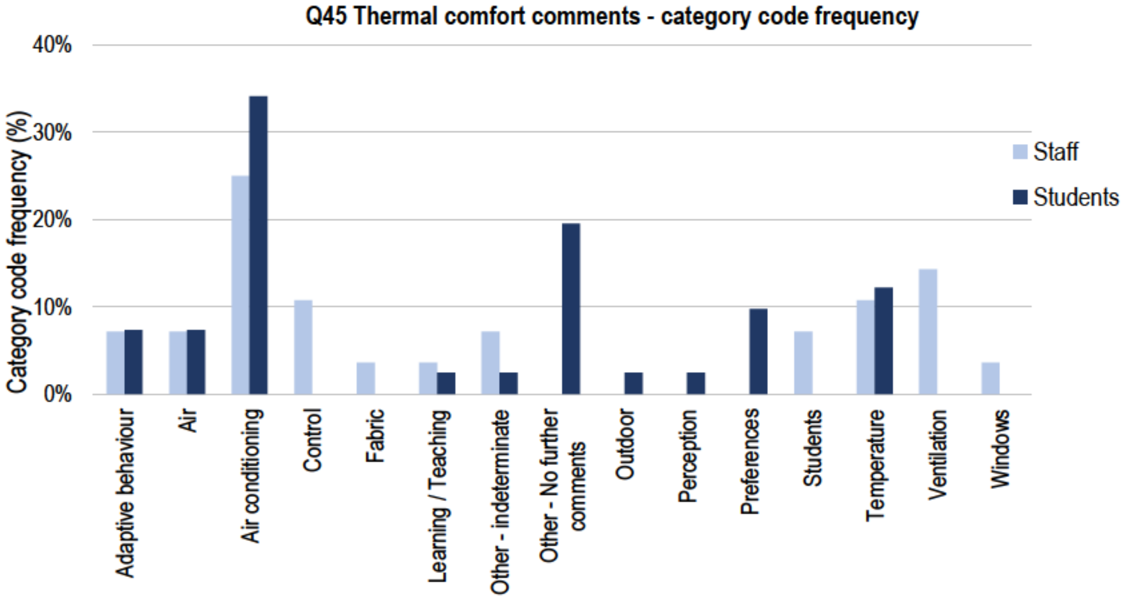


Figure 6.52: Q45 Thermal comfort other comments – Student and Staff – open question category code frequency

Though the response rates were low, the higher detail coding shows that students providing comments were split between the air conditioning operating to preference or the perception that it was not operating well with White school students more likely to consider the system as operating poorly (Table 6.43) as do White staff (Table 6.44). Staff also commented on the effect of air conditioning on students. In the full list in Appendix L.9, students codes include their preferences and observation of other student preferences, whereas staff offered comments about the attempts at ventilation at the cost of noise ingress.

Table 6.43: Q45 Thermal comfort other comments – Student – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Other - No further comments	2	1	5	0	**8**
Air conditioning - operates poorly, not controlled	0	5	1	0	**6**
Air conditioning - temperatures are acceptable	0	1	3	1	**5**
Air - stuffy	0	1	2	0	**3**
Temperature - cold in winter	0	1	2	0	**3**

Table 6.44: Q45 Thermal comfort other comments – Staff – detail codes

Category code – detail code	Yellow	White	Orange	Red	Total
Air conditioning - operates poorly, not controlled	0	3	0	0	**3**
Air conditioning - want better distribution of air	0	1	1	0	**2**
control - no control, want manual control AC	0	1	0	1	**2**
Other - indeterminate	0	2	0	0	**2**
Students - some students affected by poor air distribution	0	1	1	0	**2**
Temperature - hot in summer	0	2	0	0	**2**

During site visits staff offered many comments during incidental conversations. The airflow rate and distribution was commented on because it affected the overhead display and the operable windows could not be used because they were locked (O.c 17/8/14). Students were also kept home on extremely heat (O.e 29/11/12; O.g 29/11/12; O.h 29/11/12).

The measured humidity in Orange.1 was found to be above 70% on some occasions. Staff were asked about humidity effects on books, but it was reported that water from water bottle spills caused more damage (O.d 12/12/12).

Having noticed the constrained temperature pattern in White.3 (Section 5.2.4) attempts were made to investigate the set points. Ultimately, this was not possible since the site visits did not coincide with accessibility to the BMS, as demonstrated by the timeline of paraphrased incidental conversations below, presented as in indicator of the lived experience of this form of BMS:

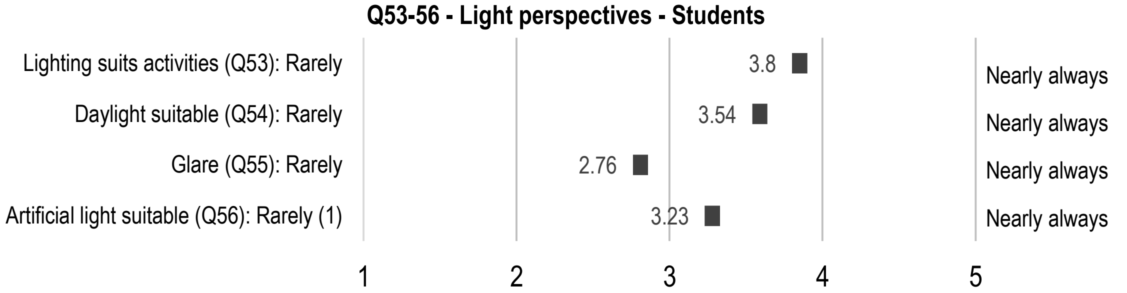
- First week of the term (16-20 July) was hot indoors and last week it was cold (W.e 30/7/12)
- Had lost local access to BMS. Network access problems were fixed last week. (W.g 30/7/12)
- BMS not allowing vents to be open when HVAC is off. 'Getting a new computer system... Currently no access.' (W.f 16/10/12)
- Hot inside the day before. Had door open to try to cool it down (W.e 16/10/12)
- Day before was 'foul' and 'horrible'. Windows would open a little then shut. '[teacher named] running around trying to fix it.' (W.c 16/10/12)
- Technician out the day before because there was no network access to part of the school BMS, and the other part was only accessible within its own network. The AC was set too hot. (W.b 16/10/12)
- Later on 16/10/12: Now no access anywhere, so can’t show the set points. (W.b 16/10/12)
- Network access still intermittent. Additionally, someone had jumped the perimeter fence and turned the AC off. (W.b 1/11/12).
- Network access to BMS not available. (W.b 28/11/12)
- HVAC working better (W.c 13/12/12)

This sample demonstrates the nuances of air conditioning problems that this particular school experienced. It is likely that students are shielded from this sub-optimal operation to some extent, however, if negativity does trickle through it may contribute to the unexpected student perceptions and preferences reported above.

6.4.4.2 **Perceived light quality**

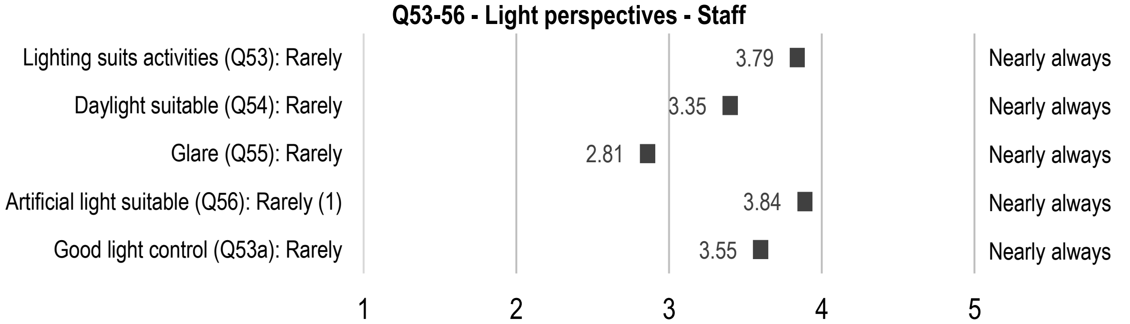
Staff and students were asked to rate their perceptions of their classroom lighting on five point scales (Figure 6.53, full frequency tables in Appendix K.22). Given that lighting can be designed for adaptation with relative ease, it was expected that lighting responses should tend towards good perceptions. According to the means students perceived that their lighting was appropriate and for learning with daylight more appropriate than artificial light, however standard deviations of greater than a scale point suggest that there were a range of responses, and glare was not fully controlled.

Staff were generally in agreement with students about all aspects of lighting, except for perceptions of artificial lighting, where significant difference between students and staff such that students perceived artificial lighting as less suitable than staff (Appendix K.2)



(1) significant difference between staff and student cohort

Figure 6.53: Students' classroom light perceptions: descriptive statistics of responses



(1) significant difference between staff and student cohort

Figure 6.54: Staff classroom light perceptions: descriptive statistics of responses

One way ANOVAs were performed for all light questions by school. There were no significant differences between schools in the staff responses (Table 6.46), however, in the student responses, Orange students were significantly less satisfied with the daylighting than Red

Students, and Yellow students identified that there was more glare than the other schools. First, the light measurements recorded show that Orange.5, and to a lesser extent, Orange.4 were lower than those taken in Red.4 and Red.5 were. This is consistent with the observed fenestration, use of blinds, and use of windows for display, where Orange.5 had small windows with opaque blinds down often, and Orange.4 had tinting on the glazing and was used for display, whereas little display was found on the large Red School windows and blinds were translucent (see Sections 4.2.5, 4.4.3). Thus, this lesser access to daylight within the classroom is likely to explain the lower satisfaction by Orange School students.

Large variations in light were measured in most rooms (Section 5.3.2, Appendix H.10.1). Yellow.3 (only survey participant class at Yellow School) returned a higher perspective of glare from the students. This room had large east facing windows, as well as north and south windows. All windows had white translucent blinds, which were observed to be used, in conjunction with artificial lighting. In contrast, Red.5 had a similar configuration, with large east-facing windows, yet returned a lower score for glare, possibly due to less glare through the narrow north window. Another possibility is that, unlike Red.5's IWB' Yellow.3 used an older style projector onto a whiteboard, not an IWB, so any deficiency in projection power would be sensitive to the 270-degree daylighting.

Table 6.45: Light scale questions – Students – One-way ANOVA tests

Variable	**Levene test homogeneity of variances**	**One Way ANOVA**	**Homogeneous subsets (using Tukey HSD for unequal group sizes)**				
			Group 1 (mean, *N*)		**Group 2 (mean, *N*)**		**Harmonic Mean Sample Size**
Lighting helps learning (Q53)	$p = 0.095$	$F(3, 140) = 2.43$ $p = 0.068$	White Yellow Orange Red	(3.65, 52) (3.68, 22) (3.72, 46) (4.38, 24)			31.23
Daylight suitable (Q54)	$p = 0.109$	$F(3, 140) = 2.79$ $p = 0.043$	Orange White Yellow	(3.26, 46) (3.50, 52) (3.55, 22)	White Yellow Red	(3.50, 52) (3.55, 22) (4.17, 24)	31.23
Glare occurs (Q55)	$p = 0.569$	$F(3, 139) = 7.59$ $p < 0.0005$	Orange White Red	(2.33, 46) (2.63, 52) (2.96, 23)	Yellow	(3.77, 22)	30.79
Artificial light suitable (Q56)	$p = 0.121$	$F(3, 137) = 1.19$ $p = 0.318$	Yellow Orange White Red	(3.09, 22) (3.14, 44) (3.17, 52) (3.65, 23)			30.56

Table 6.46: Light scale questions – Staff – One-way ANOVA tests

Variable	Levene test homogeneity of variances	One Way ANOVA	Homogeneous subsets (using Tukey HSD for unequal group sizes)			
			Group 1 (mean, *N*)		Group 2 (mean, *N*)	Harmonic Mean Sample Size
Good control of lighting (Q53a)	*p* = 0.169	*F*(3, 38) = 0.99 *p* = 0.406	White Yellow Red Orange	(3.24, 21) (3.75, 4) (3.83, 6) (3.91, 11)		7.21
Lighting helps learning (Q53)	*p* = 0.714	*F*(3, 39) = 0.76 *p* = 0.521	Yellow Red Orange White 21),	(3.25, 4) (3.50, 6) (3.75, 12) (4.00,		7.30
Daylight suitable (Q54)	*p* = 0.339	*F*(3, 39) = 0.25 *p* = 0.864	Red Orange White Yellow	(3.00, 6) (3.33, 12) (3.43, 21) (3.05, 4)		7.30
Glare occurs (Q55)	*p* = 0.486	*F*(3, 39) = 1.73 *p* = 0.177	Orange Yellow White Red	(2.17, 12) (2.75, 4) (3.05, 21) (3.33, 6)		7.30
Artificial light suitable (Q56)	*p* = 0.594	*F*(3, 39) = 0.94 *p* = 0.432	Yellow White Orange Red	(3.24, 4) (3.81, 21) (4.00, 12) (4.00, 6)		7.30

Stepwise multiple linear regression was performed on staff and student light variable data and found models that predicted what helped with learning (students) and activities (staff). The model from the student data showed that students perspectives of lighting helping with learning is predicted by the logical combination of perspectives of artificial light, daylight and glare. Staff perspectives that lighting was suitable for activities was predicted only by perspectives about natural light and control.

Table 6.47: Q53 Lighting helps learning – Students and Staff – multiple linear regression on light variables only

Dependent variables	R^2	*F, p*	Coefficients	Beta	*p*
Student participants					
Lighting helps learning (Q53)	0.35	*F*(3,140)=24.19 *p* < 0.0005	Artificial light suitable (Q56) Daylight suitable (Q54) Glare occurs (Q55)	0.45 0.33 -0.20	< 0.0005 < 0.0005 0.005
Staff participants					
Lighting helps learning (Q53)	0.42	*F*(2,39) = 14.30 *p* < 0.0005	Daylight suitable (Q54) Good control of lighting (Q53a)	0.46 0.30	0.002 0.030

Again, participants were given the opportunity to make additional comments and just under a third of student respondents provided a comment, with most received from White and Orange Schools, with a similar response from staff (Appendix L.12.1).

Excluding general comments, most student comments revolved around light quality (level, glare, preference) and control using blinds, whereas staff commented most on general control and daylight, suggesting that students reported problems and staff reported perceived improvements (Figure 6.55).

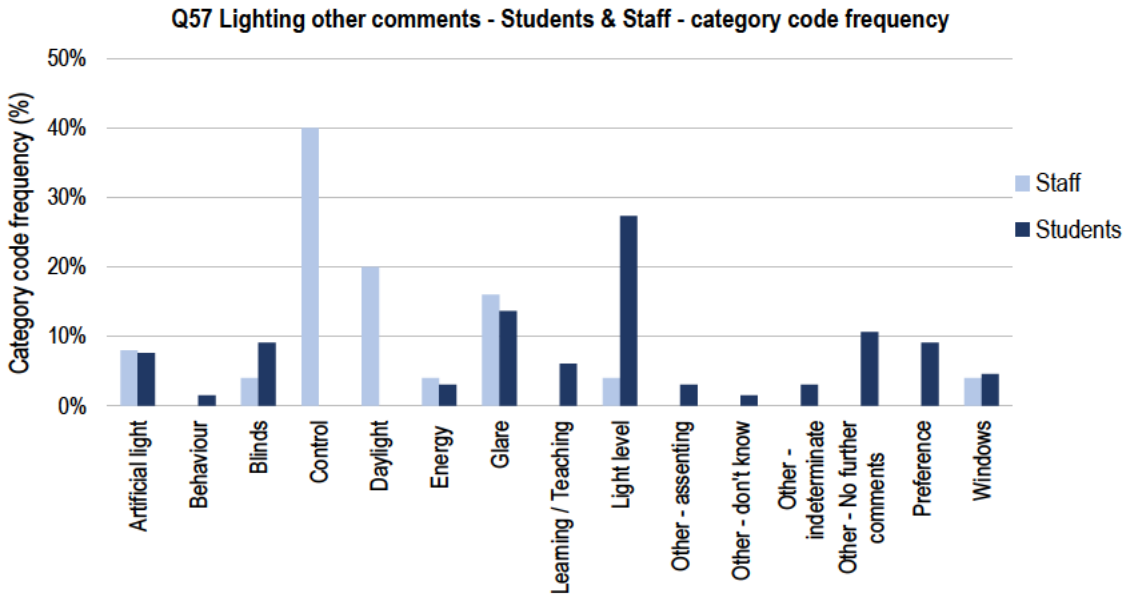


Figure 6.55: Q57 Lighting other comments – Student and Staff – open question category code frequency

The highest frequency detailed coding presented in Table 6.48, for students (with full list in Appendix L.12.2), and all staff detail coding presented in Table 6.49 (full list in Appendix L.12.3). White students were troubled by light levels on IWB, which Orange students had concerns about the low lighting levels. This is consistent with the observed lighting configurations where the large clerestories in White provide high natural lighting to the south sides of classrooms, but also induces glare off the retrofitted IWBs. Most participants from the Orange school were located in a double transportable, where the widows are relatively smaller to other permanent buildings and the north window blinds were observed in the down position on all visits.

Staff were generally concerned that there was too much daylight with little control.

Table 6.48: Q57 Lighting other comments – Student – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Light level - too bright	0	18	0	0	**18**
Glare - Nat/Art light level too high for IWB	1	7	0	0	**8**
Other - No further comments	2	2	3	0	**7**
Preference - Want lights off and more natural light	1	1	3	0	**5**
Learning / Teaching - nat light helps	1	1	2	0	**4**
Blinds - not installed, needed	0	3	0	0	**3**

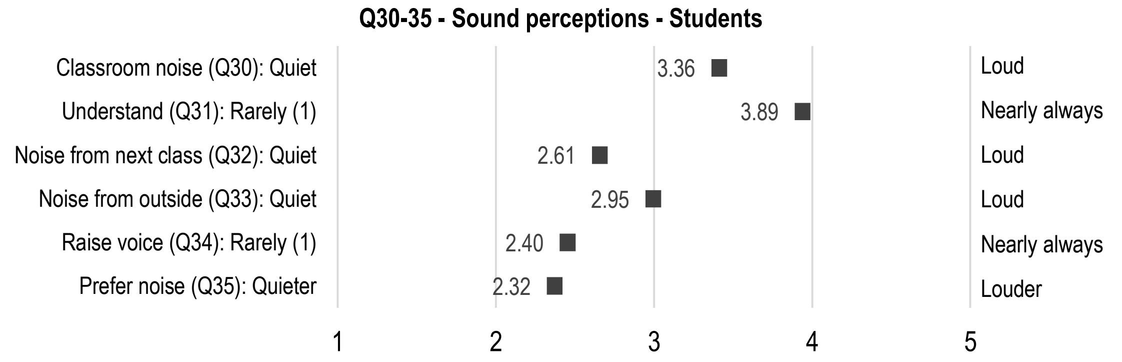
Table 6.49: Q57 Lighting other comments – Staff – detail codes ≥ 2

Category code – detail code	Yellow	White	Orange	Red	Total
Control - need more room zones	0	3	0	0	**3**
Glare - Natural light level too high	0	0	1	2	**3**
Control - not enough	0	2	0	0	**2**
Control - timers annoying	0	0	0	2	**2**
Daylight - makes room 'uncomfortable', overheating	0	1	1	0	**2**
Daylight - over lit due to north elevation windows	0	0	0	2	**2**

During site visits, incidental conversations with staff revealed that the IWB was difficult to read in the morning due to daylight, but better after midday (O.j 27/8/12), early morning sun during winter was more annoying than sun from skylights during summer (O.4 12/12/12), and that halogens and CF lamps were blowing regularly, so some lights permanently off after energy audit. There were also concerns that CF lamps could trigger epileptic seizures (O.d 17/8/12).

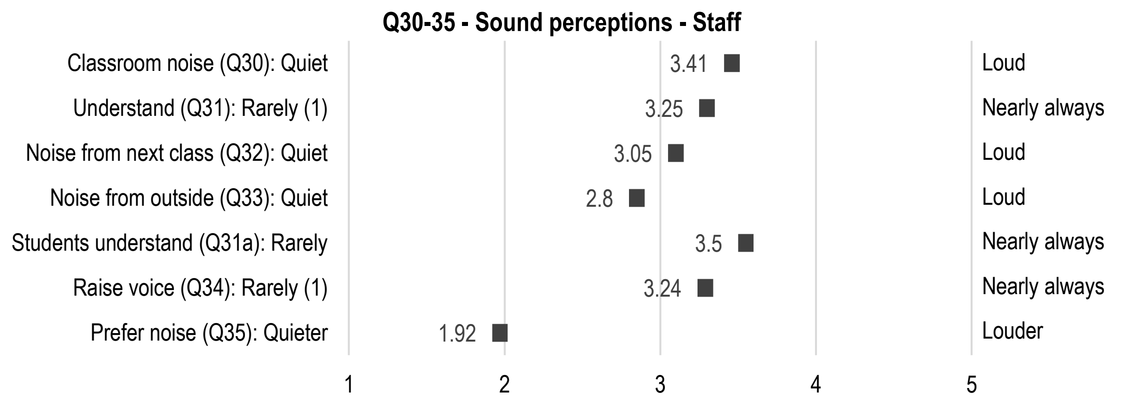
6.4.4.3 **Perceived sound quality**

Students and staff participants were asked to complete five point scale questions about their perceptions of classroom and workplace acoustics (Figure 6.56, full frequency tables in Appendix K.20). Students reported their classrooms to be neither quiet nor loud, but they would prefer noise levels to be quieter. Students hear some noise from other classrooms and outside. Generally, students understand what is said (but it was not known if students with hearing impairments completed the questionnaire). Staff tend to agree with students. Both cohorts wish for a quieter class.



(1) significant difference between staff and student cohort

Figure 6.56: Students' classroom sound perceptions: descriptive statistics of responses



(1) significant difference between staff and student cohort

Figure 6.57: Staff classroom sound perceptions: descriptive statistics of responses

Staff and student cohort means were tested for significant difference (See Appendix K.2). The null hypothesis could not be supported for perceptions about understand-ability (Q31) and perceptions about the need to raise participants' voice (Q34). In these cases, staff indicated that they had more trouble understanding what was being said (*M* = 3.25 as compared to the student response mean, *M* = 3.89), and that they had to raise their voice more (*M* = 3.24) than students (*M* = 2.40).

One way ANOVAs were performed for all questions by school. These are summarised in Table 6.50 for students and Table 6.51 for staff. All tests met Levene's test for homogeneity of variances, however, there were some statistically differences between case study schools for both staff and student responses.

Table 6.50: Noise scale questions - students - One-way ANOVA tests

Variable	Levene test homogeneity of variances	One Way ANOVA	Homogeneous subsets (using Tukey HSD for unequal group sizes)				
			Group 1 (mean, *N*)		Group 2 (mean, *N*)		Harmonic Mean Sample Size
Noise is loud (Q30)	*p* = 0.277	*F*(3,142) = 5.68 *p* = 0.001	Red White Orange	(3.08, 25) (3.10, 52) (3.52, 46)	Orange Yellow	(3.52, 46) (3.96, 23)	32.14
Easy to understand speech (Q31)	*p* = 0.188	*F*(3,141) = 0.92 *p* = 0.433	Yellow Orange Red White	(3.65, 23) (3.83, 46) (3.92, 24) (4.04, 52)			31.72
Loud noise from adjacent room (Q32)	*p* = 0.734	*F*(3,141) = 1.17 *p* = 0.322	Red White Orange Yellow	(2.28, 25) (2.58, 52) (2.67, 46) (2.91, 22)			31.64
Loud noise from outside (Q33)	*p* = 0.250	*F*(3,142) = 4.40 *p* = 0.005	Red Yellow White	(2.32, 25) (2.74, 23) (3.02, 52)	Yellow White Orange	(2.74, 23) (3.02, 52) (3.30, 46)	32.14
Teacher needs to raise voice (Q34)	*p* = 0.089	*F*(3,142) = 9.43 *p* < 0.0005	Red White	(1.88, 25) (1.98, 52)	Orange Yellow	(2.78, 46) (3.17, 23)	32.14
Prefer overall noise louder (Q35)	*p* = 0.076	*F*(3,142) = 3.29 *p* = 0.022	Yellow Red Orange	(1.78, 23) (2.20, 25) (2.41, 46)	Red Orange White	(2.20, 25) (2.41, 46) (2.54, 52)	32.14

Students at schools with double classes, Orange and Yellow, reported that their classrooms were louder than other and that need to raise their voice more often than single class schools. Orange School students also reported that they perceived noise ingress from as louder than other schools. This would be consistent with the lightweight construction of the transportable that housed Orange.5 and the low acoustic isolation offered by the large glazing area and vents of Orange.4. While all school students responded that they preferred their classroom to be quieter, Yellow Students were stronger in this preference.

The noise levels presented in Figure 5.23 to Figure 5.20 show that noise levels varied when students were present, however, noise levels Yellow.3 and Orange.5, the two double classes participating in the survey were not measured as louder than other classes, however, it must be noted that these are spot measurements in dBA. Since they are a weighted frequency average, they do not show any skewing of noise frequency that could cause annoyance. Furthermore, they do not show the time duration of high noise levels throughout. As noted parameters associated with speech intelligibility were not measured, but the observed acoustic treatment of Yellow.3 differs to other classes (Section 4.4.5) in its lack of absorptive material. This, and the double class configuration, could lead to the different noise perceptions of Yellow.

Staff responses were relatively consistent across schools about their perspectives of workplace noise and sound quality (Table 6.51), however Orange and Red staff perceived that they were able to understand voices more than Yellow and White School staff, and that, from the staff perspective, students were able to understand what was being said. This suggests that the acoustic retrofitting of Red School was perceived as providing either good sound quality, or actually did provide good voice quality. Yellow school staff perceive that there are sound quality problems, which was consistent with student responses.

Table 6.51: Noise scale questions - staff - One-way ANOVA tests

Variable	Levene test homogeneity of variances	One Way ANOVA	Homogeneous subsets (using Tukey HSD for unequal group sizes)		
			Group 1 (mean, *N*)	Group 2 (mean, *N*)	Harmonic Mean Sample Size
Noise is loud (Q30)	*p* = 0.682	*F*(3, 40) = 2.99 *p* = 0.042	Red (2.50, 6) Orange (3.00, 12) Yellow (3.75, 4) White (3.82, 22)		7.33
Easy to understand speech (Q31)	*p* = 0.102	*F*(3, 40) = 3.96 *p* = 0.015	Yellow (2.00, 4) White (2.97, 22)	Orange (3.83, 12) Red (4.17, 6)	7.33
Students understand speech (Q31a)	*p* = 0.090	*F*(3, 32) = 4.73 *p* = 0.008	Yellow (2.75, 4) White (3.11, 19) Orange (4.00, 8)	Orange (4.00, 8) Red (4.80, 5)	6.37
Loud noise from adjacent room (Q32)	*p* = 0.941	*F*(3, 40) = 4.34 *p* = 0.010	Orange (2.00, 12) Red (2.67, 6) Yellow (3.25, 4) White (3.68, 22)		7.33
Loud noise from outside (Q33)	*p* = 0.456	*F*(3, 40) = 3.22 *p* = 0.033	Red (2.17, 6) Yellow (2.25, 4) Orange (2.25, 12) White (3.36, 22)		7.33
Teacher needs to raise voice (Q34)	*p* = 0.330	*F*(3, 34) = 1.46 *p* = 0.243	Red (2.20, 5) Orange (3.00, 8) White (3.48, 21) Yellow (3.75, 4)		6.42
Prefer overall noise louder (Q35)	*p* = 0.496	*F*(3, 34) = 2.68 *p* = 0.062	White (1.62, 21) Yellow (2.00, 4) Orange (2.38, 8) Red (2.40, 5)		6.42

Stepwise multiple linear regression on all noise variables and the respective school satisfaction variable was used to find significant predictive models for student and staff noise preferences (Table 6.52). The need to raise voice was found to be a predictor for students' preference to reduce noise level, but with a very small influence of 6%. Staff preference for a quieter room was predicted by the perception of noise ingress from other classes and a perspective of being less satisfied with the job.

Table 6.52: Q35 Prefer overall noise louder – Students and Staff – multiple linear regression on noise variables and satisfaction

Dependent variables	R^2	F, p	Coefficients	Beta	p
Student participants					
Prefer overall noise louder (Q35)	0.05	$F(1, 133) = 7.82$ $p = 0.006$	Teacher needs to raise voice (Q34)	-0.24	< 0.0005
Staff participants					
Prefer overall noise louder (Q35)	0.44	$F(2, 31) = 11.72$ $p < 0.0005$	Loud noise from adjacent room (Q32) Staff satisfaction with job (Q92)	-0.45 0.39	0.004 0.010

In an open question, students and staff were invited to provide further comments about noise and sound quality in their school. Only a quarter of students provided responses, with Orange and Yellow students providing the most comments per school, whereas there was a slightly higher response from staff (Appendix L.8.1).

Category coding for both student and staff responses is provided in Figure 6.58. Students tended to report problems such as noise level and the source of the noise (identity and behaviour), whereas staff tended provide perspectives of what was causing the problem (aspects of the building design) and how it affected the teaching and learning.

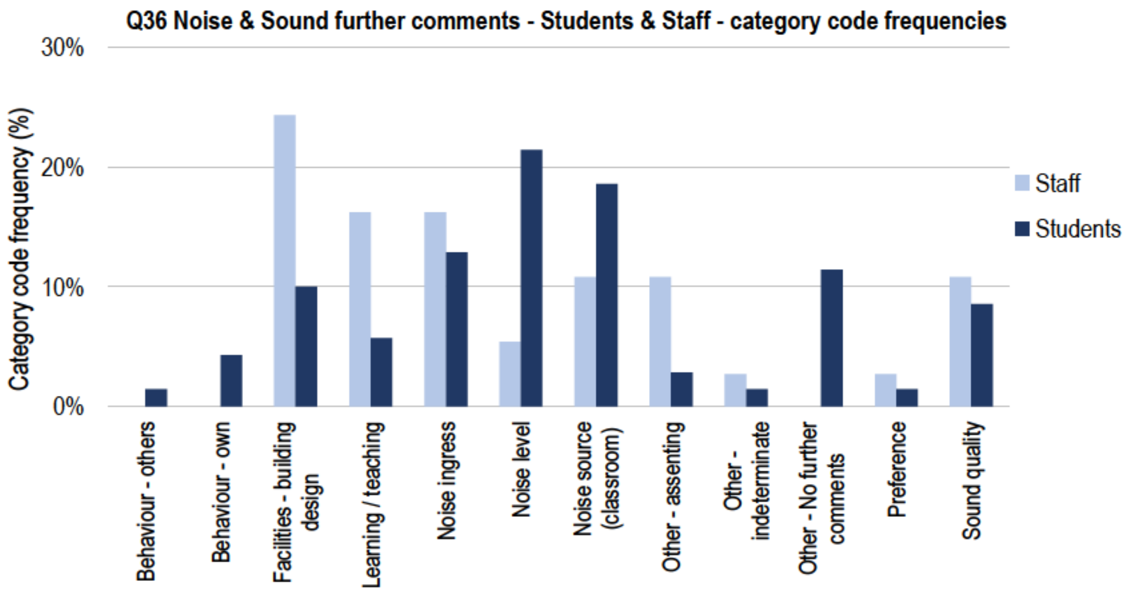


Figure 6.58: Q36 Noise and Sound further comments – Students and Staff – open question category code frequencies

The highest detail codes for student responses are presented in Table 6.53, with all detail codes in Appendix L.8.2, and similarly staff detail codes are found in Table 6.54 and Appendix L.8.3.

Student comments focused on noise level, noise sources and noise ingress with detail coding showing most comments were about noise from classes from adjacent classes within the same room or their own class. Most of these comments came from Orange and Yellow case study students, where Orange students were located in a transportable in a 'team-teaching' arrangement (two classes of same year group, two teachers, but teachers often work together), whereas the Yellow student respondents were considered to be in an 'open plan' arrangement where there were two teachers and two classes of different year groups, but working in the same space.

The comments from students in double and team teaching rooms is consistent with the scale results reporting that that have to raise their voices more often. The spot noise levels measured in these rooms were no higher than other classrooms, which may be due to the very low sampling rate of occupant activity noise. The construction of the rooms are very different, with the most of Orange School student respondents from a transportable classroom, i.e., lightweight with low (2700AFL) ceiling, whereas Yellow school students respondents located in a stone construction with 4000AFL ceiling, i.e., a much larger volume. The common link was the use of spaces by two classes.

Students also attempted to identify the spatial cause of the noise issues, with students at all schools stating that there were 'echoes' present that cause problems. Staff identified open plans as the source of noise issues, and that teaching was impacted by noise issues. Two staff also noted that hearing capabilities differed between students, and that some students had hearing loss.

Table 6.53: Q36 Noise and Sound further comments – Students – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Noise level - loud	6	0	**8**	1	**15**
Noise source - adjacent class shared room	**6**	0	0	2	**8**
Other - No further comments	1	2	**5**	0	**8**
Noise source - own class	0	0	**5**	0	**5**
Sound quality - echoes	1	1	**2**	1	**5**
Learning disruption	**2**	0	1	1	**4**
Noise ingress - from outside learning activities	0	1	**3**	0	**4**
Facilities - building design - causes noise ingress	0	**2**	1	0	**3**

Table 6.54: Q36 Noise and Sound further comments – Staff – detail codes ≥ 3

Category code – detail code	Yellow	White	Orange	Red	Total
Facilities - building design - open space learning poor	**2**	**2**	0	0	**4**
Learning / teaching - impacted by noise	**2**	**2**	0	0	**4**
Other - assenting	0	1	**2**	1	**4**
Facilities - building design - large volume of room	**2**	1	0	0	**3**

Acoustics were discussed often during incidental conversations at site visits. Discussions included strategies needed for teaching hearing impaired students, such as moving from a double class, with team teaching, to single class (O.c 12/12/12). Previous attempts by one school to improve acoustics had been to install more pinboards, however when this did not work an electronic speech enhancer was purchased. This was found to be much 'better on the voice' (Y.c 26/3/12)

6.4.4.4 **School building components as environmental modelling tools**

Participants were asked about the awareness and control of environmental components to determine the possibility and extent of HVAC and passive ventilation features being used as modelling tools for teaching. This section presents staff awareness, control and comments about building components, and then addresses the awareness of students to identify any modelling effects.

From the responses in Appendix L.10, staff were aware of the observed HVAC control and passive ventilation features (Table 4.5). The five responses to the 'other' choice provided two personal actions (use of a pedestal fan and using the door for ventilation), one observation of ventilation chimneys, and two observations about the operation of windows ('...operated by building management system', and windows can be opened 'but never opened'). This detail suggests staff are acutely aware of the building as a system.

All staff indicated that they knew the control mode for heating and cooling (Appendices L.24 and L.25). Some White School staff indicated that they had full control over heating and cooling, but it is unknown whether these responses came from transportable building with split systems, or whether despite the difficulties described earlier accessing the BMS, staff perceived that they actually did have full control over their heating and cooling. Some Orange and Red school staff described their heating and cooling control as fully automatic, whereas the observed systems had set points set centrally, but there staff were able to control operation locally through on/off switches and timers. This suggests that the perspective of automation includes removal of access to set points.

Staff identified a range of ventilation control modes, with five participants, from all schools, admitting they did not know (Appendix L.26). This suggests that there is some confusion about how to control fresh air in the classroom. The 'other' questions for heating (Q104), cooling (Q109) and ventilation (Q114) control all provided one response each about the control being by a 'computer'. It was also commented that for ventilation control 'only door and windows open', implying an expectation that the air conditioning system also provided ventilation.

More than half of staff responded to an open response question to make further comments about temperature and ventilation control (Appendix L.27.1). Referring to the category code frequency summary staff commented mostly about control, comfort and windows (Figure 6.59).

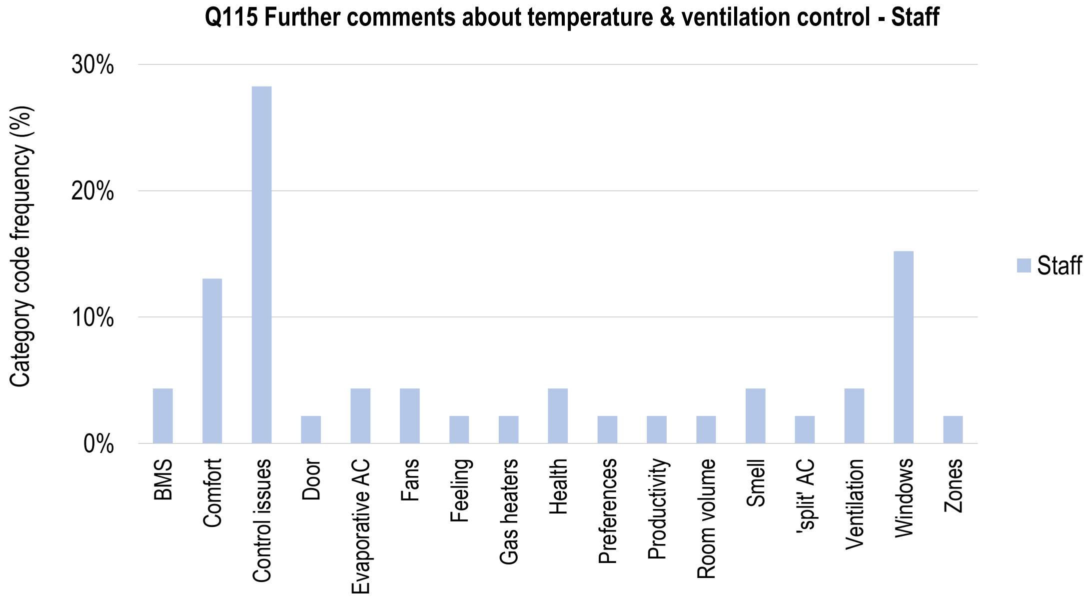


Figure 6.59: Q115 Further comments on temperature and ventilation control – Staff – open question category code frequencies

The highest detail codes show that comments were centred on elements that were expected to work but did not, such as control of HVAC and windows, and the consequent lack of comfort (Table 6.55, with full list in Appendix L.27.2).

Table 6.55: Q115 Further comments on temperature and ventilation control – Staff – detail codes ≥ 4

Detail Code	Yellow	White	Orange	Red	Total
Control - poor, no control of work environment	0	3	1	1	**5**
Comfort - poor thermal comfort	0	2	1	1	**4**
Control - on / off only, not temp	0	0	1	3	**4**
Control - want more local control, easier	0	3	1	0	**4**
Windows - should but don't open	0	4	0	0	**4**

Staff were also asked about controls available for daylight (Appendix L.28), and they identified building components consistent with those observed in Section 4.2.5. The 'other' question (Q120) received seven responses. Single responses each stated that there were no blinds available, a veranda, and window tinting, suggesting that daylight control options were understood. The remaining four responses state were difficult to interpret because they stated only 'windows'.

Since modelling influences student learning in general, and is proposed as a major influence in students understanding of sustainability (Section 2.2.2.4), students were asked what environmental components they observed their teachers using. The multiple-choice question was attempted by 95% participants (Appendix L.11) with response frequencies in Figure 6.60.

Responses were consistent with observed case study building elements. For example, students observed heating and cooling used in schools with wall controls (Yellow, Red and Orange) whereas White case study students observed their teachers taking other actions or did not know. Both Orange and White case study schools have air vents in the walls, but only Orange students tended to observe them being used, possibly because the White air vents are centrally controlled and subtly located under storage, so are not obviously visible to students. As expected, since Red school was the only school with ceiling fans, Red students indicated that they observed these more than other case study school.

The intention of asking about 'windows that open and close' was to identify whether students see teachers use operable windows. It was observed that operable windows were only used by some classrooms at Orange and Red, however case study students indicated that they observed windows being used at these and at Yellow and, to a lesser extent, White, where operable windows are centrally controlled. Either this could be interpreted as operable windows were used in between site visits and not observed, or that use of blinds (White and Yellow) and display on windows (White) were interpreted as 'using windows that open and close'.

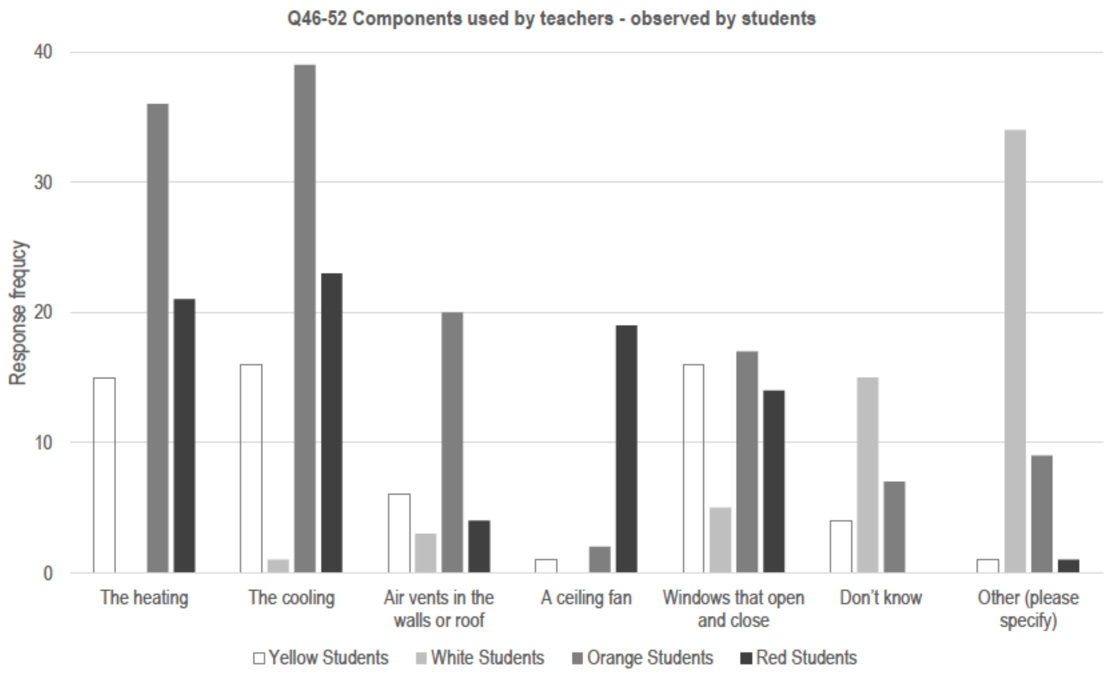


Figure 6.60: Q46-Q52 Components used by teachers – as observed by students

The coded responses to 'Other (please say)' (Q52) are presented graphically in Figure 6.61. White school provided most of the 'other' responses, indicating that opening the door is alternative to adjusting the internal climate, and is consistent with observations (Photograph 6.1). Given that White is the only school with fully automated HVAC controls, this suggests that occupants are finding alternative manual local control over internal environment.

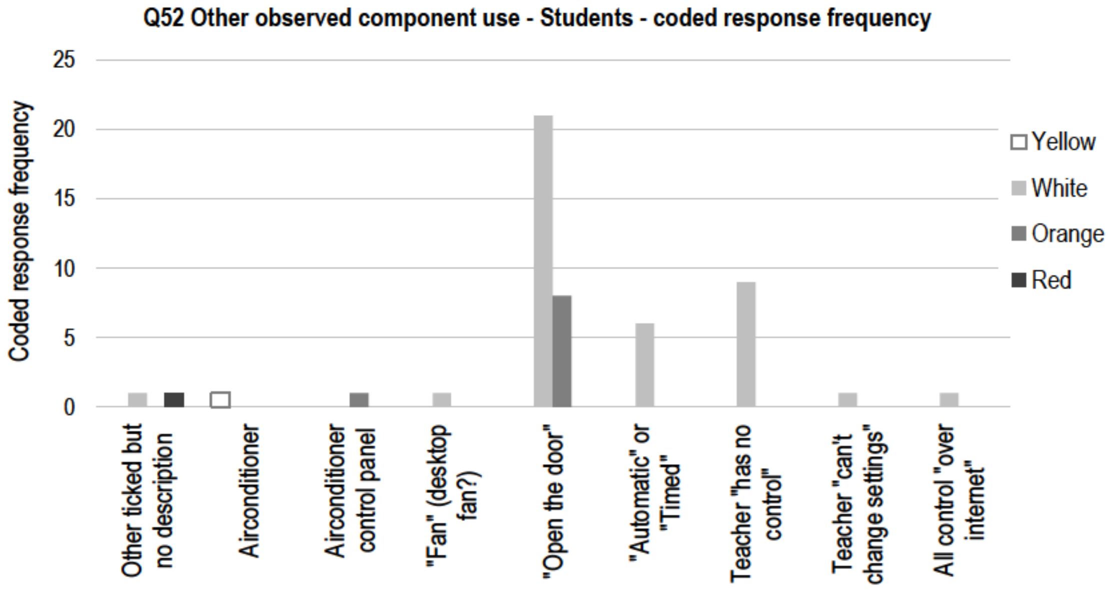


Figure 6.61: Q52 Student coded responses to 'other (please say)'

Photograph 6.1: Ventilation and HVAC controls with local adaptations: White.3 door propped open in winter (DSCF6281_120730mod.JPG), and Yellow.2 HVAC instructions (DSCF6058_120326mod.JPG)

The above suggests that students are observing and recalling how teachers are modifying the room environmentally, where control systems permit this. Other forms of local adaptations, included the such as creation of simple local instructions for operation, as shown in Photograph 6.1. The instructions for White School were viewed (site visit 30/7/2012) and noted to be five A4 pages.

6.4.5 Classroom redesign preferences

Similarly to school redesign preferences (Section 6.3.2.5), staff and students were asked what they would change if they could in their classroom, and responded with rates of 93% and 78%, respectively (Appendix L.21.1).

Category coding comparing student and staff coding frequencies found that both staff and students would change the size of the classroom (Figure 6.62). Students wanted mostly to change the air conditioning, the design, fixtures, furniture, IWB, and visual appearance, whereas staff most wanted to change control devices, fixtures, and space layout. A number of students did not want to change anything, but a far lower proportion of teachers felt classrooms did not need changing.

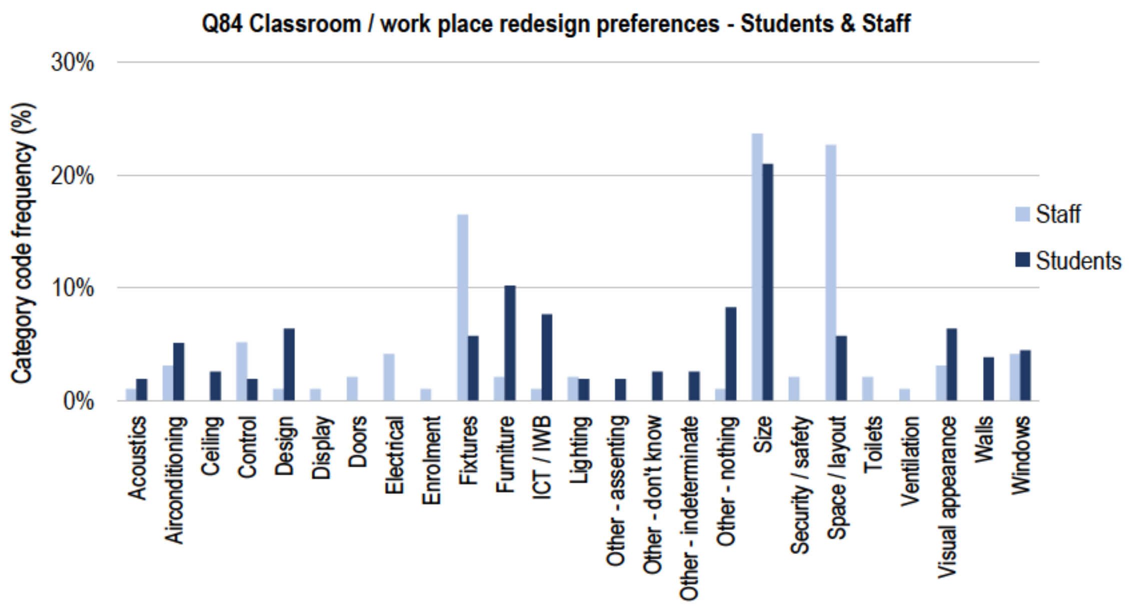


Figure 6.62: Q84 Suggested changes to classroom – Students and Staff – open question category code frequency

All detail coding is available in Appendix L.21, with the highest response frequencies for students shown in Table 6.56, and for staff in Table 6.57.

Both students and staff wanted larger classrooms. Students also wanted changes to furniture, with larger desks, and staff wanted to change fixtures, in particular, more storage. This suggests that cohorts want to change the furniture and fixtures that they use the most. Students would like to change the design so that it is 'more exciting', and, notably, the students from the newest schools, White and Orange, wanted changes in colour. Staff wanted more flexibility to both open up and close off space.

Orange and Red students wanted more computers, but staff at White and Orange, wanted more power points and data connections, again suggesting scope of interest depends on use. Some students, across all schools, also stated that no change was necessary.

Table 6.56: Q84 Suggested changes to classroom – Students – detail codes ≥ 5

Category code – code detail	Yellow	White	Orange	Red	Total
Size - larger	2	**19**	7	2	**30**
Other - nothing	3	**4**	**4**	2	**13**
ICT / IWB - more PC, tablets, wireless	0	1	**5**	3	**9**
Visual appearance - update, more colour	1	**4**	3	1	**9**
Airconditioning - Improved	0	**6**	1	1	**8**
Furniture - desks, more, larger	1	1	**4**	0	**6**
Furniture - redesign, more comfortable	0	2	**3**	1	**6**
Display - more student work display areas	1	0	**3**	1	**5**

Table 6.57: Q84 Suggested changes to classroom / workplace – Staff – detail codes ≥ 3

Category code – code detail	Yellow	White	Orange	Red	Total
Size - larger classroom	2	**7**	5	2	**16**
Fixtures - more storage, shelves	0	3	**4**	2	**9**
Space / layout - no shared classrooms, single classes only	2	**4**	0	2	**8**
Size - larger storage area	0	**3**	**3**	0	**6**
Control - AC/windows - by students/teachers	0	**3**	0	1	**4**
Airconditioning - Improved	0	**2**	0	1	**3**
Electrical - more GPOs and wire data connections	0	**2**	1	0	**3**
Fixtures - wet area	0	**2**	0	1	**3**
Fixtures - pinboards increased, all walls	0	**2**	1	0	**3**
Space / layout - flexible open up / close off space	1	**2**	0	0	**3**

6.5 Spaces other than classrooms

While this study focussed on learning spaces, participants identified that teaching and learning requires more than classroom space, and went on to identify other spaces that support the school community, and where poor design might contribute to poor service and safety issues.

School reception areas were mentioned as being an important space for communicating with parents and children and, thus, should provide good visibility and accessibility for all users. Furthermore, reception staff monitor sick children so they should have good visual access to the sick room. This creates the need for a 360 degree view out of and into the main school entrance. While discussing these aspects with Orange reception staff, a blind spot was demonstrated when a year 2 student was noticed hiding around a corner under an internal window, i.e., the window was too high to allow visibility of small students (O.a 12/12/12).

Office space for management was observed to limited in some cases, with the principal of one campus using the allocated 'teacher preparation' room for an office (W.g 10/8/12). Learning support roles, such as education support officers and school services offices, were also reported as needing more dedicated areas (Q83 and Q84 responses).

6.5.1 Perspectives of school toilets

School toilets are a sensitive area, so students and staff were asked neutrally to comment about their toilets in an open question. This question provoked a good response rate, with around 80% of students and staff providing a response (Appendix L.19.1).

Because the question was phrased generally, a wide range of responses was received and the consequent coding used three coding levels, not two as in previous coding strategies. The first exploratory post-code was used to develop response type (observations vs. suggestions) and response categories (built environment vs non-built environment). Students responded mostly with general and specific observations, but behaviour and suggestions also featured, whereas staff responded with observations and suggestions (Table 6.58).

Table 6.58: Q78 Toilets – Students and Staff – response type code frequency

	Students		Staff	
Response type code	**Code frequency**	**Percentage**	**Code frequency**	**Percentage**
observation - general	124	49.8%	28	24.1%
observation - specific problem	67	26.9%	22	19.0%
behaviour - others	22	8.8%	1	0.9%
behaviour - own	1	0.4%	1	0.9%
suggestion for action	35	14.1%	20	17.2%
total	*249*		*116*	

Figure 6.63 shows the category coding of responses. While students responded most frequently with suggestions about the daily management of the toilets, together with many descriptions of their toilets, staff were more concerned about the capacity of the toilets. Both staff and students commented about ventilation.

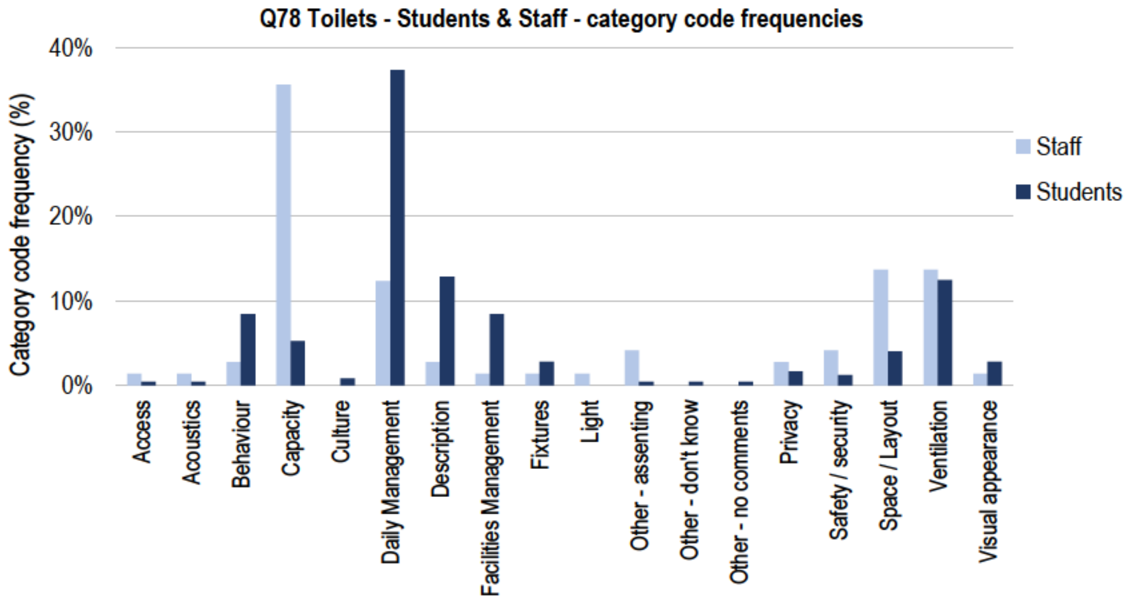


Figure 6.63: Q78 Toilets – Students and Staff – response type and open question category code frequency

Detail codes with the highest frequencies for students and staff are presented in Table 6.59 and Table 6.60, respectively, with all detail codes available in Appendix L.16. The highest student detail codes were generally negative about cleanliness, smell, consumables (toilet paper, soap, etc.) used to create mess, and perceived issues with toilet waste. Some students did comment that they perceived their toilets positively (8). Number of toilets and basins, and space, were perceived to be problematic (11) with some students indicating that they were too tall for fixtures and cubicles as designed. These are all consistent to some extent with observations detailed in Section 4.5.3.8; however, while some toilets were observed to be messy, the fabric itself was not significantly dilapidated, suggesting that user opinion and student opinion may diverge.

Table 6.59: Q78 Toilets – Students – response type and detail codes ≥ 6

response type code	Category code – detail code	Yellow	White	Orange	Red	Total
observation - general	Daily Management - dirty (slightly to very) / not clean	4	**12**	7	8	**31**
observation - general	Description - negative -'bad','unhygienic','disgusting' etc.	3	**8**	**8**	**8**	**27**
observation - general	Ventilation - unpleasant smell	1	8	**10**	7	**26**
observation - specific	FM - damage to walls	**8**	1	3	1	**13**
suggestion for action	Capacity - more pans, basins needed	2	3	**6**	0	**11**
suggestion for action	Daily Management - need cleaning / to be cleaner	0	2	**6**	3	**11**
observation - general	Daily Management - clean / mostly clean	1	**4**	2	1	**8**
observation - specific	Daily Management - consumables - on floor, ceiling	1	0	**5**	2	**8**
observation - specific	Daily Management - consumables - poor quality, not available	1	2	**5**	0	**8**
observation - specific	Daily Management - sewer waste not in pan / urinal	**3**	2	2	1	**8**
behaviour - others	Behaviour - others - toilet paper thrown around	0	0	**5**	2	**7**
behaviour - others	Behaviour - others - vandalism, graffiti	1	**2**	**2**	1	**6**
observation - specific	Daily Management - wet floor; taps leaking, left on	1	**2**	1	**2**	**6**

Staff were asked to comment about both staff and student toilets. Of the responses, approximately one third each were about student toilets and staff toilets specifically, with the remaining responses not specified or implied. For staff the main issues were capacity, location, daily management, and lack of ventilation. Issues with capacity are consistent with possible lack of availability and queueing as calculated in 4.5.3.8

Table 6.60: Q78 Toilets – Staff – response type and detail codes ≥ 4

response type code	Category code – detail code	Yellow	White	Orange	Red	Total
suggestion for action	Capacity - more pans, basins needed	0	**10**	6	3	**19**
observation - general	Ventilation - unpleasant smell	0	**5**	3	1	**9**
observation - specific problem	Space / Layout - not distributed around school	0	1	0	**4**	**5**
observation - specific problem	Capacity - queue / crowding	0	0	**3**	1	**4**
observation - general	Daily Management - clean / mostly clean	**3**	1	0	0	**4**

Some comments were emotive in their tone. The following comments are taken from all case study schools and are typical of the management and maintenance issues present in school toilets:

> There are a lot of spiders; They're dirty; Vandalised and a barren wasteland of smelly gross things.

> (W.Stu30);
>
> They are a bit unclean, but also the basins and mirrors and toilet stalls are for smaller children. I can see over the toilet stall (not directly at the toilet, but to the wall) and when I look at the mirror my shoulders and head aren't visible. (W.Stu29);
>
> dirty. smelly (sometimes). wet (sometimes). needs to be cleaner. more sanitary bins. (R.Stu129);
>
> The toilets smell and have pee every where and poo on walls and bad words on walls and door. (O.Stu116);
>
> People scratch rude things in there, pee on the seats and floor and don't flush (Y.Stu14).

These comments were consistent with some of observations described in Section 4.5.3.6.

Some students also had firm opinions on their toilet design:

> boring, old fashioned (O.Stu108);
>
> I would [like] better toilets like the ones at the shops. (O.Stu96);
>
> Our toilets are a bit dirty because of the younger kids. I think it would work better if we had separate toilets for younger and older students. (R.Stu130).

Thus, though the toilets studied are contemporary in architectural age, they seem to be aging quickly and do not compare to other non-residential buildings where students use toilets.

6.6 Latent variable extraction

Exploratory Factor Analysis was applied to all scale questions to test for underlying constructs (also see Section 3.5.7.3). Only the student responses were used in the following analysis because the number of staff responses was not enough to try meaningful factor extraction.

To maximise the reliability of the analysis data was investigated using the following principles for the exploratory Principal Components Analysis (PCA):

- since factor analysis relies on correlation, all variables without significant (p<0.05) and moderate correlation (R^2<±0.3) were omitted;
- factor analysis also relies on the ratio of participants to responses (Pallant 2011, p. 183) (Costello & Osborne 2005)). To maximise the number of cases available, variables with low response were omitted;
- Principal components analysis was originally used to test for the possibility of factors. Initial principal components analysis used both scree plot as a visual selection tool and parallel analysis as confirmation;

- Oblique rotation used for all analysis;
- Variables with low communalities were removed due to their lack of contribution to common variance of a group of variables;
- Common sense and intelligibility was used for interpreting factor loadings (Maroof 2012, p. 33).

After a PCA with all variables, it was found that there were likely four to five factors.

Analysis was then repeated with principal axis factoring (PAF) to remove common variance (Costello & Osborne 2005; Tabachnick & Fidell 2001). The PAF was repeated heuristically with different forced factors and oblique rotation (SPSS OBLMIN) and each result evaluated for internal logic. There were 38 five point scale variables to consider but seven were removed due to low correlation (<0.3) with other variables leaving 31 variables to consider. This factor forcing and removal of communalities are summarised in Table 6.61.

Table 6.61: Heuristic Principal Axis Factor passes of student surveys

Passes	Forced factors	Number Vars	Surveys	Par/Var Ratio	Kaiser-Meyer-Olkin sampling adequacy (>0.6 OK)	Commun -alities <0.3	Total extracted loading	Pattern matrix
First	5	31	147	4.7	0.784	12	39.9%	7 vars loaded on 5th factor Illogical loadings
Second	6	31	147	4.7	0.784	9	42.6%	5 vars loaded on 6th factor Illogical loadings
Third	5	21 (10 vars in first pass removed)	147	7	0.869	1	49.6%	3 vars loaded on 5th factor
Fourth	6	24 (6 vars in second pass removed)	147	6.1	0.843	2	49.0%	3 vars loaded on 6th factor

Of the above analysis, the third pass was considered the most promising, in terms of being internally consistent and logical. The full matrices are shown in Appendix K.31, with the extracted loadings summarised in Table 6.62. Factor 1 providing the highest loading towards describing the common variance (31.9%), whereas factors 2 to 5 provide less than 7% loading in each case, and a total 17.7% contribution to the total variance explained.

The summary pattern matrix is shown in Table 6.63 with loadings less than 0.3 removed for clarity. The variable loadings for each factor fit into logical groupings, i.e., the factors demonstrate internal consistency, and descriptive names based on the variables were given to each factor for convenience. Factor 1 ‘Wellbeing’, covers a collection of health and safety variables. Factor 2 ‘Smell’, Factor 3 ‘Acoustics’, Factor 4 ‘Vision’, and Factor 5 ‘Satisfaction’ are self-explanatory.

Table 6.62: Total variance explained factors extracted from student data (PAF with forced five factors, truncated table)

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.175	34.169	34.169	6.705	31.929	31.929	5.058
2	1.736	8.265	42.433	1.351	6.435	38.364	4.447
3	1.548	7.370	49.803	1.062	5.055	43.419	2.512
4	1.317	6.270	56.073	.786	3.742	47.161	3.329
5	1.023	4.873	60.946	.520	2.478	49.640	2.484

Extraction Method: Principal Axis Factoring.
a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 6.63: Summary pattern matrix for factors extracted from student data (PAF with forced five factors)

Pattern Matrix[a]

	Factor				
	1	2	3	4	5
	Factor names (applied post-hoc)				
	Wellbeing	*Smell*	*Acoustics*	*Vision*	*Satisfaction*
School buildings are healthy (Q19)	.882				
Buildings good for learning (Q18)	.651				
Buildings are safe (Q17)	.645				
Buildings are clean (Q14)	.604				
Buildings are well maintained (Q16)	.595				
Easy to save water (Q22)	.408				
Easy to save energy (Q21)					
Winter air smells dirty (Q44)		.917			
Summer air smells dirty (Q40)		.798			
Winter air is stale (Q43)		.695			
Summer air is stale (Q39)		.613			
Teacher needs to raise voice (Q34)			.552		
Easy to understand speech (Q31)			-.535		
Noise is loud (Q30)			.376		
Views are calming (Q65)				.653	
Views are attractive (Q64)				.520	
School is sustainable (Q10)				.427	
Lighting helps learning (Q53)				.356	
School buildings are interesting (Q15)					-.706
Student satisfaction with school (Q92)					-.464
Proud of school buildings (Q20)	.333				-.387

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.a
a. Rotation converged in 33 iterations.

These factors were derived using oblique rotation of axes, i.e., the optimised variable groups forming each factor require axes that are not orthogonal. As such, there is the possibility for correlation between the factors. The factor correlation matrix in Table 6.64 shows the factor with the highest loaded factor, Wellbeing, is correlated (>±0.3) with all other factors (with rounding). This is logically consistent given the nature of the variables and factors, but the correlations are not particularly high, i.e., the correlation is low enough for Wellbeing and Smell to be two separate factors, albeit with some association. Similarly, Wellbeing and Vision are two distinct factors, but are connected.

Table 6.64: Factor Correlation matrix for factors extracted from student data (PAF with forced five factors)

Factor Correlation Matrix

Factor names		***Wellbeing***	***Smell***	***Acoustics***	***Vision***	***Satisfaction***
	Factor	**1**	**2**	**3**	**4**	**5**
Wellbeing	**1**	1.000	-.490	-.298	.421	-.311
Smell	**2**		1.000	.318	-.365	.232
Acoustics	**3**			1.000	-.246	.239
Vision	**4**				1.000	-.335
Satisfaction	**5**					1.000

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

This group of variables was designed to focus on the fixed built environment. One other known factor analysis of student perspectives included additional variables associated with loose furniture, various ICT components, and specific building components, such as a bulletin board (Leung & Fung 2005). Although the extraction method used is not stated, this Hong Kong study of year 5 and 6 students (*N*=750), extracted factors to cumulative loading of 49.98% (cf. 49.64% in Table 6.62). The loadings were more evenly spaced than above, with the top two factors associated with furniture and circulation, and teaching tools, i.e., items that students interact with closely. The results in this inquiry are consistent with the third and fourth factor with 'light and ventilation' and 'comfortable atmosphere', where 'wellbeing' in this inquiry is similar to the latter factor.

The extraction of these factors, apart from providing additional contribution to the inference of student's perspectives of their school built environment, also provides some confidence in the validity of the data collected as a representation of a sample of school students as a single population, rather than on a case-by-case basis. Had student responses been remarkably different across the cases then these factors could not be extracted. The extraction of a dominant factor, Factor 1, named here as Wellbeing (32% variance), suggests that this is an important construct for the students within the sample.

6.7 Summary

To respond to research question 4, this section presented the user perspectives of the case studies at the school and classroom level. Perspectives were collected from 147 students and 44 staff across all the case studies using a survey test instrument developed specifically for this inquiry. The perspectives were analysed in the context of architectural and use observations (Chapter 4), and environmental monitoring of selected case study classrooms (Chapter 5), so as to create rich and rigorous interpretations (Teddlie & Tashakkori 2009, pp. 301-303).

It was found that users saw their schools as unique for a variety of reasons, some of those included the buildings and grounds. Both staff and students were aware of their school buildings architecture as broad form categories, and, in the case of the heritage-looking buildings, associate their buildings with age and history. When asked what they liked, staff liked their buildings and students liked their grounds, suggesting a demarcation of preference possibly associated with use. Perspectives of maintenance predicted student perspectives of safety and health. Perspectives of cleanliness predicted perspectives of health in both cohorts, suggesting that the state of facilities does indeed have consequences on wellbeing, as suggested by previous studies (Section 2.3.5).

Students' perception of sustainability was predicted by perspectives of ease of energy saving, together with maintenance. In open response students identified sustainability with their grounds and their own actions over demonstration appliances, although there was awareness of these elements. Students recalled operation of HVAC and other building elements, but they also recalled staff resorting to propping open doors to increase ventilation when the automatic windows were not operating, thus questioning the value of modelling behaviour available with automatic control of indoor climate, where modelling behaviour is assumed to be an effective teaching tool.

Staff reported a range of interpretation of their pedagogy, which is at odds with the simpler pedagogy described in design statements from architects. At the level of classrooms, students reported that they spent much of their time at their desks, working alone, in groups or on a laptop. ICT is important, and students liked their interactive whiteboards. Teaching and learning seemed to occur mostly at desks, and in rectilinear rooms. Staff preferred this shape to other hypothesised shapes, seeing it as providing more flexibility and visibility. Integrated space flexibility, such as operable walls and sliding doors, were reported as mixed use, with sliding doors being operated more often than operable walls, as observed. Regardless of shape or other flexibility, the classrooms were seen, by both cohorts, as being too small.

Display space was also seen as limited and staff reported that they used all surfaces and overhead wires, as observed, and confirmed the different purposes different display had, as hypothesized.

Students were found to have lower awareness of smell and air quality in classrooms than teachers, but were very aware of smell in toilets, where their strong responses suggested an emotional component. Staff felt significantly hotter in summer than students. When comparing students' recollections of summer and winter temperatures against the monitored temperature, the mean temperatures did not align with the recalled memory of temperatures. The preferences for a cooler classroom in summer was consistent in all student and staff responses. In winter students preferred a warmer classroom, but staff were neutral. Temperature control was seen as problematic in some rooms and some staff thought it affected the students.

There were concerns about lighting design, some concerns about control in general, particularly for use of IWBs. Where blinds were installed they were reported as being down constantly, so that there was less daylight than preferred by students. This demonstrated the conflict observed earlier between the design advice to provide good levels of daylight, and the need to control light for use of technology.

Both cohorts indicated that they preferred quieter classrooms, with staff reporting that they had to raise their voice more than students to be heard. Concerns around the level of noise in double classrooms were expressed, despite no measured difference in sound level, and obvious acoustic design modification. This suggests that there are speech intelligibility problems that need further investigation.

When factor extraction was applied to student scale variables, factors that were both logical and surprising were extracted. These factors were logical in that the variables could be group together easily to form a logical construct. In this case a strong factor was extracted around wellbeing, with others 'loaded' on 'smell', 'acoustics', 'vision', and 'satisfaction'. This was surprising in that, first, the data collected fell neatly into these factors and, second, the principal factor extracted was associated with feelings rather than a visual perspective, as might be expected in an architectural study. This suggests that for ten to thirteen year olds, school infrastructure prompts an emotional response and indicates that design is more important than mere functionality or safety for teaching and learning. The next section collates the findings in this section into a framework to express the meta-inferences found in this inquiry, and suggest their application in professional design.

7 Discussion

7.1 Introduction

Chapters 4 and 5 presented the architectural and environmental context for each case study. Elements of the architecture and aspects of the measured environment were compared across the case study schools to identify similarities and differences of the observed physical environment. While these evaluations used scholarly methods, the interpretation of the presented for each element is analogous to 'expert' post-occupancy evaluation (Barrett et al. 2013; Ornstein & Ono 2010) in that it is undertaken from the perspective of someone with expertise in buildings and who is not a regular user of the case study buildings. Chapter 6 presented the findings from the users, comparing the participants as staff and student cohorts, and across the case study schools. Each finding was related back to the school contexts presented in chapters 4 and 5 to identify trends and create pictures of perspectives of the users towards their school architecture. Referring to the mixed method research map (Figure 7.1), this chapter brings together all data types and analysis methods and discusses the overall meta-inferences.

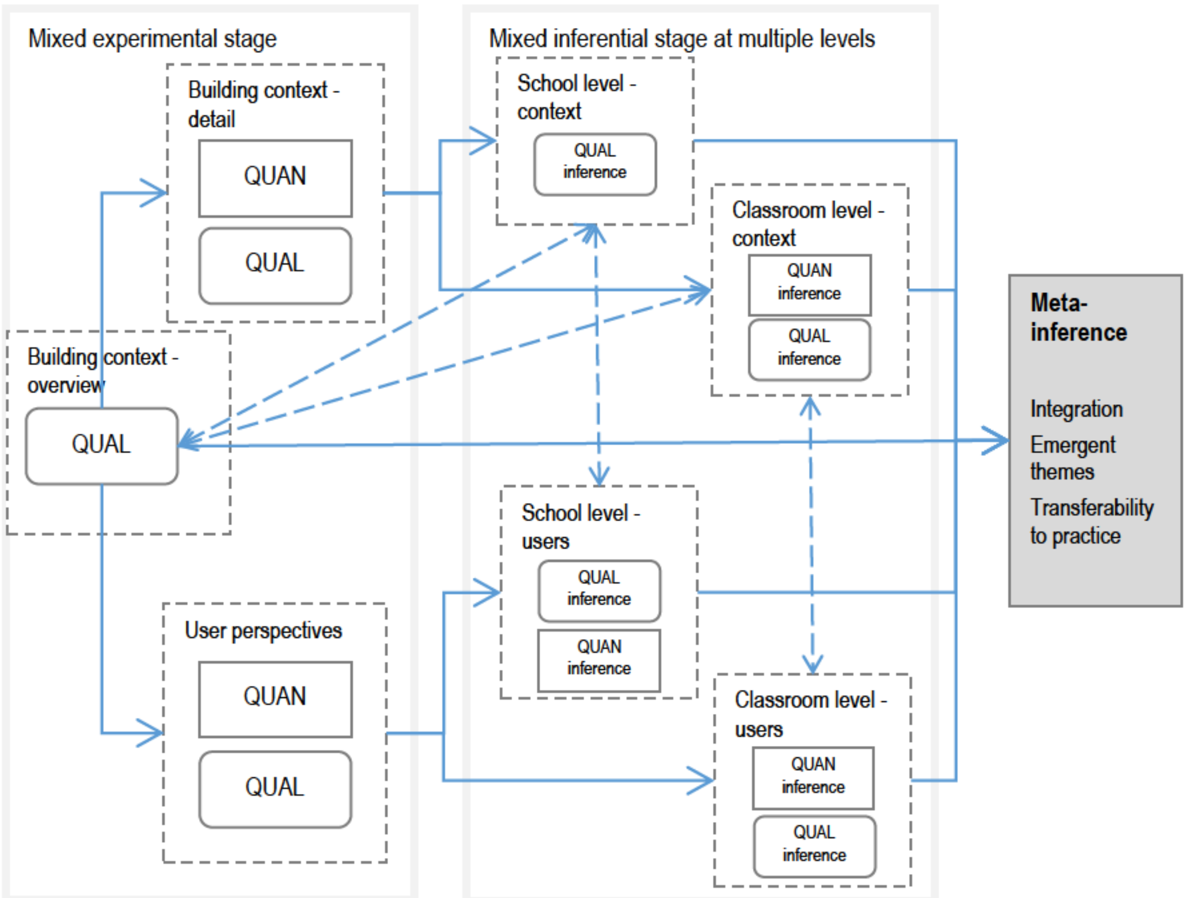


Figure 7.1: Meta-inference section located on the mixed method research map

7.1.1 Meta-inference

The objective of research question four was to explore user perspectives of the selected case studies, *their* primary schools. While the research design draws on other building performance evaluation methods, this inquiry has been designed to bring user interpretations to the fore. As such, the structure of the findings does not necessarily derive from sources reported in the literature review or the literature review structure itself. Rather, the intention is to report the findings as a whole using a structure grounded in the data and summarised according to the induced themes.

The exploratory nature of this inquiry relies largely on, but not solely, induction to create knowledge (Erzberger & Kelle 2003). During the coding process the collected user data developed clear themes (Robson 2002, p. 484), and this was triangulated against the quantitative data and observed architectural context. To rise above the case by case and element by element comparison, further triangulation, or meta-inference, sought global emergent themes within and across the data based on grounded theory (Liamputtong & Ezzy 2005, p. 265), with the intention of generating theory that is specific to this data set (Flyvbjerg 2006). The quality of the integrated findings, or meta-inference, was based on a mixed methods inference quality framework (Teddlie & Tashakkori 2009, pp. 301-302).

There were two starting points. During the analysis of user perspectives of individual topics in the previous chapter, it became clear that there were differences between the student and staff cohorts (Section 7.2), with the differences in cohorts often oriented around differences in what is seen and used by each cohort (Section 7.2.1.1). What was used was further related back to pedagogical theory introduced in the literature review (Section 2.2.2), in particular, the assumed level of interaction of the built environment with learning and teaching. This was extended to include an additional aspect of designed 'activeness' pertinent to the design professional (Section 7.2.2).

The second point of departure was the result of factor analysis using the student results (Section 6.6). From the literature (Section 2.3) it was expected that variables relating to visually explicit aspects of the built environment, such as buildings as landmarks, would be prominent in the first factor loading; however, this was not the case. The first factor showed that responses from the participant student cohort were centred around a construct consisting of variables asking about perspectives of building fabric quality as it reflects back onto student wellbeing, where wellbeing (also well-being) is defined as 'good or satisfactory condition of existence; welfare' (Macquarie Dictionary 2015).

Based on this, and the previous cohort differences, the data set was triangulated to test for themes based around different user needs and interactions, and the consequent perspectives of the quality of the building fabric during interactions (Section 7.3). This recognises that the same built environment has many interpretations. This triangulation process was an iterative process in which findings from user variables were systematically compared and contrasted to each other and to the case study context (Yin 2008, p. 129). An array demonstrating this process can be found in Appendix M. The final quality themes, functional, wellbeing, visual and place, and environmental, are mapped against user variables in Table 7.1.

In the systemic building-occupant approach, these cohort and quality themes are complex and interlinked. The quality components presented are neither independent constructs, nor do they represent a self-contained model of the quality of architecture. Rather, the thematic components presented below are intended to present evidence collected in this inquiry in a manner that facilitates fast interpretation for use in practice. The chapter concludes in Section 7.4 with implication and application of these emergent to design practice.

Table 7.1: Summary triangulation array of user perspectives (full array in Appendix M)

Section	**Title**	**Final themes** Triangulation ■ Triangulation expected but missing □					
		Cohort differences	Built environment interaction	Functional Quality	Wellbeing Quality	Visual and place Quality	Environmental Quality
6	User perceptions						
6.2	Student and staff participant characteristics						
6.2.2	Satisfaction with school and work (Q92)					■	
6.3	Perspectives of the school built environment						
6.3.1	Perspectives of school uniqueness (Q09)	■	■	■		■	□
6.3.2	Perspectives of school buildings and grounds						
6.3.2.1	School buildings as contributing to teaching and learning (Q59a)			■			
6.3.2.2	School buildings as place and architecture						
6.3.2.2.1	*School buildings as attractive is important (Q28)*	■			■	■	
6.3.2.2.2	*School buildings as landmarks (Q13)*	■				■	
6.3.2.2.3	*School buildings as interesting (Q15)*	■	■			■	
6.3.2.2.4	*Pride in school buildings (Q20)*				■	■	
6.3.2.2.5	*School buildings as architecture* *School buildings as good architecture (Q13a)* *School architecture typology multiple choice (Q23-27)*					■	
6.3.2.2.6	*What is liked about school buildings (Q29)*	■	■	■		■	
6.3.2.3	School buildings as functional space Good for learning (Q18) Good for teaching effectiveness (Q18a) Matched pedagogy (Q18b)	■	■	■	■	■	□
6.3.2.4	School buildings as healthy and safe space						
6.3.2.4.1	*Cleanliness (Q14)*			■	■		
6.3.2.4.2	*Maintenance* *Well maintained (Q16)* *Building problems fixed quickly (Q16a)*				■		
6.3.2.4.3	*Safe Buildings (Q17)*	■			■		
6.3.2.4.4	*Healthy buildings (Q19)*	■		■	■		
6.3.2.5	School redesign preferences (Q83)	■	■	■	■	■	
6.3.3	School as community asset (Q88a)						

Section	Title	Final themes Triangulation ■ Triangulation expected but missing □					
		Cohort differences	Built environment interaction	Functional Quality	Wellbeing Quality	Visual and place Quality	Environmental Quality
6.3.4	Perspectives of school sustainability School is sustainable (Q10) Expected (Q11) and experience (Q12) Saving energy easy (Q21) Saving water easy (Q22) Discussed in lesson (Q68-77)	■	■	■		■	■
6.4	Perspectives of the classroom environment						
6.4.1	Teaching and learning in the classroom space						
6.4.1.1	Pedagogy and learning activities Student learning activities (Q01-08) Teachers/staff describe pedagogy (Q01)			■			
6.4.1.2	Classroom contribution to teaching and learning (Q59)	■	■	■	■		
6.4.1.3	Teaching and classroom shape (Q121-130)			■			
6.4.1.4	ICT in the classroom Importance of ICT in current teaching (Q66) Importance of ICT in current teaching (Q67)			■			
6.4.2	Classroom design						
6.4.2.1	The importance of a well-designed classroom (Q58)	■	■	■			
6.4.2.2	Classroom size (Q62)	■	■	■			
6.4.2.3	Classroom Views – attractive (Q64) Classroom Views – calm (Q65)			■	■	■	
6.4.2.4	What occupants like	■	■	■	■		
6.4.3	Classrooms as dynamic space						
6.4.3.1	Matching space with teaching and learning (Q61)	■		■			
6.4.3.2	Moving furniture (Q63)			□			
6.4.3.3	Internal doors and operable walls (Q138-147)			■			
6.4.3.4	Dynamic display Display (Q131-137) Display use windows (Q138)			■			
6.4.4	Classroom thermal, light and aural environment						
6.4.4.1	Perceived temperature and ventilation (Q37-45)	■		■	■		■
6.4.4.2	Perceived light quality (Q53-57)	■		■	■		
6.4.4.3	Perceived sound quality Q30-36	■		■	■		
6.4.4.4	School building components as environmental modelling tools Other comments – temp/vent control (Q115) Students (Q46-52) Other comments – what students see (Q52)			■	■		■
6.4.5	Classroom redesign preferences (Q84)	■	■	■			
6.5	Spaces other than classrooms						
6.5.1	Perceptions of the toilets (Q78)	■			■		
6.6	Latent variable extraction Five constructs: Wellbeing Smell Acoustics Vision Satisfaction	N/A	N/A	■	■	□	□

7.2 Cohort differences and interactions

7.2.1 Cohort differences

In this inquiry there were differences observed in the responses of students and staff (Table 7.2). This could be explained by the convenience sampling or the low numbers of staff participants (*N* = 44) as compared to the student participants (*N* = 147), however the sampling rate over all schools is relatively similar for staff and students (28.7% and 26.8%, respectively) when related back to the total population of the participant student years and school staff. This difference is consistent with assertions that built environment users are not uniform in their needs (Moore 1979, p. 50).

Table 7.2: User perspectives relating to cohort differences (full array in Appendix M)

Section	**Title**	**Final themes** Triangulation ■ Triangulation expected but missing □
		Cohort differences
6	User perceptions	
6.3	Perspectives of the school built environment	
6.3.1	Perspectives of school uniqueness (Q09)	■
6.3.2	Perspectives of school buildings and grounds	
6.3.2.2	School buildings as place and architecture	
6.3.2.2.1	*School buildings as attractive is important(Q28)*	■
6.3.2.2.2	*School buildings as landmarks (Q13)*	■
6.3.2.2.3	*School buildings as interesting (Q15)*	■
6.3.2.2.6	*What is liked about school buildings (Q29)*	■
6.3.2.3	School buildings as functional space Good for learning (Q18) Good for teaching effectiveness (Q18a) Matched pedagogy (Q18b)	■
6.3.2.4	School buildings as healthy and safe space	
6.3.2.4.3	*Safe Buildings (Q17)*	■
6.3.2.4.4	*Healthy buildings (Q19)*	■
6.3.2.5	School redesign preferences (Q83)	■
6.3.4	Perspectives of school sustainability School is sustainable (Q10) Expected (Q11) and experience (Q12) Saving energy easy (Q21) Saving water easy (Q22) Discussed in lesson (Q68-77)	■
6.4	Perspectives of the classroom environment	
6.4.1	Teaching and learning in the classroom space	
6.4.1.2	Classroom contribution to teaching and learning (Q59)	■
6.4.2	Classroom design	
6.4.2.1	The importance of a well-designed classroom (Q58)	■
6.4.2.2	Classroom size (Q62)	■
6.4.2.4	What occupants like	■
6.4.3	Classrooms as dynamic space	
6.4.3.1	Matching space with teaching and learning (Q61)	■
6.4.4	Classroom thermal, light and aural environment	
6.4.4.1	Perceived temperature and ventilation (Q37-45)	■
6.4.4.2	Perceived light quality (Q53-57)	■
6.4.4.3	Perceived sound quality Q30-36	■
6.4.5	Classroom redesign preferences (Q84)	■
6.5	Spaces other than classrooms	
6.5.1	Perceptions of the toilets (Q78)	■
6.6	Latent variable extraction Five constructs: Wellbeing Smell Acoustics Vision Satisfaction	N/A

In general, students were observed to judge their school buildings more positively than staff. The exceptions were architectural aspects such as buildings as 'interesting' (Q15, Figure 6.9) or as a 'landmark' (Q13, Figure 6.8). Students tended to judge their classrooms as having fresher and cleaner smelling air than staff (Q39, Q40 in Figure 6.48 and Figure 6.49), but were more critical of smells in toilets (Q78, Figure 6.63). The differences in perception of air freshness and smell suggest that staff and student cohorts have either different olfactory response development (Auffarth 2013), or differently models of cleanliness (Shove 2003, pp. 86-88).

Students also judged classrooms to be cooler in summer than teachers did, but both cohorts judged the winter temperatures to be neither hot nor cold. This is not an unusual finding, given the inconsistent results in comfort studies of children (section 2.3.5.2).

Students were less judgemental about noise levels relative to staff, with staff reporting that they had to raise their voice and had problems with lack of understanding (Q34 in Figure 6.56 and Figure 6.57). Furthermore, staff reported more awareness of noise from adjacent rooms than students reported. Judgement of light was, however, different. Both cohorts provided similar responses except, in this case, students were less positive about artificial lighting (Q56 in Figure 6.53 and Figure 6.54).

Responses to open questions also highlighted the different user experiences. Students tended to respond by listing problems or simple suggestions, whereas staff tended to identify implications of the problem and/or propose solutions. For example, when asked what they would redesign in the classroom (Q84, Figure 6.62), students tended to respond with direct instructions such as 'more space' (Y.Stu14), 'Make it a bit bigger' (W.Stu28), 'larger classroom' (O.Stu94), and 'larger space' (R.Stu144). In the same question, on the same topic of size, staff tended to elaborate more such as 'larger. single classrooms with ability to merge...' (Y.Sta1), 'enlarge by about 1/3' (O.Sta30), 'Larger classroom space, wet area in all classes...' (R.Sta41).

It has been hypothesised that observer differences, generally (Gifford & McCunn 2013), and differences between adult and child, specifically (Higgins et al. 2005, p. 13) should exist, and this inquiry is consistent with this assertion. This is consistent with different perception development capabilities due to age (Baird 1982), and different environmental cognitive capabilities (Moore 1987) due to participant age.

Similarities between student and staff responses were also found. These occurred within case study schools when participants commented on acoustics (Q36, Figure 6.58); Yellow School students blamed the high ceilings '...so the noise travels easier and it echoes' (Y.Stu1) and the noise from the adjacent class for high noise levels and distraction (Table 6.53), whereas Yellow School staff identified 'high ceilings...' (Y.Sta2) as contributing to noise issues, but also noted that the electronic voice enhancement aided teaching (Y.Sta1). In contrast, in a classroom of similar volumetric configuration, Red School students did not mention their similar high ceilings as a source of a noise problem; rather, Red Students reported that 'every class has many acoustic panels on the walls...' (R.Sta5), as did Red Staff. Red Staff also mentioned the acoustic treatment as part of what they liked about their classroom:

> 'High open ceilings. The sound / baffle boards made an enormous difference to echo and sound acoustics when installed …' (Q60, R.Sta41).

The similarities of the physical explanation of these responses is suggestive of class conversations about sound that create a similar narrative or sense making about their built environment, suggesting the effects of a group culture forming between the two cohorts via their artefacts (Schein 1985, p. 23), or staff-student socialisation, similar to that reported in sustainability education (Sund & Wickman 2011b).

While acknowledging some common narratives, the consistent cohort differences serve to reinforce the somewhat obvious conclusion that different groups use school infrastructure. As banal as this statement might be, it has significant consequences since it suggests that the built environment performs differently for different user populations. Furthermore, any building evaluation must identify the differences and how this might skew the building performance evaluation. This is further reinforced in the next section which explores the cohort difference between different levels of interaction with the built environment, specifically what is seen and used.

7.2.1.1 **Seen versus used**

The user awareness of the Architecture, as a whole, and individual architectural elements, was of interest to determine the perceptions of the quality of the built environment (section 2.3.2). Since all participants were sighted, what was seen, and what was seen by different cohorts was of interest. In this data set the data presented responses that collected together around different interaction types, i.e., what was seen and what was used. Aspects were considered to be predominately seen when they were either visual, such as a specific visual description, or the question referred to a visual aspect, such what school 'looks' like, or it was deduced that there could be no interaction with a component directly, such as photovoltaic panels on a roof. Aspects that were considered to be 'used' were those which elicited a more corporeal response to being within a space, referred to a participatory play or learning action in a space, or any other physical interaction with the space. In the following discussion two examples, place and sustainability, are used to clarify this interaction type dichotomy.

When users were asked about whether it was important for schools to look attractive, responses were predicted by student perspectives of maintenance and staff perspectives of buildings looking interesting, but both with small contribution to variance (Q28, Table 6.6). This suggests that students and staff see 'attractiveness' of schools differently, where students see it though how the school is maintained against use, while staff understand it more in terms of its design intentions. The lack of contribution to variance suggests that this cohort, using this test instrument, does not have high awareness of architectural attractiveness, or attractiveness is not a high priority in the context of school operations.

This is not to say that there is no awareness of the built environment. The unique building forms of the case study schools were recognised by users (Figure 6.12), which is consistent with small studies of architectural styles perception testing of adults (Oostendorp & Berlyne 1978). Case study schools were considered to 'look like some office buildings' by some students but not by staff, suggesting that adults have a different architectural typology for office buildings than students. Some participants indicated that their buildings looked different to the architectural typologies offered for selection (Q27, Figure 6.13), with students citing their grounds as looking or being different, such as '…our oval is a community oval not our oval' (O.Stu101) or 'it's broken up into [a] unique layout' (W.Stu45). Students also made comments about the architecture forms that were consistent with those observed, such as '…very mixed up…antique yet modern..' (Y.Stu21), 'it has weird shapes for the roofs…' (W.Stu51), '…it looks like you could building [sic] a car in it.' (W.Stu65). Staff cited various building elements as looking different, such as 'metal "chimney" pipes. rammed earth walls' (O.Sta38) or 'old stonework…' (Y.Sta1), suggesting that the difference in what is seen depends on the familiarity of the user with built environment knowledge. Despite this, both students and staff perspectives of the school as a landmark were predicted by their perspectives of the school buildings as boring or interesting, suggesting that, when school is considered on a larger urban scale, there is some awareness that is congruent in language with designers. However, the contribution to variances was low for students and high for staff, again suggesting that staff have more awareness of built environment as a viewed experience (Q13, Table 6.7).

This cohort difference is further emphasised in questions about the outside of the school. When asked what users liked about their school buildings and grounds, students described aspects of the built environment they used, whereas staff described the visual appearance of the built environment they saw (Q29, Figure 6.14). Student like their grounds more than their buildings, particularly their play areas and gardens (Q29, Table 6.13):

> Grass area, so we can sit with friends, chat and it's safe … someone trip over it wont hurt as much [sic] (Q29, W.Stu28);
>
> The little gardens we have around. (Q29, O.Stu88);
>
> Big oval to play sport on and fun playground (Q29, O.Stu90);
>
> New playground. Plenty of space. Plants. Benches. (Q29, R.Stu126).

If they could, students would choose to redesign grounds over buildings (Q83, Figure 6.23). This is consistent with other studies where students highlighted outdoor space in open question formats (Barrett et al. 2011, p. 119).

Staff liked the visual appearance of the older buildings and the form and the colour generally ('the heritage look combined with the modern glass addition…' Y.Sta3; 'the old style', R.Sta138, Q29) (Table 6.14), and while they, too, would like to redesign the school grounds, they would also like to redesign the visual appearance, site plan and safety of their school (Figure 6.23). This again suggests there are differences in responses based on what is used and what is seen, with students expressing preferences more about their territory in the school grounds, whereas staff responding more towards what designers might expect, and expressing preferences about visual appearance, but with some concerns about urban design factors such as site planning and safety.

Inside the classroom, students and staff responded as similar rates for 'liking' the visual appearance of the interior of the classroom (Q60, Figure 6.42), but response rates differed by classroom elements that staff and students used. Students liked the computers and interactive whiteboard and furniture, whereas staff liked the fixtures, and, where applicable, the space and layout, and windows, proportionally more than students:

> I have decent space for yr 4 chn [children] to have tables and a floor space. (but I am in a transportable). I have a large whiteboard and pinboards. clean carpets (W.Sta18);
>
> Feeling of space. Windows – I can see tress & sky. Colour – chair bags, Chn's art. Matching furniture (O.Sta36).

These align with what the different population use, in that staff use shelves and cupboards more than students and are more aware of classroom layout to meet pedagogy, whereas students spend much of their time viewing the interactive whiteboards.

The alignment between what was liked and what could be redesigned within the classroom was less obvious than the responses to these questions about the school and grounds. Both students and staff expressed a wish to increase the size of the classroom (Q84, Figure 6.62). Students would also redesign the IWB and the furniture ('The furniture and technology. More modern and up to date', O.Stu115), coinciding with what was liked, but some also nominated design and visual appearance for change ('Not orange walls…' W.Stu72). Staff also wanted to change the fixtures ('more shelving, re-arrangeable shelving', W.Sta8), and the space and layout possibilities, together with services components ('Larger. Better light and temp control. Wet areas. Flexible panels for display', W.Sta5). Since students nominated visual aspects, such as classroom design and visual appearance, in addition to the interactive white board, this suggests that students are aware of visual interior design.

In addition to inferred use or viewing, the absence of responses also provide knowledge. For students only, the latent factors, or constructs, extracted in Section 6.6 are notable in the absence, or low priority, of variables about a building's Architecture. Variables, such as buildings being landmarks, do not contribute to a construct factor for this data set. Rather, the focus of this data set is on items that have been grouped as being part of contemporary workplace health and safety (or learning place for the student cohort) concerns suggests that fabric is noticed for its cleanliness qualities, i.e., the functional small 'a' architecture. This result has a number of interpretations. First, the Architecture of the case study schools may not be considered memorable, however, students at schools do recall specific components when specifically asked in open questions. Second, students do not understand the different components and fabric of buildings, so do not respond as expected by a visually focussed and architecturally educated audience (Parnell et al. 2008).

Third, it is possible that students recall perceived quality factors of the fabric that is used, more easily than the aesthetics of architecture, whereas staff have a perception of 'architecture' that is closer to the professional sense of the word that what students do. This would be consistent with the aesthetic perceptual development models (Baird 1982).

7.2.2 Active and passive interaction with the physical environment

The intention of schools to provide a suitable environment, with a range of learning facilities, was introduced in Section 2.3, with the conclusion that, from the perspective of designers, the physical environment is intended to have an active part in student learning, at a very minimum. Participant responses demonstrated that, indeed, staff and students were able to respond to a range of questions about their environment, with those associated with built environment interaction shown in Table 7.3.

Staff listed many aspects of the built environment as contributors to learning and teaching (Q59a, Figure 6.6). Of these the highest response frequencies expressed that specific elements of the built environment, such as acoustics, size and circulation, contributed highly to teaching and learning, with comments including problems with actively managing the environment:

> We have to constantly manage issues due to space, heat, noise. It’s detrimental to learners. (Q59a, W.Sta23).
>
> However, they also nominated other less active, but architecturally related, aspects as contributors, such as design and the learning environment:
>
> A peaceful, safe, clean environment is conducive to good learning. Students feel comfortable and able to focus. (Q59a, O.Sta33).

Size and circulation are perceived limitations, but, as seen by the observed school modifications (section 4.4) and classroom observations (section 4.5.3), design and the learning environment are a dynamic interaction between the original form and permanent and temporary modifications due to occupancy. Thus, all of these high responses suggest high familiarity and a more active use.

Table 7.3: User perspectives relating to built environment interaction (full array in Appendix M)

Section	**Title**	**Final themes** Triangulation ■ Triangulation expected but missing □
		Built environment interaction
6	User perceptions	
6.3	Perspectives of the school built environment	
6.3.1	Perspectives of school uniqueness (Q09)	■
6.3.2	Perspectives of school buildings and grounds	
6.3.2.2	School buildings as place and architecture	
6.3.2.2.3	*School buildings as interesting (Q15)*	■
6.3.2.2.6	*What is liked about school buildings (Q29)*	■
6.3.2.3	School buildings as functional space Good for learning (Q18) Good for teaching effectiveness (Q18a) Matched pedagogy (Q18b)	■
6.3.2.4	School buildings as healthy and safe space	
6.3.2.5	School redesign preferences (Q83)	■
6.3.4	Perspectives of school sustainability School is sustainable (Q10) Expected (Q11) and experience (Q12) Saving energy easy (Q21) Saving water easy (Q22) Discussed in lesson (Q68-77)	■
6.4	Perspectives of the classroom environment	
6.4.1	Teaching and learning in the classroom space	
6.4.1.2	Classroom contribution to teaching and learning (Q59)	■
6.4.2	Classroom design	
6.4.2.1	The importance of a well-designed classroom (Q58)	■
6.4.2.2	Classroom size (Q62)	■
6.4.2.4	What occupants like	■
6.4.5	Classroom redesign preferences (Q84)	■
6.5	Spaces other than classrooms	
6.5.1	Perceptions of the toilets (Q78)	
6.6	Latent variable extraction Five constructs: Wellbeing Smell Acoustics Vision Satisfaction	N/A

Grounds and site plan were identified by students as a differentiator of their school (Q27, 'It's spread/set out differently and looks nicer and newer…' O.Stu104), whereas staff provided more specific responses about building elements (Q27, Figure 6.13), again suggesting familiarity as a prerequisite for built environment judgement.

Familiarity is also a factor in reporting other comments about thermal comfort (Q45, Figure 6.52). Students made general comments about the air-conditioning ('Our aircon needs some upgrading for sure', Y.Stu20) at a slightly higher rate than staff, but only staff made comments about the ventilation and control, and about their perceptions of student comfort:

> It is important to have the temperature at a comfortable level otherwise student work is affected. (Q45, O.Sta33).

This is consistent with staff having a duty to control the physical climate for both themselves and students, and also having a duty of care towards students, and was reinforced by the staff-only question specifically about thermal comfort control (Q115, Figure 6.59):

> On extremely hot days the cooling is not effective and some children can be ill. Drink bottles in the room are essential on those days. (Q115, O.Sta31).
>
> Would prefer to be able to control air temperature for students and teacher to be more comfortable. (Q115, W.Sta15)

Thus, staff have more scope of use of physical environment controls. Similarly students reported various problems with light levels,

> Sometimes it turns off and it's hard for me to see my work. (Q57, O.Stu119);
>
> Our blinds are down almost all the time, it makes it much easier to learn when they are up (Q57, O.Stu96);
>
> We can't make the room dark so it affects the smartboard ['affects the smartboard' underlined]. Please give us curtains / blinds. (Q57, W.Stu53).

Staff, too, commented about light levels, but tended to frame their responses through their duty of care to control the physical environment (Q57, Figure 6.55):

> Lights turn off automatically every 2 hours. Often too much glare/heat to have blinds open. (Q57, O.Sta30).

In contrast, staff did not claim responsibility for building acoustics and nominated the building design as either problematic or appropriate and related that back to teaching and learning,

> Small classroom spaces, high ceilings, really noisy, very hard to teach / listen. (Q36, Y.Sta2);
>
> It depends on the room – [identified permanent building] shared space are the worst. Transportable buildings better. (Q36, W.Sta15);
>
> The deck outside is very noisy…Moving around – change of lessons are noisiest times. (Q36, O.Sta30);

whereas, students identified the noise sources (adjacent classes typically) that were problematic (Q36, Figure 6.58),

> Sharing classrooms is horrible! The noise levels can get so loud and both classes are constantly complaining about it! (Q36, Y.Stu23);
>
> The noise in class is unbearable its like a disco in here same outside. (Q36, O.Stu109).

Staff too indicated that they wanted to redesign aspects of the school grounds (Figure 6.23), but their responses were centred around redesign of student facilities outdoors, such as more seating, highlighting their professional duty of care towards students, and consistent with their own observations of student use of the built environment:

> More gathering places for students to sit together, eat, play. Functional art pieces like benches, musical equipment, discovery gardens. (Q83, O.Sta29).

Within the classroom, when asked what parts of the room help most with teaching and learning, staff and students assign different levels of importance to built environment elements (Q59, Figure 6.34). Students and staff agree that ICT/IWB aspects are important, but students at higher rate, suggesting that items such as interactive white boards are, indeed, interactive, i.e., it is not only staff that physically interact with them. Students indicate that furniture and fixtures are also important, whereas, staff identify the floor (as a learning location), fixtures and space and layout as important. This suggests that students and staff have a different scope of use for classroom aspects, and different levels of active interaction with components. Students are more interested in what they sit on and use, whereas staff are more holistic in their use of the space:

> Space to organise tables and chairs in a variety of ways. Display areas. (Q59, O.Sta38).

Furthermore, a visual interaction was inferred when both cohorts discussed what they liked about their classrooms. This was found to be consistent with what each cohort considered important for learning, but the addition of a common visual aspect (Figure 6.42), for example:

> Modern. Colour of walls. Interesting design. (Q60, W.Sta16);

> That it is very decorative and an amazing environment to be in. (Q60, W.Stu40).

There was also some indication that schools were considered sustainable by students, but staff were neutral (Q10, Figure 6.25). All schools had 'sustainability' components either integrated, or retrofitted to act as 'demonstration appliances' (section 2.3.6). This suggests that these built environment elements were intended to actively contribute to teaching and learning. When asked, both students and staff had knowledge of building and demonstration appliances, suggesting an awareness of viewed components (Q11, 12, Figure 6.26). Students and staff also indicated that had a participatory role, themselves, in categories that centred around waste, such as recycling, waste reduction and keeping the school litter-free ('…we recycle and we pick up rubbish' R.Stu129). Students also identified other student activities, such as environmental clubs. Thus, awareness is a combination of interactions, with viewed elements and used items. Regardless, sustainability elements were not reported as contributing to learning and teaching at either school or classroom level (Q59a, Figure 6.6; Q59, Figure 6.34), i.e., these elements intended to be active in learning were not recalled as being predominant in the pedagogy.

Using the environment-learner theory introduced in Section 2.2.2.1, the responses provide some evidence for the position of the learning environment within the active-passive continuum; however, if the learning environment is extended to include all aspects of the school built environment, not just the classroom, then the evidence from this inquiry suggests that the environment is actually always active, and possibly independent of the intended pedagogy.

For example, if the contemporary constructivist pedagogical intention (as interpreted in Section 2.2.2) is taken at face value and mapped onto learner-environment matrix (Figure 2.3) then the physical environment should appear as passive. Given the responses of this cohort of participants, this is clearly not the case since participants report knowledge about, and interactions with, a very wide spectrum their environment.

At the other extreme of active-passive continuum is the assumption of design advice where the physical environment is assumed to be very actively used in teaching and learning used (Sections 2.3.1, 2.3.3, and 2.3.4), such as interactive whiteboards, or actively experienced in the architectural sense (Section 2.3.5 and 2.3.2), yet this does not account for the response trends.

In some cases, such as sustainability elements, the demonstration intention behind these elements assumes that these should be dominant in memory; however, specific recall about the school built environment was not at the forefront of memory. Yet, just because these memories were not readily recalled did not mean that they didn't exist. Sometimes memory needs to be primed to recall specifics (Purves et al. 2013, p. 252). The fact that they were eventually recalled suggests that there is, indeed, an interaction, although a less successful active interaction.

Finally, fabric that is designed to be passive, yet actively interact with users, such as designing for safety or accessibility, could be considered as postulated in Section 2.3.7, an 'actively passive' interaction. The absence of perspectives of danger in responses demonstrates that this design is successful in its aim.

This environmental transaction approach implies that all interactions with the built environment, both passive and active, are appropriate, or of good quality, and omits the interactions with the environment which are not appropriate. In the case of schools these omitted inappropriate interactions, such as unsafe floors, or distracting views, are definitely 'active', in that they prompt a two-way interaction between student and environment, but are unwanted because they have the potential distract from the prime role of schools, learning and teaching. This suggests that there is a third axis to the learner environment model which describes the quality of designed interaction, as shown diagrammatically in Figure 7.2. The next section reviews the data sources for quality of these interactions.

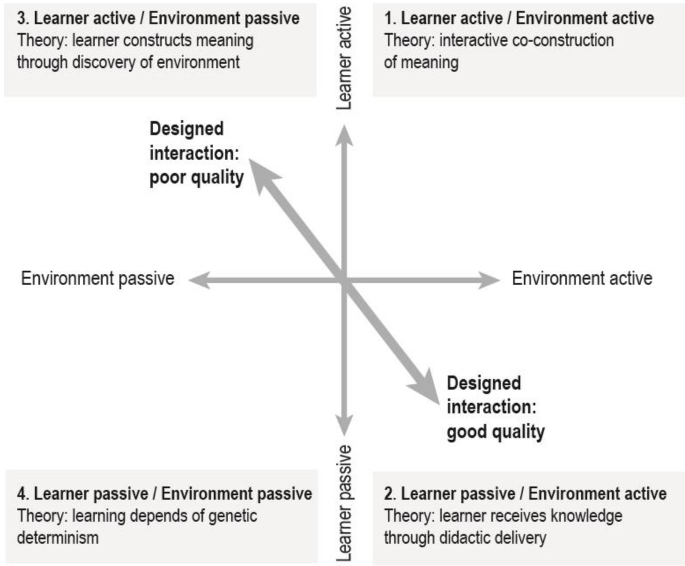


Figure 7.2: Conceptual relationship between learner and environment, with overlaid designed interaction quality (after Bowler et al. 2007)

7.3 Quality aspects of primary school built environment

School building have expectations placed on them by a variety of stakeholders, including political and procurement bodies, designers and facilities professionals, and users (Section 2.3), and there is a wide range of building performance evaluation strategies and processes used to evaluate selected expectations during occupation (Section 2.4.1). All are designed to appraise the performance of a building using indicators derived, largely, from professional interpretation of buildings. This implies that there is some sort of quality expectation of occupied buildings, where quality might be thought of as the 'degree to which a class of product possesses potential satisfactions for people generally ("quality of design")' (Juran et al. 1962 quoted in Legge 1995, p. 212); however, sole use of expert appraisal risks not assessing the ‘potential satisfactions’ of occupants with their buildings.

If education, as postulated in Section 2.2.1, is considered as a service operation then we might draw on the literature of service quality, as has been done in tertiary education (Douglas et al. 2015). This opens up a more nuanced (and much cited) approach to quality in that it acknowledges that service quality is complex and contested, is not limited to human interactions, but also includes aspects of the built environment (Johnston 1995). Working on this premise, using the data available within this inquiry, it is asserted that building quality is not a single construct and there are themes that might be grouped around different potential satisfactions, or qualities, of users’ school built environment: (1) functional, (2) wellbeing, (3) visual and place, and (4) environmental. The different interactions with school built environment will change the relevant level of importance, but these four qualities are important to both students and staff, as defined below, in their cohort specific ways.

7.3.1 Functional Quality

Aspects associated with school functionality have been grouped around building fabric that is seen mandatory for providing teaching and learning (Section 2.3.4), whereas fabric quality and comfort (Section 2.3.5) and architectural quality (Section 2.3.2), from a gauche perspective, are not necessary, but expected as part of designer expertise.

In this inquiry, the functional quality, i.e., the fitness for purpose, is judged by the observed fabric modifications and what triggered the modifications (an expert observation), and by user perspectives about the fitness for purpose. The original architecture was present and visible, but there were also modifications, both permanent and temporary, suggesting pressures on learning spaces. There was evidence that attempts had been made to match space to pedagogy and to match pedagogy to available space. This indicates change in pedagogy since buildings were built.

7.3.1.1 Building adaption and rate of change

The case study schools were either relatively recent builds (Orange, 1999, and White, 2003) or reworked older schools (Red and Yellow). Both the older schools had evidence of significant renovations in an attempt to ensure the indoor built environment met contemporary learning space standards and pedagogical needs, but all schools had evidence of physical changes to cater to the introduction of the new technology of interactive white boards. These permanent physical changes indicate that functional quality requirements change. In the case of the older buildings, their retrofits are consistent with design intentions seen integrated in the later, new buildings, and prior to IWBs, i.e., there were consistent functional quality expectations at start of the new century.

Within five years this changed. The notion of the fixed teaching wall was being challenged in popular design literature as restricting learning modalities (Nair & Fielding 2005, p. 59), yet the introduction of IWBs, and their wall fixing rather than mobile options, reintroduced the teaching wall. Staff responses implied that classrooms are considered to have orientation around a front wall:

> I would certainly include built-in cupboards, shelving. Particularly along the front wall…(Q84, O.Sta33);
>
> …horizontal rows now give better focus to front. (Q61, Y.Sta1);
>
> …we must always leave floor space at front, as our IWB is mounted [to the wall] (Q61, R.Sta40).

This, in turn, required better daylight and glare control. For permanent buildings, this timeframe of change is remarkably short, as demonstrated by the permanent changes observed on White.1's short life. Alternatively, in Australia, a wall-fixed teaching board is expected (Marsh et al. 2014, p. 57) and never went away.

The installation of interactive white boards is an example of how ICT is influencing space use when it is retrofitted to the building fabric (Section 4.4.4), and how it changed the programmed design (Figure 4.9). This had a trickle-on affect where lighting design, particularly daylight, became problematic and leading to permanent modifications to control daylight. This is consistent with other countries where large ICT changes have been observed (Cardellino & Leiringer 2014).

Even relatively new building stock (less than 10 years old) was modified, suggesting that that designers either cannot, or don't attempt to anticipate effects of major technology changes and their impact on teaching, i.e., the occupation profile is unpredictable even in the short term, making robustness for, say, 30 year minimum building life, difficult to achieve. Referring to Table 7.4, the rate of predictable technology change is much less than the lifespan of a building. From the perspective of building designers around the turn of this century it is unlikely that they would have been aware of the possibility and feasibility of interactive whiteboards.

Despite the evidence that rooms were reconfigured to accommodate interactive white boards, and the acknowledge importance of technology (see Section 6.4.1.4), staff did not express technology as important or integral to pedagogy (Q01, Figure 6.33). Again, referring again to Table 7.4, and to Section 2.2.2.1, the permanent changes in buildings do not coincide with pedagogy changes either, suggesting other factors drive permanent modifications.

Table 7.4: Selected timeframes for change in Education and the Built Environment

Item	Description	Timeframe for change	Source
Education			
Classroom climate	Changes according to cohort	Yearly	(Hattie 2009, p. 1)
Technology	Changes in personal computing or multimedia delivery or mixed reality	Short term: 1 year Mid-term: 2 years (@2014 Gamification and Learning Analytics) Long-term: 4 years (@2014 Internet of things, wearable technology)	(Martin et al. 2011) (Johnson, Adams Becker, Estrada, et al. 2014)
Pedagogy	The art and science of education. Informed by behavioural models, instructional modes and technology	(Churchill et al. 2011, p. 238) lists five groupings and 19 aspects currently in use (Kirschner 2006) suggests problem based learning arrived in 1960s under various names. (Hattie 2009, p. 9) argues that the 'grammar of school' has not changed in 100 years.	(Marsh et al. 2014) (Churchill et al. 2011) (Hattie 2009)
Architecture			
Building fabric	The enclosure of classroom space	Permanent buildings: up to 120 years (see Red School) Transportables: unknown	
Fixtures	Carpet, shelves, cupboards, whiteboards	Varies. Example: Carpet 100% wool 48oz commercially heavy duty rated. Example warrantee 3 years full replacement with variable depreciation after.[76]	(DECS Capital Programs & Asset Services 2010)
Loose furniture	Chairs, desks, mobile storage, mobile whiteboards	Varies. Example chair with castors: 10 year warrantee.[77]	
Services – AC	Ducted or split system typical	20 years life of equipment	(DECS Asset Services 2008)

[76] I've specified Tuftmaster carpets during my professional work (http://www.tuftmastercarpets.com.au/warranty-information/).

[77] On the advice of clients, I've previously used dimensions of the Woods Furniture range for planning purposes (eg. http://www.woodsfurniture.com.au/products/computer-chairs/durapos-gas-lift-swivel/)

7.3.1.2 **Teaching and learning, and transient building adaption**

When asked how buildings and grounds contributed to teaching and learning, staff responded with a very wide range of built environment aspects and elements (Q59a, Figure 6.6), suggesting that the built environment is perceived as having a complex interaction with teaching and learning.

Overall both students and staff indicated that a 'well designed' classroom was important (Q58, Figure 6.38), however, the low correlation of student responses with other variables suggests that this concept is not clearly defined within the student cohort's thinking, so student perspective of functional quality needs to be determined from other sources.

Temporary (and less expensive) changes were observed that were associated with pedagogy and instructional modes. Classroom space was observed to be dynamic (4.5.3.1) and personalised with displays of teaching materials and student work (Section 4.5.3.3), suggesting that classroom space is not restricting pedagogical variety. Students reported that they spent much of their time at their desks (Figure 6.32), suggesting that there was some continuation of older pedagogy, or that there were physical restrictions to attempting different pedagogical instruction modes (Marsh et al. 2014) (Churchill et al. 2011). Students also reported that classrooms (average area per student was calculated to be 2.44m^2 (Table 4.17)) were too small (Q62, Figure 6.39) and that they would change the size if they could (Q84, Figure 6.62). Staff too would change the size of their classrooms if they could (Q84, Figure 6.62):

> Larger classroom space. More areas for group work. Walls between classes. (Q84, W.Sta22).

While no standard classroom area per student was found in literature (section 4.5.1), the nearly-consistent area per student across participant classrooms provided a de facto standard. The responses raise the possibility that dynamic use of the allocated space is restricted by its size.

Staff were not positive about whether their classrooms helped them to do their jobs, i.e. classrooms were not seen as improving teaching effectiveness (Q18a, Figure 6.16), or matching pedagogy (Q18b, Figure 6.17). From the perspective of students, school buildings were seen more positively and considered good for learning, but staff were consistent in their less than positive judgement (Q18, Figure 6.15). Comparing the regressions on whether the school buildings are good for learning, both cohorts have the perspective of buildings as healthy as a predictor, suggesting an aspect of wellbeing contributes to the perspective about buildings as good for learning (Q18, Table 6.15). In addition to this, the very strong staff model includes a relationship with buildings as good for teaching, i.e., buildings as a facilitator for teaching staff to do their professional job. Some staff also expressed concerns when questioned about what they like about their classroom area, and reiterated issues when asked for any further comments:

> Not much – the space is very difficult to work in. (Q60, Y.Sta2);
>
> I feel my teaching has been compromised by the lack of space to move desks around and be more flexible. Because of the noise level I have left children in rows facing the front. (Q149, Y.Sta1).

The student regression model, however, includes additional wellbeing perceptions such as safety and winter air smells, together with a perspective about pride in the school buildings. This again demonstrates the complexity of student perceptions.

Students and staff expressed clear differences in their perspectives of the parts of the classroom that helped with learning and that these coincided with the cohort scope of use (Section 6.4.1.2). The responses to what staff and students liked about their classrooms could be seen as an expression of quality of these components (Figure 6.42). Referring to the response code rates greater than 5%, both staff and students liked the visual appearance, but from the perspective of functionality, they also liked the display opportunities. Students liked the functionality of IWB and furniture whereas staff were more pleased with fixtures and space and layout, and the windows. So, despite there being a very wide range of pedagogy used, the functionality of classroom fabric is either relatively simple, the classroom fabric is not working well because there are only few aspects that are liked, or the classroom fabric is adaptable to the needs and activities placed on it.

Starting with the middle proposition first. What was liked about the classroom is consistent with what each cohort deems to be useful for learning, i.e. it depends on the active use by each cohort. One room, two experiences.

The proposition that the functionality of the classroom fabric is relatively simple from the perspective of users is also reasonable. As discussed in Section 2.2, politically and socially, school is for education, not architecture appreciation, so it seems reasonable that users filter out non-relevant information.

The proposition that the classroom fabric is adaptable to a certain extent is also reasonable. The control exercised locally over the classroom space by staff is endorsed contemporary educational texts:

> While teachers and students may feel constrained by the school's architecture - that is, the overall space available for teaching and learning, the position and number of doors, the height of the ceiling, how hot or cold the space is - the teachers have the capacity to determine the feel or atmosphere of a particular classroom environment. (Marsh et al. 2014, pp. 55-56)

Staff reported that their current rooms were rectilinear (square or rectangular) (Figure 6.36) and that they rearranged the desks and other furniture to help with learning (Q61, Figure 6.43), confirming that teachers do change their rooms, although that change was observed to be relatively small (Section 4.5.3.1). Staff also indicated that they preferred to teach in rectilinear rooms. Design advice hypothesises that non-rectilinear shapes provide more opportunity for flexibility and learning stations (Dudek 2000, p. 57; Dyck 1994; Nair & Fielding 2005, p. 20), yet the perspective of staff was that rectilinear rooms offered reconfiguration, flexibility, visibility, and floor seating was easy to configure (Q126, Table 6.32):

> …allows for a mat area, plus chn can see smart board from desks. (Q126, R.Sta44);
>
> Rectangular shape best suits rectangular desks (in groups or rows). Also space for class to sit on the carpet together. (Q126, O.Sta31);
>
> We need equal space all around for older students. No nooks – students out of sight. (Q126, O.Sta29);
>
> Keep it simple, max flexibility. (Q126, W.Sta5).

Notably, flexibility that was specifically built into the fabric was not necessarily used daily and, some cases, not used at all (Section 6.4.3.3).

Staff also showed that they were willing to reduce the daylight provided by glazing. This is in contrast to design advice (Ceppi & Zini 1998; Gelfand & Corey Freed 2010; Nair & Fielding 2005) and with evidence of improved performance with large windows (Heschong Mahone Group 1999), but is consistent with qualitative meta-analysis of conflicting lighting effects (Higgins et al. 2005). Rather than purely limit the light level, staff substituted daylight with the opportunity for display (Section 6.4.3.4), citing logical reasons such as communication, display space and type and to control views (Q138, Figure 6.47). This suggests that glazing is considered a pedagogical tool:

> …windows display both inside and outside depending on the display. We often use clear plastic for images. (Q138, O.Sta27);
>
> …double sided…shows the other students what has been happening in that class. (Q138, O.Sta32);
>
> …art work such as stained glass windows[78] look superb with light shining through. (Q138, R.Sta42).

However, some students did express a preference for having the blinds raised (Q57, O.Stu37, O.Stu105).

Overall, staff did not necessarily use buildings as planned. Rather, they encroached on circulation space, created overhead display, attached display to walls, and obstructed daylight. If this is a measure of functional quality, then the buildings could be considered to provide poor functionality. Alternatively, the empowerment of staff to modify their space could also be interpreted that classroom functionality is reasonably appropriate. It depends on the quality goals. And the

[78] Red School may have a true glass craft area, but actual stained glass windows were not observed. However, window-type displays using coloured cellophane sandwiched between black cutout paper were observed in schools other than Red School.

economic prospects for change.

The functional quality of the school infrastructure to facilitate new ICT did not appear integrated into staff perspectives of pedagogy and building. Like sustainability elements, if asked directly about ICT, direct answers were received. Indirectly, ICT appeared to be a low level consideration (Q59a, Figure 6.6), suggesting it is either fully integrated into learning and teaching, or is disconnected in participants' minds from teaching and learning. Given that, statistically, Australia scores very highly on availability and use of internet by young people within and outside of schools (OECD 2014), and to do this requires computers and other communications technology at schools, it is likely that ICT is a taken-for-granted element of school life, or that which 'digital repertoires' are intrinsic to all participants (Stevenson 2013). Additionally, might not be considered part of the built environment, and its infrastructure presence is invisible to the users, unless asked specifically.

7.3.2 Wellbeing Quality

The wellbeing quality of the built environment emerged as a theme primarily through factor extraction of an underlying construct from the student responses (Section 6.6), with supporting evidence from quantitative and qualitative evidence from the questions about the toilets (6.5.1), overall school (6.3.2.4), and classroom environment responses (6.4.1).

It was originally tempting to group this theme as workplace health and safety, as informed by statutory, policy and guideline drive design processes (Architects Professional Risk Services 2013; Australian Human Rights Commission 2013; DECS Executive Director Human Resource & Workplace Development 2010; Department for Education and Child Development 2013; Piatkowska 2013; Safe Work Australia 2012). The term 'wellbeing', as introduced here, is neither the psychological construct that has been a recent strategic initiative of the Government of South Australia (Seligman 2013), nor as an umbrella term for comfort aspects as seen in industry assessment (International WELL Building Institute 2015). Rather, 'wellbeing' is used here in its everyday sense, and is the user response to functionality, fabric quality and indoor comfort that staff and students experience as a systemic complementarity.

7.3.2.1 The student wellbeing construct

The principal axis factor extraction demonstrated that, from the students' perspective, there was an underlying construct that was a combination of health, learning productivity, safety, cleanliness, maintenance, water, and pride, which is suggestive of workplace health and safety concerns (Section 6.6). Furthermore, constructs of smell, sound, vision, and satisfaction, also appeared, but with significantly less loadings on the total variance of the data set. This primary construct is similar to theory about good spatial educational quality for all ages (Berris & Miller 2011; Sanoff

2001a), but the inclusion of health, as 'situated knowledge' (Till 2009, p. 60) from students, adds another aspect to the effects of spatial quality, hence its inclusion under wellbeing rather visual and place quality.

Given the design advice around creating views to the outdoors for students and staff (Berris & Miller 2011; Sanoff 2001a) (Heschong Mahone Group 1999), it would have been expected that the view variables might appear in principal construct, however the lack of strong opinions around the perspectives of views as attractive (Q64, Figure 6.40) and calming (Q65, Figure 6.41), is consistent with lack of view due to high sills and obstructed glazing (Section 6.4.2.3). The qualitative questions did provide a hint that lack of views out of classrooms were noted:

> I would like to put some more trees outside the classroom windows. (Q83, Y.Stu8, in a classroom on the storey above ground level)

Students tended to be more positive about rating their buildings for wellbeing than staff, in that students rated their school buildings as cleaner (Q14, Figure 6.18), better maintained (Q16, Figure 6.19), safer (Q17, Figure 6.21), and healthier (Q19, Figure 6.22), than staff. This is consistent with previously noted student positivity in both functionality and ventilation perspectives (Section 7.1.1). Regressions on all of these have, in each case, similar predictors for both participant cohorts. The perspective of school buildings as healthy predicts cleanliness perspective, but the student model also includes perspective of pride, whereas the staff model includes their ability to observe time scale of maintenance (Q14, Table 6.17). School buildings as healthy also predicts the perspective of buildings being well maintained (Q16,16a, Table 6.18), with staff responses also predicted by time to fix building problems, while student responses also predicted by a complex range of perspectives about noise, views, safety and light. Thus, although students were more positive about their school buildings, in this cohort there are suggestions that there was emotional affect contributing to their assessment. Regressions showed that perspectives of good maintenance contributed to predicting student perspectives of safety (Q17, Table 6.19), and health (Table 6.20).

The results here support the case for an active 'reciprocal' interaction between students and their environment (Bowler et al. 2007, p. 394); however, the interactions found here were with aspects that are not necessarily components seen as active in learning. Although cleanliness and good maintenance is the responsibility of school administration, the ability to clean and maintain buildings starts with design, so there is an 'activeness' in the intended passivity of these design components. This interaction is complex and has the potential to be unwanted active interaction. Wanted and unwanted interactions might be inferred from student comments about what they perceive as helping with their learning, and what they like about their classrooms:

> Having the lounges[79] because they make me feel calm. (Q59, W.Stu40);
>
> The quite [quiet?] if it is. And having the lights dimmed or off. (Q59, W.Stu49);
>
> My table because they are quiet. (Q59, O.Stu82);
>
> …the windows help with my learning because the natural light freshens my mind. (Q59, R.Stu125);
>
> The thing that has helped me are the displays in the classroom. (Q59, RStu142);
>
> All of our art is up and its pretty. And we learn with what it says on some of the work. (Q60, O.Stu84);
>
> - The welcoming feeling with people and the classrooms…(Q60, R.Stu139).

The built environment is hypothesised to contribute to ‘physical and emotional stress (Zimring 1981). If students experience more traumatic stress or anxiety than results an excessive stress response, this can reduce their learning motivation (Churchill et al. 2011, pp. 122-123). Similarly, in the case of ADHD this interaction could be ignored and medication adjusted (student is modified), or accepted and environmental adjustments attempted (Bowler et al. 2007, p. 394). In this inquiry, buildings considered safe and healthy predict the perspective that they are good for learning, and vice versa. Maintenance predicts the perspective of safety. Cleanliness predict the perspective of healthiness. Thus, buildings perceived as clean and well maintained may reduce additional stress arousal, if, as the findings suggest, these are connected to health and safety.

7.3.2.2 School and Classroom environment

The student cohort do not make a convincing case for the expectation that students have an understanding of the visual quality of school architecture as understood by adult non-experts (Section 7.3.3). However, students do have perspectives about the visual quality of non-aesthetic building fabric. This is first hinted at in the question about whether the school should look attractive (Q28, Figure 6.7). Here, regression shows that the perspective of school building as being well maintained is a predictor, albeit weakly, of whether a school should look attractive (Q28, Table 6.6).

For students, pride in school buildings is strongly predicted by visual components, both aesthetic and perspectives of cleanliness and maintenance, but also by the perspectives of school buildings as being good for learning (Q20, Table 6.9). The former are consistent with the importance of fabric quality to students, as derived from factor extraction. This suggests that there is a connection between how students observe the interaction of their learning with the built environment, and when it works it contributes to pride. Although discussed here under wellbeing, it is also applicable to place attachment discussed in Section 7.3.3. This confirms the complexity of the interaction between school students and their school buildings, and their young judgements

[79] Local Adelaide use, defined in Oxford English Dictionary (2015) as “3. A kind of sofa or easy chair on which one can lie at full length."

are formed through an active interaction with their school buildings.

The measured environment and user perceptions of the classroom environment were inconsistent. In Section 6.4.4.1 the temperature data collected and the student memory of comfort were inconsistent, where the coolest classrooms in summer prompted the perception of being the hottest. Spot measurements did not find stratification in classrooms, however, qualitative data was suggestive of inconsistent response occurring in schools with more discussion about air conditioning, i.e., White School students (Q45, Table 6.43). This infers that these discussions might inform memory recall, but the data is unable to rule out other external influences such as adaption to different temperature ranges due to influences outside of school, such as home. Despite this, temperature did not appear in the principal axis factor extraction, suggesting that it is of lesser importance in students' perceptions overall in this cohort.

Light, however, does appear as a factor construct, and was measured as highly variable within classrooms. This is consistent with comments by students as being bright Table 6.48 (Q57). Staff expressed concern at the artificial lighting design with fluorescent lights perceived as '…hard on eyes' (Q57 R.Sta41), and halogens triggering seizures (incidental conversation at Orange School).

Similarly, a sound construct corresponded to students wanting classrooms to be quieter (Table 6.50; Q36, Table 6.53). Student and staff perceptions of noise was consistent with the observed architecture, but not by measured spot noise level, suggesting frequency analysis and noise duration need further investigation. Staff preferences were predicted by outside noise and job satisfaction, i.e., a workplace health issue (Q35, Table 6.52). Acoustic design as contributing to teaching and learning was not discussed specifically (Q59), possibly because it is not explicitly visible as a design element. It was noted by some staff in further comments (Q36, Figure 6.58) that the perception of sound is variable and complex and that, in addition to the building fabric and space design ('…high ceilings…', '…vastness…', Y.Sta1; 'lack of internal walls…', W.Sta7), the influence of pedagogy ('Quieter – is the ideal – but not appropriate for today's pedagogy', W.Sta25), individual student needs also play a role in assessing the noise:

> The quality is alright, not necessarily the environment. Other factors impact – how loud chn speak, hearing loss. (Q36, O.Sta36).

This latter comment invokes the questions about disability. Disability and impairment is a contested area between biological differences and social construction (Anastasiou & Kauffman 2013). If the social model of disability is considered within the remit of designers, i.e., that an impairment becomes a disability due to physical barriers designed into the built environment, then this falls within legislative obligations of designers, and at most within ethical obligations of designers. It has been demonstrated previously that acoustic design is seen as fixed and not accessible for adjustment by staff. This puts further obligation on designers to design for the wellbeing of students of all capabilities, impairments and disabilities, and is independent of disability paradigm.

7.3.2.3 Spaces other than classrooms

The best evidence for supporting the factor analysis wellbeing construct came from the neutral question asking for comments about toilets (Q78, Figure 6.63). Students cited daily management as a key issue, together with descriptions of behaviour and design issues. Smell was a problem in toilets, which was in contrast to neutral responses to questions about air freshness in classrooms, suggesting that the type of smell in toilets is more of an issue.

The toilets observed did not appear significantly dilapidated, although the building fabric showed evidence of use, such as stained grout (particularly in the un-coved[80] corners, and adjacent the urinals), marks on the walls, and insects in skylights. The toilet designs were consistent with the styles and materials of the timings of construction or renovation. The main sources of the student concerns were the daily management of the toilets (Q78, Figure 6.63) with common descriptions such as 'disgusting', and concerns about ventilation, smell and behaviour. Mess and smell was observed during visits and discussed in Section 4.5.3.8.

If the perception of cleanliness is considered a social construct that is a dynamic interaction between 'morality, technology and practice' (Shove 2003, p. 90), and that home life is structured around cleaning activities (Shove 2003, p. 90), it would be easy to dismiss students responses as having expectations that are too high for the school context.

Alternatively, the emotive language used is consistent with other descriptions of school toilets by students (Lundblad et al. 2010, p. 221) and these descriptions, together with the factor extraction, suggests that this was a major area of concern. Given this, it might also be a source of anxiety and contribute to reducing wellbeing. There are numerous models for human environment perception (Tveit et al. 2013) or, from the perspective of cognitive neuroscience, memory formation (Purves et al. 2013). Risk assessment and emotions are interconnected (Bohm & Tanner 2013). Smell is connected with emotion, so a perception that has overtones of unpleasant smell may invoke a stronger memory (Purves et al. 2013), as occurs in toilets (Lundblad & Hellström 2005). It is this that may influence the language used in responses.

It has been asserted that student perceptions bathroom (toilet) and classroom 'quality contributed the most to both cognitive and socio-emotional outcomes' (Simon et al. 2007, p. 43). Accordingly,

[80] Coving refers to rounded corners between wall and floor junction. My understanding is that they are designed to allow better access for mopping. Personally, I've observed poor cleaning in both curved and square floor wall junctions in public buildings.

the responses need to be taken seriously, regardless of how expectations were constructed. Students in this inquiry still clearly expressed disgust. Disgust can be considered a protective strategy to avoid harmful pathogens (Curtis 2007), and is a multi-sensory phenomenon (Oum et al. 2011), such that its effect is strong enough to change hygiene behaviour (Porzig-Drummond et al. 2009). Thus, for young students learning about how to interact with their surroundings, the expression of disgust is a significant and personal response. Given this, toilets that don't flush away waste completely, fluids and grime on the floor, strong smells, and capacity restrictions, create a space type of 'toilety-ness', or 'dunny-ness'[81], which is potentially more emotive when seen through the eyes of children, and, thus, contributes to the wellbeing construct.

Staff, too, expressed concerns about toilets and the lack of capacity and gender appropriate fixtures. While unisex toilets might relieve capacity issues, particularly in a workforce with a high proportion of female employees, the lack of urinals was noted (W.Sta17).

7.3.3 Visual and Place Quality

In practice, visual school building evaluation tends to be divided between the indoor fabric quality, under indoor environment quality assessments, or expert judgement by people other than design professionals (Section 2.4.1), thus omitting other built environment quality such as place identity (Section 2.3.2). In this inquiry, visual and place quality is constructed as a continuum of user experience of the built environment that is separate, but not disconnected, from function, wellbeing and environmental quality of school buildings.

When asked directly what their schools looked like, staff and students chose items from an architectural typology list (Figure 6.12) and provided descriptions for 'looks like different to other schools' (Q27, Figure 6.13) that were all consistent with the observed architecture. Thus, users do recall building forms accurately. However, the quality of the Architecture, its visual and place qualities are better determined from the indirect questions.

In describing school uniqueness (Q9, Figure 6.5) there were mutual reporting of visual aspects and grounds, indicating again that, the visual aspects of schools is not lost on both cohorts. Staff tended to identify specific building elements:

> Beautiful old historic buildings … high ceilings and lots of light enters through large windows. (Q9, R.Sta42);
>
> Campus set-up. Landscaped – aesthetic. Designed for open plan or single classrooms. (Q9, O.Sta29);

Whereas students tended to report more aspects that are more people oriented, such as history

[81] In Australia the '… dunny was originally any outside toilet. In cities and towns the pan-type dunny was emptied by the dunny man, who came round regularly with his dunny cart. Dunny can now be used for any toilet. The word comes from British dialect dunnekin meaning 'dung-house'.'(Australian National Dictonary Centre 2015)

and age, culture and teaching and learning,

> My school is a small school, so has a deeper relationship with everyone. We have lovely working spaces that are colourful and full of inspiration. (Q9, R.Stu125)
>
> We call teachers by their first names. We have 2 sides..[two campuses] (Q9, W.Stu34)

This, together with the student regression model for pride in school buildings (Table 6.9), is suggestive of an emotional response to the place, and possibly a sense of emotional place identity (Gifford 2014, p. 562), particularly for the older Red and Yellow Schools. This difference in perspectives is consistent with the attitudes about whether a school should look attractive (Q28, Section 6.3.2.2), where students response that it is slightly less important than staff. The differences in regression model strengths between student and staff cohorts (Q28, Table 6.6) suggests that students do not have a well formed attitude to visual attractiveness of buildings, whereas staff have a better understanding of their attitude towards attractiveness of buildings.

This difference is also reflected in perceptions of buildings as landmarks, where staff were more likely to consider their buildings as landmarks than students did (Q13, Figure 6.8) and, although the perspective of buildings as interesting predicted both staff and students perceptions of the school buildings as landmarks, again the model strength was much lower for students (Q13, Table 6.7), again suggesting the visual attractiveness of buildings, or the language around visual attractiveness, is more developed in staff than students.

The responses to perspectives of school buildings as boring or interesting support the earlier suggestion of students having place attachment. There was little difference between student and staff ratings of school buildings as interesting (Q15, Figure 6.9), however strong regression models predictors are quite different for the different cohorts (Table 6.8). Staff predictors are visual, but student predictors indicate a level of emotion, including pride and their satisfaction with school.

There was some evidence that perspectives of the schools with heritage-looking buildings, Red School and Yellow School, were different to the contemporary Orange School and White School, but it was not consistent. Staff and students, from the former schools acknowledge the age and history of their schools (Q09, Table 6.3 and Table 6.4), and some indicated that their schools looked old (Q27, Table 6.11 and Table 6.12), only Red School responses were significantly different in the specific questions about buildings as landmarks (Q13, Figure 6.8) and buildings as interesting (Q15, Figure 6.9). The exterior redesign question (Q83, Table 6.21 and Table 6.22) elicited low responses about visual appearance changes from Red School and Yellow School. This, together with responses from other open questions, suggests that the heritage-looking facades might influence perspectives, but the evidence is inconsistent within this cohort.

As a direct indicator of place attachment there was little difference between staff and student ratings of their pride in their school buildings, with both being just above neutral (Q20, Figure 6.10). No regression model was possible for staff, but the strong student model contained a range of predictors, where the Architecture of the buildings was represented by the perspective of the buildings as interesting, but the three other predictors were more functional and wellbeing (Q20, Table 6.9), again suggesting a more complex interaction.

Finally, when asked what users liked about the exterior of their school buildings, staff liked what they saw of the buildings and students liked what they used (Section 7.2.1.1).

From the above, the user perspectives about the visual and place quality of the school and its grounds must be interpreted according to the cohort. Staff either have a higher recall of architectural aspects of school buildings or, knowing that this research is positioned in architecture, filter their responses to architectural aspects of the school buildings. The first proposition is certainly plausible since the adult brain is different to that of a child in its cognition and memory (Churchill et al. 2011, p. 92).

As a social place, staff responded that their school was important to the community in its capability to provide facilities for community activities (outreach), or as providing opportunities for the community to integrate into the school, as a meeting place for parents or through volunteering (Figure 6.24). Thus, school as a community place is understood by staff, but decoupled for school as visual place. This more nuanced understanding of school as community centre is consistent with changing policies around education facilities as ‘one-stop shops’ (Berris & Miller 2011).

Students, however, respond with less knowledge of architecture per se, suggesting that students may not have developed the strength of 'appreciation of beauty', including physical beauty and the 'awe, wonder and elevation' that might be triggered by good Architecture, and its corollary for bad Architecture (Peterson & Seligman 2004, p. 520). However, the student responses suggest the quality of the visual environment is complex and integrated with and emotion response. This proposition is also plausible since school is a place of learning and learning is influenced and engaged by emotion (Churchill et al. 2011, p. 92). It is not unlikely that a school building is more than just a school building. Thus, the visual and place quality of school buildings can be judged by staff, but responses from students need more context, yet, ironically, might be more holistically honest in their judgement.

7.3.4 Environmental Quality

Other recent building performance evaluations place environmental quality at the centre of inquiry and their investigations focus on resources used and impact on ecosystems (Section 2.4.1.3). In this inquiry, environmental quality refers to user perspectives of the impact of the built environment on the biophysical world, and how the school built environment is used as an exemplar for achievable care of the natural world, i.e., ‘harnessing’ the social element for environmental improvement as a ‘bridge’ (Vallance et al. 2011).

Since all schools had built environment design, fabric, or systems that were deemed by designers to contribute to 'sustainability', and that some of these were intended to be teaching tools (Table 4.9), it was expected that users would rank their schools highly in perspectives of sustainability. This was not the case and scores were closer to neutral in their overall assessment (Q10, Figure 6.25) and the capacity for school buildings to make energy and water saving easy (Q21, Figure 6.27; Q22, Figure 6.28). Student perspectives were predicted by both perspectives about energy saving and visual aspects (light and maintenance quality).

As discussed, expectations of sustainability and reporting of sustainability elements present within the school fell along cohort lines and according to scope of use (Q11, 12, Figure 6.26). Staff were aware of the more (possibly intellectually) complex concepts of energy use, water, and building elements. These were consistent with the component-driven approach as proposed by the facilities standards (DECS Asset Services 2009) but did not include the 'organising ideas' of social and environmental sustainability as proposed by the Australian Curriculum (ACARA 2011a), or the holistic approach of (DECS 2007). In contrast, student responses tended more towards participatory action rather than fabric-integrated solutions.

It has been proposed, on one hand, that school buildings act as teaching tools (Newton et al. 2009). On the other, the claim that behaviour modelling is more effective in teaching sustainability (Higgs & McMillan 2006). From the data collected in this inquiry, it is likely that the answer lies somewhere in the middle ground. There is some evidence that sustainability elements are discussed in class (Q68-77, Figure 6.29), however, gardens, not photovoltaics, are recalled most by students, as might be expected from the inferred scope of use and ‘activeness’. Similarly, where observable, students reported control elements observed to be used by teachers in class, where they were available. However, where control is automated, such as in White School, modelling knowledge is lost (Q46-52, Figure 6.60), and there was no evidence that the BMS was used in lieu as a teaching tool.

Students also reported observing use of mechanical heating and cooling at the highest rates, however, where installed, wall vents and ceiling fans were also reported as being used (Q46-52,

Figure 6.60). On a school by school basis, the observation of use of vents and ceiling fans is consistent with student perspectives of expected school sustainability (Q11, Table 6.25), thus inferring the 'use' of a component is important in sustainability perceptions. Students also indicated that they observe teacher use of components, including ad hoc ventilations solutions such as opening a door (Q52, Figure 6.61), which tended to be reported in White School. Given the lack of observed building management input, this mixed-mode, fully automated system could be categorised as 'risky, with performance penalties' (Bordass, Leaman, et al. 2001, p. 148), where any benefits from an early 'activation process' (Preiser et al. 1989) had been lost over time. Furthermore, in adult employees at least, 'perceived control' provides a better prediction of satisfaction that 'actual control' (Boerstra et al. 2013), suggesting that the designed control intentions do not predict outcomes. This is also consistent with modelling increasing awareness (Higgs & McMillan 2006). If behaviour modelling is considered powerful, then a negative interaction observed with the building fabric has similar potential for learning as does a fully participatory activity.

In questions where participants were not specifically asked about aspects of sustainability, few volunteered this as, say, something that makes their school unique or special (2-3% of coded responses in Q09, Figure 6.5), or something that they like about their school (Q29, Figure 6.14). Thus, the presence of sustainability elements neither predicts sustainability awareness, not is at the forefront of recall about the school buildings. It is hypothesised that, given there are reports of some discussion in class about sustainability elements, they are present within the curriculum, and, if they were used to the extent of interactive whiteboards in the day to day teaching and learning activities, the perspectives would be different. Thus, in this inquiry, the environmental quality found was that, as part of the curriculum, sustainability elements are present, there is some awareness of them, and that they are modelled by teachers to some extent, and that they might comply with the notion of 'demonstration appliance', although it is unknown whether they are used for fact based environmental education or the more contextual approach of 'education for sustainable development', i.e., for socialisation (Sund & Wickman 2011a). The more recalled sustainability elements present at schools are where active participation takes place, such as recycling, and in the investigation of on-site gardens and ecosystems, i.e., soft landscape at student level.

7.3.5 Omissions

Schools provided a mixture of lockers, shelves and hooks for students to use, as required by the education authority (DECS Capital Programs & Asset Services 2010, p. 37) and, based on other school building assessment methods (Sanoff 2001a) and reviews (Higgins et al. 2005), it was expected that these would feature in responses. Students responded that they would prefer lockers over open bag racks (2 responses) and would generally like more security over their belongings (2 responses). Two staff responses expressed the opinion that the lockers provided were unpleasant to look at through their windows. This small rate of response suggests that either bag storage is adequate, or is not considered part of the built environment. Given the vocal student response about daily management of toilets, the first interpretation is more likely. Possibly, like toilets, a direct question about bag storage may have provoked a more focused response.

Three of the four case study schools were near external noise sources. Red and Yellow Schools are located adjacent to busy roads and White School located approximately 1500m away from an airport. Excluding noise sources from other teaching and learning activities, one student reported car noise and bird noise, and one staff member reported traffic noise and the need to keep the door shut. This lack of reporting about external non-teaching noise source is likely due to external noise ingress being controlled by the building fabric construction, which is suggested by the staff comment about keeping the door shut. Evidence about the effect of noise on learning and teaching is generally contradictory (Higgins et al. 2005, p. 18), however there is some evidence that external noises are less disruptive than noise from learning and teaching activities (Schield and Dockrell 2004 as cited in Higgins et al. 2005, p. 18), which is consistent with this inquiry.

7.3.6 School building quality framework

Having reported the case studies in detail and reviewed the common emerging themes, the next step is to form a framework[82] to summarise the findings. The specificity of case study methodology is noted; however, the value of case study is its inherent density and complexity, and its ability to provide exemplars to complement, not replace, broad inquiries (Flyvbjerg 2006), and this work has presented dense inquiry. As an intended exemplar, it is must address its audience (Metcalfe 2008). In this case, the audience is both scholarly and practical, so the emergent themes are summarised in a visual framework designed to scaffold interpretation of the findings (Figure 7.3).

Having established a physical context for the case studies, user perspectives revealed different filters that depended on user cohort – student or staff – and the building interaction, the latter being consistent with active or passive interactions. Thus, any building performance evaluations *differ by these filters for each user cohort*. There are more than one post-occupancy evaluations *for the same school infrastructure*. One size does not fit all.

[82] The word ‘framework’ is selected here over ‘model’ because, as discussed in Section 3.2, the research structure is both pragmatic in the epistemological sense, and utilises exploratory case study to create depth of understand about the selected primary schools. This presentation of a diagram of a framework was influenced by Corbin and Strauss (2008) via Liamputton and Ezzy (2005, pp. 273-274). The author notes that intense discussion exists within and without the community of ‘model theoreticians’ (Alvesson & Sköldberg 2009, pp. 19-23) but, in light of the selected research structure, has chosen not to engage in this area. If readers wish to substitute the ‘model’ for ‘framework’ they are welcome to do so, but the author believes it is not supported due to the case study research structure.

Examining the user data, four themes emerged and were grouped around different aspects of building quality. To a certain extent these map back to the assessment perspectives found in the literature review, but they also extend these perspectives and reinforce the perspective of users, rather than experts, i.e., it presents the lived experience of building quality aspects as seen by the building occupants. From the perspective of users, the built environment is not disaggregated into the building evaluation components. Rather, this induced framework proposes new quality categories that are connected to each other.

While this quality framework is derived from user perspective data, it is not intended to be a 'user-centred theory' (Vischer 2008), since that overlooks both the building procurement stage responsible for existence. Rather, it is experienced as a socio-ecological model of interactions over time between user and built environment (de Vrieze & Moll 2014; Moffatt & Kohler 2008).

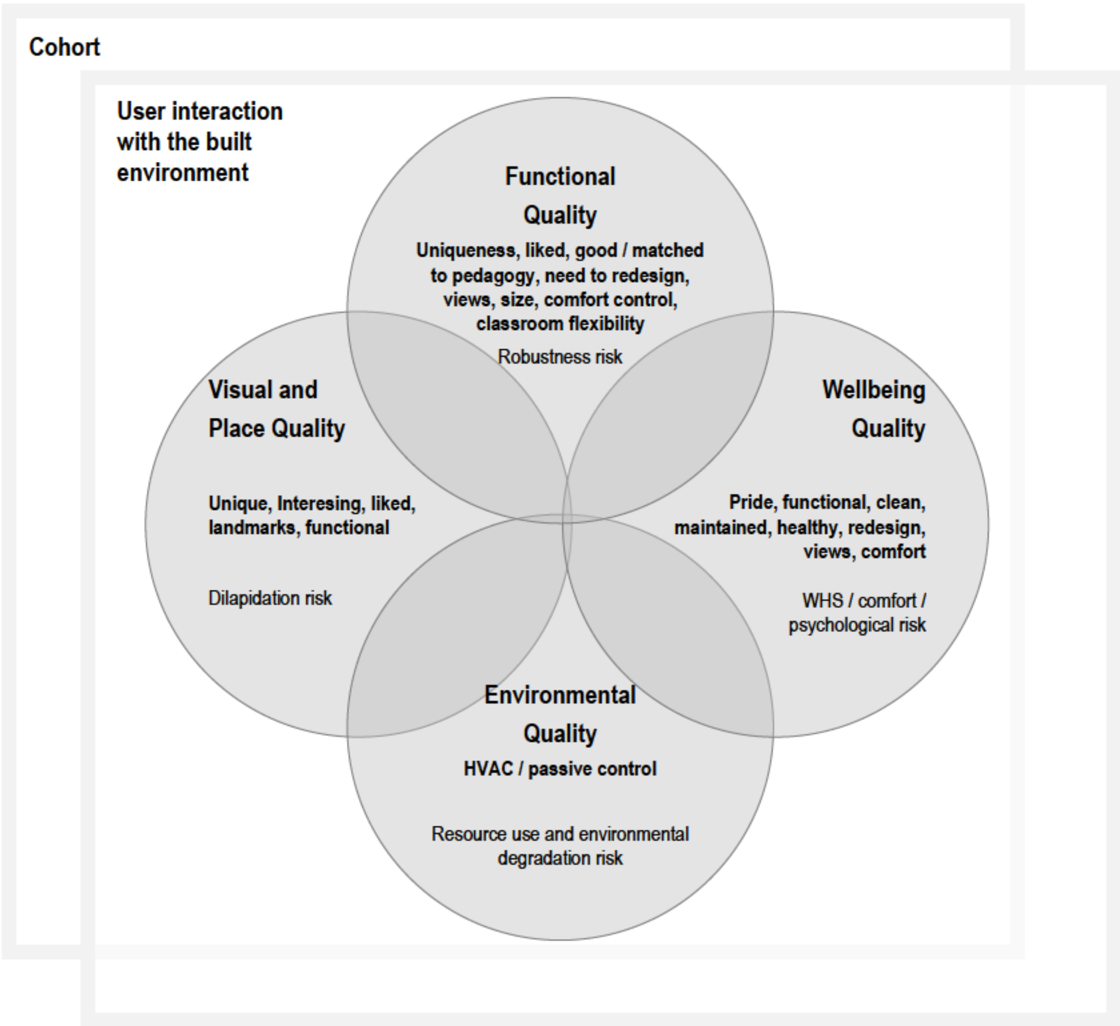


Figure 7.3: School building quality framework – quality from the perspective of users

7.4 Application to design in practice

This section approaches what architects might learn from selected architecturally recognised schools through the quality framework lens.

Since the sampling of case studies was driven by purposeful selection of architecturally significant South Australian primary schools, this essentially qualitative study has limits to its generalisability to other schools, both locally and internationally (Creswell 2003, pp. 148-149). The intention of qualitative research is to interpret the results in their wider context (Liamputtong & Ezzy 2005, p. 320) and, in this inquiry, the wider context is built environment design. Thus, the following discussion interrogate the framework from the perspective of design in practice, so as to provide useful knowledge about how architects should act in the future (Metcalfe 2008), while exploiting the value and strength of mixed methods meta-inference (Teddlie & Tashakkori 2009, p. 288).

Whereas other evaluation frameworks have been derived pragmatically through expert design (see Section 2.4.1), the above framework is derived inductively (Erzberger & Kelle 2003) from a occupied building perspective, through an architectural lens. The objective of this section is to discuss the application of this inductive framework, as an example of professional project based learning (Scarbrough et al. 2004) and expansion beyond the ‘focussing illusion’ (Kahneman & Sugden 2005; Tversky & Kahneman 1974) of this scholarly inquiry and apply it to architectural design. The application of this framework is also an attempt to comply with the ethical imperatives of architecture (Hill et al. 2013; Latham 2005; Oliver 2005; Radford 2009; Spector 2005) and address the complexity in built environments (Tainter & Taylor 2014).

Framework application is discussed below using four aspects: systemic strategies, design participation, function and wellbeing as entropy, innovation, and sustainability.

7.4.1 Systemic design: strategy and quality

This inquiry provides evidence that relationship between the school built environment and teaching and learning is not a functionalist relationship. Rather it is a changing and complex interaction between fabric and users and where optimisation is transitory. Staff indicated that they adjust their teaching delivery because of the fabric, but that the fabric also aids teaching. Students indicate that they benefit from the interactive whiteboard, but the retrofitting of IWBs was observed to interrupt the designed building fabric. This suggests that systems thinking is, indeed, an appropriate method (Checkland 1981, p. 273) for interpreting these interactions. And, rather than programming space (Sanoff 1977), the built environment that might allow for self-adjustment of the occupant-building system is best described as 'slack space':

> It is space that something will happen in, but exactly what that something might be is not determinedly

> programmed. Slack space operates more as a robust background than a refined foreground. ...[It] takes just as much design skill, but that skill is deployed quietly in setting a social scene rather nosily in constructing a visual scenography...It allows the user to make choices...(Till 2009, p. 134)

Thus, the overarching application of the results of this inquiry as applied to professional practice is to accept the unknowable in time, unknowable in use and liminality, design quietly, and 'collaborate with entropy' (Till 2009, p. 106). This introduces risk into the design process, but this inquiry gives focus for relevant design qualities rather than components.

7.4.2 Process: designing with users

Building-user participation in design has been proposed (Parnell et al. 2008; Woolner et al. 2007) as an opportunity for student learning about built environment (Section 2.3.4.2).

This inquiry has found evidence that the perspectives of the student cohort differ from the staff cohort and that is likely due to age and different physical areas of activity and ownership (Section 7.1.1). Thus, the interpretation of user engagement outcomes in building design or evaluation processes must be assessed and be adjusted for each cohort's particular expertise about their built environment. For example, in this inquiry there was a common narrative but different emphasis, such as the different cohort interpretations of issues with acoustics (Section 7.2).

Participatory design should lend itself to social science research due to its social nature (Luck 2012a), so there is opportunity for rigorous evaluation of the process. There are different 'kinds of seeing and spatial reasoning' between designers and non-designers (Luck 2012b); however, in addition to cohort differences in perspectives between staff and students shown here, these differences will be magnified once the design team and building contractors are added to the list (Parnell et al. 2008). Overlaying this is the differences within the design teams themselves and their particular design approaches (Gifford & McCunn 2013). Thus, the potential for respecting the differences and resolving them into a complete project becomes more complex. Concerns about 'pseudo-consultation' and time commitment needed, together with the different timeframes between the design and construction process and cohort involved in any consultation have also been raised (Woolner et al. 2007).

In practice, toolkits for involving students are available (The Lighthouse 2005), but it is unknown how far into the design process user perceptions have been retained and respected using these toolkits. Other participation guidelines exist for adaptation by schools according to participants, and school needs (Sanoff 2001a, 2001b), but these do not address sensitive areas around wellbeing. Similarly, this inquiry found that 'good design', in the designer sense, is not well understood by students (Section 6.4.2.1). In lieu of this, the quality framework developed does demonstrate what is understood by staff and students, and raises these areas for inclusion in future participatory projects.

7.4.3 Function and Wellbeing: collaborating with entropy

Before evaluating an existing built environment or testing robustness of the functional and wellbeing quality, the test outcome for each user cohort needs to be clarified. As has been shown, school and classroom 'environment' have different meanings to design and educational disciplines (Section 2.2.2.1). Furthermore, pedagogy as reported by architects is a simplified concept (Table 4.9), whereas staff report a range of pedagogy and instructional modes (Figure 6.33), as is consistent with the observation that every year every class is different (Hattie 2009, p. 1). Thus designing for 'a good environment' or 'matching space to pedagogy' are too vague to evaluate.

An alternative is to measure learning outcomes; however, researching specific outcomes does not necessarily make evaluation of design goals easier since education is about both learning achievement and affective (non-achievement) outcomes (Hattie 2009, p. 12), and few have been successfully related back to the learning built environment (Higgins et al. 2005). In recent years, some studies have attempted this (Barrett et al. 2013); however, as discussed in Section 2.4.1.1, these studies do not provide enough detail about design variables to make them useful in practice.

What might be achievable is testing how the school building built environment relates to the 'non-achievement' outcomes. Applying the functionality and wellbeing qualities that emerged in this cohort, the design goal might be design for appropriate environmental interaction, i.e., design for positive built environment interaction and reduce inappropriate interactions.

It has been shown that, regardless of the school's age, continuous permanent modification of the building fabric occurred in the case study schools, and it has been proposed that this is because the teaching and learning needs changed from the original design. While it has been deduced that some of these changes are due to technological innovation, many are due to optimisation for sound or light or comfort, or to increase pedagogical display. Giving the designers the benefit of the doubt, the results here might be generalised as an observation to test occupied building performance for transience in use, to evaluate the consequent changes, and, furthermore, disseminate the results so that others may design for user needs transience.

One example of transience is that it was demonstrated that windows were more art galleries than daylight and ventilations sources, possibly making daylight and artificial light design assumptions void. Thus, the building team (architects and engineers), should be aware of this use and ‘collaborating with entropy' (Till 2009, p. 106).

The wellbeing quality factor found within this study shows some consistency with other studies (Lundblad & Hellström 2005; Senior 2014; Simon et al. 2007). It is proposed that, while the wellbeing details are specific to this inquiry, wellbeing quality could be used as a measure of future building evaluations and for future design.

There are ethical, legal and educational considerations incentives to consider this possibility. In addition to the various professional code of ethics of designers, responsive cohesion also includes the mind-sharing realm, so that if one chooses to invoke responsive cohesion for the built environment (Radford 2010), designers need to look in all directions of this ethical model, including people. Legally, safe work and equity of access are entering statutory requirements, and have expanded the scope of Australian design responsibilities in recent years (Australian Human Rights Commission 2013; Safe Work Australia 2012). Drawing on foresight processes described previously, there is risk (in the forecasting sense) or continuing scope creep of design responsibilities.

Finally, there might be educational imperatives to assume that design relates wellbeing built environment quality to wellbeing of students, i.e., affective outcomes and the safety and emotional health of students. While the link between health and built environment is not well researched (Marmot 2002), but school infrastructure is seen as a contributor to bariatric diseases (Gorman et al. 2007), and contributor to inclusion for students with medical and psychiatric classifications Tufvesson & Tufvesson 2009). Reducing student anxiety and stress due from academic sources has been shown to have a 40% effect size on improving learning outcomes (Hattie 2009, p. 298), so it would follow that reducing other stresses in the physical environment is potentially a worthwhile endeavour. Certainly, small effects should not be discounted in improving educational outcomes, particularly if they are simple and cost effective to implement (Hattie 2009, p. 9). It is noted that, regardless of health, students are individuals and each has his or her own needs (Bowler et al. 2007; Guerin et al. 2009). This research can be generalised as to demonstrate the need to 'collaborate with entropy' of student wellbeing needs.

While most student comments revolve around day to day use and maintenance, it is argued that the origin of some of these issues lie in the base architectural design decisions. For example, toilets are a management and maintenance challenge, however prudent lining and fixture selections, such as choosing concealed S bends, can make it easier to clean toilet bases. Selection of automatic flush systems may reduce reducing stress associated with unflushed pans. In conjunction with this functional approach, designing for pure maintenance functionality is not what all students want ('…better toilets like the ones at the shops', O.Stu96), and not recommended by educationalists (Rinaldi 1998, p. 119). Visual quality is intertwined with wellbeing and functionality.

7.4.4 Innovation: risks and rewards

Another application of this work is to learn from the attempted built environment innovations and how they withstood the challenges of occupation.

There are many contexts, definitions and approaches to innovation. Simplistically, innovation is a social multi-stage process that aims to improve a service or product (Baregheh et al. 2009), thus, architects and designers could be seen as providing outsourced innovation services in building and space. In this context, this inquiry is part of the innovation process in its documentation of user interaction to built environment innovations, in particular to three types of built environment innovations observed to be attempted – space, environmental and cost.

Space innovation was observed in two ways. The first was attempts to provide spatial flexibility for teaching using either a multi-class open space (White.1) or flexible internal doors and walls (e.g., White.3 and White.5, Orange.2, Orange.3, Orange.4). This latter was observed to be configured to create the former in Orange.5, i.e., the multi-class space was configured for the duration of the study year, rather than used for intermittent space flexibility. Legacy designs, such as Yellow.3, were configured to work as multi-class open space. Although the noise measurements did not support the perception that noise was louder in open classrooms, they were reported as noisy despite some form of acoustic modification being observed in all rooms. This perception is consistent with other studies about perceived annoyance due to noise in open plan classrooms (Chiang & Lai 2008; Shield et al. 2010) or student numbers within the space (Mydlarz et al. 2013) and suggests that there is risk of acoustic discomfort associated with spaces containing a large number of people in the current acoustic designs. It is noted, however, that recommendations for appropriate noise levels varies across studies and regions (Shield et al. 2010) so justification for design objectives are fluid within themselves, adding further design risk.

Space innovation was also observed in toilet distribution around the school. Although schools with distributed toilets were not necessarily positive, staff at schools with central toilet blocks expressed concerns about lack of safety and ability to supervise central toilet blocks during class and lack of access during lock downs, suggesting distributed toilet blocks is an appropriate innovation in space planning. This is consistent with recent design advice (DfES 2007), but no comparisons between centralised and distributed toilets were found in scholarly literature.

Environmental built environment innovation was observed in both fabric choices and passive design, and control systems of active elements. The fabric choices and design elements were observed as passive, but noticeable, elements. Active elements were used by teachers and observed by students. Where air-conditioning and vent control was fully automated this removed the opportunity for modelling behaviour other than 'work arounds' for when the system was not operating correctly. 'Demonstration' appliances created some awareness, but were not prominent in recall.

Cost innovation was observed in three schools in the use of transportable buildings to cater to changing capacity needs in the local catchment area. The lack of negative comments suggests that they are seen, at least, as adequate teaching spaces, if with a few idiosyncrasies such as the suspended floor causing IWB to go out of calibration regularly, to the point where the whole class has adapted and students were able to recalibrate it.

The above are all intended built environment innovations. Innovations in technology were observed to put pressure on the case study building fabric and systems. Given the innovation rate of technology and the relatively recent construction of some buildings, it is curious that the possibility of the influence of ICT on teaching and learning was not integrated into designs (Johnson, Adams Becker, Cummins, et al. 2014; Johnson, Adams Becker, Estrada, et al. 2014; Smith et al. 2006), but this could be because it is not fully integrated into teaching (Marsh et al. 2014, pp. 356-358). Thus, another generalisation from this inquiry might be to plan for future pedagogical disruption via personal communication technology, and how the school built environment might respond, particularly in the context of the anticipated 'internet of things' (Kortuem et al. 2013; Mu et al. 2015; Porter & Heppelmann 2014).

Should post occupancy evaluation be undertaken, another test of the potential for innovation success might be the collective contribution, or complementarities, of individual elements to quality, where 'doing more of one thing increases the returns to doing more of another' (Ennen & Richter 2010; Milgrom & Roberts 1995). For example, would better insulation and acoustic design be a small but worthwhile price to pay for a reduction in noise annoyance by sensitive students, and would this lead to less stress on other students and staff? The factor constructs in this inquiry hint strongly that combinations of small effects might lead to a large complementarity effect.

Innovation has risk, some predictable and some not, and this inquiry has shown that the creativity of occupant use within specific built environments. Risk and rewards of innovation might be better predicted if the unpredictable building-occupant system is tested for sensitivities.

7.4.5 Sustainability: quietly robust

This inquiry has assumed that sustainable built environment is a key objective of designers. It has also been assumed that, in the case of schools, sustainability is intended to have an active role in teaching and learning (Section 2.2.2.4), and, so, tested the perspectives of users to built environment elements commonly assumed to be associated with sustainability (Section 2.3.6). Overall it found that users have lesser awareness of sustainability elements, particularly sustainability appliances, than they do about other aspects of the built environment (Section 7.3.4).

While these perceptions are specific to this inquiry, there exists an opportunity to generalise the findings in two ways. First, given that the sustainability elements were only recalled when participants were directly asked, future building performance evaluations should not assume that recall to specific sustainability questions is equivalent to prominence in memory. Without establishing the relative importance of sustainability elements to a participant in the context of their whole built environment experience, there risks claims of success. Mere presence of 'sustainability' elements should not equate to education for sustainable development, ESD(Ed), particularly if ESD(Ed) is seen as a socialisation process, not fact based content (Sund & Wickman 2011a). To not establish context is to risk false positives in building evaluation and false hope in sustainable design.

Second, complex sustainability innovations have risks and unintended consequences, as observed and discussed in Section 7.4.4. Learning from the White School case study, those undertaking building evaluation might allocate more time to investigating possible unintended outcomes and difficulties of complex and non-obvious control systems (Stevenson et al. 2013), or lack of personal control (Baird & Lechat 2009). This suggests that designs might be tested, or simulated, for sensitivities and robustness to differing user capabilities, and/or self-organising robustness (Anderies 2014) intentions, during the early design phase. This latter design advice is particularly important in the context of current evolution of distributed energy systems and storage components and the changing economics of energy (Harell & Daim 2009; Jägemann et al. 2013), where new infrastructure such as battery storage, and associated energy facilities management personnel, might become economic necessities for schools – like the evolution of ICT. Or the hypothesised arrival of regenerative design and technologies (Cole 2012; du Plessis 2012; Mang & Reed 2012)

Thus, the observation of this inquiry is that attempts at sustainability exist and there is some awareness, but the complex environmental systems do not necessarily work as planned either functionally or pedagogically. The more successful built environment sustainability elements are perceived as quietly robust, in that they operate without infringing on the main objective of education.

Given the trend towards a 'technical fix' and 'high performance buildings', which require commensurate technical skills and attitudes to operate (Hyde 2014), together with the changing education for sustainable development (de Leo 2012), and, more fundamentally, the evolving sociology of climate change (Shove 2010), to expect interactive sustainability within the building-occupant system, without pursuing a socio-technical systemic approach, is unjustified hope.

7.5 Summary

This section presented the meta-inference of this inquiry as a response to research questions 4 and 5. This triangulation of the mixed methods used interprets the findings so that they are consistent, in agreement, are distinctive, and correspond with the research intent (Teddlie & Tashakkori 2009, pp. 301-303).

First, the meta-inference strategy was clarified by outlining the inductive themes that emerged from the data body as a whole. These identified two overarching themes – perspectives that differed by cohort and interaction, and how those perspectives of four built environment quality: functional quality; wellbeing quality; visual and place quality; and environmental quality. Of these, wellbeing quality was particularly interesting since the inferential statistics suggested that wellbeing includes an emotional component, thus making it more than safe building fabric.

Since the objective of this inquiry was to learn from architecturally significant school buildings, these perspectives and qualities were presented as a framework and their application to practice was discussed. It is suggested that the disaggregation of evaluation might need to be reviewed to take into account systemic effects.

The different cohort perspectives have implications for integrating the school built environment into education through participatory design, as does the dynamic use of school buildings and the complexity of wellbeing. The risk of innovation was discussed, with examples of innovation attempts that did not appear to meet expected objectives, and it is suggested that more socio-technical evaluation and simulation be undertaken before committing to future innovation.

Finally, justifying sustainability elements as teaching tools was questioned in light of innovation risks and the perspectives of the study cohort. There is awareness, but it does not seem to equate to integration.

All of the schools in this study are well into the occupation lifecycle. It is acknowledged that design does need to ‘freeze time’ during the design phase (Till 2009, p. 86) simply to complete projects. It could be argued that the purpose of building performance evaluation is to unfreeze time and explore the lived experience of the built environment. The intention of this section was to unfreeze time, learn what goes on in schools, and close the design loop.

8 Conclusion

In response to professional architectural practice observation of changing expectations of school built environment typology, this inquiry sought to use the rigor of scholarly research to perform building performance evaluations of occupied primary school buildings.

The literature review assumed systemic perspective of building-occupant interaction, thus allowing the literature review to cross discipline boundaries into areas that were useful in evaluating school building performance. This provided a context of school buildings (Section 2.2), contemporary expectations of the school built environment (Section 2.3), and a review of built environment evaluation processes (Section 2.4).

Five occupied case study schools were recruited by approaching schools local to the researcher, in Adelaide, South Australia, to evaluate the effects of occupancy and use have a school building's fabric over time. A range of case study school buildings were included in the study, which ranged from 'exemplar' architecturally recognised buildings, older heritage-looking buildings (up to 120 years old), contemporary permanent buildings (up to 15 years old and newer), and lightweight relocatable buildings ('transportables').

The evaluations used mixed methods to develop an architectural and environmental context, through visual observations and publically available sources about the school buildings (Section 4) together with logged environmental data of participating classrooms (Section 5). The evaluation then obtained user perspectives from both staff and students of their school buildings through an ethically approved survey. The survey utilised different question types (scale, multiple choice, and open response) and these were analysed using quantitative and qualitative methods, which were interpreted within the context of the established architectural and environmental findings. The case study interpretation used triangulation of data across the case studies, on a topic by topic basis (Section 6), and then emergent themes from the data set as a whole was used to induce a framework based on user interaction with their built environment, and the separate building qualities that are relevant to the case study primary school users (Section 7). The applicability of these qualities to the design professions were also explored in Section 7.

This chapter closes the inquiry by, first, responding to the initial research questions posed. It then states the significance of the work and its contribution to knowledge, and closes with recommendations for future work arising from this work.

8.1 Response to research questions

It was assumed that school building performance evaluation should be an important task, particularly when public expenditure is involved, yet the literature review showed a disparate collection of attempts to evaluate building performance, often by so-called 'experts', and with little formal and rigorous input from users, and none specific to South Australian building stock. This is not to say that school building performance evaluation is not performed in practice, only that evidence was not reported in available peer-reviewed literature.

This inquiry took the position that building users are actually experts in their own built environments. They may not use the same language as designers and architects (Appendix D.3), or have the same pedagogical objectives (Section 2.2.2) as built environment professionals research (Section 2.3) and evaluate (Section 2.4.1), but they have opinions, often strong, about their built environment. Thus, if designers and architects are to learn from how their designs 'work' they need to take the time to revisit, listen ethically and empathetically, and learn the language of use. Thus this inquiry proposed the question:

> In order to provide future inclusive and equitable building performance evaluation, this inquiry questions how can school occupants (staff and students), located in selected South Australian primary schools, be included in evaluation, what perspectives do they have about their built environment and its use, and how can these perspectives improve school building evaluation?

This question was then broken down into five sub-question which are answered below.

8.1.1 Research Question 1

Since this inquiry was undertaken in the context of a scholarly research institution, the need to comply with a code of ethics for human research was invoked, which then prompted research question one:

> How can architectural researchers investigate occupied primary school architecture and the users' perspectives of the architecture?

While an unremarkable process required by all scholarly research, the invocation of human research ethics in primary school architecture research prompted two operational research components worth reporting. Involving people under 18 years old, who are unable to give informed consent to participate in research invokes a complex consent process for inclusion of students in survey participation, regardless of the relatively low risk architectural research offers.

It is noted that this consent process is complex and may act as a barrier to inclusion of students in school architectural research and, thus, limit knowledge of interaction of students with their school building fabric. This may explain the lack of reported research.

This ‘barrier’ is not necessarily in place when 'research' is undertaken by professional architectural investigation, but neither is the rigor of the knowledge. Thus, it is in the interest of all to report solutions that open up access to students without compromising their right to a the merit and integrity, justice, beneficence and respect of good quality research, regardless of the perceived risk of the research. The duty of care and process taken to ensure this is reported in Section 3.3.

Photography was used to record the exterior and interior of school buildings for later, site-remote analysis. This is a typical process used in the practice of architecture; however, once the full implications of duty of care and consent towards students and staff was understood, it was identified that photographs taken for the building fabric research included student items, such as artwork and pedagogical materials displayed on walls. In addition to copyright and moral right law on reproduction and assignment of artist rights, this also fell under the code of ethical research of humans, and its need to respect participants. This was particularly interesting since, although the research was about inanimate objects, the research required consent to record additions to the building fabric by humans, thus crossing the line into social science research. These additions to the building fabric by users could not be ignored since they occurred on architectural elements of interest, such as glazing.

The ethical implications of these changes to the building fabric were resolved by classifying the changes in two dimensions. First, they were classified as either permanent or temporary, and second, drawing on a sociological SOGI (Society, Organisation, Group, Individual) hierarchy, if the entity responsible for the change was identified as an individual, human ethics principles were applied, i.e., a picture on a window, if published, would need to be obscured for human ethics reasons, yet a veranda extension, being a decision by a group or organisation, did not fall under human ethics consideration since human ethics does not operate consent at group level.

With appropriate ethics quality procedures were in place, this inquiry proceeded using mixed methods to collect a range of data. The data was collected over the 2012 school year (four terms) and the visits were based around physically downloading data from the environmental loggers in participating classrooms in the first two terms. This continued in the second two terms with surveys given in term three.

School safety is a high priority within the current education culture and the visits during the first two terms allowed students to become familiar with a new person entering their space, and for staff to feel confident in allowing access and interaction during the research. This may have contributed to the good consent and participation rate during term three. After the surveys were completed, the research gave back to the schools by giving seminars to students about design and architecture. By the end of the year a number of students felt open to approaching the researcher and asking questions directly about architecture and architectural science. This new interest of students in design was the delight in the research. It is recommended that future architectural research takes time to develop a safe relationship with participants if they are under 18 years old and deemed to be 'vulnerable'.

8.1.2 Research Question 2

The second research question,

> What is publically expected of primary school buildings in South Australia?

was asked so as to establish the baseline purpose of primary school buildings in South Australia. This was addressed by first discussing the contextual design and pedagogical influences in professional and peer reviewed literature, together with Australian federal and state guidelines and regulations (Section 2.2). This was further underpinned by a review of the literature about the school built environment (Section 2.3).

Public documentation, specific to the case studies, was collected from education, architectural and other sources (Section 4.3). This provided a background ethnographic description of the case study school infrastructure.

Using a survey test instrument, school building users were asked about specific expectations of their buildings and classrooms (Section 6). It was found that the different cohorts, students and staff, often had different expectations and that these were aligned with their active or passive interaction with built environment components (Section 7.1.1).

Responses from other questions also allowed expectations to be implied from open ended responses. For example students described perspectives of poor cleanliness and hygiene in their toilets that might be considered daily maintenance. From this we can imply that there is an expectation of clean toilets. Staff just wanted more toilets.

The expectations of primary school architecture in general, and primary school architecture in specific South Australian schools varies, and depends on the background and role of the respondent. For scholarly research in this area, the position of the respondent must be clarified to provide context for any interpretation of results. For professional building performance evaluation, the sole reliance of 'experts' on building assessment must be questioned in light of this variability of user expectations.

8.1.3 Research Question 3

Once appropriate data collection methods were determined and building expectations identified, the question was posed,

> How are selected South Australian primary school buildings observed to be used?

where 'observed' is from the perspective of an architectural researcher using data collection methods, such as visual ethnography (architectural documentary photography), site visits and observation notes, environmental measurements of classrooms, historical building documentation and other publically available documents.

The original configuration of buildings was determined from original building documentation and through professional observation of the fabric. Permanent modifications of the case study buildings were identified and the most significant are reported in Chapter 4. Permanent modifications were observed on all buildings, regardless of age. The oldest (120 years) had significant interior modifications that include, but were not limited to, wall and acoustic reconfigurations. The most recent buildings (10 years old) had fewer modifications, and these ranged from veranda extensions, which reduced glare, to additional display space infrastructure. This suggests that school buildings are constantly modified to fit needs, regardless of building age.

Modifications for 'sustainability', i.e., water or energy saving appliances, were observed in all case study schools. Attempts at innovative design include automated comfort control. However, the most uniform permanent change across all case study schools and classrooms was a retrofit of an interactive white board, as demonstrated by fabric modifications across all schools. This provided an example of how new technology can significantly change a teaching space. The significance of this example is that schools that were designed and built less than ten years prior to the 2012 research year had evidence of obvious reconfiguration to cater to this new technology. This suggests that either the technology change was rapid and unforeseeable, or that designers were not aware of the coming technology.

Temporary modifications were observed in the classroom. Desks configurations were observed change, but not in all cases. Display was observed to be located beyond the confines of the ‘official’ pinboards, to new pinboards, walls, windows, acoustic panels, retrofitted overhead catenary lines, and luminaires. Display was also observed to be dynamic.

Some classrooms were observed to be used differently to design expectations. For example, rooms with operable walls were observed to be either permanently open or shut for the duration of the school year, suggesting that this in-built flexibility has, at least, a yearly rather than daily time frame. Rooms that were designed as flexible open plans had class zones marked off with ad hoc barriers of shelves and partitions and showed little reconfiguration during the observation year.

Overall, the users were observed to modify all observed buildings, permanently and temporarily.

8.1.4 Research Question 4

Since one of the critiques posed by this inquiry is that school building performance are often judged by 'experts', i.e., non-users, it was imperative to ask:

> Within the selected South Australian schools, what are users' perspectives of the architecture of their primary schools?

Through the survey test instrument it was found that user perceptions differed according to their cohort, i.e., as either students or staff, and their extent of interaction with the fabric. This has been discussed as depending on the active or passive interaction with the built environment components. It was also noted that there were aspects of design that should be passive, although they were actively reducing interaction, such as design intended to be safe and not cause harm, or design to be easily used, i.e., designed to be actively passive.

Through these interactions, responses were inductively grouped together using qualitative meta-inference into four types of quality categories:

- functional quality – that part of the school built environment used in teaching and learning;
- wellbeing quality – a quality associated with comfort and safety, but including maintenance, cleanliness and the perception of health, which, if of poor quality, may invoke emotional and, possibly, psycho-social stress responses;
- visual and place quality – the characteristics of the aesthetic, identity and place aspects;
- environmental quality – the quality of the interaction of the school with the biophysical realm, such as how natural resources are used and waste is reduced, and how that is communicated to users through the school fabric.

There was an emotional component to the judgement of the school by students, suggesting that visual and place quality was more about place identity for students than for staff. This is logical since going to school is potentially an emotional endeavour in both bad and good ways.

Functional quality described how the infrastructure worked with the objective of learning and teaching. Classrooms were felt by all to be too small. Complex air-conditioning controls led to ad-hoc improvisation, such as propping open a door for ventilation. Buildings designed originally for good daylight saw that naturalism turn into glare with the interactive white board retrofits. On the positive side, staff took control of what infrastructure they could, as evidenced by the personalisation and dynamism of the observed rooms.

Wellbeing quality is defined here as aspects concerned with legal requirements for workplace health and safety, and duty of care, but results, particularly the factor construct derived from a factor analysis on the student data, extend that to possibility of using design to also provide a sense of healthiness and safety. In the cohort studied, students and staff were generally satisfied with their school and jobs, and expressed that their school buildings were safe and healthy. However, the open question about toilets elicited strong negative responses, consistent with other studies. This suggests that wellbeing could be more than just managing legal risk, and opens possibilities for design influence.

The environmental quality of the school buildings in this study is the perceived use of resources and impact on the environment. There was awareness of sustainability appliances if asked directly, but these did not appear as an integral awareness. Gardens were more at the forefront of memory, which is logical since students are likely to use them more than the building management system, even if the latter is available via intranet, as intended by designers. Students at the school with a regenerated natural ecosystem responded with enthusiasm about its contribution to their lives, but not about the installed photovoltaic cells. Again this is logical since the PV cells are not visible by small people from ground level, but the waterway plants and frogs are easily accessible.

8.1.5 **Research Question 5**

This final question is included with the objective of moving these results into the design profession:

> Based on these findings, what can design professionals learn from formally collecting school building user perspectives, and how and why this should be used in future school design?

When designers choose to investigate how their designs are used this presents a learning opportunity to test the accuracy of their original design theories about building use in their particular design. This can be done through an array of post occupancy evaluation techniques, but these rely largely on expert opinion (Section 2.4.1.2). As has been shown, the user ‘lived experience’ may differ from expert observations, particularly if the users are not adults. If designers do choose to seek the perspectives of users they must be aware that, extending this inquiry's findings, users filter their responses according to their profile and interaction with the building fabric. This does not lessen the validity of their experience. Rather, it increases diversity of importance of building fabric elements and makes good design in the mundane, the actively passive, an opportunity and an imperative.

Design strategies might need re-considering. Rather than commencing with grand plans to match buildings to pedagogy, more functionality might be gained through improving acoustics in an otherwise plain rectilinear room. More wellbeing might be achieved by designing toilets that are easier to clean. More sustainability learning might occur by risking installing photovoltaics at student level, i.e., on the ground. Given that this inquiry shows that architecture and place might be an emotional experience, all of these will feed back into 'good' architecture through systemic complementarity.

And how might user perspectives be integrated into future design? There are two possibilities. First, professional designers undertaking occupied building evaluation test and improve their design hypotheses through evidence based methods. Architects already attempt 'innovations' in design, such as the L-shaped classroom (Section 2.3.3.3), but there is little peer-reviewed evidence about the achieved benefits. Legally, Australian architects are not required to design ‘fit for purpose’ buildings: testing one's own occupied designs does open up the risk of generating evidence that they do not operate as predicted, thus acting as a barrier to design learning.

The second alternative is to learn from evidence-based independent evaluations, such as this inquiry. The results provide evidence of how technology has changed the building fabric needs in a short, possibly unforeseeable, timeframe. The results also show that even with acoustic components installed, noise is an issue. With the trend towards portable technology and even more group work, acoustic design will need to be moved to forefront of consideration. If technology is anticipated to drive future pedagogy, buildings will need to be more robust to change. In the context of changing energy sources and supply costs, the robustness and sensitivity to user activities will, logically, become more important to investigate.

All this this suggests moving back to basics of building fabric design, but with more pre-construction testing. This requires two changes in approach. The first is to accept that, in the case of schools, the unseen fabric might be more important than the architectural finery. This is the humbling of architecture. The second change in approach is to test the sensitivity of building fabric to the extremes of school users. As this integrates into BIM, this is now possible, but falls in the design divide between architecture and engineering.

8.2 Contribution to knowledge

In the Australian context, this inquiry is original because it presents detailed case studies of the use of occupied primary schools from the perspective of both staff and students, the latter cohort being typically omitted from building performance evaluations. The primary schools are located in metropolitan Adelaide, in South Australia, and were selected for their locally recognised architectural significance. Thus, there are limits to generalising beyond the geographic and cultural boundary of Adelaide. However, the intention was to learn from occupied exemplars of architecture, as is typical in practice of drawing on precedents, and the inquiry achieves this, should users wish to use it. Furthermore, the triangulation across the schools produced common results and these are presented as a quality framework, which is argued to offer the possibility of generalisation on which future work may build.

It has been shown that the building-occupant systemic view is, indeed, appropriate and useful. School buildings do provide space for learning and teaching and users do modify them, both temporarily and permanently, to the point where the boundary between the fabric and the occupant becomes blurred. Ethnographic observations, together with other results, provide a detailed narrative of how school buildings might not be used as expected. Since this inquiry also proceeded from the perspective that users are experts in their own environment, it is argued that this behaviour is valid because architects are not educators. Thus, architects should design for flexibility and robustness of primary school use that architects might not expect to be architecturally logical.

The framework, induced from the common results, centres on users' perspectives of four building qualities. These qualities demonstrate that users evaluate their buildings partly on architectural (visual and place) and environmental qualities, but also on their functional and contribution to wellbeing during occupation.

If schools are seen as a service business then quality is part of the service offering that contributes to customer satisfaction. Quality in service organisations is a complex and an integrated play between service product and service process, both of which are reinforced by what the delivery portal communicates to the user. The framework developed here represents that part of the service offering associated with the built environment. To best of what this inquiry could achieve, this represents the users perspectives of what aspects of quality is important in their built environment, not what designers and facilities managers say they should be. Where designers might extoll the virtues of passive environmental design or building management system as both energy saver and teaching tool, users in this study wanted good quality building fabric *because it made them feel safe and proud*. From the perspective of a designer, this suggests that addressing the detail of the fabric in the school built environment is important, and appropriate funding should be made available to create the best quality building fabric possible because it is associated with wellbeing and, extending this logically, may reduce emotional responses in users.

8.2.1 Application beyond selected schools

The separation of wellbeing quality from architectural aspects, such as aesthetic and place quality, suggests that this can apply to all school buildings, not just those judged by professional design bodies to be architecturally significant. With this logic, this extended interpretation of wellbeing quality of the school built environment, if decoupled from functionality, visual and place, and environmental quality aspects, is dependent on experience of spatiality felt by staff and students. This is likely to have some commonalities across cultures, particularly the emotional feeling around nasty places like toilets, as has been demonstrated by other research. This is an area that designers can focus on and be confident in making a difference with their practice. Furthermore, in cultures and countries where education is deemed important but with limited funds, this is an area designers might direct their efforts.

The cases observed presented attempts at built environment innovations that do not appear to be used as planned and this implies that design radicalism should proceed with care. A more rigorous approach to school design change might be to investigate incremental evidence-based improvements to the school built environment to test the good and the bad, so that the metaphorical ugly is never built. To do this would prompt architects to better define their objectives. Are they designing to improve learning outcomes or for other, equally valid reasons? Researching space changes may improve inclusion or clarify the extent overall learning outcome change. Architects need to know what doesn't work as much as what does work, and advise their clients accordingly. This raises the possibility that architects need to expand the practice of architecture beyond practical completion and defects period. This is either a radical suggestion, or a rewarding opportunity. Only time will tell.

8.3 Challenges and limitations and challenges of this work

The challenges and limitations of this work is largely due to the exploratory nature of the inquiry and the need to design the research to be achievable within the limited resources available in terms of time, equipment and funding. Furthermore, since this research strayed into interdisciplinary approaches, the research design was inelegant in places due to lack of background knowledge of what is possible in other disciplines.

The research was designed to ensure that a wide range of data was collected both to create richness and to provide alternative if one data type was not available. This decision was based professional experience of variable access to architectural documents and school infrastructure. While this decision mitigated project risk, it also created a large overhead for collecting and analysing data to the scholarly level required in this project. Future projects should consider focussing on specific aspects and working in conjunction with other disciplines to distribute the data analysis workload.

Having reviewed some existing post-occupancy evaluation questionnaires (section 3.5.7.1) it was decided that they were inappropriate because they were designed for adults and did not cover the detail about architectural design and user perspectives that this inquiry set out to capture, so it was decided, very early in the project, to create an inquiry-specific survey. At the time of doing this, the author was both not aware of freely available survey test instruments, such as the Children's Physical Environment Rating Scale (CPERS) (Moore & Sugiyama 2007). While using an existing test instrument might have saved time, an evaluation and adjustment would still be necessary to focus it on architectural perspectives as required by this inquiry.

The environmental monitoring equipment used had small memory storage and relied on regular visits to the schools to download and restart the equipment. Although there was monitoring equipment available that could be used remotely via internet, it was not possible to purchase this at the time. The risk was that monitoring would be lost if regular downloads on site were not possible. This risk became a reality in term 2 (autumn term), so the environmental monitoring of the whole school year did not eventuate, however term 3 (winter) and term 4 (spring and early summer) were very close to complete data sets, with data lost due to restrictions due school-led restrictions (school holidays, preparation for school year close down) rather than researcher-led restrictions.

Recruitment of participating school was also found to be a challenge. After achieving approval from the education authority, primary schools principals were approached via mail and email to invite them and their school to participate. Principals were approached in term four of the year prior to the planned monitoring year and by this stage of the year some principals seemed less disposed to consider a study. This process took longer than anticipated because already busy principals could take a number of weeks to go through non-essential correspondence.

It was a conscious decision to gain approval from the education authority to approach principals directly, so as to avoid coercion. However, future recruitment might be easier if the recruitment is done via the education department on behalf of a named university academic to give it more credibility initially. Having said that, most of the schools that were recruited were welcoming and open to the research, as intended using the direct approach method, and rich data was gathered.

8.4 Recommendations

Since this inquiry started from a practitioner's perspective, two sets of recommendations are offered below.

8.4.1 For future research

This inquiry has opened up many opportunities for future research work. These are summarised under two options: extension of original inquiry and expansion of scope.

The first option is to extend the study to more schools, both in Australia and internationally. This is possible now that the research process has been resolved so that research allows inclusion of vulnerable populations to participate in occupied building performance evaluations, while maintaining 'duty of care' and 'informed consent'. This should be done to reproduce or build on the results of this study so as to confirm (or refute) the framework.

It should also be undertaken outside of Australia to test the framework in other cultural contexts. It is hypothesised that the framework itself might be generalizable, in that all schools can be judged according to their visual and place quality, functional quality, wellbeing quality, and environment quality, however the scope of use by the different international teaching and learning practices is very likely to differ. For example, where a pedagogy is largely didactic and there is less movement within rooms, room size may not be a consideration of functional quality. Similarly, wellbeing quality may differ according to different standards of cleanliness. Alternatively, toilets might be 'disgusting' in their own special way everywhere.

The second option is to expand the scope of research. The perspectives of quality derived in this inquiry are qualitative due to the research methods selected and recruitment constraints. With appropriate design the qualities identified could be further investigated using quantitative methods and an interdisciplinary approach. In particular, with the growth of embedded and wearable ICT, personal data that include metrics for stress, or other physical sensations and perceptions, could be integrated into a building performance evaluation design to relate independent user experience back to the physical location. Leaving aside the ethical implications, this opens up the following opportunities:

- Further investigation of the interaction between user and the educational built environment and consequences of that interaction for wellbeing;
- Differences between staff and student perspectives of place attachment associated with visual aspects of school infrastructure, and any interaction with other quality aspects;
- ‘Actively passive’ fabric design as contributor to emotional and physical stress reduction in students;
- Investigation into what architecture is actually seen by users.

It is assumed that all of the above are investigated within the built environment design disciplines so that they can be then related back into evidence-based advice for design practitioners.

8.4.2 For practice

Based on this research, it is recommended that stakeholders in the procurement and maintenance consider the following:

- Policy makers:
    - Collaborate with and fund university researchers to test educational facility design claims and provide evidence-based guidelines;
    - Support stakeholder consultation, particularly to include both staff and student cohorts, as an opportunity for action research rather than an overhead;
    - Provide appropriate funding for the procurement of schools that allow design to match user quality expectations;
- Procurement teams (clients, project managers, and other procurement stakeholders depending on location):
    - Provide a research phase in the procurement, where evidence around learning built environment is assessed and stakeholders are included in the research;
    - Where evidence for a design component or innovation is limited, use formal risk analysis procedures to test the return on investment;
    - If funding is limited, divert funds towards building fabric that is durable, maintainable and easy to clean;
    - Commit to maintaining inclusion of stakeholders throughout the entire procurement process, including the post-occupancy period;
    - Test the outcomes of the built environment for the four qualities and learn from discrepancies;
- Design teams
    - As for the procurement team;
    - Critically assess educational facility design theory and question the quality and validity of the evidence presented in support of buildings claimed to be exemplars;
    - Critically assess the design against functional, wellbeing, visual and place, and

environmental quality, both now and after years of occupation. Base these sensitivity analyses on a systemic perspective;

- Assume sustainability elements will not be a significant part of the curriculum, and ensure their justification is valid for their original purpose – reducing resource use or waste generation;

- Users
    - Where offered, be a part of any building evaluations;
    - Be open about where buildings are excellent or deficient;
    - Use and test the framework developed in this inquiry and improve it where necessary.

9 List of sources

Please refer to Appendix A for a list of the data sources.

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Appendices

Appendix A List of data sources

This list contains identifying information and is subject to confidentiality requested by participant education authorities. It is provided for thesis examination only, with examiners trusted to not distribute this list in either paper or electronic form.

For public domain access this list is not for publication and will be redacted. Readers are invited to contact the author with their inquiries.

A.1 Architectural drawings code and sources

Sources other than inspection (coded)	Sources other than inspection
SAS1	Services SA [redacted]
DAIS1	DAIS [redacted]
DAIS2	DAIS [redacted]
DAIS3	DAIS [redacted]
DTEI1	DTEI [redacted]
DTEI2	DTEI [redacted]
DTEI3	DTEI [redacted]
COE1	Architect in Chief Office Adelaide for Council of Education [redacted]
COE2	Council of Education [redacted]
AUSCO1	Ausco [redacted]

A.2 Public document code and sources

Reference code	Source description	Source reference – Embargoed – Identifying information to be redacted for publication
YellowPD 2014	Description of 2004 redevelopment from architect website	[redacted]
YellowPD 2013	Architect narrative for architecture award entry	[redacted]
YellowPD 2012a	School context statement	[redacted]
YellowPD 2012b	School site improvement plan	[redacted]
YellowPD 2012c	School Newsletter	[redacted]
WhitePD 2014	Description of East Campus from primary architect website, post 2004 awards included.	[redacted]
WhitePD 2010a	Architect narrative for facilities award entry, East campus	[redacted]
WhitePD 2010b	Architect narrative for architecture award entry, West campus	[redacted]
WhitePD 2012a	Jury citation for architecture award, East campus	[redacted]

Reference code	Source description	Source reference – Embargoed – Identifying information to be redacted for publication
WhitePD 2005	Education Consultant description of School	[redacted]
WhitePD 2011	Community website description	[redacted]
WhitePD 2006	International development organisation description	[redacted]
WhitePD 2012b	School context document	[redacted]
OrangePD 2012	Architect narrative for 2002 award type 2 entry	[redacted]
OrangePD 2010	Architect narrative for award type 1 entry	[redacted]
OrangePD 2012a	School context document	[redacted]
OrangePD 2012b	School site learning plan	[redacted]
RedPD 2014a	Description of 2006 redevelopment from architect website	[redacted]
RedPD 2014b	Description of 2006 redevelopment from service engineers website	[redacted]
RedPD 2014c	Description of 2010 hall build from service engineers website	[redacted]
RedPD 2012a	School context document	[redacted]
RedPD 2012b	School improvement plan	[redacted]
RedPD 2012c	School strategic plan	[redacted]
PurplePD 2011	Jury citation for facilities award	[redacted]
PurplePD 2012a	School context report	[redacted]
PurplePD 2012b	School curriculum	[redacted]
PurplePD 2012c	School Buildings and facilities	[redacted]

Appendix B PhD Candidature vs practice as a Registered Architect

In assessing this research proposal and contribution to the 'discipline', it needs to be noted that architecture as a discipline that can be interpreted as either academic or professional. While the academic discipline is contained within the bounds of an academic institution, with careful outreach, the professional discipline concerns the design, documentation, administration of the construction, renovation and other services, using professional knowledge and practices, by a typical registered architect using reasonable care and skills. The professional discipline is regulated by state laws and, as an architect, currently registered in South Australia, I am obliged to conform to those laws. To do otherwise is to risk substantial penalties. In South Australia these laws changed on the 1 January 2011. Their interpretation is still being developed by the South Australian Architectural Practice Board.

As a required submission for my PhD candidature, this proposal must also meet the rules of The University of Adelaide's Adelaide Graduate Centre (AGC). This research proposal is assessed by the AGC and School of Architecture for potential contribution to the academic discipline (i.e., subject) of architecture, i.e., a body of knowledge that is generated through conforming to academic research processes that require more rigor than knowledge created through professional non-academic activities. The research must conform to the "Australian Code for the Responsible Conduct of Research" (NHMRC et al. 2007). Research involving human input must conform to "The National Statement on Ethical Conduct in Human Research" (National Health and Medical Research Council et al. 2007). In other words, this research process uses skills beyond what a typical practicing architect would use. To restrict the research to the skills of a typical practicing architect would render it invalid from the academic perspective. This would also limit the possibility of innovation and generation of new knowledge for the wider good of society.

This proposal is written first and foremost to meet the requirements of PhD candidature under AGC regulations. All post graduate research students are required to submit this. As such, the audience is academic and all terms used should be interpreted in their academic context, e.g., discipline refers to the academic subject area, architecture refers to the description of that subject. Any references to the profession of architecture will be made explicit. Should there be any ambiguity perceived between academic and professional realm, the reader is encouraged to contact the author.

Participants make informed decisions to participate in the research on a volunteer basis. Since there is no client/architect agreement in place the researcher will not provide any professional architectural services to the participants. However, as a registered architect, when on site I am obliged to notify the site's responsible office of any safety issues I notice about their built environment.

This proposal is written in the context of flux of legal requirements. As the first registered architect to go through this process of complying with both the University of Adelaide's AGC Regulations and new SA Architect Practice Act 2009 all attempts have made in good faith to comply with both.

References

NHMRC, ARC & AVCC 2007, *National Statement on Ethical Conduct in Human Research*, Australian Government, viewed 21 June 2011, <http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/e72-jul09.pdf>.

NHMRC, ARC & UA 2007, *Australian code for the responsible conduct of research*, Australian Government, viewed 21 June 2011, <http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/r39.pdf>.

Appendix C Human ethics

C.1 Background to including children in architectural research

Prior to committing to including primary school students in the study, the feasibility of child participants was investigated, and precedents for involving students in assessment of their built environment were found[83]. For example, middle primary students have participated in thermal comfort studies using pictorial questionnaires, with older students more reliable (Humphreys 1977) and secondary school student and teachers perceptions of a solar wall in a secondary school were investigated (McKennan 1985). Attitudes of senior primary students towards fenestration, using observation and questionnaires were collected in the UK (Stewart 1981). Questionnaires were also used in high school thermal comfort studies (Corgnati et al. 2007), and focus groups have been attempted middle primary school students (Simon et al. 2007).

While the subject of this research is school architecture, this research involves collecting data about the built environment from people, which invoked the need for human ethics research consent protocols (National Health and Medical Research Council et al. 2007). Furthermore, because some intended participants were under the age of eighteen they were deemed ‘vulnerable’ and unable to provide informed consent, thus requiring a more complex consent protocol involving their parent or guardians.

While developing an appropriate consent process two issues became apparent. The first was the practicality of obtaining parental / guardian consent for student participation as required from participants under the age of 18. The research was considered low risk because of the subject matter (i.e., not a sensitive topic like 'bullying'); however, the information sheets and consent sheets needed to provide specific information about the project, including notifying them of the extent of photographic and other recording and the process for participation so that parents/guardians could make informed decisions about their ward participating in a survey. These documents were approved for distribution by three levels of administration - the University human ethics committee, the education authority administration and the school principal. Once approved they were distributed either by the researcher to the students, or by the class teacher and collected by the class teacher. This nested consent process, while thorough, had the potential to be a significant time burden. Four out of the five case study schools participate in this section of the research and it is suspected that the fifth did not participate due to other time commitments.

Under the requirement for requirement for respect and justice for participants by researchers (National Health and Medical Research Council et al. 2007, pp. 12-13), a decision was made to

[83] Other precedents include, but not investigated during the research design phase, include Kwok (1997), and Kwok and Chun (2003)

put student learning needs before data collection. It was decided to use unobtrusive research methods where possible to minimise intrusion into class activities. Judgement was made on a visit-by-visit and classroom by classroom basis as to whether data could be collected, and always with full consent of the class teacher during class time. Sensitivity was used to assess whether it was appropriate to enter a participating class. Where a class was obviously unsettled, that class teacher was not approached.

During all site visits, an informal risk assessment of the current activities of each class was done before entering the class as follows:

- if students were present then no photos were taken
- if a teacher was present then some photos were taken if permission was first obtained and the area where the teacher was working was excluded
- if the teacher was delivering a didactic lesson then the room was entered only for logger maintenance
- if the students were working quietly at their desks and the teacher was available to ask about extent of works then spot measurements were made without distracting students
- if the students were doing active group based learning then, again the teacher was asked about extent of accessibility and spot measurements were made.
- if the teachers seemed to be having to work hard to facilitate lessons, as judge by raised voices and voice stress level, then the intrusion was kept to an absolute minimum.

This approach meant that there were differing level of accessibility throughout the year and, together with the variable desk layout, led to spot measurements in variable locations. However, this was offset by the trust that was built up over the year and it was felt, first, accessibility opened up more and, second, the novelty and potential distraction reduced towards the end of the year.

All of this relied largely on participants trusting that the research would be used sensitively and ethically and that all data would be stored securely. Schools, school staff and school students have a right to privacy. It was a condition of being allowed into schools that privacy is maintained. Consequently, this thesis is written, as far as possible, to maintain the anonymity of case study schools. To do this, schools were assigned pseudonyms, building descriptions are the minimum necessary to communicate the physical aspect under discussion, photographs and drawings are modified. The extent of data modifications was judged based on the normative architectural knowledge, i.e. equal but different data.

C.2 Approvals

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
RESEARCH ETHICS AND COMPLIANCE UNIT

BEVERLEY DOBBS
EXECUTIVE OFFICER
HUMAN RESEARCH ETHICS SUB-COMMITTEES
THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA

TELEPHONE +61 8 8303 4725
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email: beverley.dobbs@adelaide.edu.au
CRICOS Provider Number 00123M

29 September 2011

Associate Professor V Soebarto
School of Architecture
Landscape Architecture and Urban Design

Dear Associate Professor Soebarto

APPROVAL No.: **H-241-2011**
PROJECT TITLE: **An investigation of the 'sustainability' expectations and outcomes of the architecture of school buildings from design to occupancy**

I write to advise you that on behalf of the Human Research Ethics Committee I have approved the above project. Please refer to the enclosed endorsement sheet for further details and conditions that may be applicable to this approval.

The ethics expiry date for this project is: 30 September 2012

Participants taking part in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain.

Please note that any changes to the project which might affect its continued ethical acceptability will invalidate the project's approval. In such cases an amended protocol must be submitted to the Committee for further approval.

It is a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants
- proposed changes in the protocol; and
- unforeseen events that might affect continued ethical acceptability of the project.

It is also a condition of approval that you inform the Committee, giving reasons, if the project is discontinued before the expected date of completion.

A reporting form is available from the website at http://www.adelaide.edu.au/ethics/human/guidelines/reporting.This may be used to renew ethical approval or report on project status including completion.

Yours sincerely

PROFESSOR GARRETT CULLITY
Convenor
Human Research Ethics Committee

THE UNIVERSITY *of* ADELAIDE

RESEARCH BRANCH
RESEARCH ETHICS AND COMPLIANCE UNIT

BEVERLEY DOBBS
EXECUTIVE OFFICER
HUMAN RESEARCH ETHICS SUB-COMMITTEES
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email: beverley.dobbs@adelaide.edu.au
CRICOS Provider Number 00123M

Applicant: Associate Professor V Soebarto

School: School of Architecture

Application No: 12412

Project Title: **An investigation of the 'sustainability' expectations and outcomes of the architecture of school buildings from design to occupancy**

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

APPROVAL No: **H-241-2011**

APPROVED for the period until: 30 September 2012

It is noted that this study is to be conducted by Linda Pearce; PhD Candidate.

Refer also to the accompanying letter setting out requirements applying to approval.

PROFESSOR GARRETT CULLITY
Convenor
Human Research Ethics Committee

Date: 29 SEP 2011

Government of South Australia
Department of Education and Children's Services

Policy and Communications
Education Centre
Level 8//31 Flinders Street
Adelaide 5000
South Australia

Tel: 8226 0119
Fax: 8226 7839

DECS CS/11/99.3

1 November 2011

Ms Linda Pearce (PhD Candidate)
University of Adelaide - School of Architecture
North Terrace
Adelaide SA 5005

Dear Ms Pearce

Your project titled *"An investigation of the sustainability expectations and outcomes of the architecture of school buildings fro design to occupancy"* has been reviewed by a senior DECS consultant with respect to protection from harm, informed consent, confidentiality and suitability of arrangements. Subsequently, I am pleased to advise you that after careful consideration, your project has been **approved**.

Please contact Mr Jeffrey Stotter, Research Coordinator on (08) 8226 0119 for any matters you may wish to discuss regarding the general review/approval process.

Please supply the department with an electronic copy of the final report which will be circulated to interested staff and then made available to DECS educators for future reference.

I wish you well with your project.

Ben Temperly
HEAD OF POLICY AND COMMUNICATIONS

Catholic Education
SOUTH AUSTRALIA

Catholic Education Centre
116 George Street Thebarton SA 5031
PO Box 179 Torrensville Plaza South Australia 5031
Telephone: (08) 8301 6600
Facsimile: (08) 8301 6611
ISD: 61 8 8301 6600
Email: director@cesa.catholic.edu.au
www.cesa.catholic.edu.au

Ms Linda Pearce
PhD Candidate
The University of Adelaide
School of Architecture, Landscape Architecture,
and Urban Design
Architecture Building
ADELAIDE UNIVERSITY SA 5005

Dear Ms Pearce

Thank you for your recent letter in which you seek permission to include a selection of Catholic primary schools as case studies in the research project *'An Investigation of the 'Sustainability' Expectations and Outcomes of the Architecture of School Buildings from Design to Occupancy'.*

I understand the study will involve:

- a pilot study to test questionnaires
- installation of data loggers
- a post-summer questionnaire of staff and students
- a post-winter questionnaire of staff and students
- interviews with a small number of school staff during 2012
- focus groups of students during 2012
- collection of utility bills
- visual inspection and access to building and services drawings.

I note that you are currently seeking approval for the first stage of the study which involves installation of data loggers in interested schools prior to the start of term 1 2012.

In the normal course, permission of the Principal of each school in which you wish to conduct research is required. Research in Catholic schools is granted on the basis that individual students, schools and the Catholic sector itself is not specifically identified in published research data and conclusions.

Approval for all stages is also contingent upon the following conditions, i.e. that:

- a copy of the questionnaires has been provided to the Principal
- the permission of parents has been obtained
- the research complies with the ethics proposal of the University
- the research complies with any provisions under the Privacy Act that may require adherence by you as researcher in gathering and reporting data
- no comparison between schooling sectors is made

...../2.

- the researcher will be carrying out the research within view of the class teacher or school observer
- sector requirements relating to child protection and police checks are met by researchers:
    - where researchers obtain information in relation to a student which suggests or indicates abuse, this information must be immediately conveyed to the Director of Catholic Education SA
    - all researchers and assistants, who in the course of the research interact in any way with students, are required to undertake a police check through the Archdiocese of Adelaide Police Check Unit.

Researchers should forward a certified copy of their National Police Certificate, which has been issued within the last three months, to the Catholic Archdiocese of Adelaide Police Check Unit at the Catholic Education Office, PO Box 179, Torrensville Plaza SA 5031. The Police Check Unit will then post a clearance letter to the researcher. This letter should be provided to the Principal of each school.

I trust that you will inform this office prior to undertaking further stages of the study.

Please accept my very best wishes for the research process.

Yours sincerely

HELEN O'BRIEN
ASSISTANT DIRECTOR – CATHOLIC EDUCATION SA

30 November 2011

C.3 Information sheets

C.3.1 Students

THE UNIVERSITY of ADELAIDE

Sustaining School Buildings

A PhD research project in the School of Architecture by Linda Pearce

Information sheet for guardians of student participants

This information sheet is for guardians of student participants who are volunteering to take part in the PhD project *An investigation of the 'sustainability' expectations and outcomes of the architecture of school buildings from design to occupancy.*

The purpose and outcome of the project

The life of a school building is long - over 120 years in some cases in South Australia. However teaching methods change and architects, who design school buildings, must respond appropriately, knowledgeably and professionally to those changes.

This project aims to identify the most important aspects of sustainability and sustainable development that a school wants, identify how existing school buildings are expected to, and actually function, within that framework, and identify how building resources identified for 'green' initiatives could be allocated to maximise benefit for school stakeholders.

The outcome of the project will be a thesis which will (hopefully) lead to the researcher receiving a Doctor of Philosophy degree. But, the intention is also to contribute to the education (DECD, CESA) and architectural community with new knowledge about school design, which is particularly important in the context of emerging strategic directions, such as the Gonski report. I will also share the findings about your school with you and your community.

How your child can contribute to the project

To get a full picture of sustainability of school buildings I would like input from your children, the key building users, about their experiences of the building. Your child can contribute by

- Completing a questionnaire (scales, multiple choice and open questions) later this year
- Letting me make notes if I have a quick chat with your child about their school buildings
- Volunteering to be in a focus group (maximum of 5 per group) to talk more about their experiences of their school buildings (about 20 minutes).

I will be asking about

- sustainability in the curriculum and school.
- the buildings, their sustainability and how do they perform as learning spaces
- their perceptions of satisfaction and comfort of their school buildings.
- some demographic information, e.g. year, age.

What happens to the data?

Any information identifying people will be kept confidential. The school itself will not be identified without prior permission from all levels of authority. Additionally, care will be taken to avoid identifying information via school descriptions.

The data will be collected and stored for 7 years according to the *Australian Code for the Responsible Conduct of Research*. The data will be analysed, discussed within the School of Architecture and used to complete a PhD thesis and associated academic papers. Some 'quotable quotes' may be used in publications.

Are there risks?

The subject area of this research is considered low risk, i.e., it does not investigate sensitive areas such as psychological or cultural issues. The main risk is infringing on limited school time. The intention is to keep everything short, but effective.

If there are any concerns or unintended effects, please raise these with me, Linda, or my principal supervisor (see over the page). You can also contact the independent University of Adelaide Human Ethics Committee (see the attached sheet).

Timber cladding St Edward's School Oxford Photo: LPearce

CRICOS PROVIDER 00123M

Life Impact | The University of Adelaide

Info Sheet Ethics Guardian Student Participant V1.3

Can your child leave the project?

The questionnaire does not collect any identifying information, so once the survey is submitted it cannot be removed from the data.

If your child volunteers to participate in a focus group, or allows me to note any quick conversations, then their contribution can be removed up until the time of thesis submission. Just let me know of your wishes.

Project funding

This project is funded by an Australian Postgraduate Award, through the Australian Federal Government.

Next steps

If you wish your child to participate please complete the attached consent form and have your child return it to school.

Please note that to save everyone's time and paper this consent form covers a number of activities for the remainder of 2012. If you wish to revoke consent you can do so by contacting me below.

If you have more questions please contact...

Main researcher:
Linda Pearce
email: linda.pearce@adelaide.edu.au
tel. 08 8313 3702

Principal supervisor:
Associate Professor Veronica Soebarto
email: veronica.soebarto@adelaide.edu.au
tel. 08 8313 5695

Ethics clearances

University of Adelaide Human Research Ethics Committee H-241-2011

About Linda Pearce

I am a registered architect. I am also a former management consultant and engineer. I have an interest in making it easier for people to make informed decisions about how they can be sustainable. I hope that my research will provide more evidence for sustainable development in the real world with time, money and regulatory restraints.

Prior to my current full time study I worked for Russell & Yelland Architects and Swanbury Penglase Architects, working on schools and churches including:

Galilee Catholic School, Aldinga, stage 2
O'Sullivan Beach Children's Centre
St Francis de Sales College, Mt Barker:masterplan/GLA
St John Bosco School, Brooklyn Park: masterplan/GLA
Xavier College, Gawler, Trade training centre
Wanslea Children's Centre

Linda's qualifications and clearances:
SA Architect Registration No. 2926
BArch(Hons) Adel
BE(Hons)(Elec) Adel
MBA Warwick UK
SA Police clearance IND-100819-140818 23/8/2010

Further Information

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Life Impact | The University of Adelaide

C.3.2 Staff

THE UNIVERSITY of ADELAIDE

Sustaining School Buildings

A PhD research project in the School of Architecture by Linda Pearce

Information sheet for adult participants

This information sheet is for adult participants who are volunteering to take part in the PhD project *An investigation of the 'sustainability' expectations and outcomes of the architecture of school buildings from design to occupancy.*

The purpose and outcome of the project

The life of a school building is long - over 120 years in some cases in South Australia. However pedagogies change and architects, who design school buildings, must respond appropriately, knowledgeably and professionally to those changes.

This project aims to identify the most important aspects of sustainability and sustainable development that a school wants, identify how existing school buildings are expected to, and actually function, within that framework, and identify how building resources identified for 'green' initiatives could be allocated to maximise benefit for school stakeholders.

The outcome of the project will be a thesis which will (hopefully) lead to the researcher receiving a Doctor of Philosophy degree. But, the intention is also to contribute to the education (DECD, CESA) and architectural community with new knowledge about school design, which is particularly important in the context of emerging strategic directions, such as the Gonski report. I will also share the findings about your school with you and your community.

How you can contribute to the project

To get a full picture of sustainability of school buildings I would like input from you, the building users, about your experiences of the building. You can contribute by

- Completing a questionnaire (scales, multiple choice and open questions) later this year
- Letting me make some notes if we have a quick chat about your buildings
- Volunteering to be interviewed about your experiences of your school buildings (about 20 minutes)

I will be asking about

- sustainability in the curriculum and school,
- your buildings, their sustainability and how do they perform as teaching spaces
- your perceptions of satisfaction and comfort of your buildings
- some demographic information.

I would also like to take photos of and make notes about the building exterior and interior including classrooms.

What happens to the data?

Any information identifying people will be kept confidential. The school itself will not be identified without prior permission from all levels of authority. Additionally, care will be taken to avoid identifying information via school descriptions.

The data will be collected and stored for 7 years according to the *Australian Code for the Responsible Conduct of Research*. The data will be analysed, discussed within the School of Architecture and used to complete a PhD thesis and associated academic papers. Some 'quotable quotes' may be used in publications.

Are there risks?

The subject area of this research is considered low risk, i.e., it does not investigate sensitive areas such as psychological or cultural issues. The main risk is infringing on your limited work time. The intention is to keep everything short, but effective.

If there are any concerns or unintended effects, please raise these with me, Linda, or my principal supervisor (see over the page). You can also contact the independent University of Adelaide Human Ethics Committee (see the attached sheet).

Saltire resource centre, Scotland photo: L Pearce

Info Sheet Ethics Adult Participant V1.3

Can you leave the project?

The questionnaire does not collect any identifying information, but once it is submitted it cannot be removed from the data collection.

If you volunteer to be interviewed or allow me to note any quick conversations, then your contribution can be removed up until the time of thesis submission. Just let me know of your wishes.

Project funding

This project is funded by an Australian Postgraduate Award, through the Australian Federal Government.

Next steps

If you wish to participate, please complete the attached consent form and tick which parts of the study you would like to be involved in, and return the form to me (I will collect it during a site visit).

If you have more questions please contact...

Main researcher:
Linda Pearce
email: linda.pearce@adelaide.edu.au
tel. 08 8313 3702

Principal supervisor:
Associate Professor Veronica Soebarto
email: veronica.soebarto@adelaide.edu.au
tel. 08 8313 5695

Ethics clearances

University of Adelaide Human Research Ethics Committee H-241-2011

About the Researcher: Linda Pearce

I am a registered architect. I am also a former management consultant and engineer. I have an interest in making it easier for people to make informed decisions about how they can be sustainable. I hope that my research will provide more evidence for sustainable development in the real world with time, money and regulatory restraints.

Prior to my current full time study I worked for Russell & Yelland Architects and Swanbury Penglase Architects, working on schools and churches including:

Galilee Catholic School, Aldinga, stage 2
O'Sullivan Beach Children's Centre
St Francis de Sales College, Mt Barker:masterplan/GLA
St John Bosco School, Brooklyn Park: masterplan/GLA
Xavier College, Gawler, Trade training centre
Wanslea Children's Centre

Linda's qualifications and clearances:
SA Architect Registration No. 2926
BArch(Hons) Adel
BE(Hons)(Elec) Adel
MBA Warwick UK
SA Police clearance IND-100819-140818 23/8/2010

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Further Information

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Life Impact | The University of Adelaide

Appendix D Real world data collection in occupied schools

One intention of this research, albeit a secondary emerging intention, is to resolve challenges associated with researching occupied school buildings, i.e., real world research as opposed to experimentation (Robson 2002, p. 33). While the intended mixed-method approach was designed with the best information available at the beginning of the project, data collection flexibility was needed to take into account the actual feasibility of interaction with the participant sites (Maxwell & Loomis 2003). Like any project, risks and unexpected situations emerged during the lifetime of this inquiry, and these, and solution strategies, are reflexively discussed in the following sections. It is presented after the methodology and methods discussion to provide readers with the actual context of the research data collection process.

D.1 Access to schools

School hours vary slightly from school to school but are typically between 8.45am and 3pm with a morning and lunch break. It was found that access for logger maintenance and other data collection was best during school hours (particularly at break times). While it might be expected that before and after the core school times would be good for uninterrupted data collection, it was found that not all staff use the classrooms before and after core teaching hours so rooms were typically locked. While it might have been possible to obtain keys, there were two risks involved, even if keys were offered. First, reception areas tend to close soon after school hours so returning keys would have been problematic. Second, being entrusted with after-hours security carries a number of liabilities that were beyond the risk profile of a PhD researcher. Thus, core hours, and the difficulties associated with working around occupants was seen as preferable to after core hours data collection.

D.2 Participant benefits & changing relationships

Scholarly researchers are obliged to return a benefit to participants were possible (National Health and Medical Research Council et al. 2007). In this project this was seen as opportunity to increase trust and familiarity of the researcher.[84]

There were three ways in which benefits were returned to participants. First, results were returned to each school and education authority. Second, each class was offered a talk about 'what architects do' designed to introduce students to design and architecture, without being specific to school design or sustainable building design. This talk was delivered to 10 classes.

---

[84] As a registered architect, subject to codes of conduct and continuing professional development, there are also ethical obligations to contribute to the community and the profession of architecture.

Finally, there was an unexpected benefit returned. During the spot measurements there were a number of informal and incidental conversations with students about the instruments used and the purpose of their use. All questions were answered briefly and with courtesy and used as an opportunity to increase trust in the researcher's presence. A number of teachers also welcomed this interaction as a role model for female students, i.e., a female architect and researcher using technical instruments.

In some cases the talks and conversations were undertaken before the student survey. The timing was driven by teacher and student demand and, while it could have contributed to skewing of student survey responses to the written surveys due to social desirability, compliance, or the demonstration of new architectural knowledge, it was assessed that the benefit of developing trust between researcher and vulnerable participants, i.e., changing the relationship, outweighed the possibility of skewness.

D.3 Not everyone speaks 'architecture'

Being aware of specialist language and the need for 'demystifying the language of the professions' (Coady 1996, p. 30) or provide the opportunity for users to 'have a voice' about their built environment (Parnell et al. 2008), care was taken in the language used with participants in general conversation, during the survey development, and when interpreting the survey responses. Despite this constant professional language reflexivity some terms were found to differ between the research intentions and participants' language. The most common and obvious are presented in Table 9.1. Though most of these emerged during the qualitative survey responses, they are provided here to give the reader full disclosure of interpretation background in the forthcoming discussion.

Table 9.1: Professional / participant language differences

Term	Architectural interpretation	How used by participants	Participant reference
Roof	Cladding material and structure on top of the building	Used to refer to the ceiling, i.e., what can be seen inside a room.	Student response to Q60 'like most about inside of classroom' and Q84 'redesign the inside of your classroom'
Space	A 3D void with certain environmental and atmospheric qualities	Amount of floor area.	Student and staff response to Q60 'like most about inside of classroom' and Q84 'redesign the inside of your classroom'
Ventilation	Outside air made available inside through window, vent or mechanical fan	Term used by staff, not students	Students identify elements (Q09 school uniqueness) or smell (Q78 Toilets)
Post-occupancy evaluation	Building evaluation after being occupied, i.e., after owner has taken 'possession of works'	'Post-occupancy' not understood since 'is', not 'was', occupied.	Early feedback during participant school recruitment.
Heritage, conservation	Anything to indicate awareness of cultural significance and/or building conservation	Use to terms like 'restored', 'old', 'retaining the old look', descriptions of building fabric indicating age in context of Adelaide built environment	Students, Staff (Q09 school uniqueness, Q27 school looks different)

Appendix E Site visit notes proforma

Note that this reduced. Full size has graph at 5mm.

Room

Case study

Teacher

Date

Year

Weather

Noise

ICT

Surface temp

Room activity

Lights type on/off

Blinds/curtains

Teacher comments

HVAC

Operable windows

Student comments

Furniture layout

Logger issues

Fabric additions

30/03/2012 3:00:59 PM C:\Users\lp\Documents\01 PhD\07 Data\room data collection sheet.rvt

Linda Pearce PhD Candidate [School of *Architecture*, Landscape Architecture & Urban Design University of Adelaide] *linda.pearce@adelaide.edu.au*

Appendix F Principles for photographic data collection

The use of study specific photographic data needs to be distinguished from critical "analysis of the visually constructed world" (Harper 2003). To achieve this, photographic data must not be altered and it must "[present] a visual portrait of reality that is consistent with the scientifically understood reality of the situation" (Harper 2003). Like all social science, data collection reflexivity should be used to reduce subjectivity (Pink 2003). Furthermore, like all social science data collection, issues of anonymity and informed consent need to be resolved (Harper 2003; Pink 2003). Given these, six principles were used for the photography undertaken in this inquiry.

> **Principle 1**: Photographs of school buildings are taken to **visually record the buildings, and their additions, renovations, retrofits, and occupation at a point in time**.

While acknowledging that photographs are a construction in and of themselves, the photographs are **not intended** to be interpreted as a 'visually constructed world' in this research project, and are intended as the visual equivalent of site notes.

The ephemeral intersection between photographic data collection of buildings and the additions to buildings by current occupants was observed early in the study. In the paradigm of the architectural professional, photographing the additions to building fabric poses no human ethics issues but architects must be guided by their clients' policies.[85] In the academic architectural paradigm, an addition to the building fabric, such as the display of artwork, could be interpreted as the unobtrusive observation of human activity (Liamputtong & Ezzy 2005; Robson 2002, p. 316), thus bringing the research into the remit of human research ethics, albeit with low risk (National Health and Medical Research Council et al. 2007) as discussed in Section 3.3, leading to:

> **Principle 2:** Photography of school buildings **must be ethical** and conform to today's best practice human research ethics protocols.

Furthermore, the scope of interest of the content in the photographs was guided by Section 3.3, and explicitly identified using:

> **Principle 3:** Photographs should be divided into **three categories** to identify ethical implications. For this project these are considered to be photos that include the **original building fabric**, **additions by current individual occupants** (such as display applied to pin boards) and those that are made by the school for **building maintenance or improvement** (such as an addition of an interactive whiteboard or a rainwater tank).

Regardless of the building-occupant demarcation, in both the professional and academic architectural paradigms the intrusion of the photographer into the operation of schooling must be

[85] For an example of policy refer to the Catholic Education Office circular http://online.cesanet.adl.catholic.edu.au/docushare/dsweb/Get/Circular-4908/FAQ+CIRCULAR+Coversheet+%26+FAQs+Aug09.pdf accessed 11/4/12

considered (e.g. reactive effect Preiser et al. 1998, p. 76; Sanoff 1991, p. 76). Education authorities (DECD, CEO) generally prohibit photographing students and staff, however when used in education research, cameras can act as a tool to facilitate interaction with school users (Loughlin 2013). As a registered architect, there is a general professional consideration to not interrupting the operations of client activities during any inspections. Furthermore, the academic paradigm requires that any human research must weigh up the inconvenience with the benefits to participants (National Health and Medical Research Council et al. 2007), which, in this case, would extend to interruption of class time.

> **Principle 4:** All photography of school buildings **must exclude staff and students and maintain anonymity**. Photographs must be taken when staff and students are not in the space under inquiry and **must not interrupt schooling**.

Photographs must record the space under inquiry. Their purpose is not to make a visually attractive or interesting image in itself and should not be framed, cropped or digitally altered to do so. However, some spaces, particularly indoor spaces, present difficult lighting conditions requiring either on site positioning, the use of flash or post processing adjustment of brightness/contrast in order to give more clarity to the visual record.

> **Principle 5:** Where possible, the photographic data will be **collected and analysed without any visual or aesthetic adjustments to the images**, however, if the image is adjusted to improve clarity, the original image will be kept for reflexive assessment.

The photographic data's prime purpose is to investigate the architecture of school buildings. Since the author has recognised professional expertise in architecture, it is certain this knowledge will subconsciously influence the photographic technique and the analysis of the photographs. Drawing on this knowledge also has the potential to reduce the interruption to schooling by targeting a priori areas of interest. Thus, while there will be subjectivity in the photographic technique there are also potential benefits to maximising limited access to school buildings.

> **Principle 6:** The photographic process is subjective by virtue of the fact that the photographer is a registered architect. A **reflexive process** will be used to identify the subjectivity of images, the benefits to the subjectivity of the images, such as the trade-off between limited access to a space and the use of professional knowledge to target photographic data.

Principle 6 recognises that (like all data collection) there are limitations to visual data and care needs to be taken in identifying bias from personal experience.

Appendix G Toilet queue calculations

It was assumed that peak toilet use would be during teaching breaks, particularly for staff, so it was anticipated that queueing issues might occur. If toilets are considered to be a queueing system, with an arrival time, waiting time, and a service time, and mean occupation times are comparable to toilet use in offices (women pan use 80 seconds) with Poisson distributed arrival times (Davidson & Courtney 1976), then it could be considered to be a multiple server queue (M/M/s queue). This is equivalent to a queue of people in a bank waiting for s bank tellers (Durrett 2012, p. 164). If this is accepted as analogous then the traffic characteristics of the queue can be predicted using Erlang-C queueing calculations (Papoulis 1984, pp. 367-379).

For simplicity, the following applies to female staff only. This avoids the complexity of multiple queues of male and female plans, and male urinals, and given the predominantly female population is a fair approximation of toilet capacity. It assumes a single queue, multiple server queueing system, i.e., a line of female staff waiting for a limited amount of toilet cubicles in a single location. Assuming that an arbitrary arrival interval of 2 minutes (120 seconds), toilet cubicle duration of occupation of 80 seconds (Davidson & Courtney 1976), and an arbitrary target wait time for a free toilet of 30 seconds. Again, for simplicity, it also assumes that female staff do not share toilet facilities with male staff, which is known to occur in some schools, particularly with the practice of sharing accessible toilets, however accessible toilets are included in calculations if they are the closest option and male staff do not add to the occupation. These calculations are summarised below, with Erlang-C queueing tables in Appendix G.1. From this, it can be anticipated that there is significant queueing for female pans during breaks. Given breaks can be as small as 20 minutes; some female staff may use a significant proportion of their time queueing to use the toilet.

School	Female Staff pans	5 arrivals per 2 minutes (slow arrivals during break)		10 arrivals per 2 minutes (fast arrivals during break)		Female Staff in 2012
		Pan occupancy	Average speed of available pan	Pan occupancy	Average speed of available pan	
Yellow School	5	67%	16 sec	133%	> 2 min interval	24 – significant wait if large groups queue
White School	7	48%	1 sec	95%	> 2 min interval	33 – significant wait if large groups queue
Orange School	8	42%	0 sec	83%	32 sec	48 – 30 second wait time for large groups
Red School	3	111%	> 2 min interval	222%	> 2 min interval	19 – significant wait if large groups queue

G.1 Erlang-C queue tables

Input Values					Working Values				Results			
Arrivals per interval Needing the toilet	Interval	Toilet occupation Duration (TS)	Number of toilets (M)	Target Pan avail-ability Time	Traffic Intensity (U)	Toilet Occupancy (RHO)	Erlang-C Function	SLVL	Toilet Occupancy	Immediate availability	Service Level	Average Speed of Available Pan
	seconds	seconds	agents	seconds					%	%	%	seconds
5	120	80	1	30	3 33	3 33	3.33	-7.00	333 3	-233.3	-699.6	-114 3
5	120	80	2	30	3 33	1.67	2.08	-2.43	166.7	-108.3	-243.5	-125.0
5	120	80	3	30	3 33	1.11	1.22	-0.38	111.1	-21.7	-37.9	-292.0
5	120	80	4	30	3 33	0.83	0.66	0.49	83.3	34 2	48.8	78.9
5	120	80	5	30	3 33	0.67	0.33	0.83	66.7	67 3	82 5	15.7
5	120	80	6	30	3 33	0 56	0.15	0.95	55.6	85 2	94 5	4.4
5	120	80	7	30	3 33	0.48	0.06	0.98	47.6	93 9	98 5	1 3
5	120	80	8	30	3 33	0.42	0.02	1.00	41.7	97.7	99.6	0.4
5	120	80	9	30	3 33	0 37	0.01	1.00	37.0	99 2	99 9	0.1
5	120	80	10	30	3 33	0 33	0.00	1.00	33.3	99.8	100.0	0.0
5	120	80	11	30	3 33	0 30	0.00	1.00	30.3	99 9	100.0	0.0
5	120	80	12	30	3 33	0 28	0.00	1.00	27.8	100.0	100.0	0.0
5	120	80	13	30	3 33	0 26	0.00	1.00	25.6	100.0	100.0	0.0
5	120	80	14	30	3 33	0 24	0.00	1.00	23.8	100.0	100.0	0.0
5	120	80	15	30	3 33	0 22	0.00	1.00	22.2	100.0	100.0	0.0
5	120	80	16	30	3 33	0 21	0.00	1.00	20.8	100.0	100.0	0.0
5	120	80	17	30	3 33	0 20	0.00	1.00	19.6	100.0	100.0	0.0
5	120	80	18	30	3 33	0.19	0.00	1.00	18.5	100.0	100.0	0.0

Input Values					Working Values				Results			
Arrivals per interval Needing the toilet	Interval	Toilet occupation Duration (TS)	Number of toilets (M)	Target Pan avail-ability Time	Traffic Intensity (U)	Toilet Occupancy (RHO)	Erlang-C Function	SLVL	Toilet Occupancy	Immediate availability	Service Level	Average Speed of Available Pan
	seconds	seconds	agents	seconds					%	%	%	seconds
10	120	80	1	30	6.67	6.67	6.67	- 54.82	666.7	-566.7	-5481 9	-94.1
10	120	80	2	30	6.67	3 33	5.13	- 28 51	333 3	-412.8	-2851.1	-87.9
10	120	80	3	30	6.67	2 22	3.84	- 14 20	222 2	-284.2	-1419.7	-83.8
10	120	80	4	30	6.67	1.67	2.79	-6.60	166.7	-179.4	-659.5	-83.8
10	120	80	5	30	6.67	1 33	1.96	-2.67	133 3	-96.4	-266.9	-94.3
10	120	80	6	30	6.67	1.11	1.33	-0.71	111.1	-32.8	-70.6	-159.4
10	120	80	7	30	6.67	0 95	0.86	0.24	95.2	13 9	24.0	206.7
10	120	80	8	30	6.67	0.83	0.53	0.68	83.3	46.7	67.7	32.0
10	120	80	9	30	6.67	0.74	0.31	0.87	74.1	68.7	86 9	10.7
10	120	80	10	30	6.67	0.67	0.17	0.95	66.7	82 5	95.0	4 2
10	120	80	11	30	6.67	0.61	0.09	0.98	60.6	90.8	98 2	1.7
10	120	80	12	30	6.67	0 56	0.05	0.99	55.6	95.4	99.4	0.7
10	120	80	13	30	6.67	0.51	0.02	1.00	51.3	97.8	99.8	0 3
10	120	80	14	30	6.67	0.48	0.01	1.00	47.6	99.0	99 9	0.1
10	120	80	15	30	6.67	0.44	0.00	1.00	44.4	99.6	100.0	0.0
10	120	80	16	30	6.67	0.42	0.00	1.00	41.7	99.8	100.0	0.0
10	120	80	17	30	6.67	0 39	0.00	1.00	39.2	99 9	100.0	0.0
10	120	80	18	30	6.67	0 37	0.00	1.00	37.0	100.0	100.0	0.0

Appendix H Environmental monitoring and measurement

H.1 Logging equipment and operation testing

The One-temp loggers do not allow for post-manufacture calibration, i.e., the adjustment of logger measurements to agree with a standard reference. The objective of the logger preparation is to check logger operation, reject those that do not operate and record the offsets of loggers that are deemed appropriate to use.

Logger operation testing used Hoboware Pro (v3.2.1) and Boxcar Pro (V4.0) software for all testing and operation.

H.1.1 Logger operation test – temperature and relative humidity

Logger operation was tested by comparing the readings of loggers under test with a known environment. An insulated container (an esky or similar) was considered to be a known environment and a whirling hygrometer was used as a temperature and relative humidity reference within this space.

Loggers were tested as follows:

- Start loggers using software, synchronising time with computer;
- Place loggers on the base of the esky allowing for at least 10mm air circulation space around each logger;
- Wet whirling hygrometer wet bulb;
- Wind up whirling hygrometer and place in esky and put lid on esky;
- Leave for 5 minutes;
- Open lid and read wet and dry bulb thermometers, and note the time on the same computer used to set up loggers;
- Remove loggers;
- Download logger data and compare reading at time of temperature and relative humidity measurement to hygrometer reading;
- Reject loggers not working or with discrepancies outside of manufacturer's specifications.

H.1.2 Logger operation test – light

The loggers testing light were be tested for operation and error. Since the loggers will be placed in classrooms where both natural and artificial light is used during the day, the response to a range of light conditions was checked as follows:

- Start loggers using software, synchronising time with computer;
- Place loggers next to a light meter under indoor natural light;
- Leave for 30 seconds and note the light meter reading and time on the same computer used to set up loggers;
- Repeat for artificial light;
- Download logger data and compare reading at time of natural and artificial light measurements;
- Reject loggers not working or with discrepancies outside of manufacturer's specifications.

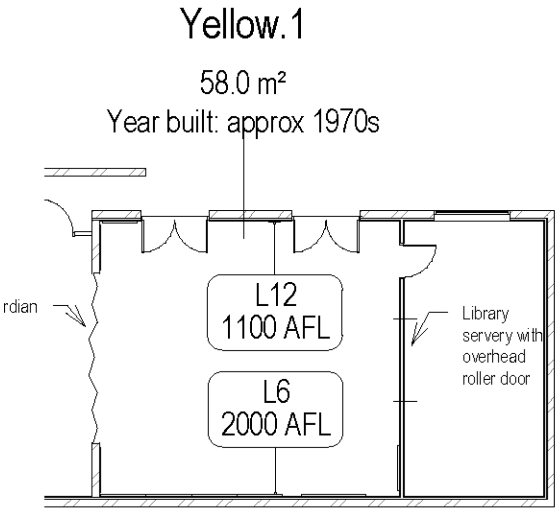
H.1.3 **Logger types, serial numbers and pre-operation check results**

Monitoring available	No	outdoor	Logger model	Serial No	T, RH, L working	date 15 min stability test	Test comments	Owner
Temp only	2		H08-007-02	217963	T	8/01/2012	NO RH	UoA
	46	y	UA-001-64	875068	T	9/01/2012		UoA
	47	y	UA-001-64	850857	T	9/01/2012		UoA
Temp & RH	1		H08-003-02	232678	T, RH	8/01/2012		UoA
	3		H08-003-02	633271	T, RH	8/01/2012	RH highish	UoA
	4		H08-003-02	435023	T, RH	8/01/2012		UoA
	5		H08-003-02	232680	T, RH	9/01/2012		UoA
	6		H08-003-02	355177	T, RH	8/01/2012	displaced sensor	UoA
	7		H08-003-02	436018	T, RH	8/01/2012		UoA
	8		H08-003-02	436032	T, RH	8/01/2012		UoA
	9		H08-003-02	411877	T, RH	10/01/2012	RH lowish	UoA
	10		H08-003-02	310140	T, RH	9/01/2012		UoA
	11		H08-003-02	436009	T, RH	8/01/2012		UoA
	12		H08-003-02	606293	T, RH	8/01/2012		UoA
	13		H08-003-02	606282	T, RH	8/01/2012		UoA
	14		H08-003-02	411871	T, RH	8/01/2012		UoA
	15		H08-003-02	606286	T, RH	8/01/2012		UoA
	16		H08-003-02	633268	T, RH	8/01/2012	RH highish	UoA
	17		H08-003-02	606280	T, RH	8/01/2012		UoA
	18		H08-003-02	310177	T, RH	8/01/2012		UoA
	19		H08-003-02	232686	T, RH	10/01/2012		UoA
	20		H08-003-02	217959	T, RH	9/01/2012	RH lowish	UoA
	23		H08-003-02	606295	T, RH	9/01/2012		UoA
	24		H08-003-02	232694	T, RH	9/01/2012		UoA
	25		H08-003-02	411857	T, RH	9/01/2012		UoA
	26		H08-003-02	633235	T, RH	15/01/2012		UoA
	27		H08-007-02	602848	T, RH	15/01/2012	RH highish	UoA
	28		H08-007-02	340144	T, RH	9/01/2012		UoA
	34		H08-004-02	391015	T, RH, L	9/01/2012	L ok on/off	UoA
	48		H-08-003-02	633260	T, RH	8/01/2012	L - NO	UoA
Temp RH & light	31		H08-004-02	603516	T (RH?) (L?)	9/01/2012	RH-NO Lok-on/off	UoA
	32		H08-004-02	603515	T, RH, L	9/01/2012	L ok on/off	UoA
	33		H08-004-02	632602	T, RH, (L?)	9/01/2012	ok	UoA
	35		H08-004-02	646660	T, RH, L	9/01/2012	L lowish	UoA
	36		H08-004-02	646659	T, RH, L	9/01/2012	L ok on/off	UoA
	38		H08-004-02	390972	T, RH, L	9/01/2012	L ok on/off	UoA
	65	y	UA-002-64	9693078	T, L	9/01/2012	L powerof10 out?	UoA
Extras for linda								

Monitoring available	No	outdoor	Logger model	Serial No	T, RH, L working	date 15 min stability test	Test comments	Owner
Temp only	67	y	UA-001-64	10040709		9/01/2012		UoA
	68	y	UA-001-64	10040707		9/01/2012		UoA
	70	y	UA-001-64	10040699		9/01/2012		UoA
Temp RH Light	101		U12-012	10063550		10/01/2012	20 lux under	LP
	102		U12-012	10043042		9/01/2012	20 lux under	LP
	103		U12-012	10063551		10/01/2012	20 lux under	LP
	104		U12-012	10063549		10/01/2012	20 lux under	LP
	105		U12-012	10096690		9/03/2012		LP

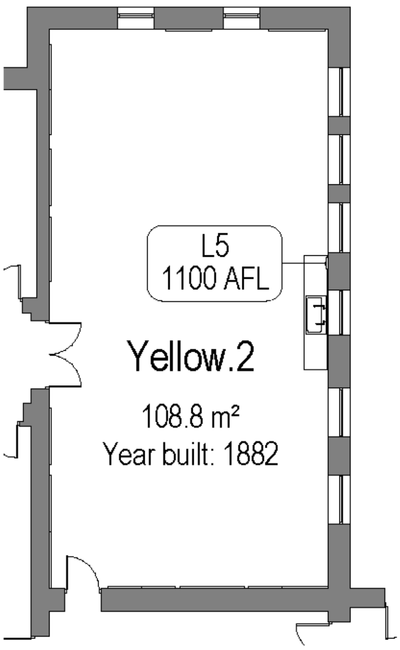
H.2 Floor plans and logger installation locations

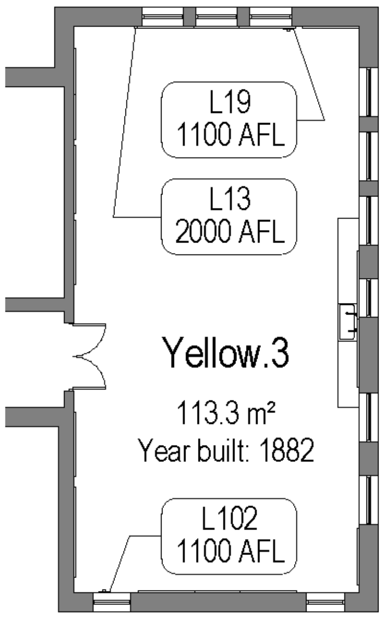
H.2.1 Yellow School



Yellow.1 logger location

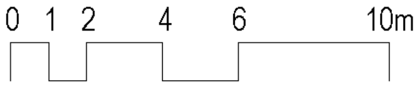
1 : 200





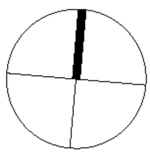
Yellow.2 logger location

1 : 200

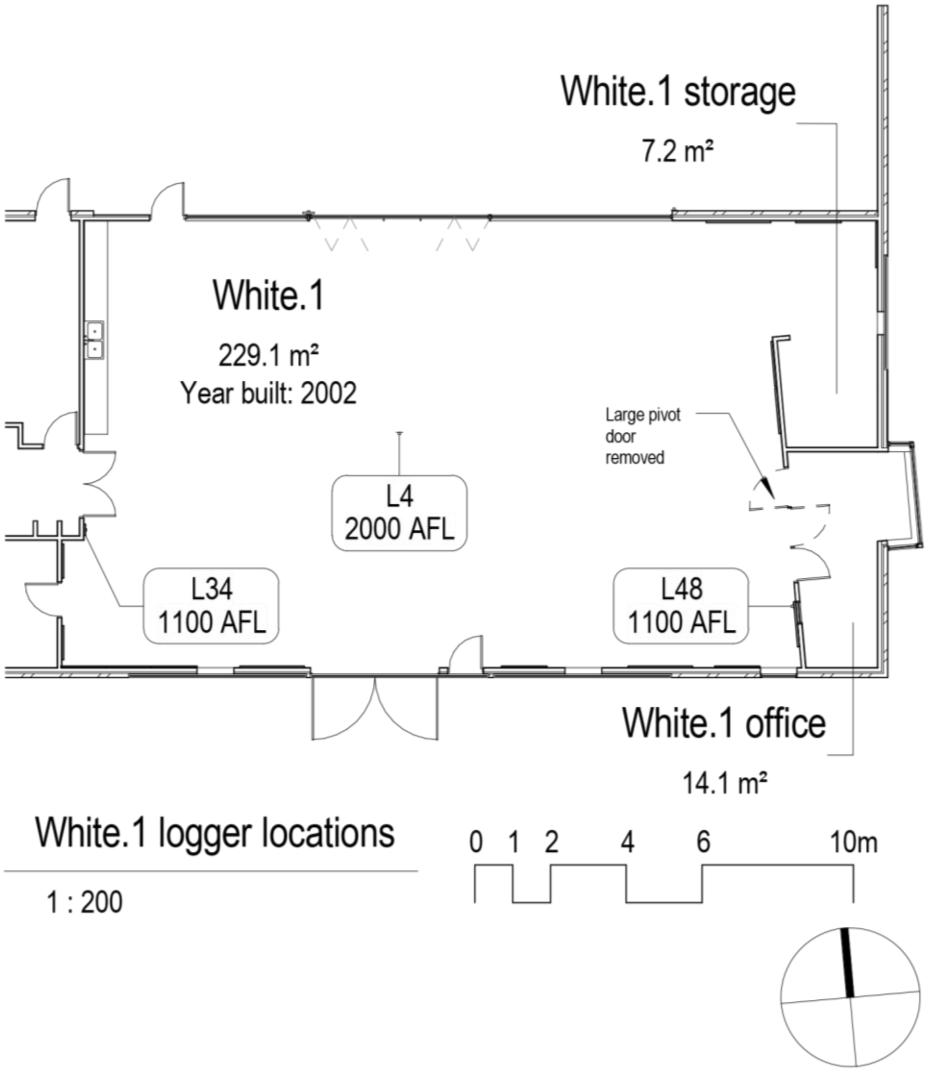


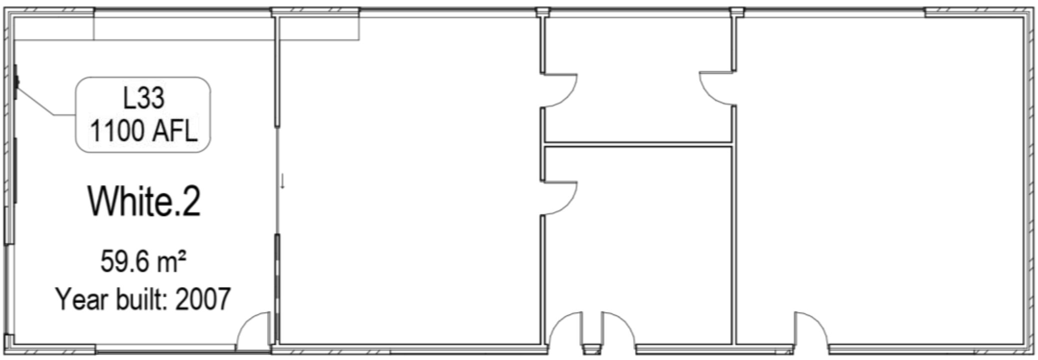
Yellow.3 logger location

1 : 200



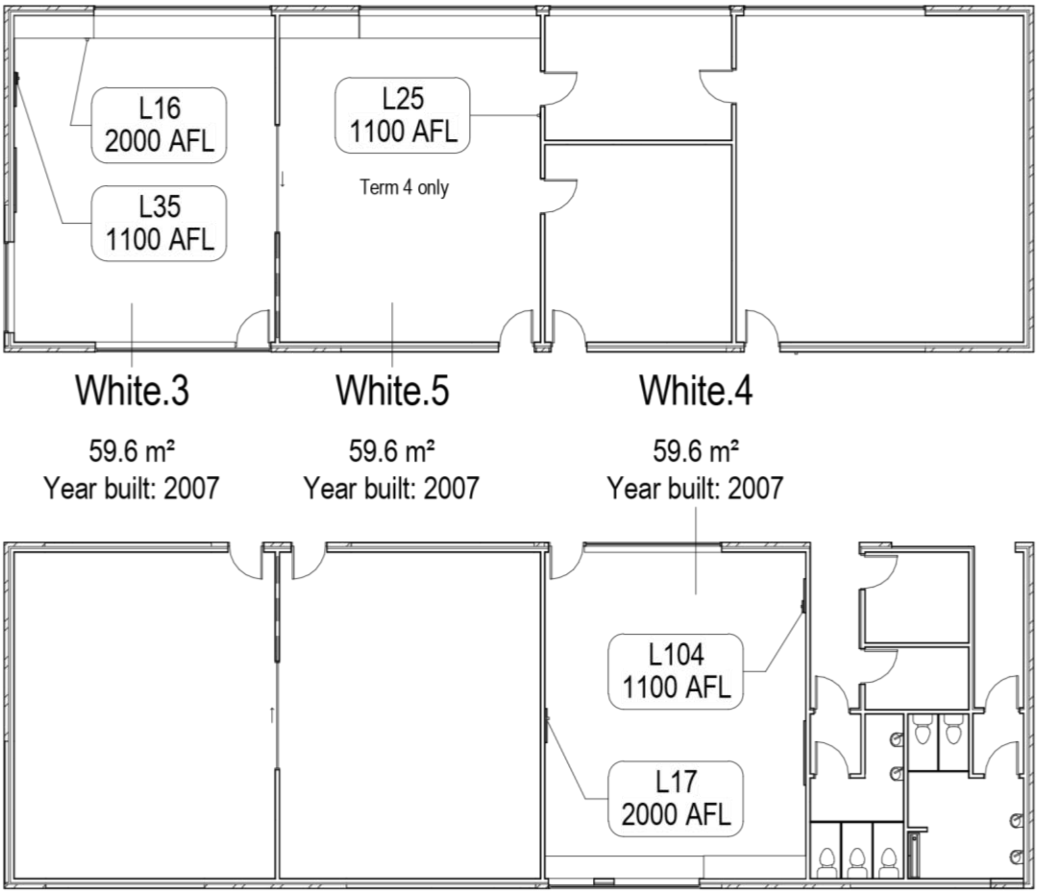
H.2.2 **White School**





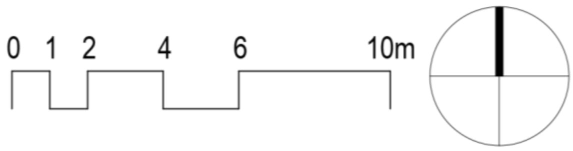
White.2 logger locations

1 : 200

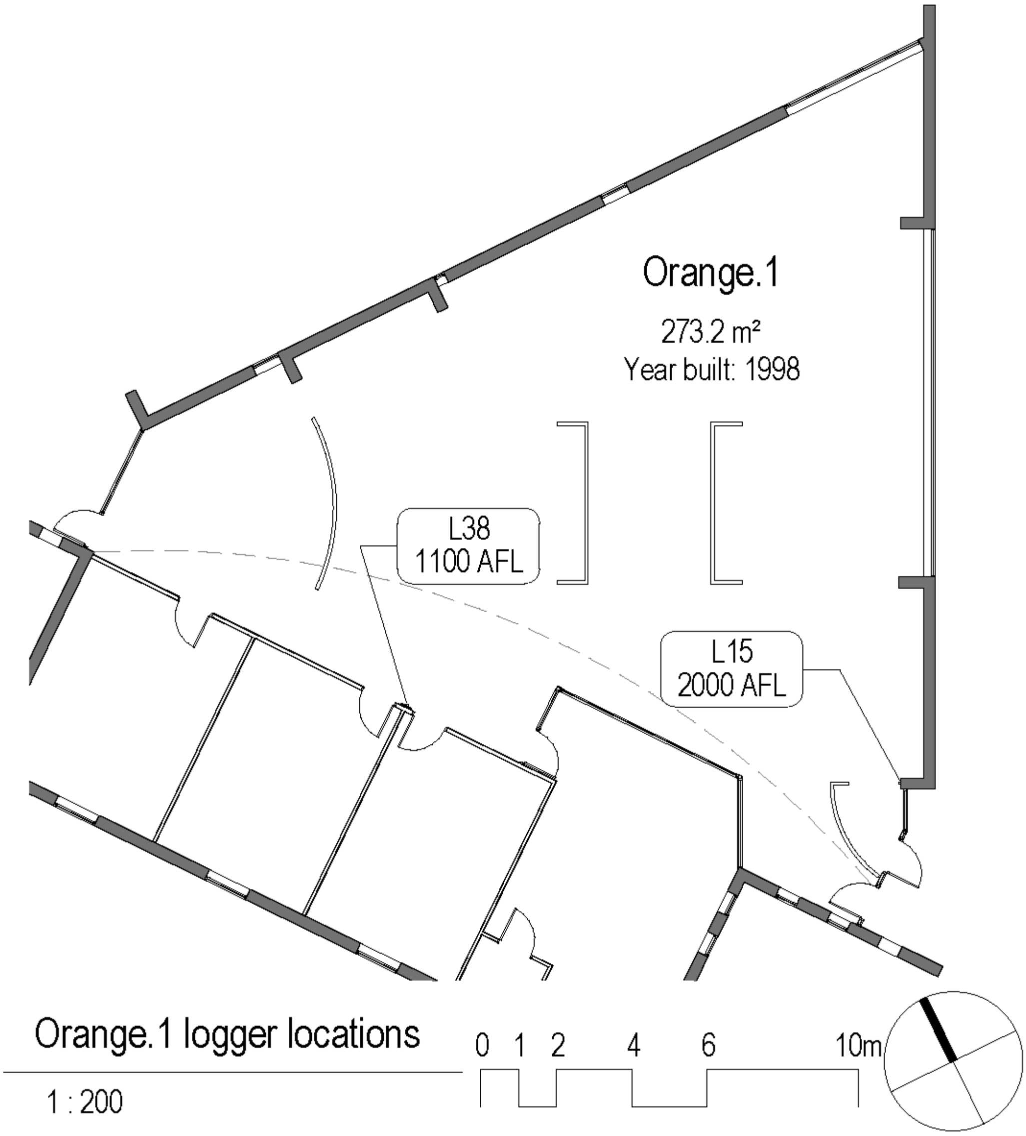


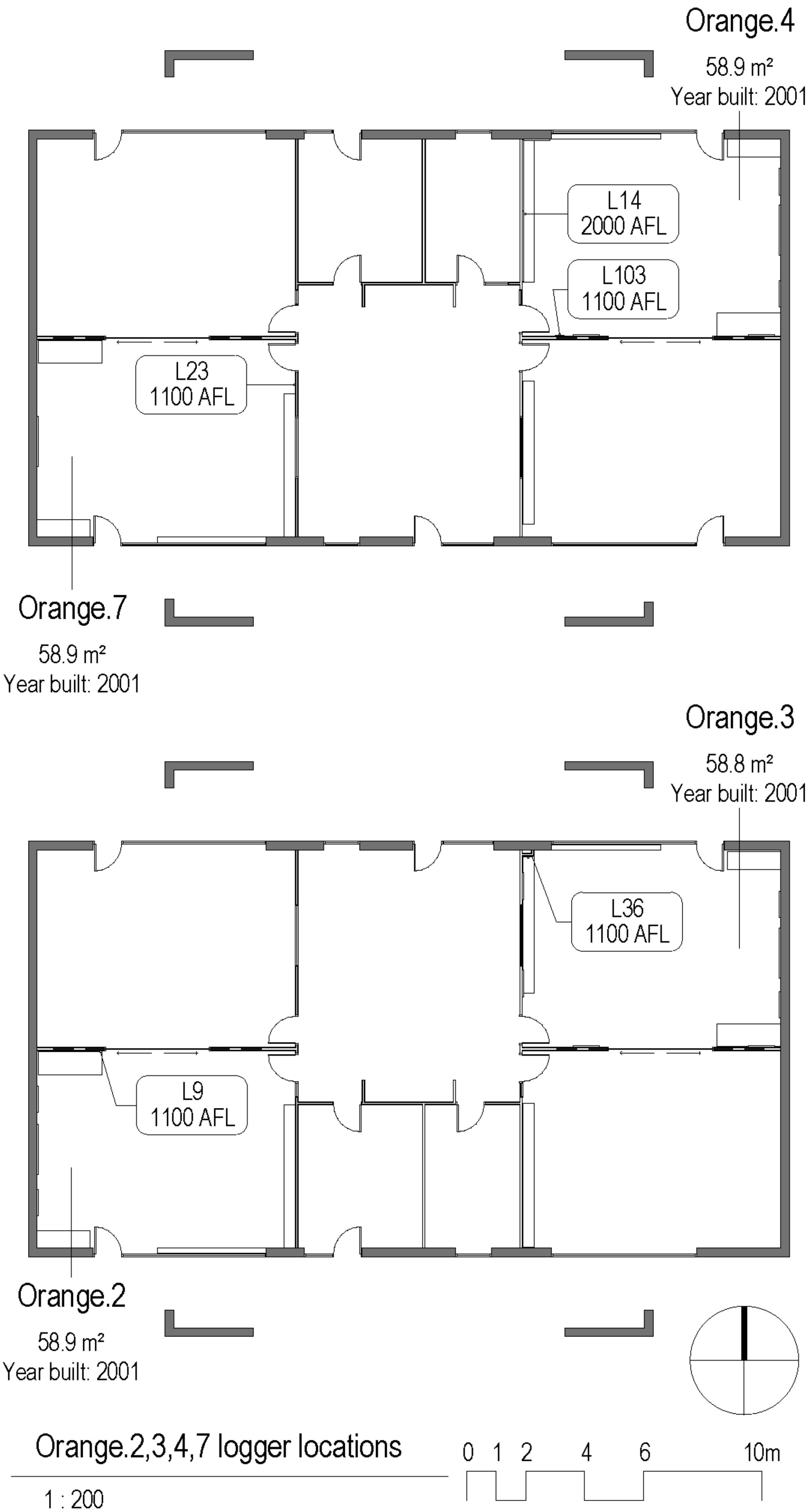
White.3, 4 & 5 logger locations

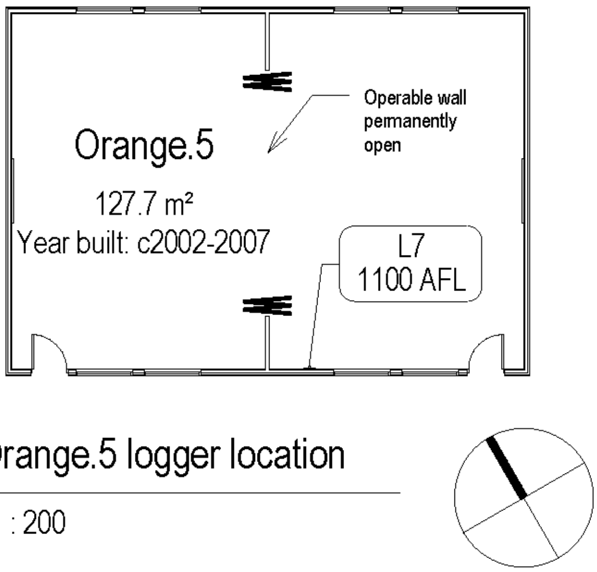
1 : 200



H.2.3 **Orange School**

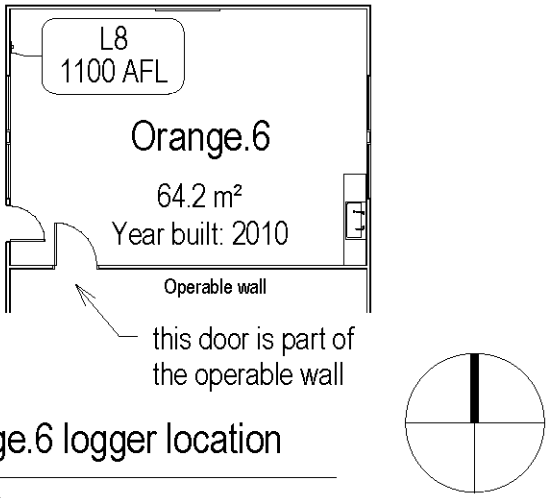



Orange.4
58.9 m²
Year built: 2001
L14
2000 AFL
L103
1100 AFL
L23
1100 AFL
Orange.7
58.9 m²
Year built: 2001
Orange.3
58.8 m²
Year built: 2001
L36
1100 AFL
L9
1100 AFL
Orange.2
58.9 m²
Year built: 2001
Orange.2,3,4,7 logger locations
1 : 200
0 1 2 4 6 10m



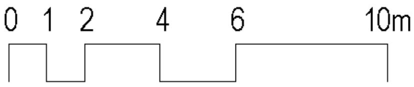
Orange.5 logger location

1 : 200

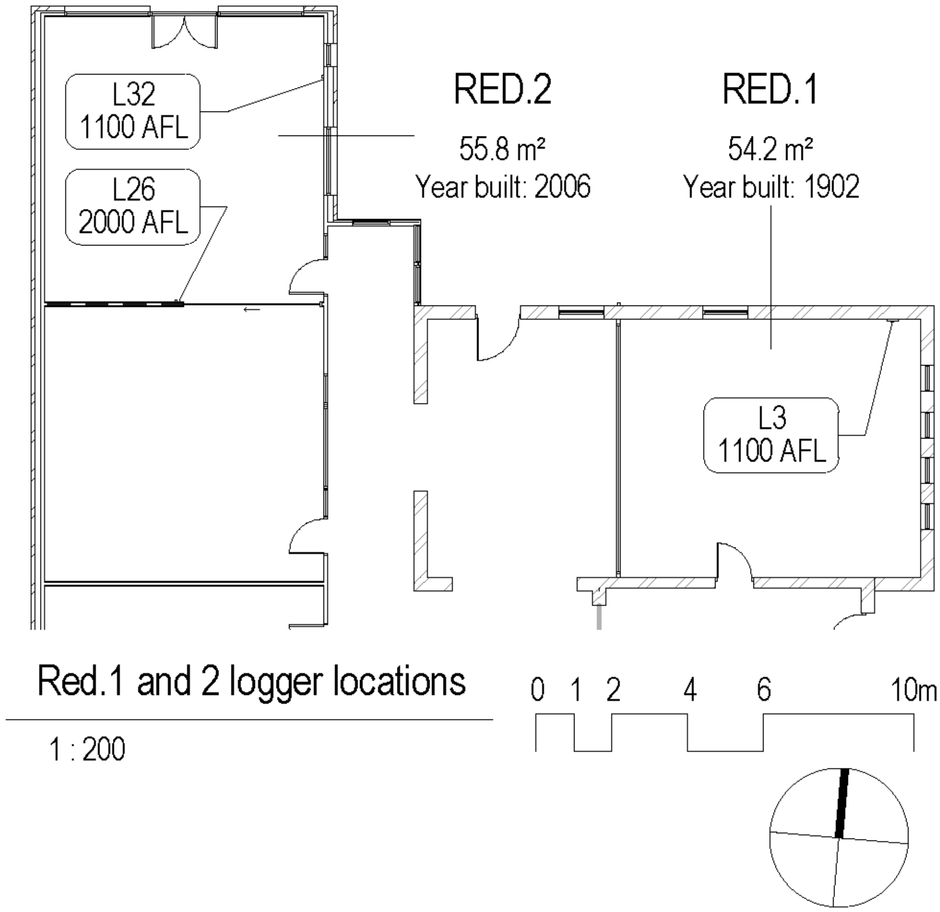


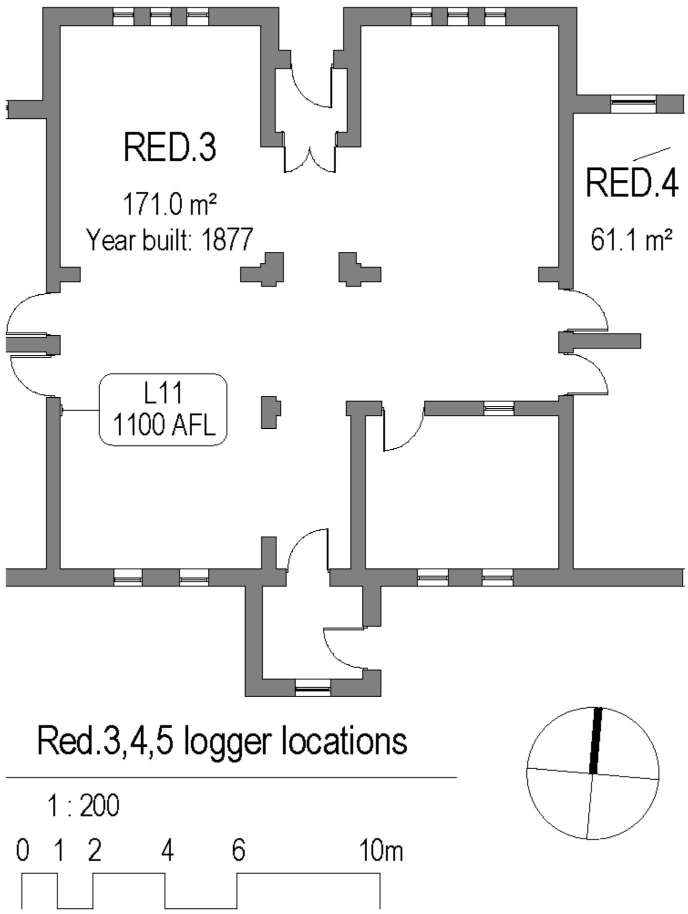
Orange.6 logger location

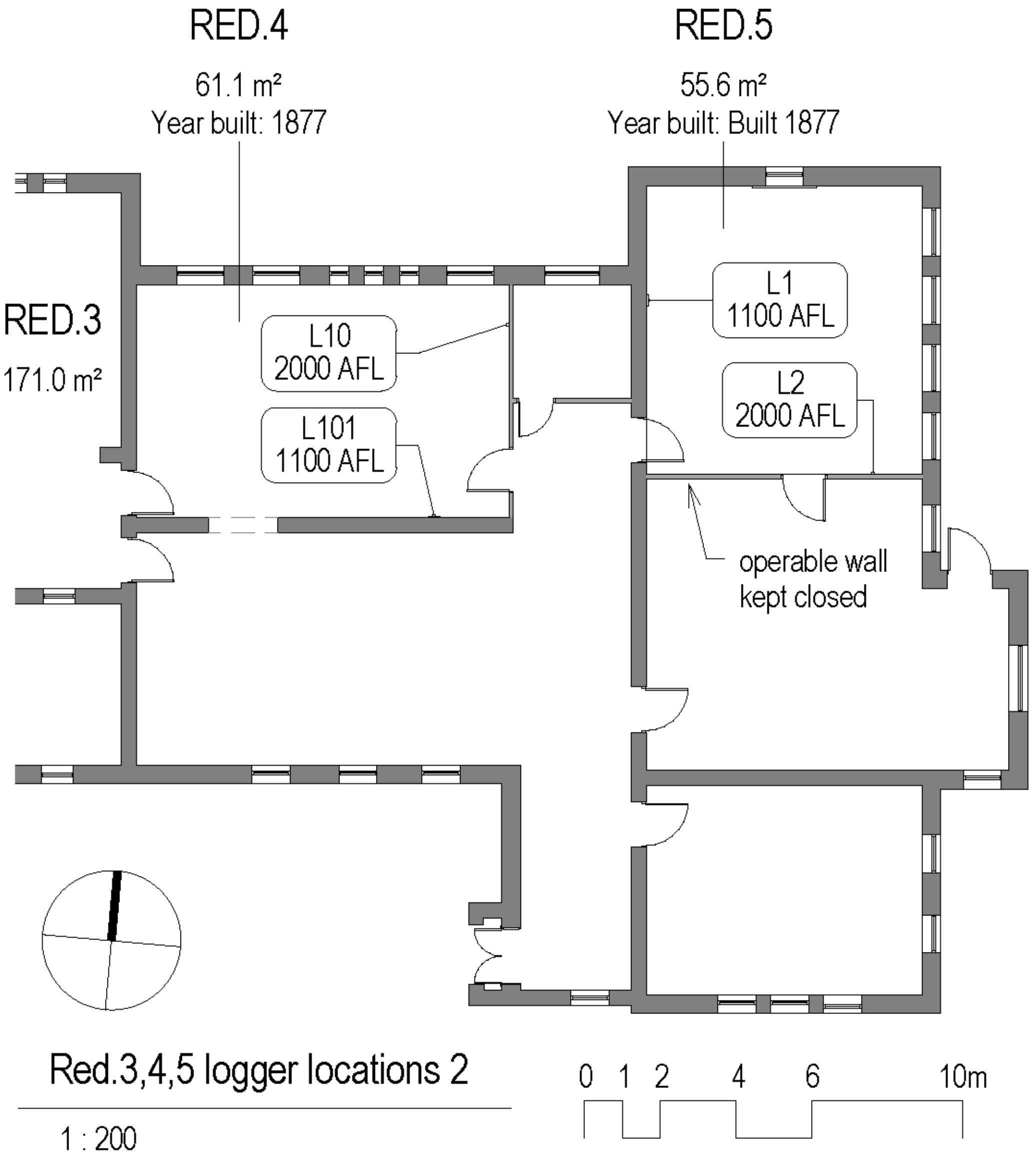
1 : 200



H.2.4 Red School



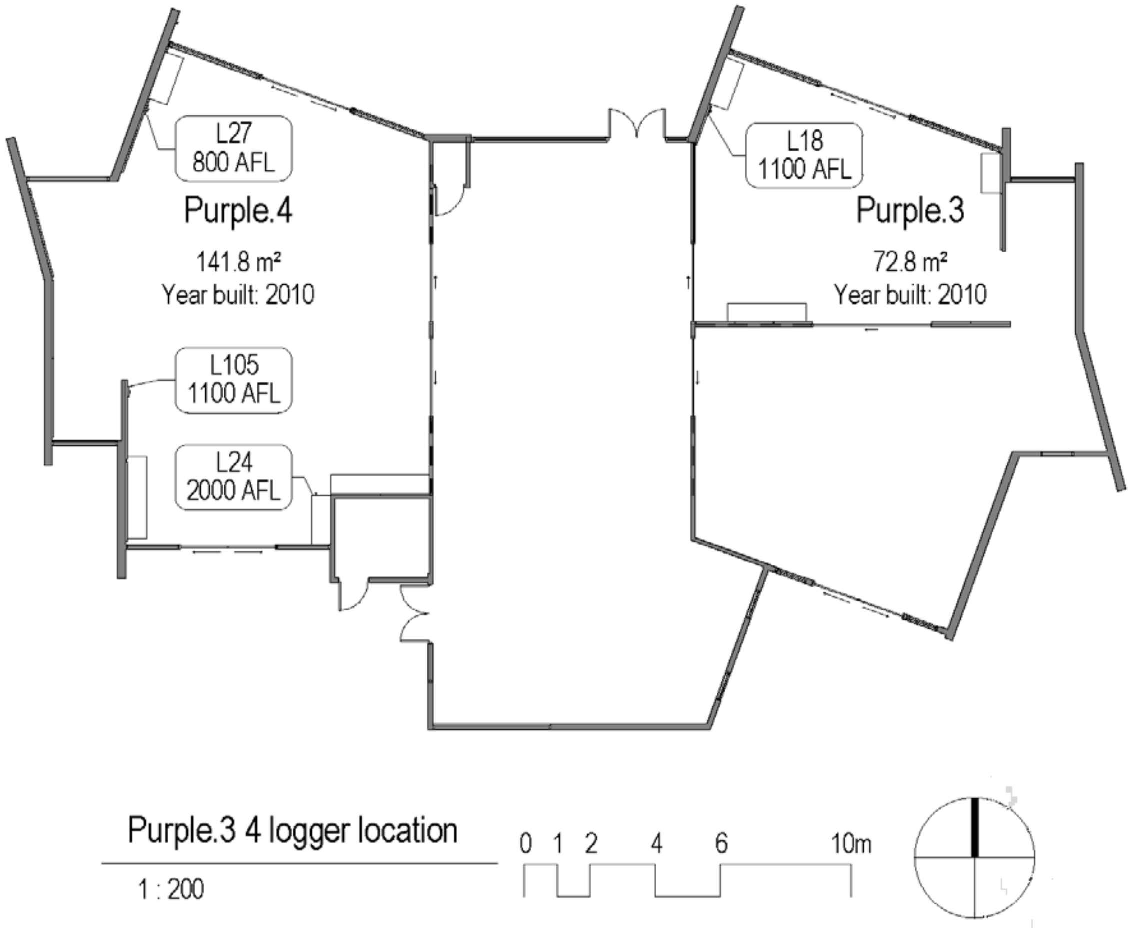


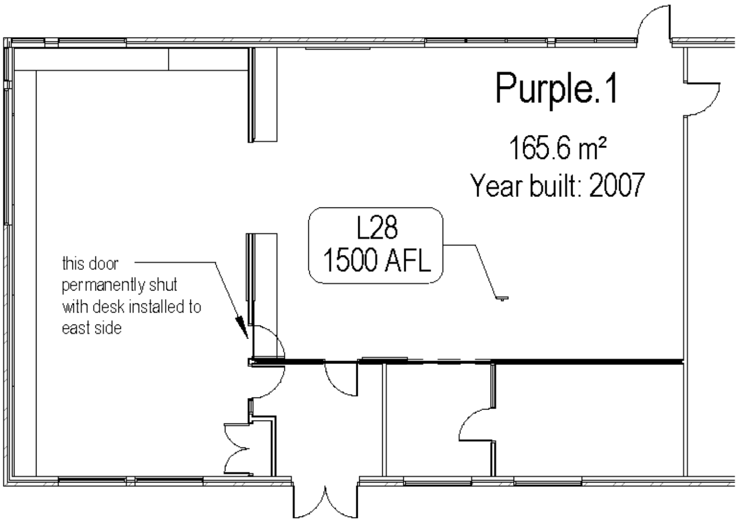


Red.3,4,5 logger locations 2

1 : 200

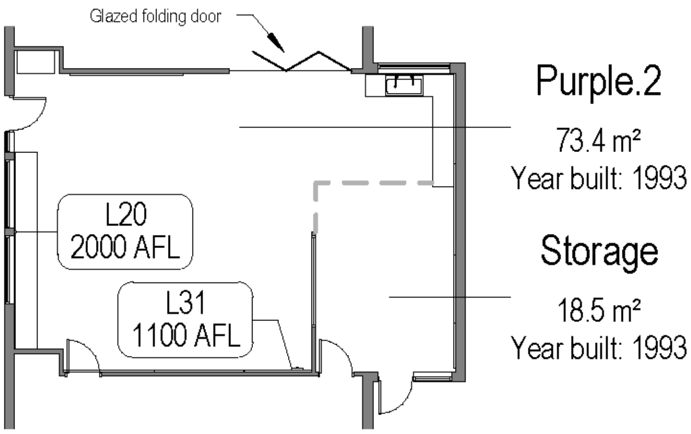
H.2.5 **Purple School**





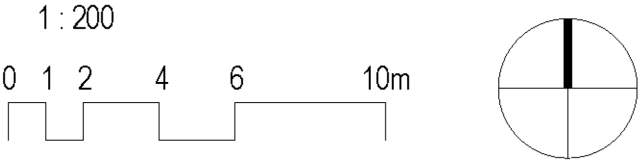
Purple.1 logger location

1 : 200



Purple.2 logger location

1 : 200



H.3 Logger data

H.3.1 Logger data collection dates

Term 1 30/1/12-5/4/12	Term 2 23/4/12-29/6/12	Term 3 16/7/12-21/9/12	Term 4 8/10/12-14/12/12

classroom	Log-ger	install location / comments	missing/ compromised term weeks	Start Date 1	End Date 1	Start Date 2	End Date 2	Start Date 3	End Date 3	Start Date 4	End Date 4	Start Date 5	End Date 5
Yellow.1	6	under split AC on pinboard, south wall	Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10	26/01/12	26/03/12	26/03/12	17/06/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
Yellow.1	12	north wall on foam on stud wall	Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10	26/01/12	26/03/12	26/03/12	17/06/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
Yellow.1	68	outdoor, south wall new toilet block under east sink tied to upvc drain	Term 4 - wk 10	26/01/12	26/03/12	26/03/12	19/07/12	19/07/12	5/09/12	9/05/12	29/10/12	29/10/12	7/12/12
Yellow.2	5	east wall centre on foam on wet area MDF	Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10.	26/01/12	26/03/12	26/03/12	17/06/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
Yellow.3	13	north wall on solid stone wall adjacent AC	Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10.	26/01/12	26/03/12	26/03/12	17/06/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
Yellow.3	19	north wall east end on foam on pinboard on stone wall	Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk10.	26/01/12	26/03/12	26/03/12	17/06/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
Yellow.3	102	south wall, east end on foam on solid stone wall	Term 4 - wk 10	26/01/12	26/03/12	26/03/12	19/07/12	19/07/12	5/09/12	5/09/12	29/10/12	29/10/12	7/12/12
White.1 stg 1	4	on column, centre room, adjacent AC	Term 1 - wk 1. Term 2 - wk 8,9,10. Term 3 - wk 1,2.	2/02/12	20/03/12	20/03/12	11/06/12	30/07/12	16/10/12	16/10/12	13/12/12		
White.1 stg 1	34	west wall on foam on stud wall, to south of door	Term 1 - wk1. Term 2 - wk 4-10. Term 3 - wk1,9,10. Term 4 - wk1,10	2/02/12	20/03/12	20/03/12	14/05/12	18/07/12	11/09/12	16/10/12	10/12/12		
White.1 stg 1	46	outdoor logger, in protective cover, hung from angled down pipe to east of north entrance door. Moved to east end without sun cover 18/7/12	term 1 - first week	2/02/12	20/03/12	20/03/12	18/07/12	18/07/12	30/07/12	30/07/12	16/10/12	16/10/12	13/12/12
White.1 stg 1	48	east end on foam on stud wall	Term 1 - wk 1. Term 2 - wk 8-10. Term 3 - wk 1. Term 4 - wk 1	4/02/12	20/03/12	20/03/12	11/06/12	18/07/12	9/10/12	16/10/12	13/12/12		
White 2 stg 2	33	west wall on foam on pinboard, north end.	Term 1 - wk 1. Term 2 - wk 4-10. Term 3 - wk 9,10. Term 3 - 10 and 11/9 7am light compromised Term 4 - wk1,10	2/02/12	20/03/12	20/03/12	14/05/12	18/07/12	11/09/12	16/10/12	10/12/12		
White 3 stg 2	16	direct on cupboard on north wall adjacent AC	Term 1 - wk 1. Term 2 - wk 1-10. Term 4 - wk 1	2/02/12	25/04/12	18/07/12	9/10/12	16/10/12	13/12/12				
White 3 stg 2	35	west wall on foam on pinboard north end	Term 1 - wk 1. Term 2 - wk 4-10. Term 4 - wk 1,10	2/02/12	20/03/12	20/03/12	14/05/12	18/07/12	30/07/12	30/07/12	23/09/12	16/10/12	10/12/12
White.4 stg 2	17	under split AC on pinboard	Term 1 - wk 1. Term 2 - wk 8-10. Term 4 - wk 1	2/02/12	20/03/12	20/03/12	11/06/12	18/07/12	9/10/12	16/10/12	13/12/12		
White.4 stg 2	70	outdoors, behind bag rack on north side of 'learning street' adjacent ICT room	Term 1 - wk 1	2/02/12	20/03/12	20/03/12	18/07/12	18/07/12	16/10/12	16/10/12	13/12/12		
White.4 stg 2	104	east wall on foam on pinboard to north end	Term 1 - wk 1	2/02/12	20/03/12	20/03/12	18/07/12	18/07/12	16/10/12	16/10/12	13/12/12		
White 5 stg 2	250	NOTE LOGGER IS 25 REUSED. 250 used for sake of this database	Term 1 - wk 1-10, Term 2 - wk 1-10, Term 3 - wk 1-10. Term 4 - wk 1.	16/10/12	13/12/12								
Orange.1	15	AC adjacent east door direct stick on RE wall	Term 1 - wk 1. Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10.	3/02/12	28/03/12	28/03/12	19/06/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange.1	38	south stud wall on foam backing	Term 1- wk 1. Term 2 - wk 5-10. Term 3 - wk 1. Term 4 - wk 3, 10	3/02/12	28/03/12	28/03/12	22/05/12	20/07/12	27/08/12	27/08/12	21/10/12	25/10/12	12/12/12

classroom	Log -ger	install location / comments	missing/ compromised term weeks	Start Date 1	End Date 1	Start Date 2	End Date 2	Start Date 3	End Date 3	Start Date 4	End Date 4	Start Date 5	End Date 5
Orange.1	65	north side staff room (outdoor.69 lost without download - was installed in bag rack outside)	Term 1 - wk 1-6. Term 4 - wk 10	28/03/12	20/07/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12		
Orange 2	9	north stud wall adjacent teacher desk on foam. Replaced on wall without foam 28/3	Term 1 - wk 1, Term 1 - wk 3-wk 9 (Temp/RH compromised) Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10	3/02/12	28/03/12	28/03/12	19/06/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange 3	36	9	Term 1- wk 1. Term 2 - wk 5-10. Term 3 - wk1, 7-10. Term 4 - wk 1,2,3,10	3/02/12	28/03/12	28/03/12	22/05/12	20/07/12	27/08/12	logger did not restart	logger did not restart	25/10/12	12/12/12
Orange.4	14	AC on pinboard	Term 1 - wk 1. Term 2 - wk 9.10. Term 3 - wk 1. Term 4 - wk 10	3/02/12	28/03/12	28/03/12	19/06/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange.4	103	south stud wall to west of slider on foam	Term 1 - wk 1. Term 1 - 29/2-3/3 (light compromised) Term 4 - wk 10.	3/02/12	28/03/12	28/03/12	20/07/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange 5	7	south wall, east side of the operable wall partition on foam	Term 1 - wk 1. Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10	3/07/12	28/03/12	28/03/12	19/06/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange.6	8	north west wall to north end on foam	Term 1 - wk 1. Term 2 - wk 9,10. Term 3 - wk 1. Term 4 - wk 10.	3/02/12	28/03/12	28/03/12	19/06/12	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12
Orange.7	23	east stud wall adjacent internal door direct stick on wall	Term 1, Term 2, Term 3 - wk1. Term 4 - wk 10.	20/07/12	27/08/12	27/08/12	25/10/12	25/10/12	12/12/12				
Red.1	3	NE corner on north wall, foam on timber lining on solid brick wall	Term 2 - wk 9.10, Term 3 - wk 1. Term 4 - wk 1,2,10	25/01/12	23/02/12	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Red.2	26	south wall AC on pinboard	Term 2 - wk 9.10. Term 3 - wk 1. Term 4 - wk 1,2,10	25/01/12	23/03/12	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Red.2	32	east wall, north end on pinboard	Term 2 - wk 5-10. Term 3 - wk 1, 9, 10. Term 4 - wk 1,2,10 Term 4 - 15/11-23/11 light compromised	25/01/12	23/03/12	23/03/12	17/05/12	19/07/12	12/09/12	18/10/12	10/12/12		
Red.2	67	Outdoor, north side building 2 under eaves, in weather protective housing hung from oblique downpipe	Term 4 - wk 10.	25/01/12	23/03/12	25/01/12	19/07/12	19/07/12	10/12/12				
Red.3	11	West wall on foam	Term 1 - wk 1-8. Term 2 - wk 9.10, Term 3 - wk 1. Term 4 - wk 1,2,10	Not used	Not used	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Red.4	10	AC on pinboard	Term 2 - wk 9,10. Term 3 - wk1. Term 4 - wk 1,2,10	25/01/12	23/03/12	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Red.4	101	south wall, east end on foam on solid stone wall	Term 1 - 25/2-26/2 (light compromised) Term 4 - wk 10 Term 2 - 14/8-16/8 (light compromised)	25/01/12	23/03/12	23/03/12	19/07/12	19/07/12	18/10/12	18/10/12	10/12/12		
Red.5	1	west wall, centre on foam on stone wall.	Term 2 - wk 9,10. Term3 - wk 1. Term 4 - wk 1,2,10	25/01/12	23/03/12	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Red.5	2	AC south wall east end on pinboard	Term 2 - wk 9,10. Term3 - wk 1. Term 4 - wk 1,2,10 No RH	25/01/12	23/03/12	23/03/12	14/06/12	19/07/12	10/10/12	18/10/12	10/12/12		
Purple.1	28	on foam on side of stack opposite borrowing desk. Relocated to top of stack late March.	Term 1 - wk 1-6. Term 2 - wk 10. Term 3 - wk 1. Term 4 - wk 2, 10	13/03/12	3/04/12	3/04/12	25/06/12	25/07/12	16/10/12	19/10/12	6/12/12		
Purple.2	20	west wall on mullion adjacent AC ceiling vent	Term 1 - wk 1-6. Term 2 - wk 10. Term 3 - wk 1. Term 4 - wk 2, 10	13/03/12	3/04/12	3/04/12	25/06/12	25/07/12	16/10/12	19/10/12	6/12/12		

classroom	Log -ger	install location / comments	missing/ compromised term weeks	Start Date 1	End Date 1	Start Date 2	End Date 2	Start Date 3	End Date 3	Start Date 4	End Date 4	Start Date 5	End Date 5
Purple 2	31	south wall, east end on foam on pinboard	Term 1 - wk 1-6. Term 2 - wk 6-10. Term 3 - wk 1,10. Term 4 - wk 1,2, 10 March-October light+temp peaks after 5pm	13/03/12	3/04/12	3/04/12	28/05/12	25/07/12	18/09/12	19/10/12	6/12/12		
Purple 3	18	west wall on foam on pinboard	Term 1 - wk 1-6. Term 2 - wk 10. Term 3 - wk 1. Term 4 - wk 2, 10.	13/03/12	3/04/12	3/04/12	25/06/12	25/07/12	16/10/12	19/12/12	6/12/12		
Purple.4	24	south end on cupboard adjacent ceiling AC cassette throw	Term 1 - wk 1-6. Term 2 - wk 10. Term 3 - wk 1. Term 4 - wk 2,10	13/03/12	3/04/12	3/04/12	25/06/12	25/07/12	16/10/12	19/10/12	6/12/12		
Purple.4	27	east wall on foam on stud wall north end adjacent fire hydrant. Relocated to west wall adjacent IWB late March	Term 1 - wk 1-6. Term 2 - wk10. Term 3 - wk 1,2. Term 4 - wk 2,10.	13/03/12	3/04/12	3/04/12	25/06/12	25/07/12	16/10/12	19/10/12	6/12/12		
Purple.4	47	outdoor downpipe inside west wall. Hung behind downpipe from DP strap to wall	Term 1 - wk 1-6. Term 4 - wk 10	13/03/12	3/04/12	13/03/12	25/07/12	25/07/12	19/10/12	19/10/12	6/12/12		
Purple.4	105	west wall south end on foam on pinboard	Term 1 - wk 1-6. Term 4 - wk 10.	13/03/12	3/04/12	13/03/12	25/07/12	25/07/12	19/10/12	19/12/12	6/12/12		

H.3.2 Logger dataset descriptions

Dataset name	Compromised data removed	Core hours	Non-core hours (AH, weekends & holidays)	Outliers included	All data (not comparable dates)	Comparable dates by school
DS-A	X	X	X	X	X	
DS-C-A	X	X			X	
DS-C-C	X	X				X
DS-C-OL-A	X	X		X	X	
DS-C-OL-C	X	X		X		X
DS-AH-OL-A	X		X	X	X	
DS-AH-OL-C	X		X	X		X

H.4 Environmental spot measurement equipment

make	type	measured variable (unit)	model	serial no	owner	owner's number
Precision Gold	Infrared thermometer	Surface temperature (C)	N85FR	08030538	V. Soebarto	
National	Digital Lux Tester	Light (lux)	BN-2000LTE	000182	University of Adelaide	No. 4
CEM	Environment Meter	Air temperature (C) RH (%) sound level (dBA)	DT-8820	04007418	V. Soebarto	
Leica	laser tape	Distance (mm)	Disto D5	314140965	L. Pearce	

H.5 Temperature summary by classroom

Descriptive statistics for logged temperatures at student level during core school hours DS-C-OL-A. Bold red shows highest mean temperatures and largest standard deviations. Bold Blue shows lowest means and smallest standard deviations.

H.5.1 Core hours

Logger Temperature summary using all data collected

	All data - school hours		Term 1 (Summer) school hours		Term 2 (Autumn) school hours		Term 3 (Winter) school hours		Term 4 (Spring) school hours	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Edinburgh BOM	18.6	6.3	23.5	5.3	15.1	3.6	14.4	3.3	22.1	6.3
Kent Town BOM	18.6	5.9	23.3	5	15	3.3	14.6	3.3	21.7	6
Parafield BOM Temp	19	6.3	23.9	5.2	15.2	3.5	14.7	3.2	22.7	6.5
Yellow All indoor @ student level	21.3	2.4	23.1	1.4	20	1.9	19.6	1.9	22.5	2
Yellow.1 L12	20.8	2.7	23.2	1.5	19.5	1.7	18.5	2.1	21.8	2.1
Yellow.2 L5	21.4	2	22.9	1.3	20	1.4	19.8	1.1	22.8	1.6
Yellow.3 L102 Sth	21.3	2.4	23	1.4	19.8	2	19.7	1.8	22.7	2
Yellow.3 L19 Nth	21.8	2.3	23.2	1.5	20.6	2.1	20.4	2	22.7	1.9
White All indoor @ student level	21.8	2.1	23	1.2	21.2	1.7	20.3	2	22.2	2.1
White.1 L34 west	21.7	2.5	23.4	1.4	21.2	1.8	19	1.5	22.8	2
White.1 L48 east	21.4	2.4	23.1	1.4	20.2	1.9	19.4	1.6	22.9	2.2
White.2 L33	22.2	2	23	1	22.1	1.1	21	2.4	22.5	1.9
White.3 L35	21.8	1.8	22.7	1.1	21.7	1.1	20.9	1.7	22	2
White.4 L104	21.7	1.8	22.8	1.1	21.5	1.6	21.1	1.9	21.5	1.9
White.5 L25	21.9	2	NA	NA	NA	NA	NA	NA	21.9	2
Orange All indoor @ student level	21	2.9	23.2	1.9	19.8	2.5	19.1	2.4	22.1	2.5
Orange.1 L38	20.9	2.5	22.9	1.5	20.1	1.6	18.6	1.7	21.7	2.2
Orange.2 L9	20.2	2.6	22.6	1.4	19.1	2	18.7	2	22	2.3
Orange.3 L36	21.1	2.8	22.6	1.9	19.8	2.2	18	1.9	22.1	2.4
Orange.4 L103	21.7	2.8	24.3	1.8	20.4	2.2	19.7	1.9	22.7	2.6
Orange.5 L7	21.4	3.1	23.5	2.1	20.3	2.9	19.9	3.1	21.8	2.7
Orange.6 L8	21	3.2	22.8	1.8	19.2	2.8	18.9	3.1	22.7	2.8
Orange.7 L23	20.6	2.6	N/A	N/A	N/A	N/A	19.2	1.9	21.9	2.6
Red All indoor @ student level	21.2	2.7	23.7	1.5	19.8	1.9	18.9	1.9	22.8	1.8
Red.1 L3	20.7	2.7	23.2	1.4	19	1.5	18	1.6	22.5	1.6
Red.2 L32	22.3	2.7	24.1	1.7	21.9	2.5	19.8	2.4	23.1	2
Red.3 L11	20.2	2	22.4	1.3	19.2	1.6	19.3	1.8	21.8	1.3
Red.4 L101	21	2.6	23.5	1.2	19.5	1.6	18.6	1.6	22.6	1.9
Red.5 L1	22	2.7	24.2	1.4	20.6	1.7	19.1	1.8	23.9	1.4
Purple All indoor @ student level	20.2	2.8	23.2	1.6	19.4	2.1	18.3	2.2	21.8	2.3
Purple.1 L28	20.2	3.2	23.2	1.6	19.4	2.6	18	2.6	22.1	3
Purple.2 L31	20.7	2	22.1	1	19.8	1.6	19.7	2.3	21.6	1.3
Purple.3 L18	20.3	2.5	23.3	1.6	19.9	1.6	18.3	1.9	21.6	2
Purple.4 L105 sth	20.1	2.9	23.9	1.8	19.2	2.1	18	1.9	22	2.4
Purple.4 L27 nth	19.9	2.9	23.6	1.5	18.9	2	17.7	1.9	21.6	2.4

H.5.2 Transition hours - 3.30pm - 5.30pm

Transition hours after school 3.30 - 5.30pm	All year		Term 1		Term 2		Term 3		Term 4	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
BOM Kent Town	***20.0***	***6.7***	***25.6***	***5.1***	***15.3***	***3.2***	***15.0***	***3.4***	***24.1***	***6.1***
Yellow.1 L12	21.7	2.6	23.8	1.9	20.1	1.4	19.4	1.9	23.1	1.8
Yellow.2 L5	21.4	2.0	23.2	1.3	20.2	1.2	19.4	1.0	22.5	1.6
Yellow.3 L19 Nth	21.7	2.1	23.0	1.7	20.9	1.7	20.0	1.5	22.6	2.0
Yellow.3 L102 Sth	21.2	2.3	22.8	1.7	19.9	1.6	19.6	1.4	22.7	2.0
White.1 L34 west	22.6	2.7	24.6	1.3	22.0	1.9	19.1	1.3	24.0	1.5
White.1 L48 east	22.2	2.6	24.1	1.3	20.9	1.8	19.6	1.4	24.2	1.6
White.2 L33	22.6	2.0	23.8	1.6	21.9	1.2	21.2	2.1	22.9	1.5
White.3 L35	21.7	2.1	23.1	1.6	21.1	1.2	20.3	1.4	22.2	2.2
White.4 L104	21.6	1.9	23.0	1.3	21.0	1.2	20.8	2.3	21.7	1.8
White.5 L25	22.4	2.0	NA	NA	NA	NA	NA	NA	22.4	2.0
Orange.1 L38	21.9	2.6	23.9	1.6	21.0	1.0	19.0	1.4	23.2	2.1
Orange.2 L9	20.7	2.6	23.4	1.3	19.5	1.7	18.9	1.5	22.9	2.0
Orange.3 L36	21.7	3.0	23.7	1.9	20.1	1.6	17.5	1.1	23.2	2.0
Orange.4 L103	22.2	2.8	25.2	1.7	20.4	1.6	19.9	1.4	23.7	2.0
Orange.5 L7	22.3	3.0	25.1	2.4	20.7	1.9	20.0	2.0	23.3	2.4
Orange.6 L8	22.1	3.0	24.4	2.1	20.3	2.2	19.7	1.8	23.9	2.2
Orange.7 L23	21.2	2.5	NA	NA	NA	NA	19.4	1.5	22.9	2.0
Red.1 L3	20.9	3.0	23.7	1.8	19.1	1.5	17.9	1.7	22.7	1.6
Red.2 L32	22.8	2.9	25.1	1.8	21.7	2.1	19.9	2.3	23.7	2.1
Red.3 L11	20.7	1.9	22.9	1.0	19.7	1.2	19.6	1.3	22.5	1.2
Red.4 L101	21.3	3.0	24.4	1.3	19.3	1.5	18.5	1.4	23.4	1.9
Red.5 L1	22.0	3.2	25.0	1.4	20.0	1.6	18.6	1.6	24.2	1.5
Purple.1 L28	21.9	3.0	24.4	2.3	21.1	2.0	19.6	2.2	24.0	2.7
Purple.2 L31	20.7	2.0	22.9	1.3	20.1	1.3	18.9	1.3	22.1	1.0
Purple.3 L18	20.8	2.5	23.9	1.6	19.8	1.4	18.8	1.6	22.7	1.8
Purple.4 L27 nth	21.0	3.0	25.1	1.4	19.7	1.7	18.5	1.7	23.1	2.3
Purple.4 L105 sth	21.1	3.0	25.4	1.5	20.0	1.7	18.6	1.5	23.5	2.2

H.5.3 Night time hours 6pm - 8am

Night time during term 6pm - 8am	All year		Term 1		Term 2		Term 3		Term 4	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
BOM Kent Town	***14.7***	***5.6***	***19.0***	***4.3***	***11.3***	***2.9***	***11.1***	***3.1***	***17.6***	***5.9***
Yellow.1 L12	20.4	3.1	23.7	1.5	18.5	1.5	17.2	1.6	21.8	2.1
Yellow.2 L5	20.4	2.9	23.4	1.3	18.4	1.5	17.5	1.2	21.9	2.1
Yellow.3 L19 Nth	19.8	3.7	23.0	2.0	17.2	2.1	16.6	2.0	21.8	3.1
Yellow.3 L102 Sth	19.4	3.7	23.0	2.1	16.7	2.0	16.4	1.8	21.9	3.1
White.1 L34 west	20.1	3.7	23.3	1.8	19.0	1.7	15.6	1.6	21.4	2.6
White.1 L48 east	19.7	3.8	23.3	1.8	17.7	2.1	15.9	1.9	21.8	3.0
White.2 L33	20.4	3.9	23.2	2.4	18.5	2.0	16.8	3.4	21.5	2.9
White.3 L35	20.0	3.6	22.7	2.3	20.6	0.5	16.6	3.1	20.9	2.9
White.4 L104	19.8	3.5	23.1	2.0	18.2	2.5	17.7	3.4	20.7	3.0
White.5 L25	21.3	2.9	NA	NA	NA	NA	NA	NA	21.3	2.9
Orange.1 L38	19.5	3.5	22.6	1.8	18.1	1.6	15.6	1.7	20.9	2.8
Orange.2 L9	18.0	3.7	21.8	2.3	16.3	2.0	15.3	2.0	21.0	3.2
Orange.3 L36	19.0	4.2	22.0	2.6	16.6	1.9	13.6[a]	1.5	20.9	3.2
Orange.4 L103	19.0	4.0	23.6	2.2	16.6	1.9	15.5	2.1	20.9	3.3
Orange.5 L7	18.6	4.9	22.8	3.5	15.7	2.7	14.6	2.8	20.9	4.4
Orange.6 L8	18.6	4.4	22.7	2.7	15.9	2.6	14.8	2.5	20.9	3.8
Orange.7 L23	17.9	3.7	NA	NA	NA	NA	15.5	1.9	20.2	3.5
Red.1 L3	19.9	3.7	23.8	1.9	17.6	1.7	16.1	1.7	21.8	2.1
Red.2 L32	20.1	3.9	23.6	2.2	18.3	1.8	15.7	2.0	21.5	2.4
Red.3 L11	19.3	2.5	22.1	1.0	18.0	1.5	17.7	1.7	21.7	1.6
Red.4 L101	19.4	3.6	23.4	1.8	16.9	1.6	16.1	1.5	21.7	2.5
Red.5 L1	20.1	3.9	23.9	1.8	17.4	1.8	16.2	1.7	22.7	2.3
Purple.1 L28	18.5	3.6	23.2	1.9	17.3	2.0	15.6	2.0	20.9	3.1
Purple.2 L31	18.8	3.1	22.5	1.5	17.9	1.4	15.8	1.6	21.0	2.0
Purple.3 L18	18.6	3.1	22.9	1.6	17.4	1.7	16.0	1.8	20.7	2.5
Purple.4 L27 nth	18.8	3.4	23.5	1.7	17.6	1.8	15.9	1.7	21.2	2.7

Night time during term 6pm - 8am										
	All year		**Term 1**		**Term 2**		**Term 3**		**Term 4**	
	mean	**sd**	**mean**	**sd**	**mean**	**sd**	**mean**	**sd**	**mean**	**sd**
BOM Kent Town	***14.7***	***5.6***	***19.0***	***4.3***	***11.3***	***2.9***	***11.1***	***3.1***	***17.6***	***5.9***
Purple.4 L105 sth	18.6	3.3	23.5	1.8	17.5	1.8	15.8	1.6	21.0	2.7

a. later part of term 3 data missing

H.5.4 Weekends and holidays

Weekends and holidays																
	All year		**Term 1**		**Autumn Break**		**Term 2**		**Winter Break**		**Term 3**		**Spring break**		**Term 4**	
	m	**sd**	**m**	**sd**	**m**	**sd**	**m**	**sd**	**m**	**sd**	**m**	**sd**	**m**	**sd**	**m**	**sd**
BOM Kent Town	***15.7***	***6.1***	***21.3***	***5.8***	***18.5***	***5.2***	***12.0***	***3.4***	***10.9***	***3.1***	***11.8***	***3.0***	***15.6***	***5.4***	***19.4***	***6.1***
Yellow.1 L12	20.5	3.2	24.1	2.1	22.7	1.6	18.1	1.5	NA	NA	16.5	1.4	19.4	1.7	21.7	2.1
Yellow.2 L5	20.8	2.8	23.8	1.8	22.9	1.8	18.5	1.6	NA	NA	17.5	1.1	19.9	1.3	21.9	2.0
Yellow.3 L19 Nth	20.4	3.9	24.2	2.8	23.0	3.0	17.1	2.0	NA	NA	16.7	2.0	19.8	2.5	21.6	3.4
Yellow.3 L102 Sth	19.2	4.2	24.1	2.9	22.4	2.9	16.4	1.9	14.3	1.9	16.4	1.7	19.4	2.4	21.5	3.3
White.1 L34 west	21.0	4.0	24.3	2.8	22.4	2.3	18.9	1.7	NA	NA	15.5	1.4	NA	NA	21.9	3.0
White.1 L48 east	20.0	4.0	24.1	2.7	22.4	2.4	17.4	2.2	NA	NA	15.6	1.5	18.0	2.3	22.1	3.3
White.2 L33	20.9	4.2	23.9	3.6	21.5	2.0	17.5	1.6	NA	NA	17.2	4.2	NA	NA	22.0	3.5
White.3 L35	20.7	3.7	23.3	3.3	21.3	0.9	20.6	0.7	NA	NA	16.6	3.1	18.6	2.3	21.6	3.6
White.4 L104	19.2	4.0	23.4	3.1	21.3	1.7	16.5	2.8	17.9	4.1	16.6	3.4	17.6	2.5	20.8	3.3
White.5 L25	21.9	3.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.9	3.5
Orange.1 L38	19.8	3.8	23.4	2.8	22.0	2.2	17.7	1.2	NA	NA	15.2	1.4	17.8	2.3	21.4	3.0
Orange.2 L9	18.0	3.8	21.7	2.2	21.0	2.4	15.3	1.9	NA	NA	14.3	1.4	17.3	2.4	21.1	3.4
Orange.3 L36	19.4	4.3	22.4	3.6	20.8	2.4	16.1	1.3	NA	NA	13.3	1.2	NA	NA	21.2	3.6
Orange.4 L103	18.7	4.3	23.7	3.0	22.2	2.4	16.1	1.9	14.0	1.3	15.2	1.5	17.9	2.3	21.2	3.5
Orange.5 L7	19.1	5.5	23.8	4.8	22.0	4.0	15.0	2.6	NA	NA	14.0	2.5	17.8	4.3	21.7	4.9
Orange.6 L8	19.0	5.0	23.7	4.0	21.7	3.2	14.8	2.5	NA	NA	14.0	2.0	17.8	3.4	21.9	4.3
Orange.7 L23	17.6	3.6	NA	NA	NA	NA	NA	NA	NA	NA	14.7	1.4	17.5	2.4	20.5	3.6
Red.1 L3	20.1	3.9	24.5	2.8	22.2	2.0	16.9	1.6	NA	NA	15.3	1.1	19.0	1.7	22.2	2.4
Red.2 L32	21.9	4.5	25.1	3.5	23.5	3.0	19.5	2.8	NA	NA	16.7	3.0	NA	NA	22.8	3.4
Red.3 L11	18.9	2.5	21.9	1.2	19.8	1.2	16.7	1.2	NA	NA	17.2	1.8	18.0	1.3	22.0	2.0
Red.4 L101	19.0	3.9	24.0	2.6	21.3	1.7	16.6	1.7	14.2	1.2	16.0	1.4	18.6	1.8	22.1	2.9
Red.5 L1	20.5	4.0	24.8	2.8	22.1	1.9	16.9	1.7	NA	NA	16.0	1.5	19.4	1.9	23.4	2.8
Purple.1 L28	19.2	3.6	22.9	1.9	22.4	2.5	17.1	2.3	NA	NA	15.9	1.8	18.2	2.5	21.4	3.5
Purple.2 L31	19.0	2.9	22.0	1.4	20.8	1.5	17.5	1.0	NA	NA	15.4	1.1	NA	NA	20.8	2.3
Purple.3 L18	19.0	3.0	22.6	1.5	21.9	1.8	17.2	1.8	NA	NA	15.8	1.5	18.1	2.0	20.7	2.6
Purple.4 L27 nth	19.0	3.2	23.0	1.6	22.1	1.8	17.1	1.9	NA	NA	15.7	1.4	18.1	1.9	20.9	2.7
Purple.4 L105 sth	18.5	3.4	23.0	1.7	22.2	1.9	17.4	2.0	14.8	1.1	15.8	1.4	18.1	1.9	21.1	2.7

H.6 ANOVA comparisons of temperature by classroom by time of day

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
BOM_Kent_Town	Core Hours	After Core Hours	-1.1806*	0.228	0.000	-1.77	-0.59
		School week nights	4.0311*	0.142	0.000	3.67	4.40
		Weekends and Holidays	2.6670*	0.140	0.000	2.31	3.03
	After Core Hours	Core Hours	1.1806*	0.228	0.000	0.59	1.77
		School week nights	5.2116*	0.212	0.000	4.67	5.76
		Weekends and Holidays	3.8476*	0.211	0.000	3.31	4.39
	School week nights	Core Hours	-4.0311*	0.142	0.000	-4.40	-3.67
		After Core Hours	-5.2116*	0.212	0.000	-5.76	-4.67
		Weekends and Holidays	-1.3641*	0.112	0.000	-1.65	-1.08
	Weekends and Holidays	Core Hours	-2.6670*	0.140	0.000	-3.03	-2.31
		After Core Hours	-3.8476*	0.211	0.000	-4.39	-3.31
		School week nights	1.3641*	0.112	0.000	1.08	1.65
Yellow.1_L12	Core Hours	After Core Hours	-.82346*	0.123	0.000	-1.14	-0.51
		School week nights	.41686*	0.077	0.000	0.22	0.61
		Weekends and Holidays	.16117	0.077	0.152	-0.04	0.36
	After Core Hours	Core Hours	.82346*	0.123	0.000	0.51	1.14
		School week nights	1.24033*	0.114	0.000	0.95	1.53
		Weekends and Holidays	.98463*	0.114	0.000	0.69	1.28
	School week nights	Core Hours	-.41686*	0.077	0.000	-0.61	-0.22
		After Core Hours	-1.24033*	0.114	0.000	-1.53	-0.95
		Weekends and Holidays	-.25569*	0.062	0.000	-0.41	-0.10
	Weekends and Holidays	Core Hours	-.16117	0.077	0.152	-0.36	0.04
		After Core Hours	-.98463*	0.114	0.000	-1.28	-0.69
		School week nights	.25569*	0.062	0.000	0.10	0.41
Yellow.2_L5	Core Hours	After Core Hours	.03791	0.108	0.985	-0.24	0.32
		School week nights	1.02108*	0.068	0.000	0.85	1.20
		Weekends and Holidays	.49073*	0.068	0.000	0.32	0.66
	After Core Hours	Core Hours	-.03791	0.108	0.985	-0.32	0.24
		School week nights	.98318*	0.101	0.000	0.72	1.24
		Weekends and Holidays	.45282*	0.101	0.000	0.19	0.71
	School week nights	Core Hours	-1.02108*	0.068	0.000	-1.20	-0.85
		After Core Hours	-.98318*	0.101	0.000	-1.24	-0.72
		Weekends and Holidays	-.53036*	0.055	0.000	-0.67	-0.39
	Weekends and Holidays	Core Hours	-.49073*	0.068	0.000	-0.66	-0.32
		After Core Hours	-.45282*	0.101	0.000	-0.71	-0.19
		School week nights	.53036*	0.055	0.000	0.39	0.67
Yellow.3_L19_Nth	Core Hours	After Core Hours	.13087	0.140	0.785	-0.23	0.49
		School week nights	1.99888*	0.087	0.000	1.77	2.22
		Weekends and Holidays	1.11942*	0.087	0.000	0.90	1.34
	After Core Hours	Core Hours	-.13087	0.140	0.785	-0.49	0.23
		School week nights	1.86801*	0.130	0.000	1.53	2.20
		Weekends and Holidays	.98855*	0.130	0.000	0.65	1.32
	School week nights	Core Hours	-1.99888*	0.087	0.000	-2.22	-1.77
		After Core Hours	-1.86801*	0.130	0.000	-2.20	-1.53
		Weekends and Holidays	-.87945*	0.070	0.000	-1.06	-0.70
	Weekends and Holidays	Core Hours	-1.11942*	0.087	0.000	-1.34	-0.90
		After Core Hours	-.98855*	0.130	0.000	-1.32	-0.65
		School week nights	.87945*	0.070	0.000	0.70	1.06
Yellow.3_L102_Sth	Core Hours	After Core Hours	.061476	0.143	0.973	-0.30	0.43

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
		School week nights	1.824218*	0.089	0.000	1.60	2.05
		Weekends and Holidays	1.765414*	0.088	0.000	1.54	1.99
	After Core Hours	Core Hours	-.061476	0.143	0.973	-0.43	0.30
		School week nights	1.762742*	0.133	0.000	1.42	2.10
		Weekends and Holidays	1.703938*	0.132	0.000	1.37	2.04
	School week nights	Core Hours	-1.824218*	0.089	0.000	-2.05	-1.60
		After Core Hours	-1.762742*	0.133	0.000	-2.10	-1.42
		Weekends and Holidays	-.058804	0.070	0.837	-0.24	0.12
	Weekends and Holidays	Core Hours	-1.765414*	0.088	0.000	-1.99	-1.54
		After Core Hours	-1.703938*	0.132	0.000	-2.04	-1.37
		School week nights	.058804	0.070	0.837	-0.12	0.24
White.1_L34_west	Core Hours	After Core Hours	-.842*	0.159	0.000	-1.25	-0.43
		School week nights	1.643*	0.099	0.000	1.39	1.90
		Weekends and Holidays	.750*	0.101	0.000	0.49	1.01
	After Core Hours	Core Hours	.842*	0.159	0.000	0.43	1.25
		School week nights	2.485*	0.148	0.000	2.11	2.86
		Weekends and Holidays	1.592*	0.149	0.000	1.21	1.97
	School week nights	Core Hours	-1.643*	0.099	0.000	-1.90	-1.39
		After Core Hours	-2.485*	0.148	0.000	-2.86	-2.11
		Weekends and Holidays	-.893*	0.082	0.000	-1.10	-0.68
	Weekends and Holidays	Core Hours	-.750*	0.101	0.000	-1.01	-0.49
		After Core Hours	-1.592*	0.149	0.000	-1.97	-1.21
		School week nights	.893*	0.082	0.000	0.68	1.10
White.1_L48_east	Core Hours	After Core Hours	-.803*	0.144	0.000	-1.17	-0.43
		School week nights	1.735*	0.090	0.000	1.50	1.97
		Weekends and Holidays	1.402*	0.090	0.000	1.17	1.63
	After Core Hours	Core Hours	.803*	0.144	0.000	0.43	1.17
		School week nights	2.538*	0.134	0.000	2.19	2.88
		Weekends and Holidays	2.205*	0.134	0.000	1.86	2.55
	School week nights	Core Hours	-1.735*	0.090	0.000	-1.97	-1.50
		After Core Hours	-2.538*	0.134	0.000	-2.88	-2.19
		Weekends and Holidays	-.333*	0.073	0.000	-0.52	-0.15
	Weekends and Holidays	Core Hours	-1.402*	0.090	0.000	-1.63	-1.17
		After Core Hours	-2.205*	0.134	0.000	-2.55	-1.86
		School week nights	.333*	0.073	0.000	0.15	0.52
White.2_L33	Core Hours	After Core Hours	-.452*	0.160	0.024	-0.86	-0.04
		School week nights	1.765*	0.100	0.000	1.51	2.02
		Weekends and Holidays	1.229*	0.102	0.000	0.97	1.49
	After Core Hours	Core Hours	.452*	0.160	0.024	0.04	0.86
		School week nights	2.217*	0.149	0.000	1.83	2.60
		Weekends and Holidays	1.680*	0.150	0.000	1.30	2.07
	School week nights	Core Hours	-1.765*	0.100	0.000	-2.02	-1.51
		After Core Hours	-2.217*	0.149	0.000	-2.60	-1.83
		Weekends and Holidays	-.536*	0.083	0.000	-0.75	-0.32
	Weekends and Holidays	Core Hours	-1.229*	0.102	0.000	-1.49	-0.97
		After Core Hours	-1.680*	0.150	0.000	-2.07	-1.30
		School week nights	.536*	0.083	0.000	0.32	0.75
White.3_L35	Core Hours	After Core Hours	.096	0.142	0.907	-0.27	0.46
		School week nights	1.813*	0.089	0.000	1.58	2.04
		Weekends and Holidays	1.161*	0.091	0.000	0.93	1.39
	After Core Hours	Core Hours	-.096	0.142	0.907	-0.46	0.27
		School week nights	1.717*	0.132	0.000	1.38	2.06
		Weekends and Holidays	1.065*	0.133	0.000	0.72	1.41
	School week	Core Hours	-1.813*	0.089	0.000	-2.04	-1.58

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	nights	After Core Hours	-1.717*	0.132	0.000	-2.06	-1.38
		Weekends and Holidays	-.652*	0.074	0.000	-0.84	-0.46
	Weekends and Holidays	Core Hours	-1.161*	0.091	0.000	-1.39	-0.93
		After Core Hours	-1.065*	0.133	0.000	-1.41	-0.72
		School week nights	.652*	0.074	0.000	0.46	0.84
White.4_L104	Core Hours	After Core Hours	.114	0.128	0.808	-0.21	0.44
		School week nights	1.855*	0.080	0.000	1.65	2.06
		Weekends and Holidays	2.504*	0.079	0.000	2.30	2.71
	After Core Hours	Core Hours	-.114	0.128	0.808	-0.44	0.21
		School week nights	1.740*	0.119	0.000	1.43	2.05
		Weekends and Holidays	2.389*	0.118	0.000	2.09	2.69
	School week nights	Core Hours	-1.855*	0.080	0.000	-2.06	-1.65
		After Core Hours	-1.740*	0.119	0.000	-2.05	-1.43
		Weekends and Holidays	.649*	0.063	0.000	0.49	0.81
	Weekends and Holidays	Core Hours	-2.504*	0.079	0.000	-2.71	-2.30
		After Core Hours	-2.389*	0.118	0.000	-2.69	-2.09
		School week nights	-.649*	0.063	0.000	-0.81	-0.49
White.5_L25	Core Hours	After Core Hours	-.546	0.232	0.087	-1.14	0.05
		School week nights	.561*	0.145	0.001	0.19	0.93
		Weekends and Holidays	.030	0.158	0.998	-0.38	0.44
	After Core Hours	Core Hours	.546	0.232	0.087	-0.05	1.14
		School week nights	1.106*	0.215	0.000	0.55	1.66
		Weekends and Holidays	.576	0.225	0.051	0.00	1.15
	School week nights	Core Hours	-.561*	0.145	0.001	-0.93	-0.19
		After Core Hours	-1.106*	0.215	0.000	-1.66	-0.55
		Weekends and Holidays	-.531*	0.133	0.000	-0.87	-0.19
	Weekends and Holidays	Core Hours	-.030	0.158	0.998	-0.44	0.38
		After Core Hours	-.576	0.225	0.051	-1.15	0.00
		School week nights	.531*	0.133	0.000	0.19	0.87
Orange.1_L38	Core Hours	After Core Hours	-.950*	0.144	0.000	-1.32	-0.58
		School week nights	1.475*	0.090	0.000	1.24	1.71
		Weekends and Holidays	1.122*	0.089	0.000	0.89	1.35
	After Core Hours	Core Hours	.950*	0.144	0.000	0.58	1.32
		School week nights	2.425*	0.133	0.000	2.08	2.77
		Weekends and Holidays	2.072*	0.133	0.000	1.73	2.41
	School week nights	Core Hours	-1.475*	0.090	0.000	-1.71	-1.24
		After Core Hours	-2.425*	0.133	0.000	-2.77	-2.08
		Weekends and Holidays	-.353*	0.072	0.000	-0.54	-0.17
	Weekends and Holidays	Core Hours	-1.122*	0.089	0.000	-1.35	-0.89
		After Core Hours	-2.072*	0.133	0.000	-2.41	-1.73
		School week nights	.353*	0.072	0.000	0.17	0.54
Orange.2_L9	Core Hours	After Core Hours	-.531*	0.151	0.003	-0.92	-0.14
		School week nights	2.244*	0.095	0.000	2.00	2.49
		Weekends and Holidays	2.185*	0.094	0.000	1.94	2.43
	After Core Hours	Core Hours	.531*	0.151	0.003	0.14	0.92
		School week nights	2.775*	0.140	0.000	2.41	3.14
		Weekends and Holidays	2.716*	0.140	0.000	2.36	3.07
	School week nights	Core Hours	-2.244*	0.095	0.000	-2.49	-2.00
		After Core Hours	-2.775*	0.140	0.000	-3.14	-2.41
		Weekends and Holidays	-.059	0.075	0.858	-0.25	0.13
	Weekends and Holidays	Core Hours	-2.185*	0.094	0.000	-2.43	-1.94
		After Core Hours	-2.716*	0.140	0.000	-3.07	-2.36
		School week nights	.059	0.075	0.858	-0.13	0.25
Orange.3_L36	Core Hours	After Core Hours	-.619*	0.185	0.005	-1.09	-0.14
		School week nights	2.016*	0.116	0.000	1.72	2.31

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
		Weekends and Holidays	1.634*	0.117	0.000	1.33	1.93
	After Core Hours	Core Hours	.619*	0.185	0.005	0.14	1.09
		School week nights	2.635*	0.172	0.000	2.19	3.08
		Weekends and Holidays	2.253*	0.173	0.000	1.81	2.70
	School week nights	Core Hours	-2.016*	0.116	0.000	-2.31	-1.72
		After Core Hours	-2.635*	0.172	0.000	-3.08	-2.19
		Weekends and Holidays	-.382*	0.095	0.000	-0.62	-0.14
	Weekends and Holidays	Core Hours	-1.634*	0.117	0.000	-1.93	-1.33
		After Core Hours	-2.253*	0.173	0.000	-2.70	-1.81
		School week nights	.382*	0.095	0.000	0.14	0.62
Orange.4_L103	Core Hours	After Core Hours	-.499*	0.147	0.004	-0.88	-0.12
		School week nights	2.695*	0.092	0.000	2.46	2.93
		Weekends and Holidays	3.024*	0.091	0.000	2.79	3.26
	After Core Hours	Core Hours	.499*	0.147	0.004	0.12	0.88
		School week nights	3.194*	0.137	0.000	2.84	3.54
		Weekends and Holidays	3.523*	0.136	0.000	3.17	3.87
	School week nights	Core Hours	-2.695*	0.092	0.000	-2.93	-2.46
		After Core Hours	-3.194*	0.137	0.000	-3.54	-2.84
		Weekends and Holidays	.329*	0.073	0.000	0.14	0.52
	Weekends and Holidays	Core Hours	-3.024*	0.091	0.000	-3.26	-2.79
		After Core Hours	-3.523*	0.136	0.000	-3.87	-3.17
		School week nights	-.329*	0.073	0.000	-0.52	-0.14
Orange.5_L7	Core Hours	After Core Hours	-.909*	0.186	0.000	-1.39	-0.43
		School week nights	2.831*	0.117	0.000	2.53	3.13
		Weekends and Holidays	2.312*	0.117	0.000	2.01	2.61
	After Core Hours	Core Hours	.909*	0.186	0.000	0.43	1.39
		School week nights	3.740*	0.173	0.000	3.30	4.19
		Weekends and Holidays	3.221*	0.173	0.000	2.78	3.67
	School week nights	Core Hours	-2.831*	0.117	0.000	-3.13	-2.53
		After Core Hours	-3.740*	0.173	0.000	-4.19	-3.30
		Weekends and Holidays	-.519*	0.094	0.000	-0.76	-0.28
	Weekends and Holidays	Core Hours	-2.312*	0.117	0.000	-2.61	-2.01
		After Core Hours	-3.221*	0.173	0.000	-3.67	-2.78
		School week nights	.519*	0.094	0.000	0.28	0.76
Orange.6_L8	Core Hours	After Core Hours	-1.159*	0.173	0.000	-1.60	-0.71
		School week nights	2.317*	0.108	0.000	2.04	2.59
		Weekends and Holidays	1.920*	0.108	0.000	1.64	2.20
	After Core Hours	Core Hours	1.159*	0.173	0.000	0.71	1.60
		School week nights	3.476*	0.161	0.000	3.06	3.89
		Weekends and Holidays	3.080*	0.161	0.000	2.67	3.49
	School week nights	Core Hours	-2.317*	0.108	0.000	-2.59	-2.04
		After Core Hours	-3.476*	0.161	0.000	-3.89	-3.06
		Weekends and Holidays	-.396*	0.087	0.000	-0.62	-0.17
	Weekends and Holidays	Core Hours	-1.920*	0.108	0.000	-2.20	-1.64
		After Core Hours	-3.080*	0.161	0.000	-3.49	-2.67
		School week nights	.396*	0.087	0.000	0.17	0.62
Orange.7_L23	Core Hours	After Core Hours	-.591*	0.183	0.007	-1.06	-0.12
		School week nights	2.686*	0.115	0.000	2.39	2.98
		Weekends and Holidays	2.996*	0.116	0.000	2.70	3.29
	After Core Hours	Core Hours	.591*	0.183	0.007	0.12	1.06
		School week nights	3.277*	0.170	0.000	2.84	3.71
		Weekends and Holidays	3.587*	0.171	0.000	3.15	4.03
	School week nights	Core Hours	-2.686*	0.115	0.000	-2.98	-2.39
		After Core Hours	-3.277*	0.170	0.000	-3.71	-2.84

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
		Weekends and Holidays	.310*	0.094	0.006	0.07	0.55
	Weekends and Holidays	Core Hours	-2.996*	0.116	0.000	-3.29	-2.70
		After Core Hours	-3.587*	0.171	0.000	-4.03	-3.15
		School week nights	-.310*	0.094	0.006	-0.55	-0.07
Red.1_L3	Core Hours	After Core Hours	-.17519	0.147	0.633	-0.55	0.20
		School week nights	.80084*	0.092	0.000	0.56	1.04
		Weekends and Holidays	.31256*	0.091	0.003	0.08	0.55
	After Core Hours	Core Hours	.17519	0.147	0.633	-0.20	0.55
		School week nights	.97602*	0.137	0.000	0.62	1.33
		Weekends and Holidays	.48774*	0.136	0.002	0.14	0.84
	School week nights	Core Hours	-.80084*	0.092	0.000	-1.04	-0.56
		After Core Hours	-.97602*	0.137	0.000	-1.33	-0.62
		Weekends and Holidays	-.48828*	0.073	0.000	-0.68	-0.30
	Weekends and Holidays	Core Hours	-.31256*	0.091	0.003	-0.55	-0.08
		After Core Hours	-.48774*	0.136	0.002	-0.84	-0.14
		School week nights	.48828*	0.073	0.000	0.30	0.68
Red.2_L32	Core Hours	After Core Hours	-.51863*	0.173	0.015	-0.96	-0.07
		School week nights	2.13877*	0.108	0.000	1.86	2.42
		Weekends and Holidays	.05274	0.109	0.963	-0.23	0.33
	After Core Hours	Core Hours	.51863*	0.173	0.015	0.07	0.96
		School week nights	2.65740*	0.161	0.000	2.24	3.07
		Weekends and Holidays	.57137*	0.162	0.002	0.16	0.99
	School week nights	Core Hours	-2.13877*	0.108	0.000	-2.42	-1.86
		After Core Hours	-2.65740*	0.161	0.000	-3.07	-2.24
		Weekends and Holidays	-2.08603*	0.088	0.000	-2.31	-1.86
	Weekends and Holidays	Core Hours	-.05274	0.109	0.963	-0.33	0.23
		After Core Hours	-.57137*	0.162	0.002	-0.99	-0.16
		School week nights	2.08603*	0.088	0.000	1.86	2.31
Red.3_L11	Core Hours	After Core Hours	-.472*	0.108	0.000	-0.75	-0.19
		School week nights	.936*	0.068	0.000	0.76	1.11
		Weekends and Holidays	1.368*	0.067	0.000	1.20	1.54
	After Core Hours	Core Hours	.472*	0.108	0.000	0.19	0.75
		School week nights	1.408*	0.100	0.000	1.15	1.67
		Weekends and Holidays	1.840*	0.100	0.000	1.58	2.10
	School week nights	Core Hours	-.936*	0.068	0.000	-1.11	-0.76
		After Core Hours	-1.408*	0.100	0.000	-1.67	-1.15
		Weekends and Holidays	.432*	0.053	0.000	0.29	0.57
	Weekends and Holidays	Core Hours	-1.368*	0.067	0.000	-1.54	-1.20
		After Core Hours	-1.840*	0.100	0.000	-2.10	-1.58
		School week nights	-.432*	0.053	0.000	-0.57	-0.29
Red.4_L101	Core Hours	After Core Hours	-.362005*	0.138	0.043	-0.72	-0.01
		School week nights	1.524549*	0.086	0.000	1.30	1.75
		Weekends and Holidays	1.667518*	0.085	0.000	1.45	1.88
	After Core Hours	Core Hours	.362005*	0.138	0.043	0.01	0.72
		School week nights	1.886554*	0.128	0.000	1.56	2.22
		Weekends and Holidays	2.029523*	0.127	0.000	1.70	2.36
	School week nights	Core Hours	-1.524549*	0.086	0.000	-1.75	-1.30
		After Core Hours	-1.886554*	0.128	0.000	-2.22	-1.56
		Weekends and Holidays	.142969	0.068	0.148	-0.03	0.32
	Weekends and Holidays	Core Hours	-1.667518*	0.085	0.000	-1.88	-1.45
		After Core Hours	-2.029523*	0.127	0.000	-2.36	-1.70
		School week nights	-.142969	0.068	0.148	-0.32	0.03
Red.5_L1	Core Hours	After Core Hours	.02645	0.153	0.998	-0.37	0.42
		School week nights	1.85359*	0.096	0.000	1.61	2.10

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
		Weekends and Holidays	1.12162*	0.095	0.000	0.88	1.37
	After Core Hours	Core Hours	-.02645	0.153	0.998	-0.42	0.37
		School week nights	1.82714*	0.142	0.000	1.46	2.19
		Weekends and Holidays	1.09517*	0.142	0.000	0.73	1.46
	School week nights	Core Hours	-1.85359*	0.096	0.000	-2.10	-1.61
		After Core Hours	-1.82714*	0.142	0.000	-2.19	-1.46
		Weekends and Holidays	-.73197*	0.076	0.000	-0.93	-0.54
	Weekends and Holidays	Core Hours	-1.12162*	0.095	0.000	-1.37	-0.88
		After Core Hours	-1.09517*	0.142	0.000	-1.46	-0.73
		School week nights	.73197*	0.076	0.000	0.54	0.93
Purple.1_L28	Core Hours	After Core Hours	-1.623*	0.152	0.000	-2.01	-1.23
		School week nights	1.693*	0.095	0.000	1.45	1.94
		Weekends and Holidays	1.032*	0.094	0.000	0.79	1.27
	After Core Hours	Core Hours	1.623*	0.152	0.000	1.23	2.01
		School week nights	3.316*	0.141	0.000	2.95	3.68
		Weekends and Holidays	2.655*	0.141	0.000	2.29	3.02
	School week nights	Core Hours	-1.693*	0.095	0.000	-1.94	-1.45
		After Core Hours	-3.316*	0.141	0.000	-3.68	-2.95
		Weekends and Holidays	-.661*	0.076	0.000	-0.86	-0.47
	Weekends and Holidays	Core Hours	-1.032*	0.094	0.000	-1.27	-0.79
		After Core Hours	-2.655*	0.141	0.000	-3.02	-2.29
		School week nights	.661*	0.076	0.000	0.47	0.86
Purple.2_L31	Core Hours	After Core Hours	-.049	0.136	0.984	-0.40	0.30
		School week nights	1.886*	0.084	0.000	1.67	2.10
		Weekends and Holidays	1.673*	0.085	0.000	1.45	1.89
	After Core Hours	Core Hours	.049	0.136	0.984	-0.30	0.40
		School week nights	1.935*	0.126	0.000	1.61	2.26
		Weekends and Holidays	1.721*	0.127	0.000	1.39	2.05
	School week nights	Core Hours	-1.886*	0.084	0.000	-2.10	-1.67
		After Core Hours	-1.935*	0.126	0.000	-2.26	-1.61
		Weekends and Holidays	-.214*	0.070	0.012	-0.39	-0.03
	Weekends and Holidays	Core Hours	-1.673*	0.085	0.000	-1.89	-1.45
		After Core Hours	-1.721*	0.127	0.000	-2.05	-1.39
		School week nights	.214*	0.070	0.012	0.03	0.39
Purple.3_L18	Core Hours	After Core Hours	-.495*	0.128	0.001	-0.82	-0.17
		School week nights	1.703*	0.080	0.000	1.50	1.91
		Weekends and Holidays	1.337*	0.080	0.000	1.13	1.54
	After Core Hours	Core Hours	.495*	0.128	0.001	0.17	0.82
		School week nights	2.197*	0.119	0.000	1.89	2.50
		Weekends and Holidays	1.832*	0.119	0.000	1.53	2.14
	School week nights	Core Hours	-1.703*	0.080	0.000	-1.91	-1.50
		After Core Hours	-2.197*	0.119	0.000	-2.50	-1.89
		Weekends and Holidays	-.366*	0.064	0.000	-0.53	-0.20
	Weekends and Holidays	Core Hours	-1.337*	0.080	0.000	-1.54	-1.13
		After Core Hours	-1.832*	0.119	0.000	-2.14	-1.53
		School week nights	.366*	0.064	0.000	0.20	0.53
Purple.4_L27_nth	Core Hours	After Core Hours	-1.096*	0.139	0.000	-1.45	-0.74
		School week nights	1.062*	0.087	0.000	0.84	1.29
		Weekends and Holidays	.855*	0.087	0.000	0.63	1.08
	After Core Hours	Core Hours	1.096*	0.139	0.000	0.74	1.45
		School week nights	2.159*	0.129	0.000	1.83	2.49
		Weekends and Holidays	1.952*	0.129	0.000	1.62	2.28
	School week nights	Core Hours	-1.062*	0.087	0.000	-1.29	-0.84
		After Core Hours	-2.159*	0.129	0.000	-2.49	-1.83

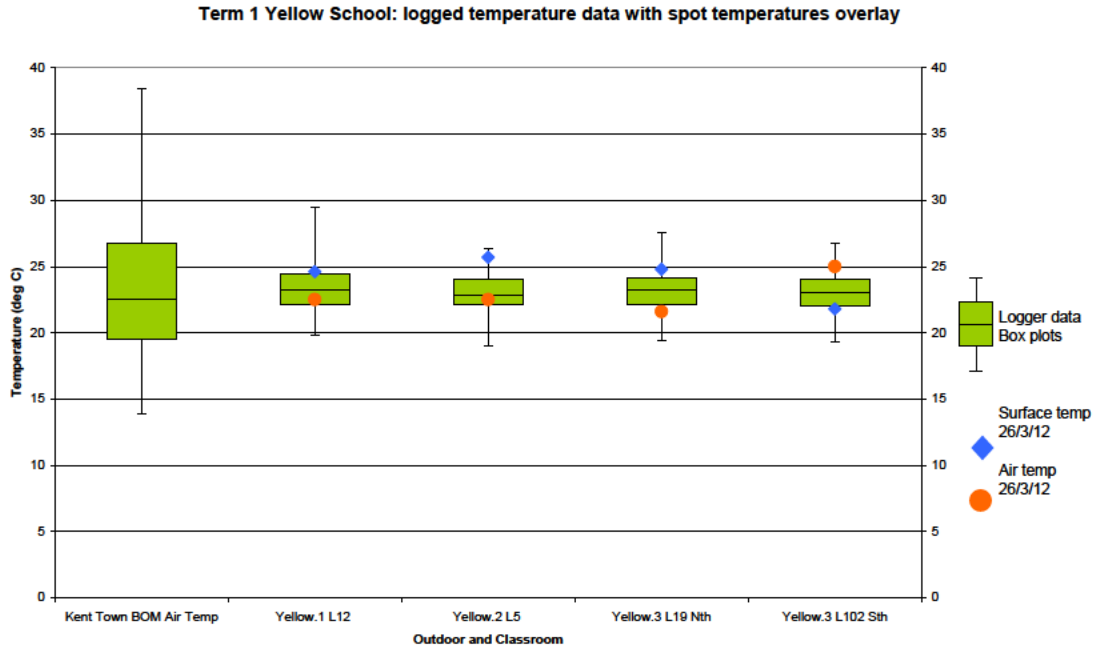
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
		Weekends and Holidays	-.207*	0.069	0.015	-0.39	-0.03
	Weekends and Holidays	Core Hours	-.855*	0.087	0.000	-1.08	-0.63
		After Core Hours	-1.952*	0.129	0.000	-2.28	-1.62
		School week nights	.207*	0.069	0.015	0.03	0.39
Purple.4_L105_sth	Core Hours	After Core Hours	-.987*	0.135	0.000	-1.33	-0.64
		School week nights	1.548*	0.084	0.000	1.33	1.76
		Weekends and Holidays	1.648*	0.082	0.000	1.44	1.86
	After Core Hours	Core Hours	.987*	0.135	0.000	0.64	1.33
		School week nights	2.535*	0.125	0.000	2.21	2.86
		Weekends and Holidays	2.635*	0.124	0.000	2.32	2.95
	School week nights	Core Hours	-1.548*	0.084	0.000	-1.76	-1.33
		After Core Hours	-2.535*	0.125	0.000	-2.86	-2.21
		Weekends and Holidays	.099	0.066	0.431	-0.07	0.27
	Weekends and Holidays	Core Hours	-1.648*	0.082	0.000	-1.86	-1.44
		After Core Hours	-2.635*	0.124	0.000	-2.95	-2.32
		School week nights	-.099	0.066	0.431	-0.27	0.07

*. The mean difference is significant at the 0.05 level.

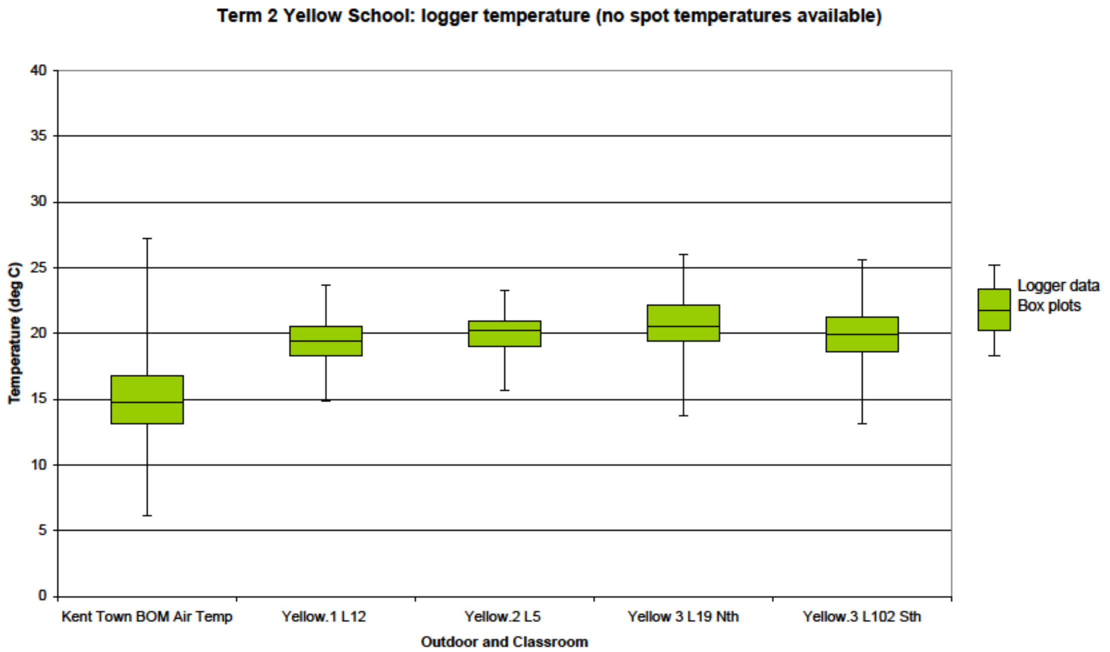
H.7 Temperature Box plots by classroom

These box plots are calculated from all valid data collected during core hours and includes valid outliers.

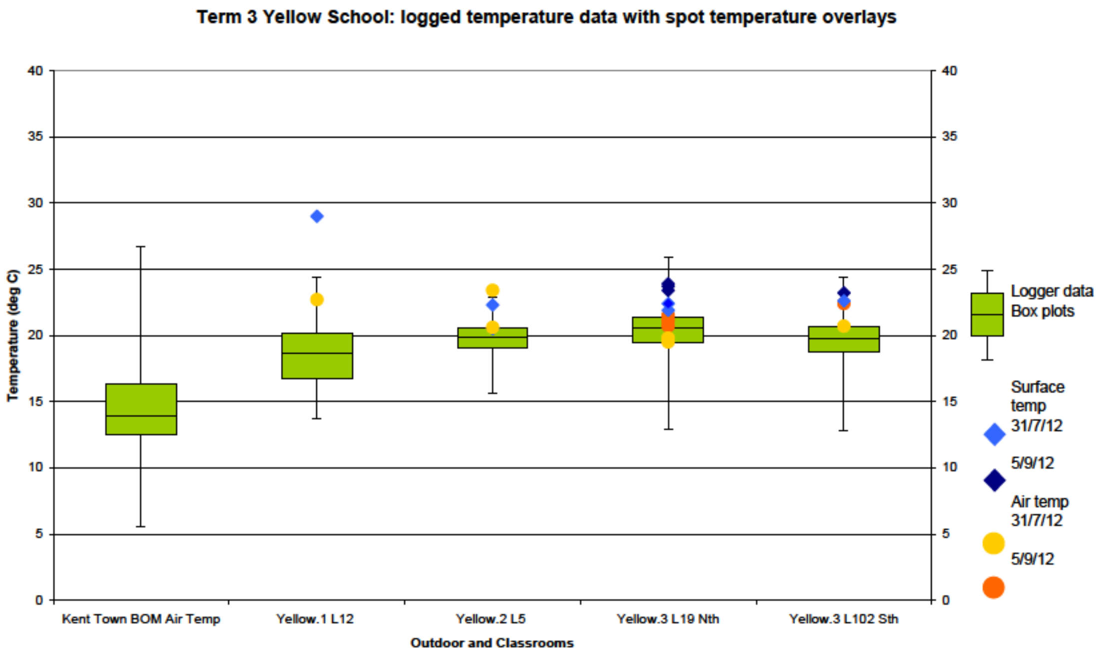
H.7.1 Yellow School



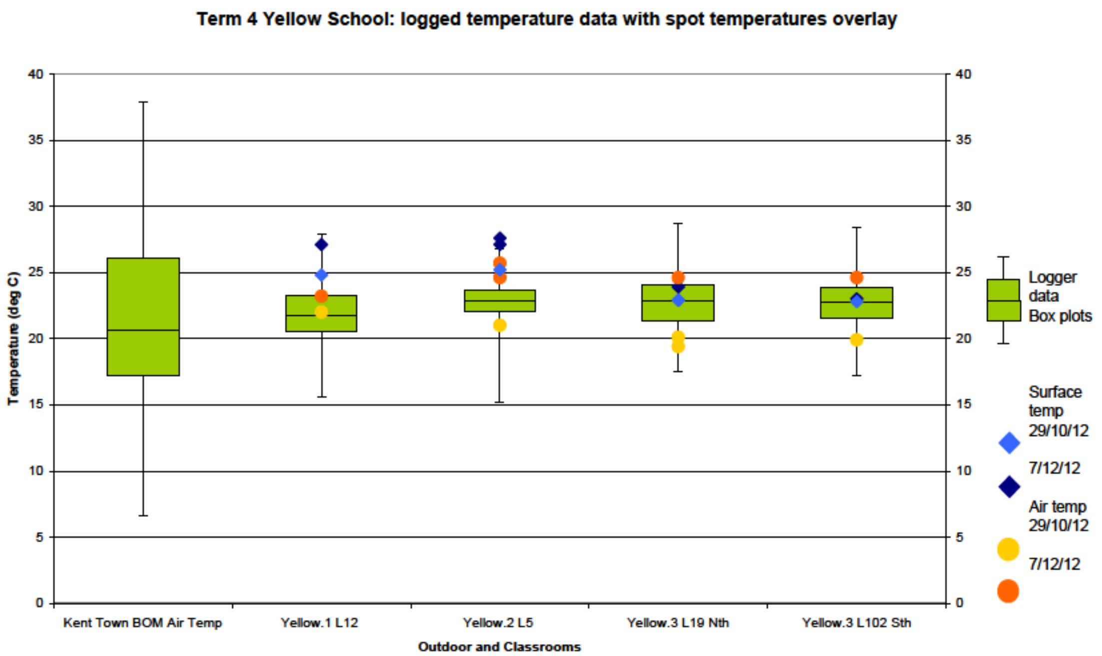
Appendix Figure 1: Logged temperature data box plots and spot measured temperatures: Yellow School term 1 (DS-C-OL-A)



Appendix Figure 2: Logged temperature data box plots: Yellow School term 2 (DS-C-OL-A)

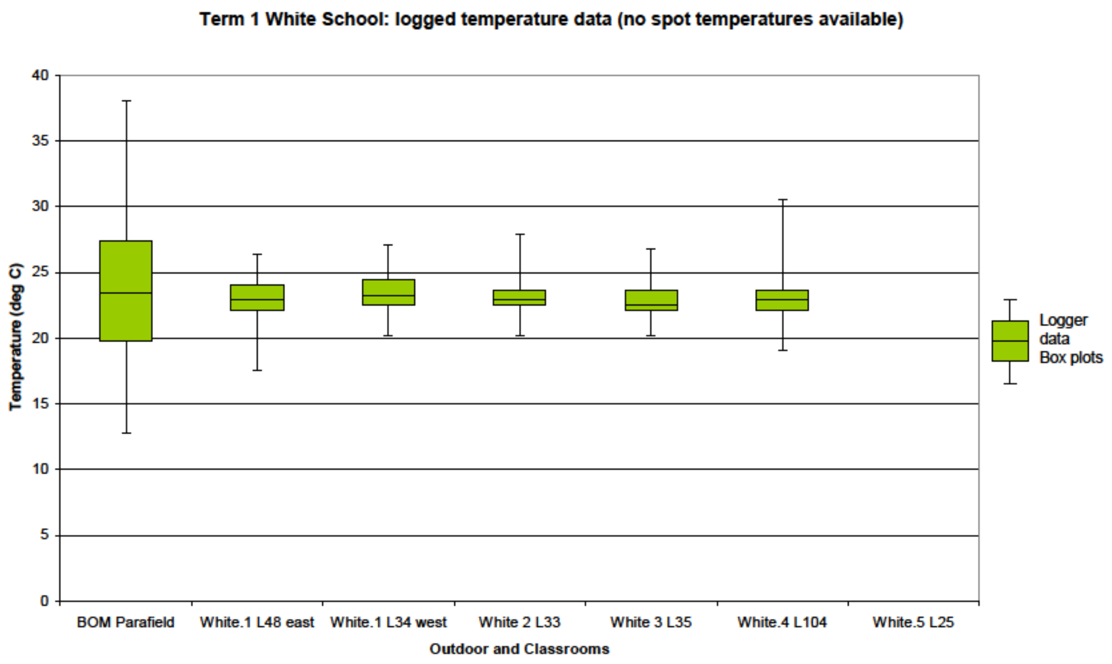


Appendix Figure 3: Logged temperature data box plots and spot measured temperatures: Yellow School term 3 (DS-C-OL-A)

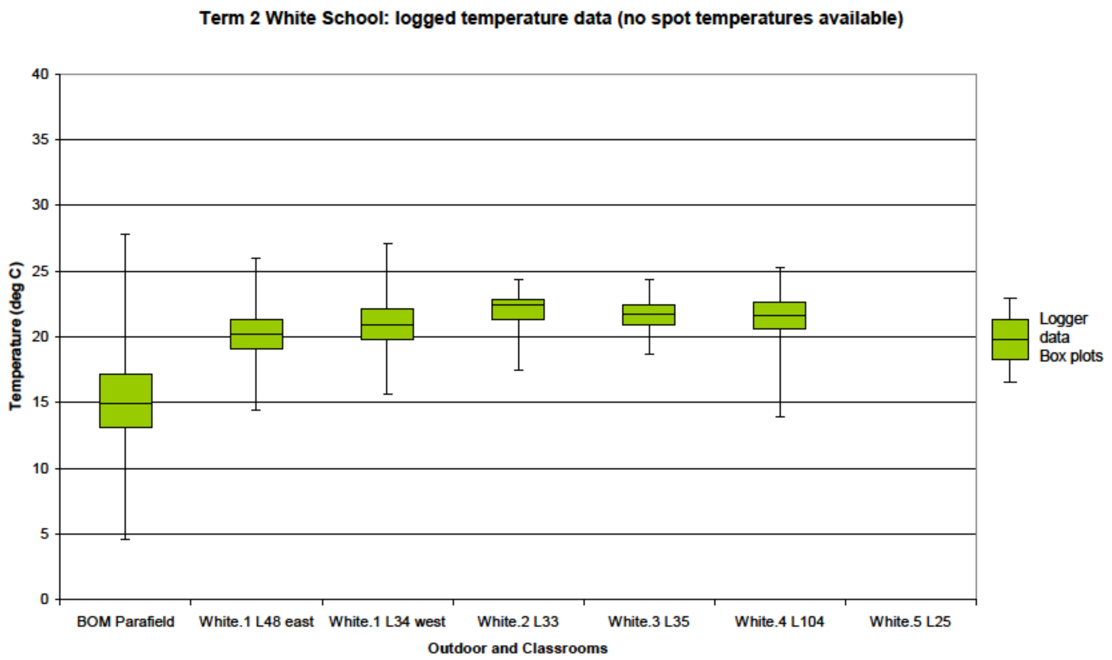


Appendix Figure 4: Logged temperature data box plots and spot measured temperatures: Yellow School term 4 (DS-C-OL-A)

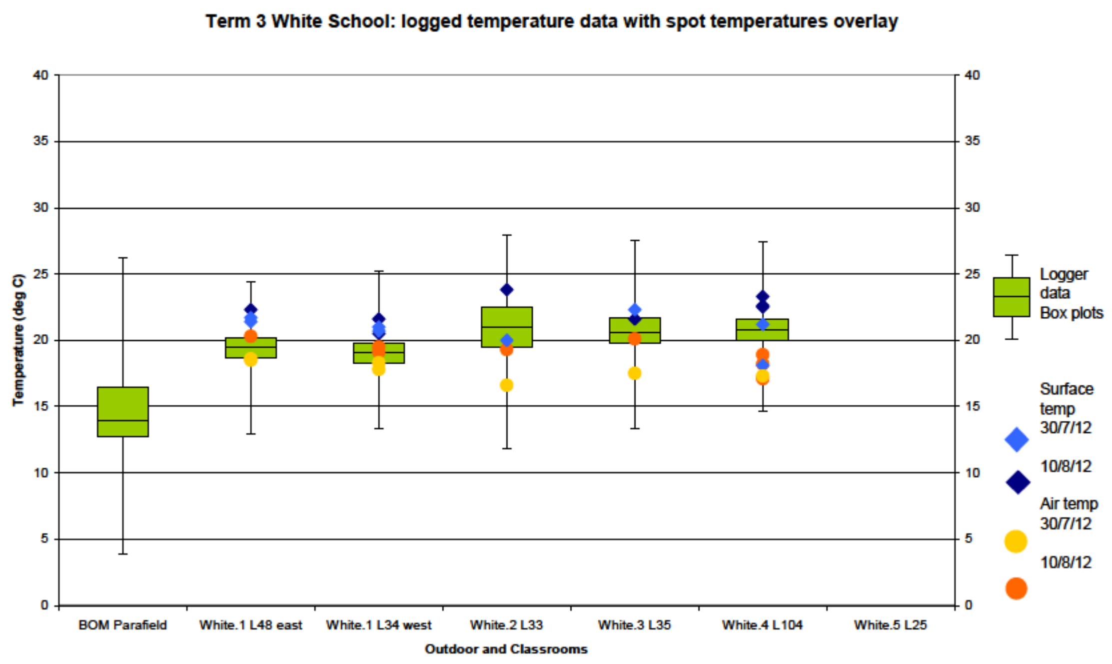
H.7.2 White School



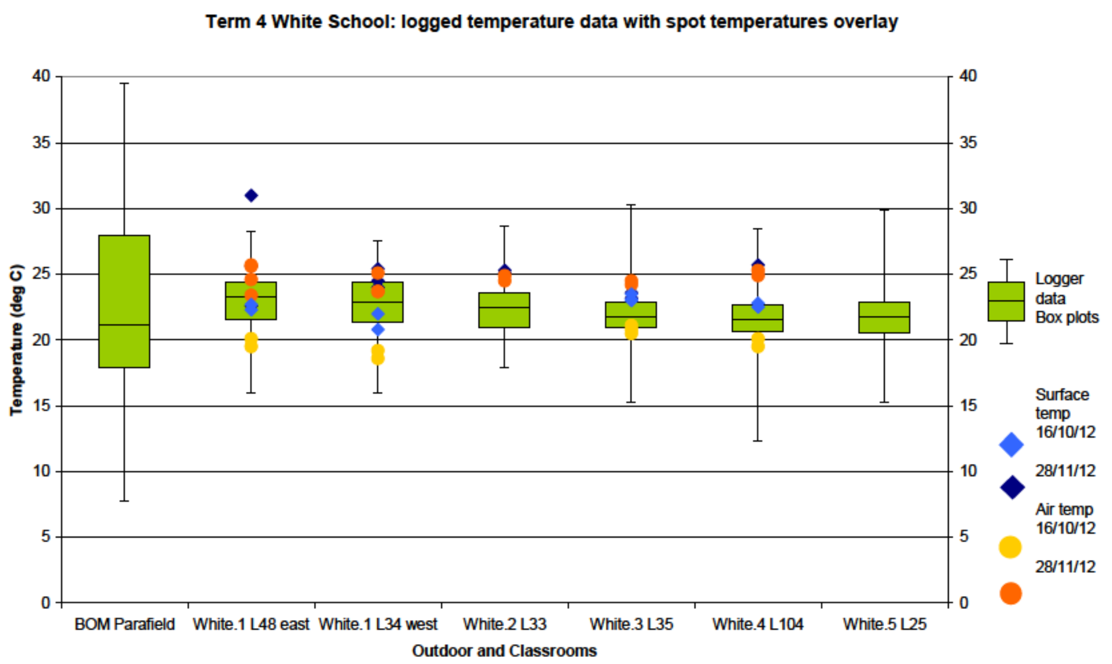
Appendix Figure 5: Logged temperature data box plots: White School term 1 (DS-C-OL-A)



Appendix Figure 6: Logged temperature data box plots: White School term 2 (DS-C-OL-A)

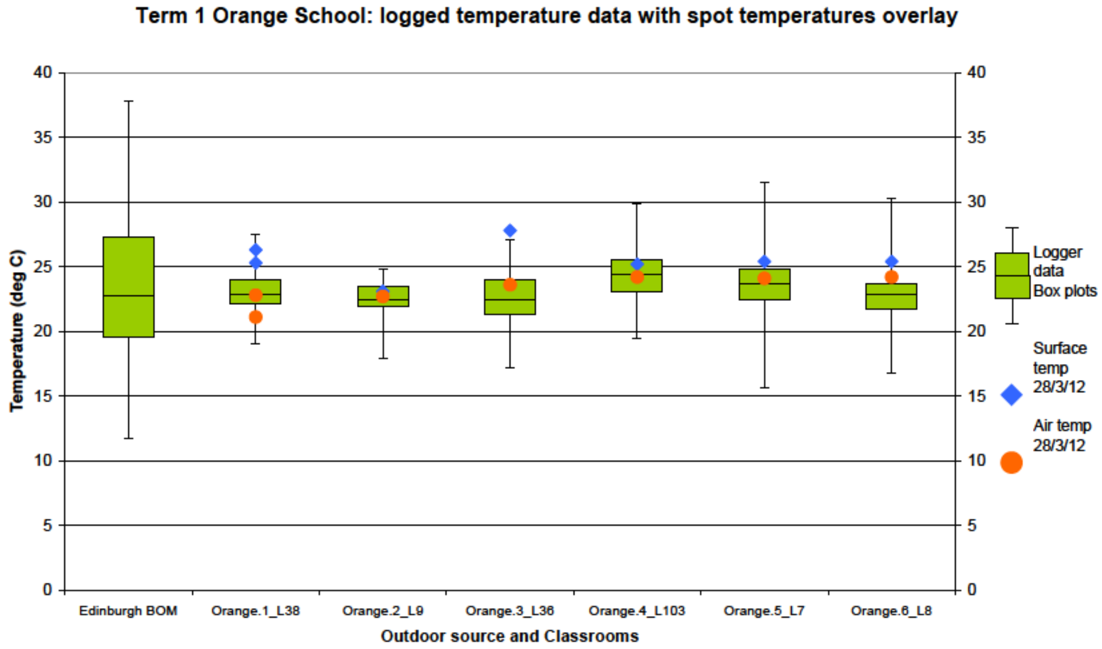


Appendix Figure 7: Logged temperature data box plots and spot measured temperatures: White School term 3 (DS-C-OL-A)

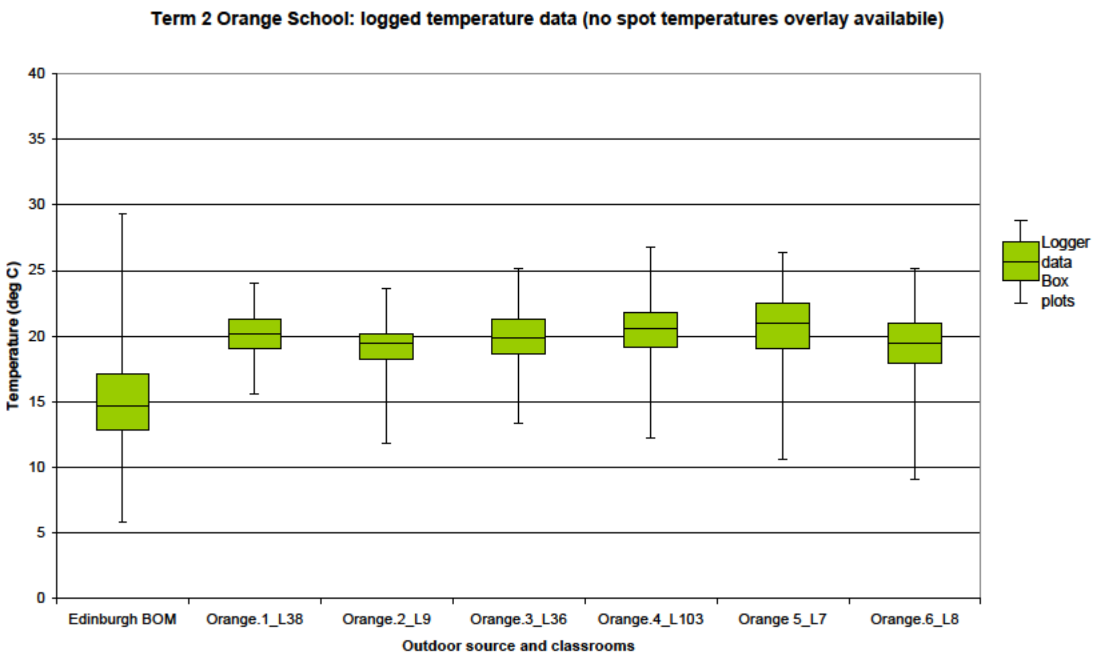


Appendix Figure 8: Logged temperature data box plots and spot measured temperatures: White School term 4 (DS-C-OL-A)

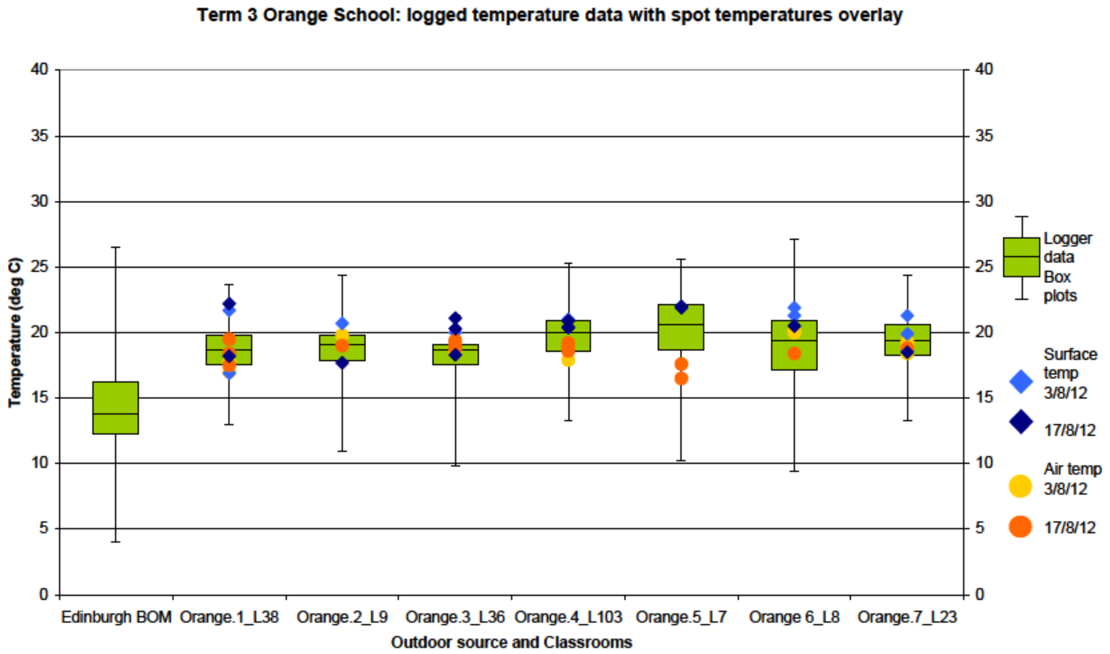
H.7.3 Orange School



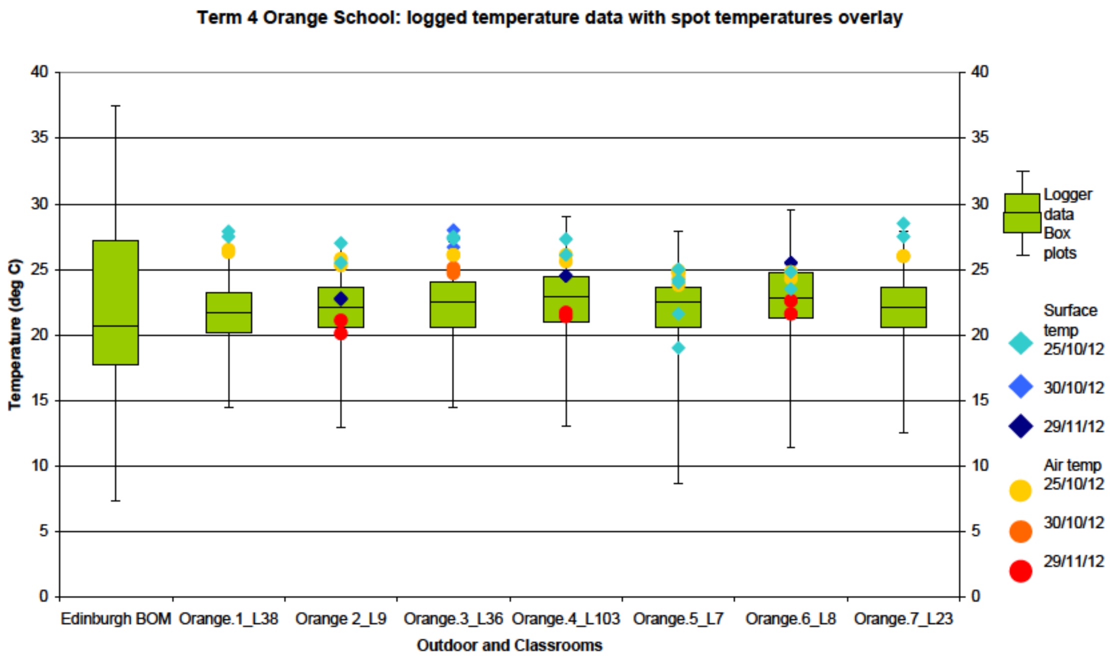
Appendix Figure 9: Logged temperature data box plots and spot measured temperatures: Orange School term 1 (DS-C-OL-A)



Appendix Figure 10: Logged temperature data box plots: Orange School term 2 (DS-C-OL-A)

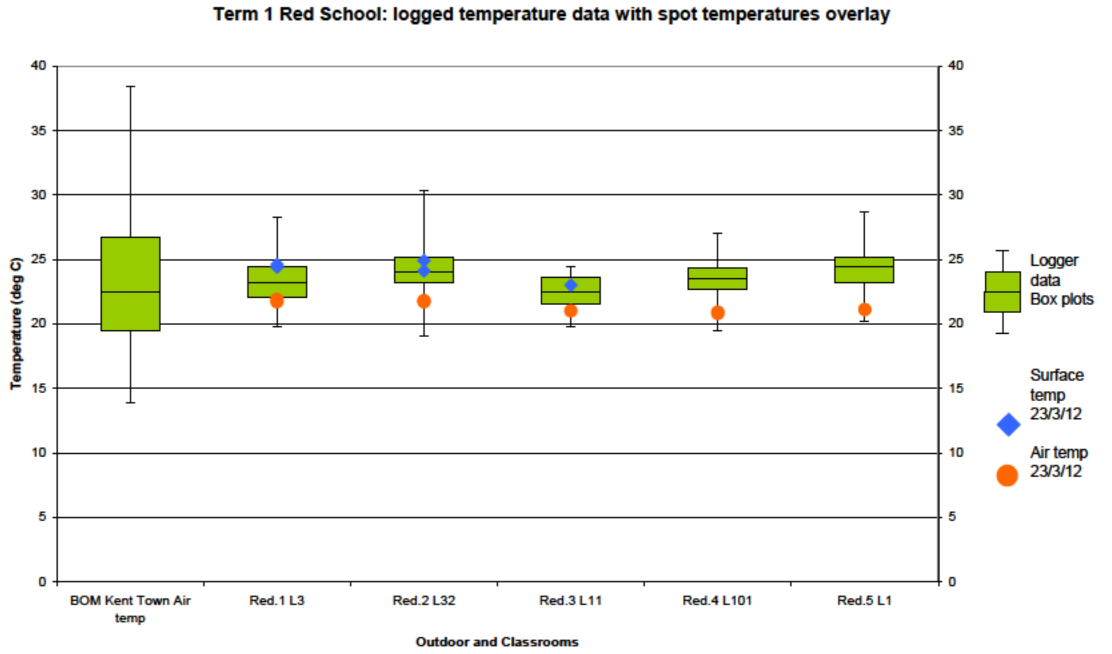


Appendix Figure 11: Logged temperature data box plots and spot measured temperatures: Orange School term 3 (DS-C-OL-A)

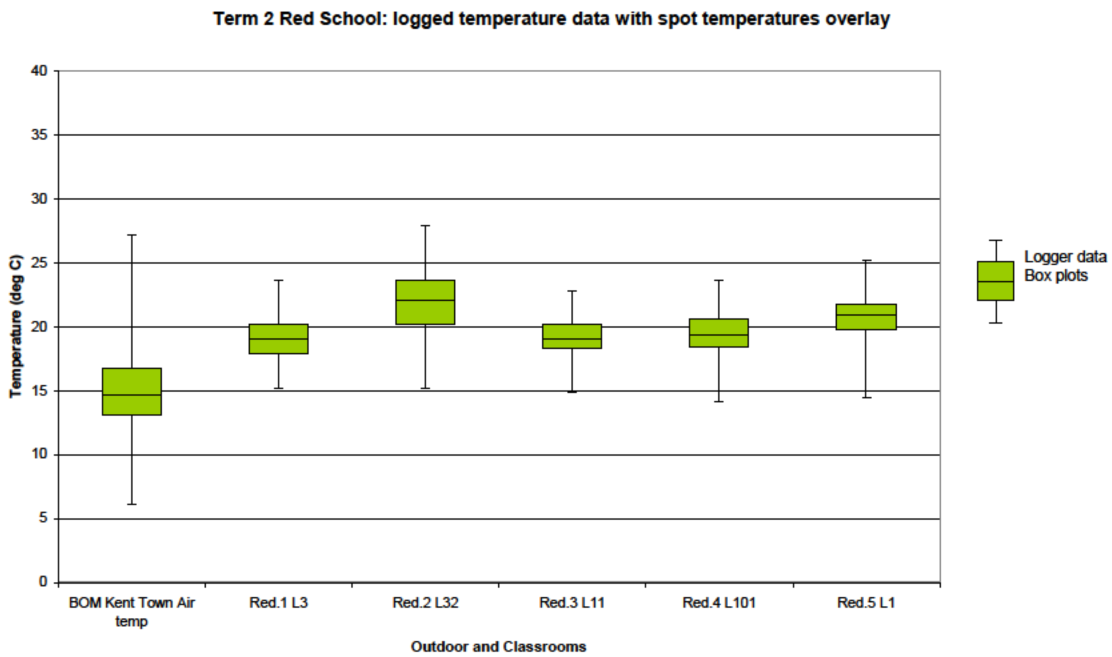


Appendix Figure 12: Logged temperature data box plots and spot measured temperatures: Orange School term 4 (DS-C-OL-A)

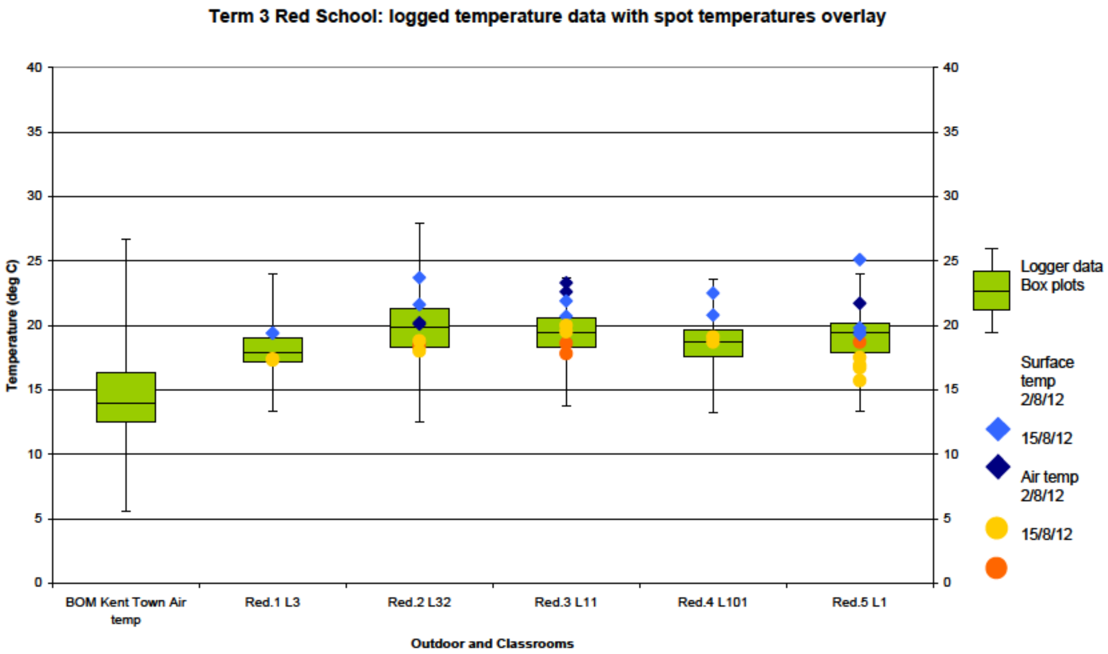
H.7.4 **Red School**



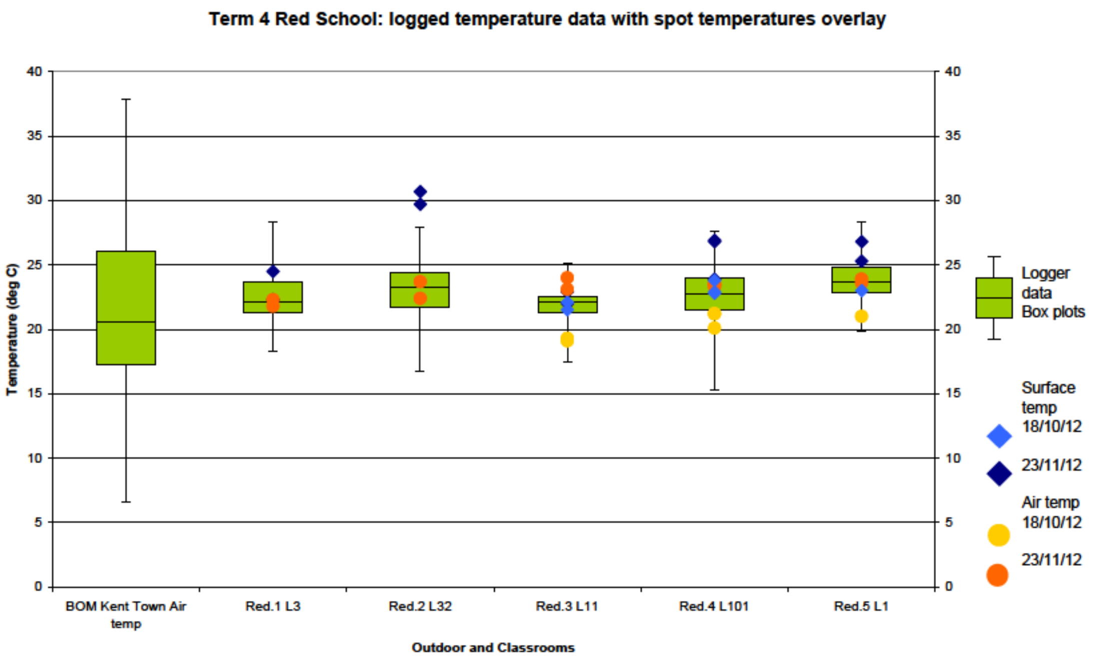
Appendix Figure 13: Logged temperature data box plots and spot measured temperatures: Red School term 1 (DS-C-OL-A)



Appendix Figure 14: Logged temperature data box plots: Red School term 2 (DS-C-OL-A)

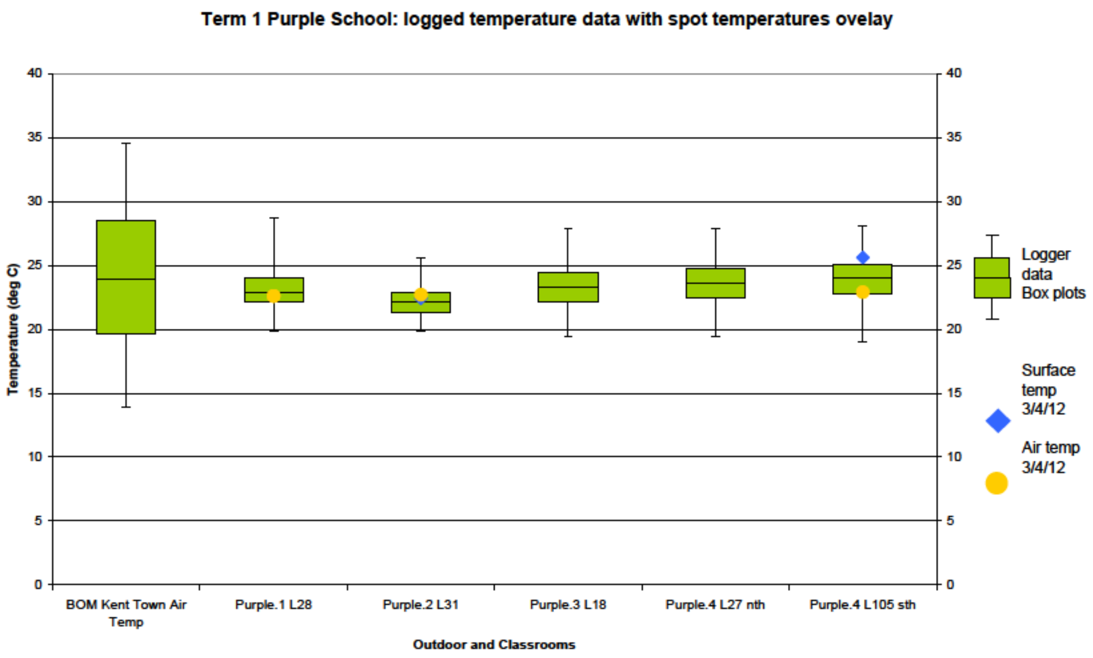


Appendix Figure 15: Logged temperature data box plots and spot measured temperatures: Red School term 3 (DS-C-OL-A)

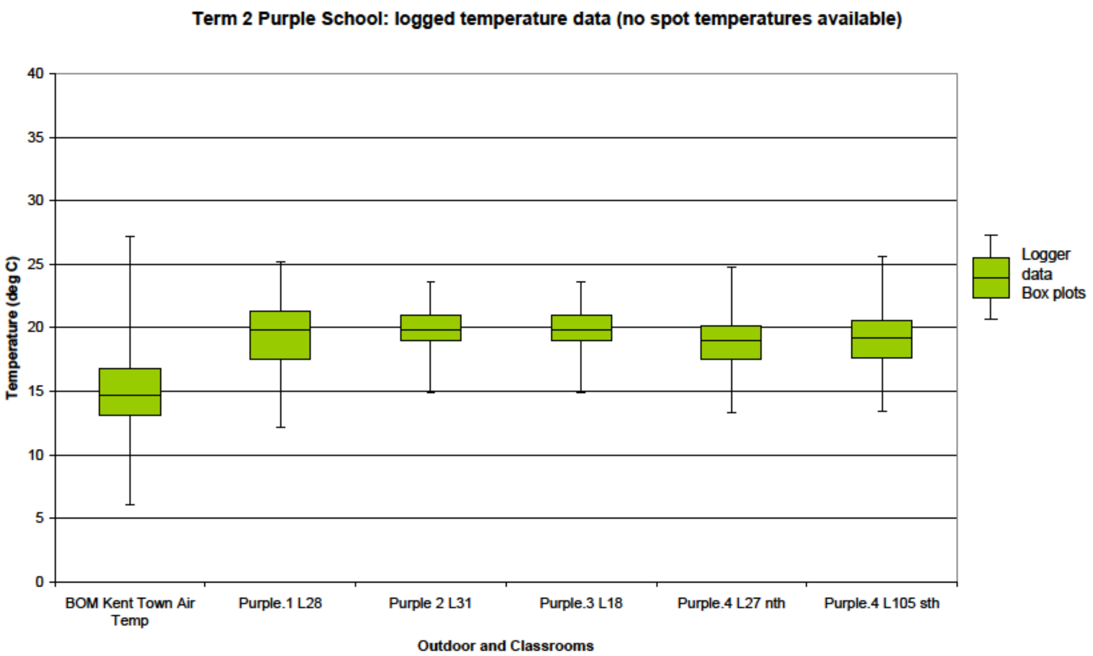


Appendix Figure 16: Logged temperature data box plots and spot measured temperatures: Red School term 4 (DS-C-OL-A)

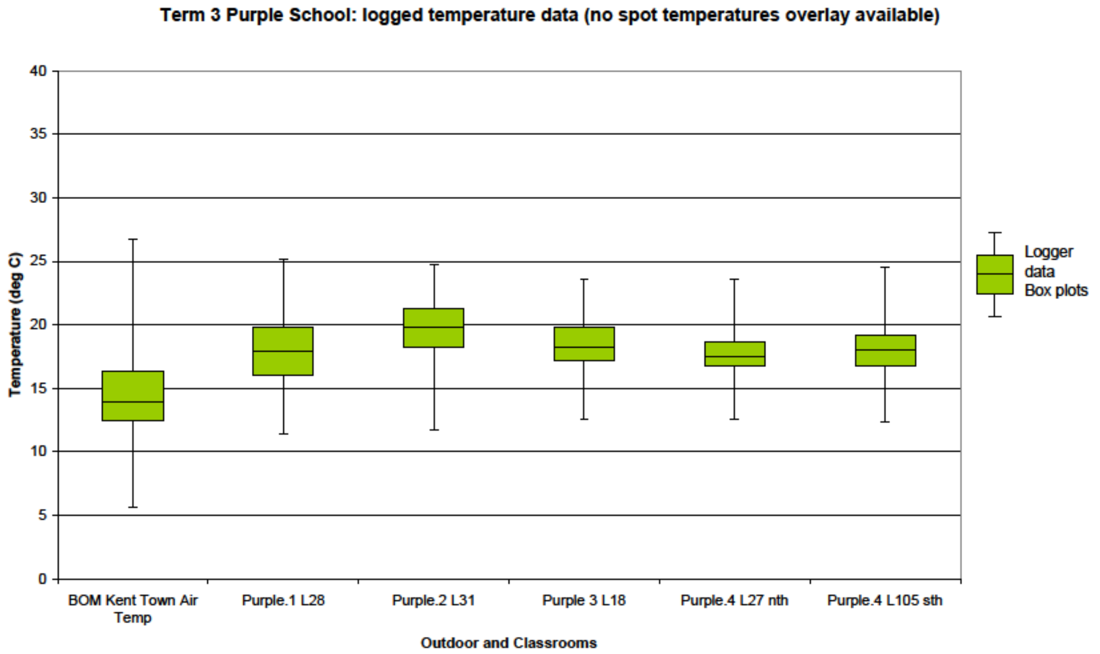
H.7.5 Purple School



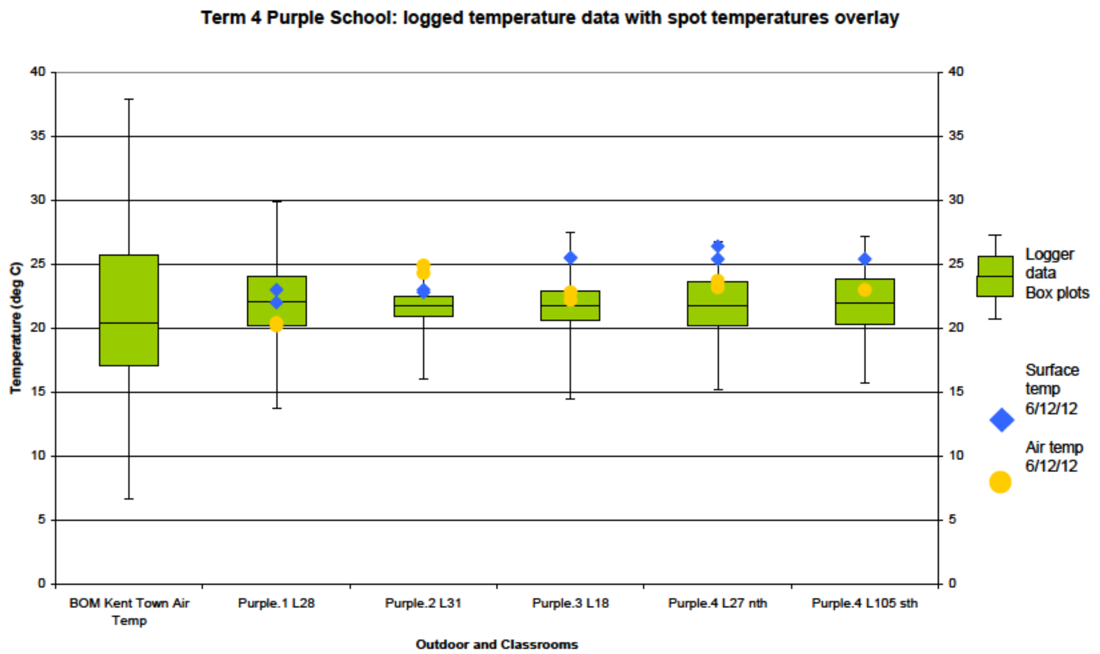
Appendix Figure 17: Logged temperature data box plots and spot measured temperatures: Purple School term 1 (DS-C-OL-A)



Appendix Figure 18: Logged temperature data box plots: Purple School term 2 (DS-C-OL-A)



Appendix Figure 19: Logged temperature data box plots: Purple School term 3 (DS-C-OL-A)

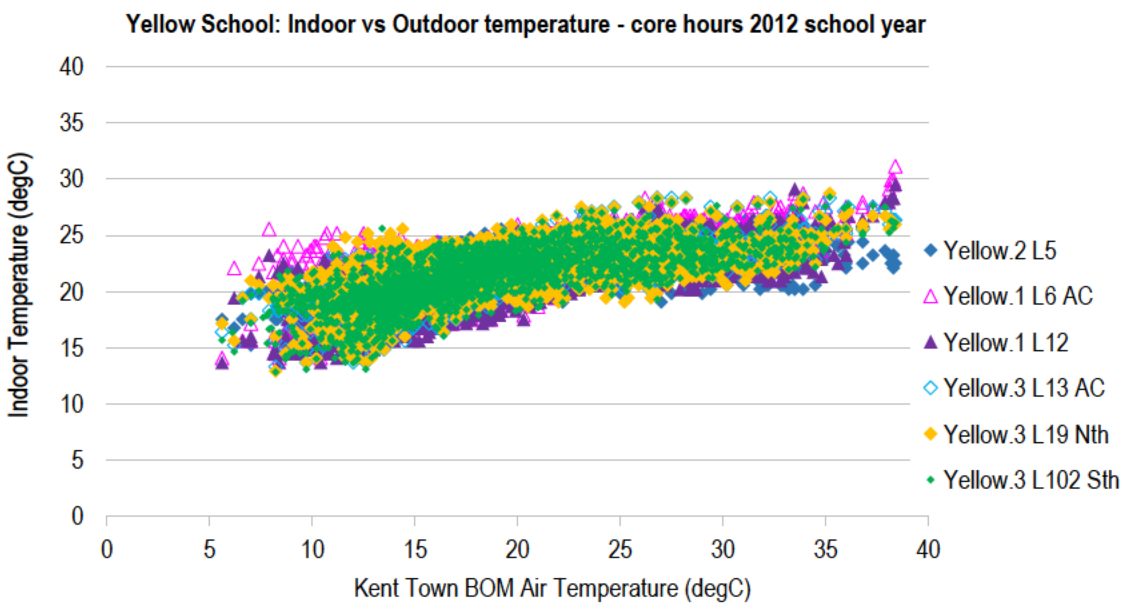


Appendix Figure 20: Logged temperature data box plots and spot measured temperatures: Purple School term 4 (DS-C-OL-A)

H.8 Temperature - scatter plots - indoor vs outdoor temperatures

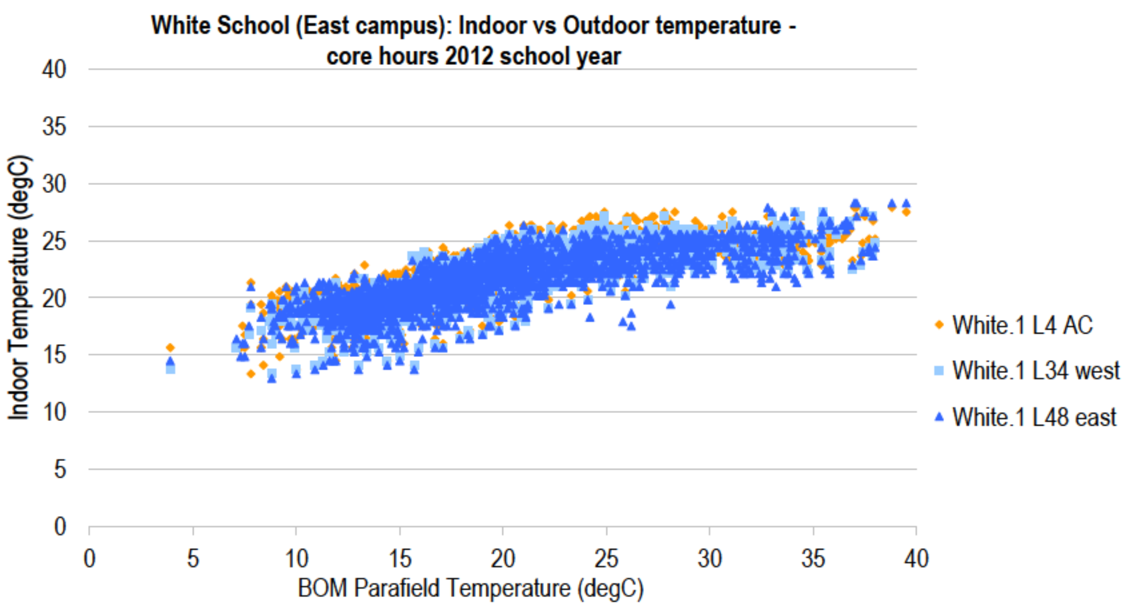
Data used for Indoor Temperature is (DS-C-OL-A), i.e., all valid core hours data plus valid (uncorrupted) outliers.

H.8.1 Yellow School

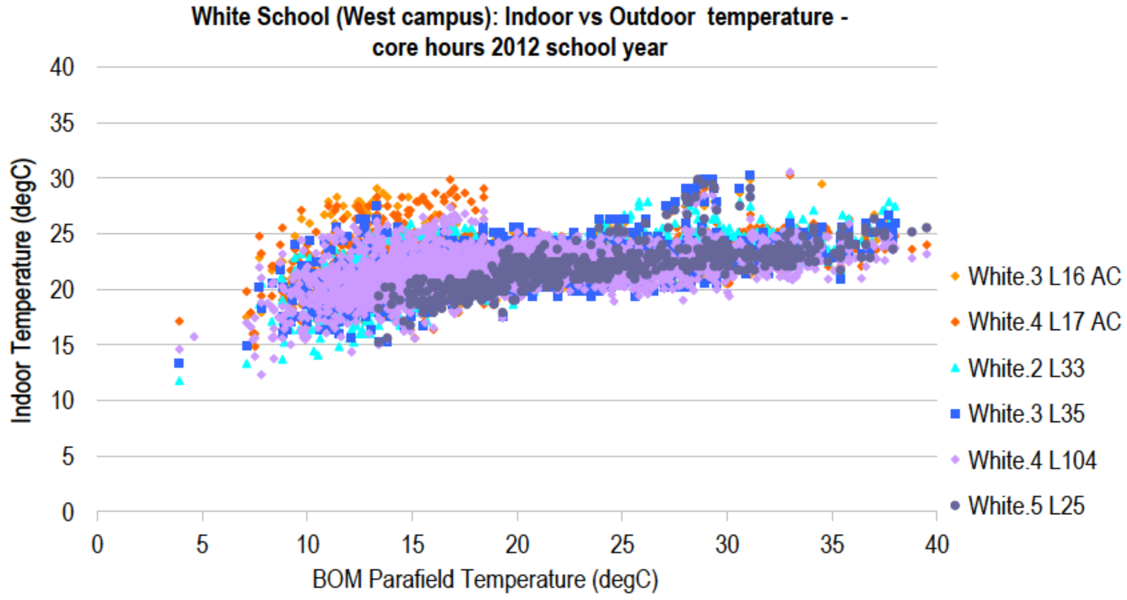


Appendix Figure 21: Indoor vs Outdoor air temperature scatter plot: Yellow School (DS-C-OL-A)

H.8.2 White school

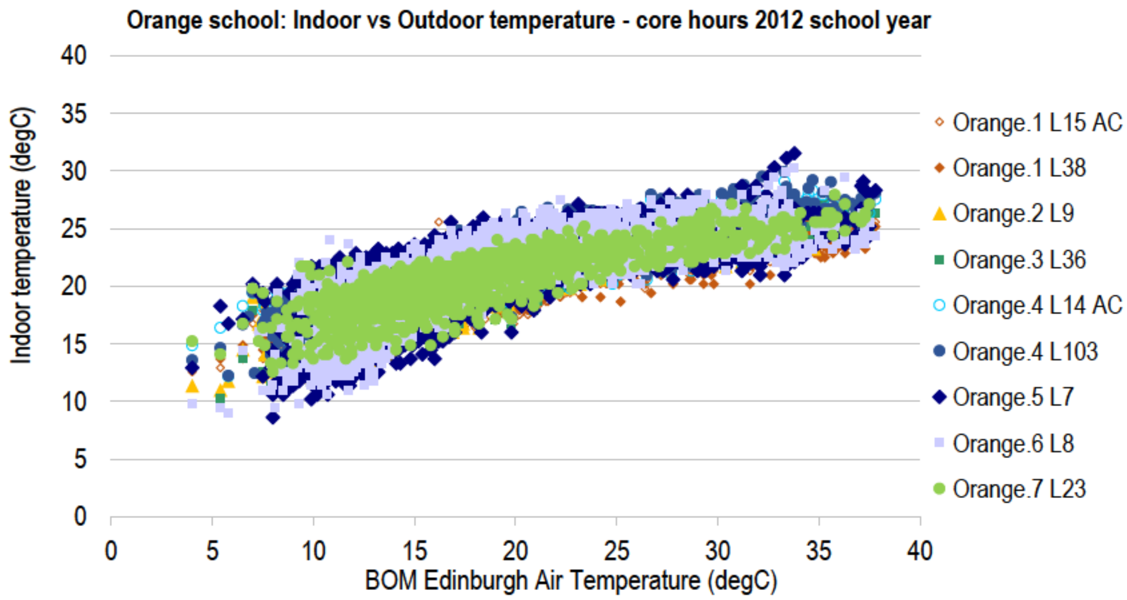


Appendix Figure 22: Indoor vs Outdoor air temperature scatter plot: White School – East campus (DS-C-OL-A)



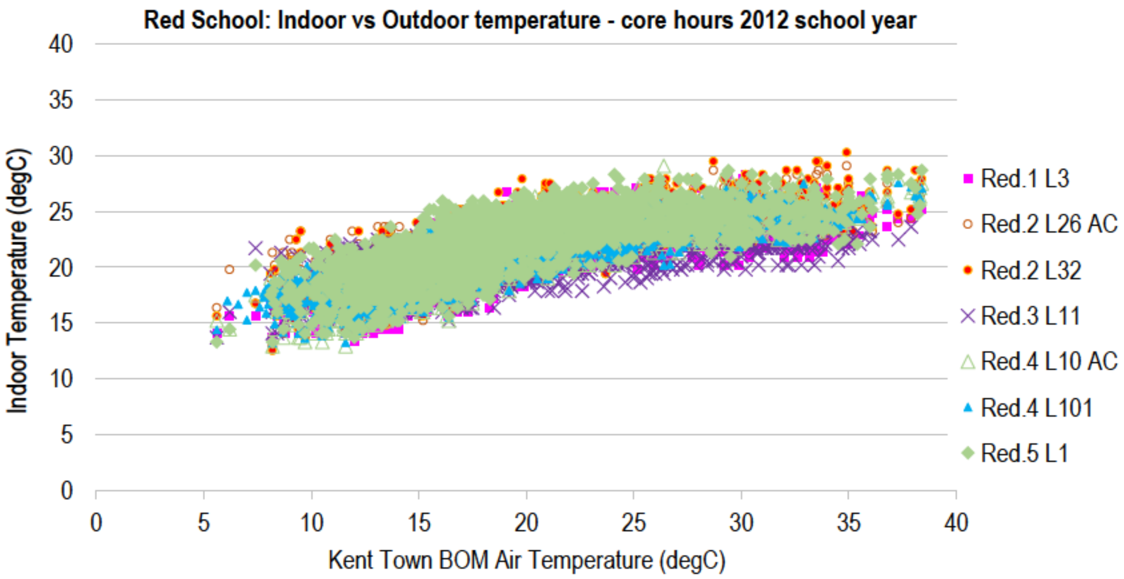
Appendix Figure 23: Indoor vs Outdoor air temperature scatter plot: White School – West campus (DS-C-OL-A)

H.8.3 Orange School



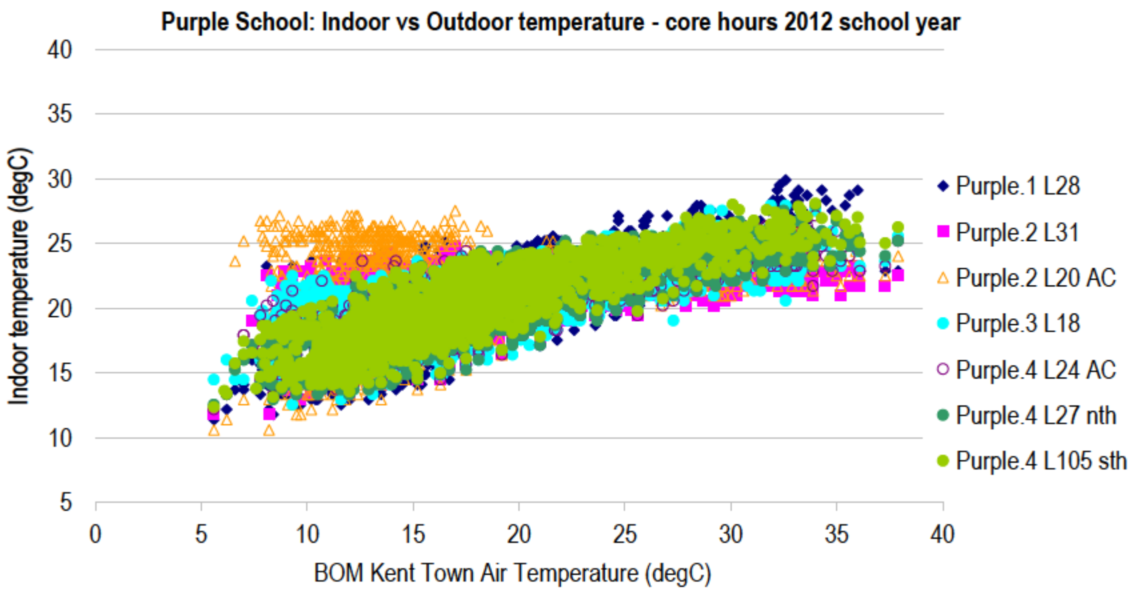
Appendix Figure 24: Indoor vs Outdoor air temperature scatter plot: Orange School (DS-C-OL-A)

H.8.4 Red School



Appendix Figure 25: Indoor vs Outdoor air temperature scatter plot: Red School (DS-C-OL-A)

H.8.5 Purple School



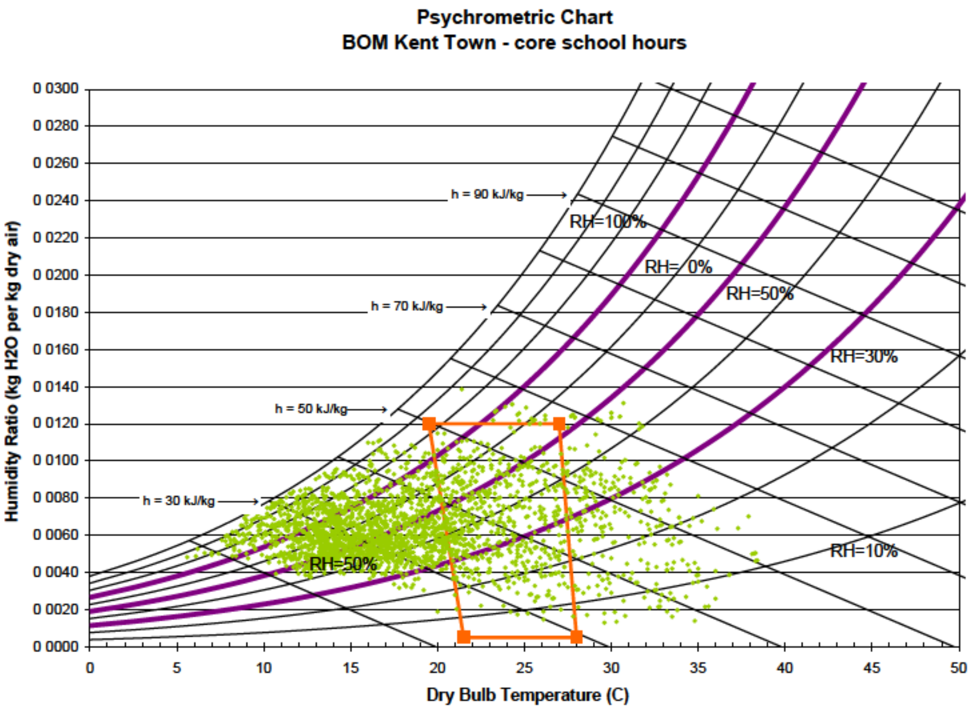
Appendix Figure 26: Indoor vs Outdoor air temperature scatter plot: Purple School (DS-C-OL-A)

H.9 Psychrometric charts

The following psychrometric charts show acceptable operative temperature and humidity ranges based on (ASHRAE 2004). Clo levels have been merged for simplicity.

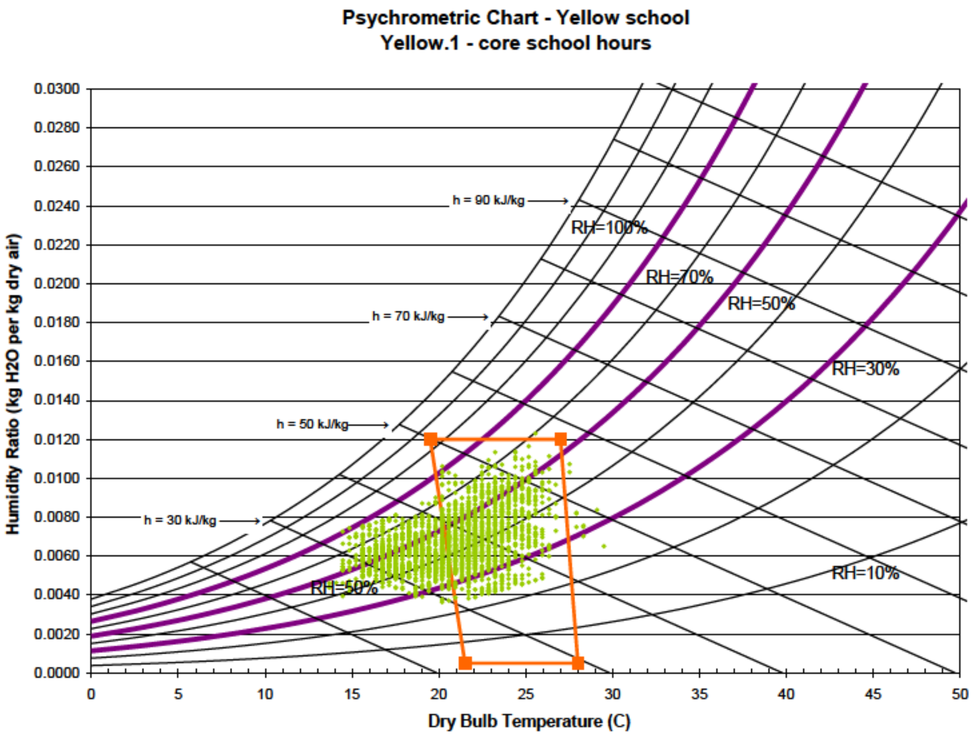
H.9.1 Outdoor

The following outdoor psychrometric chart use data from the Australian Bureau of Meteorology Kent Town station.

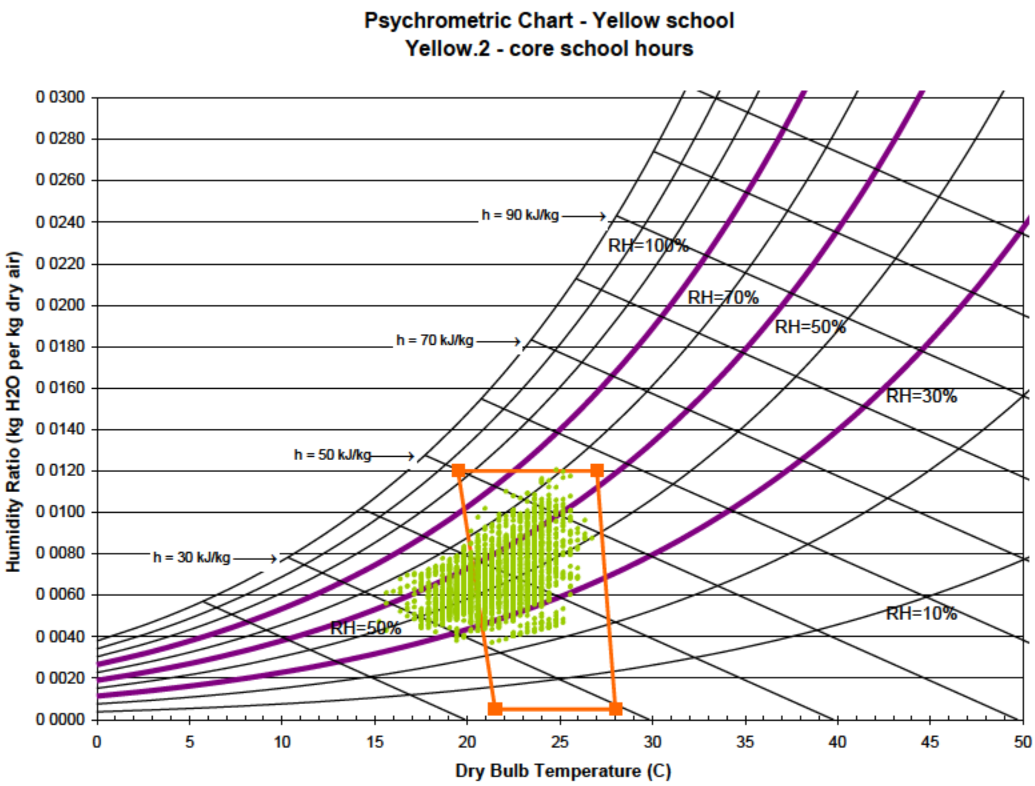


Appendix Figure 27: Psychrometric chart for core school hours: Bureau of Meteorology Kent Town Station (DS-C-OL-A)

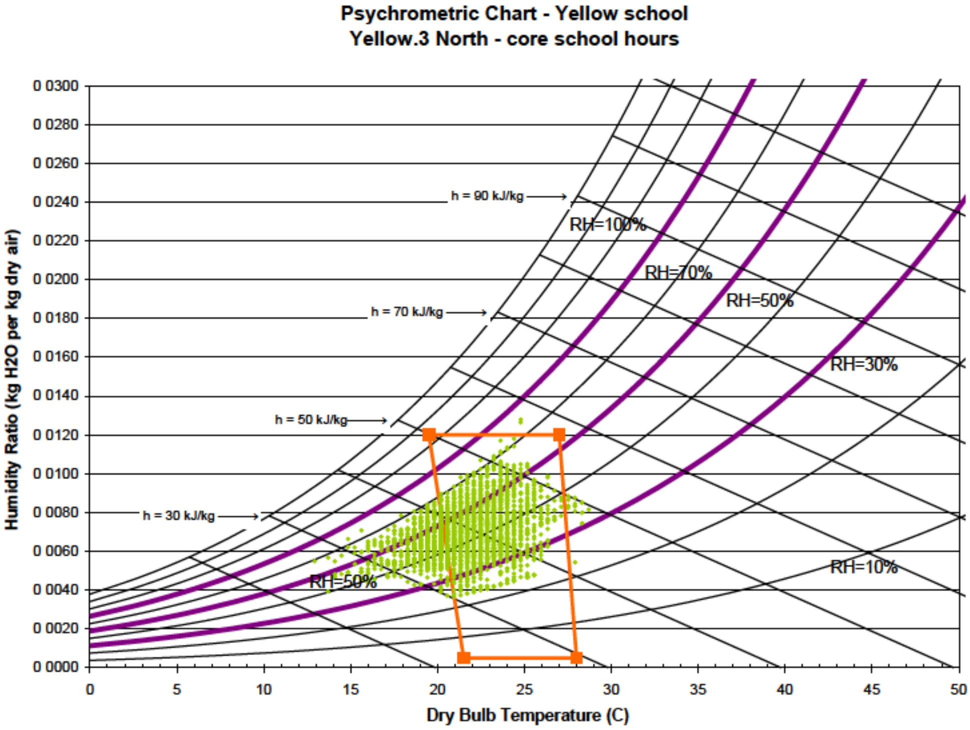
H.9.2 **Yellow School**



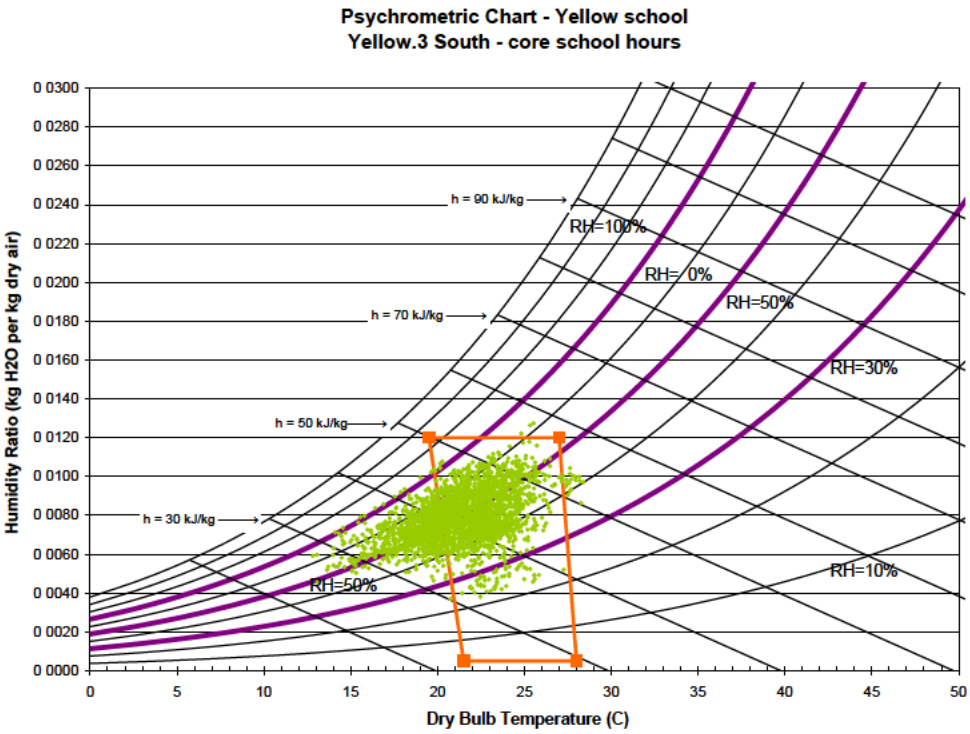
Appendix Figure 28: Psychrometric chart for core school hours: Yellow.1 (DS-C-OL-A)



Appendix Figure 29: Psychrometric chart for core school hours: Yellow.2 (DS-C-OL-A)

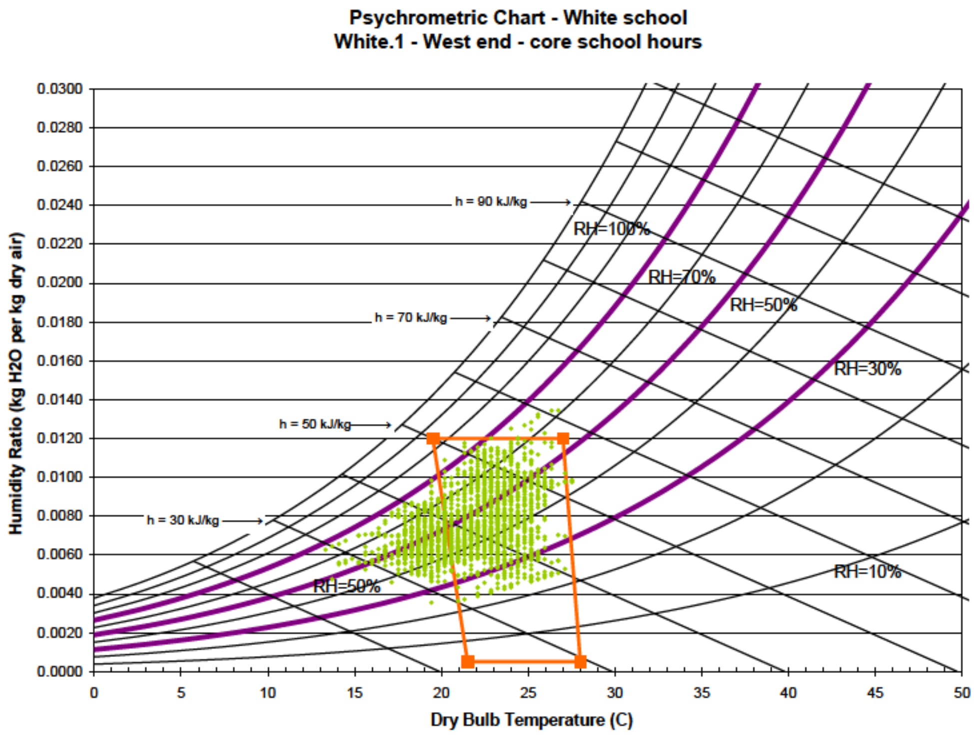


Appendix Figure 30: Psychrometric chart for core school hours: Yellow.3 north end of the space (DS-C-OL-A)

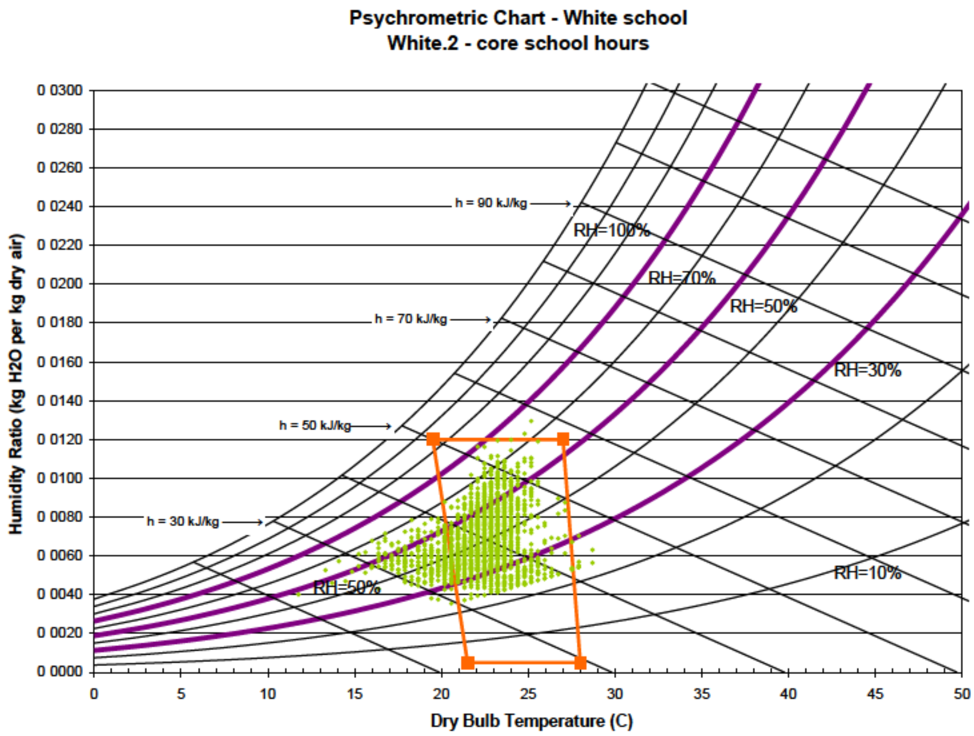


Appendix Figure 31: Psychrometric chart for core school hours: Yellow.3 south end of the space (DS-C-OL-A)

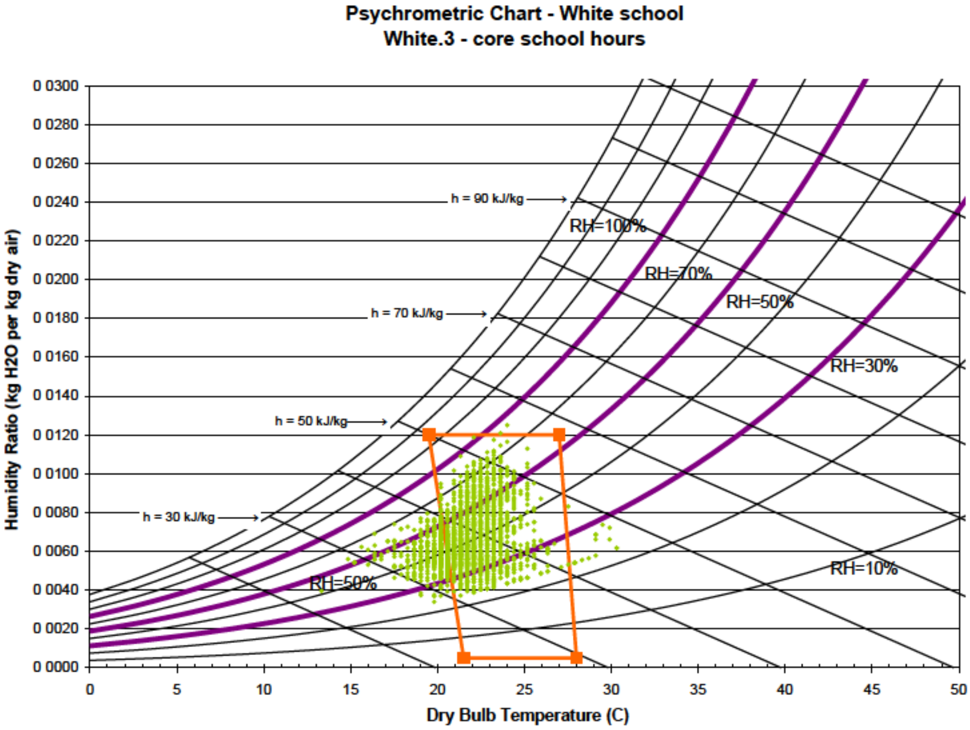
H.9.3 White school



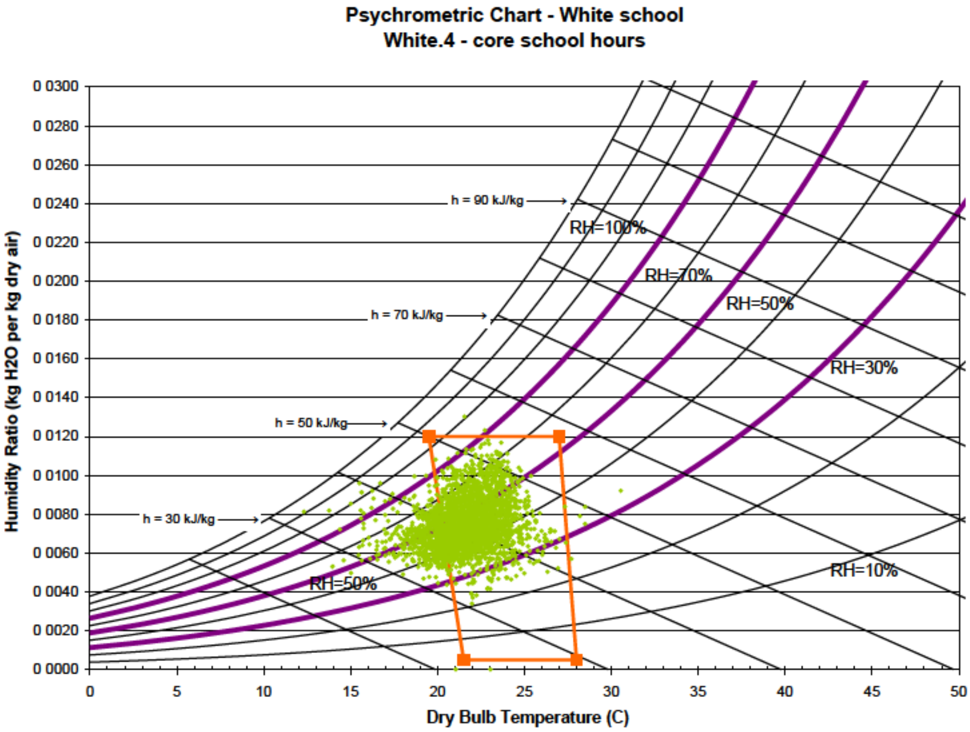
Appendix Figure 32: Psychrometric chart for core school hours: White.1 (DS-C-OL-A)



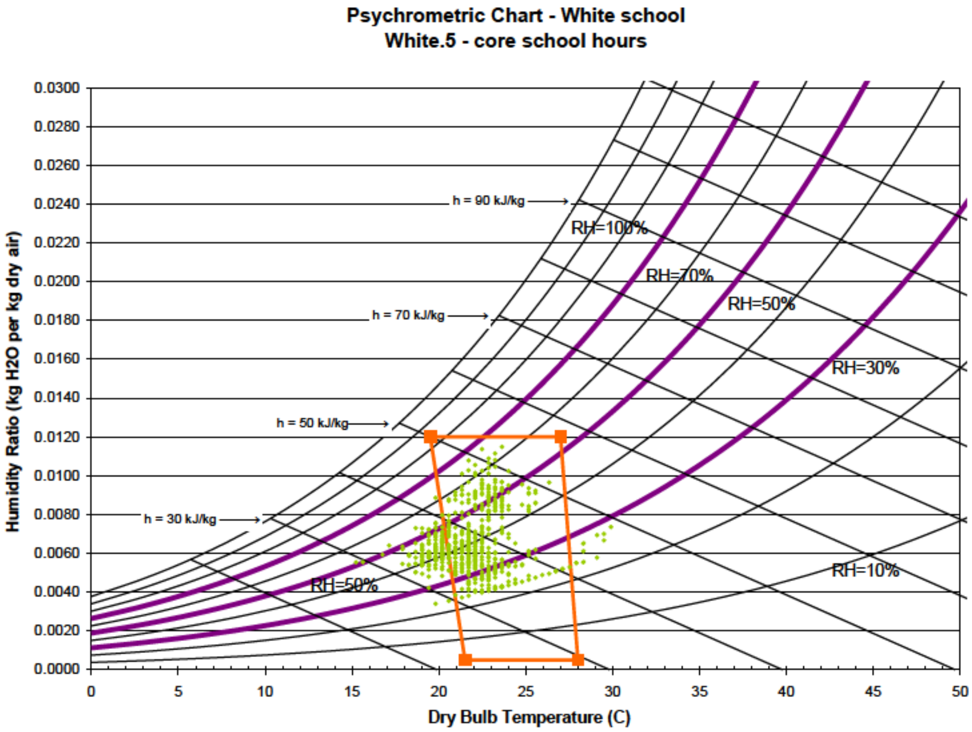
Appendix Figure 33: Psychrometric chart for core school hours: White.2 (DS-C-OL-A)



Appendix Figure 34: Psychrometric chart for core school hours: White.3 (DS-C-OL-A)

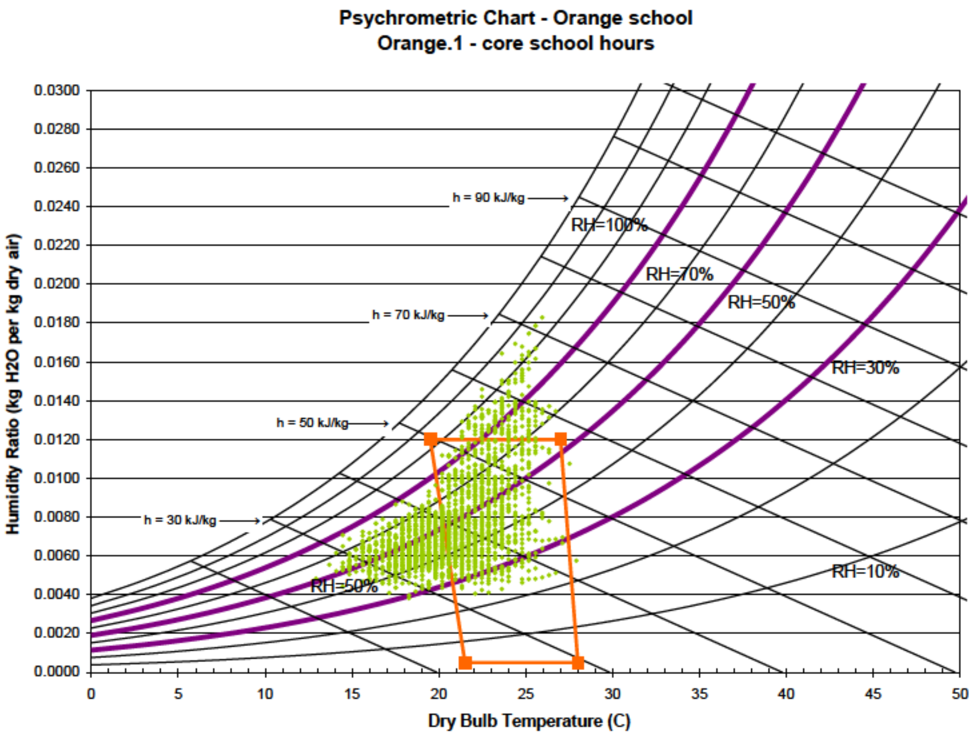


Appendix Figure 35: Psychrometric chart for core school hours: White.4 (DS-C-OL-A)

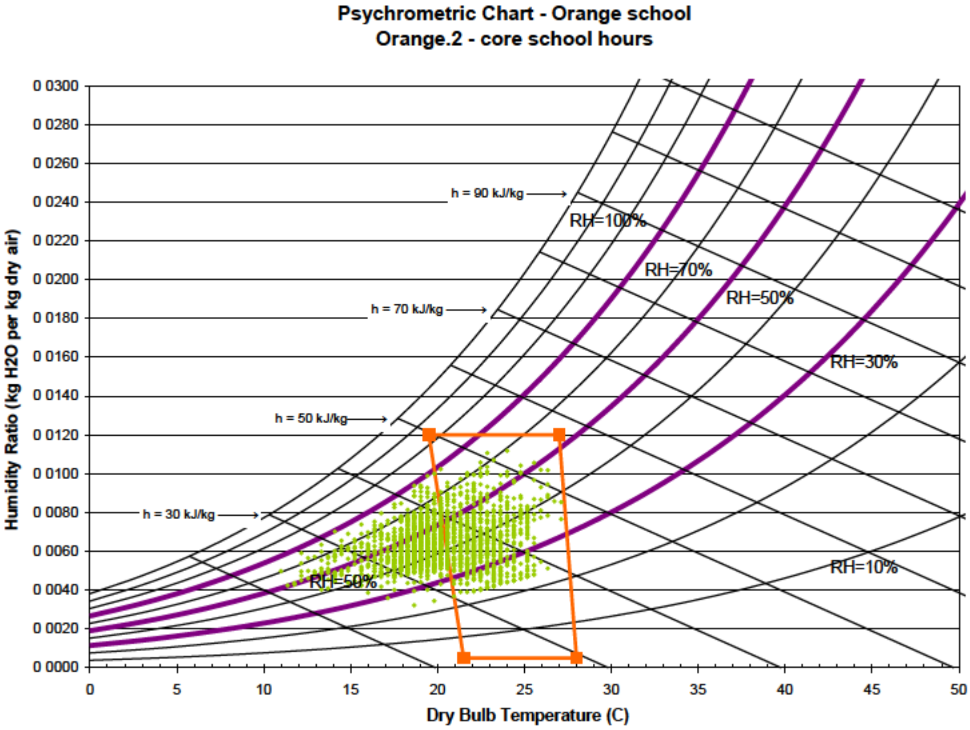


Appendix Figure 36: Psychrometric chart for core school hours: White.5 (DS-C-OL-A)

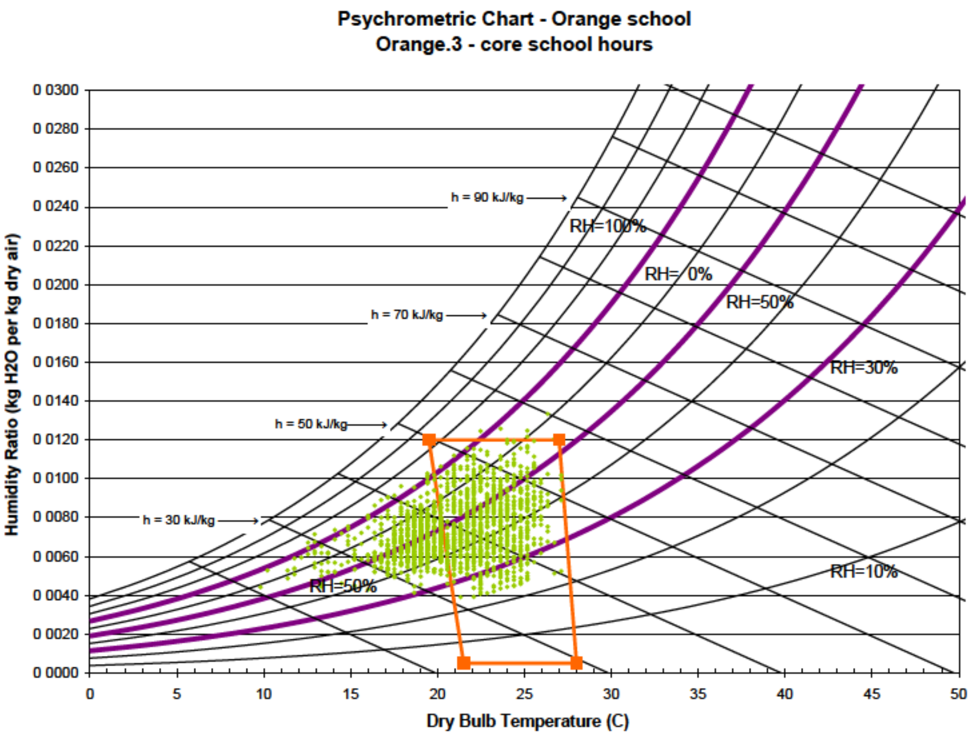
H.9.4 Orange School



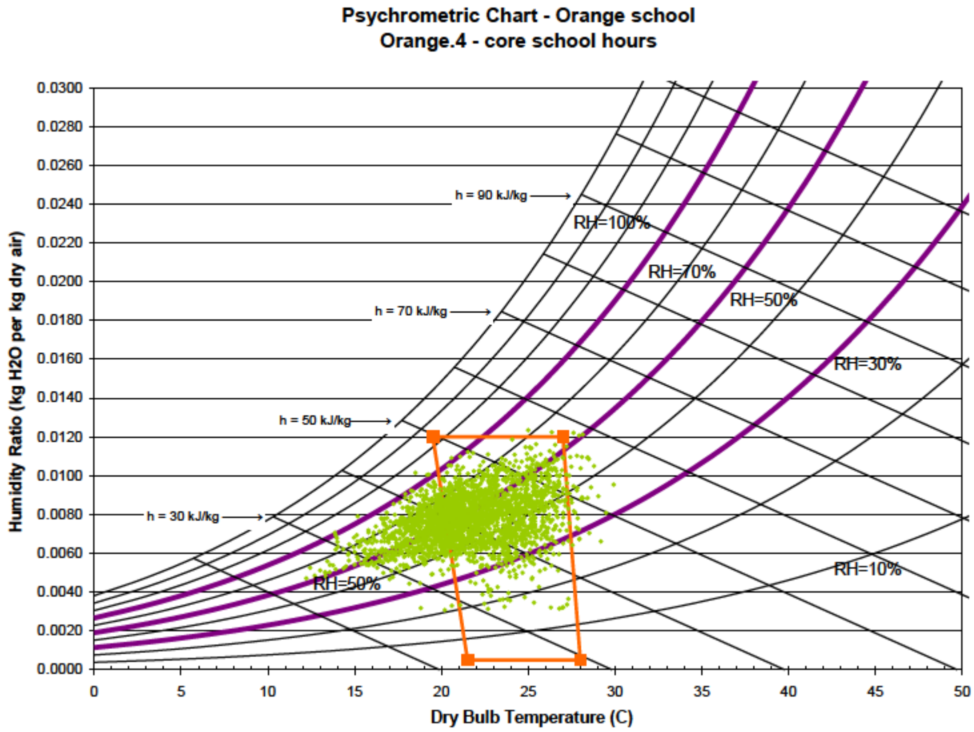
Appendix Figure 37: Psychrometric chart for core school hours: Orange.1 (DS-C-OL-A)



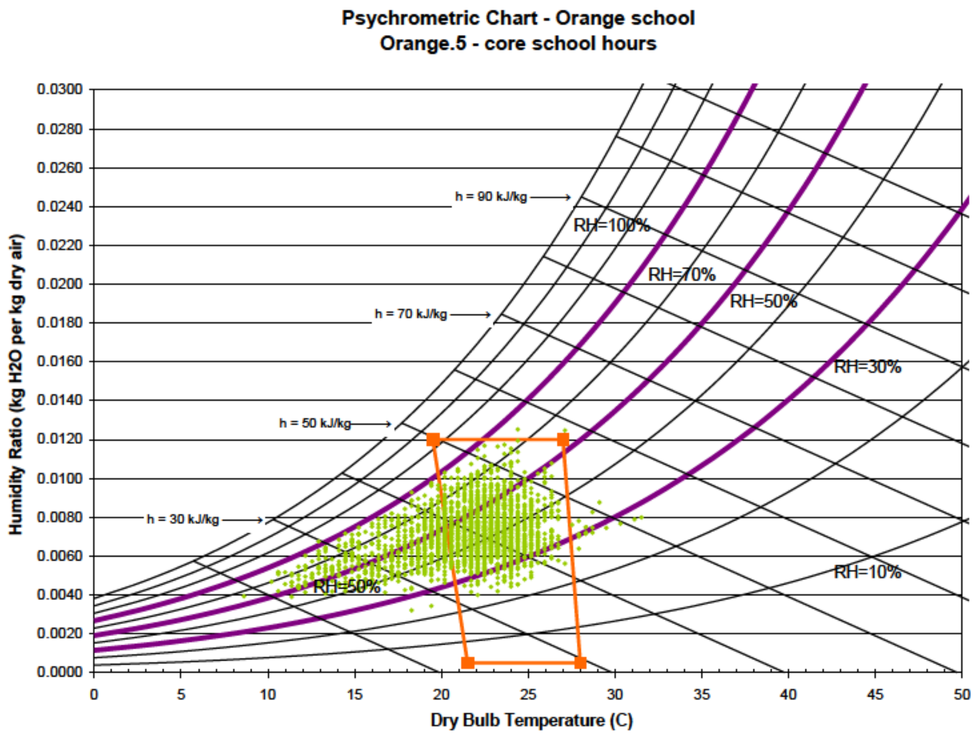
Appendix Figure 38: Psychrometric chart for core school hours: Orange.2 (DS-C-OL-A)



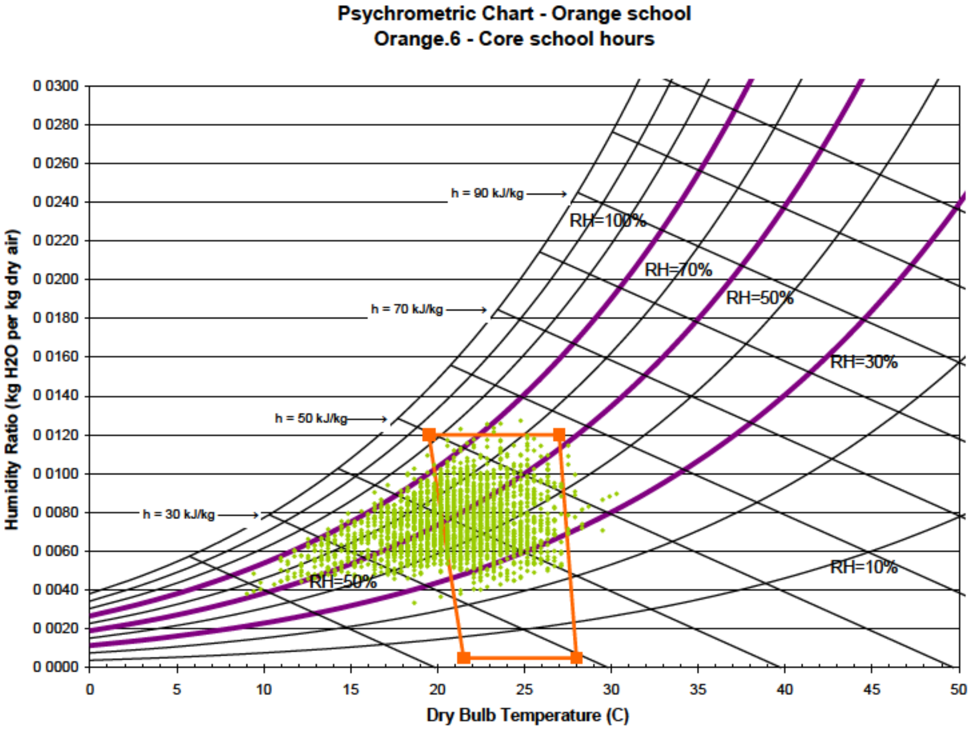
Appendix Figure 39: Psychrometric chart for core school hours: Orange.3 (DS-C-OL-A)



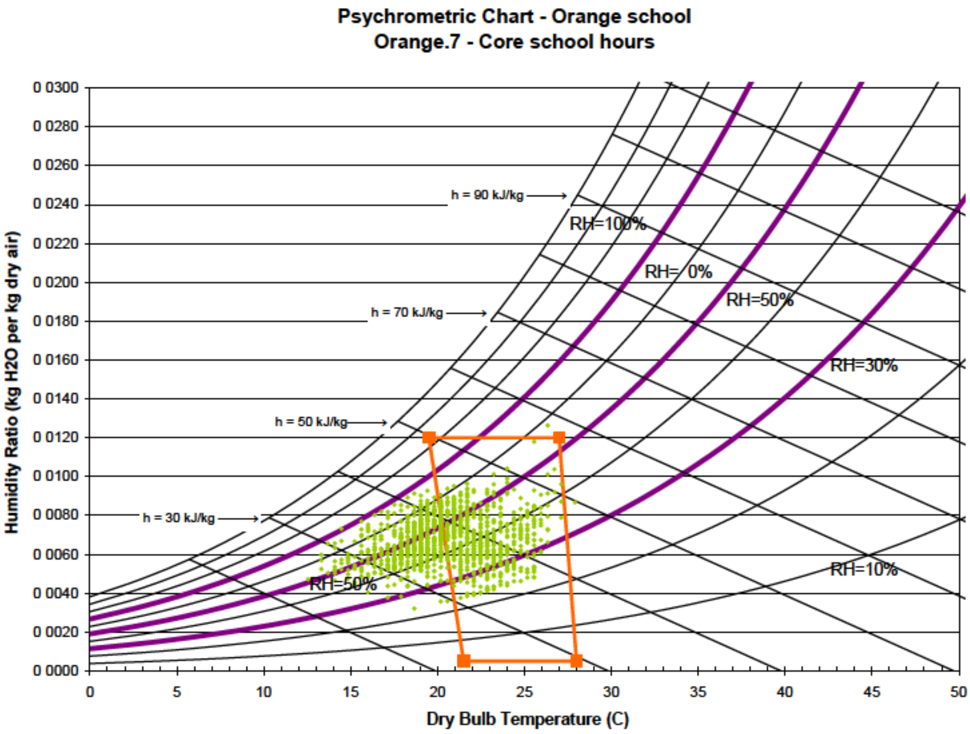
Appendix Figure 40: Psychrometric chart for core school hours: Orange.4 (DS-C-OL-A)



Appendix Figure 41: Psychrometric chart for core school hours: Orange.5 (DS-C-OL-A)

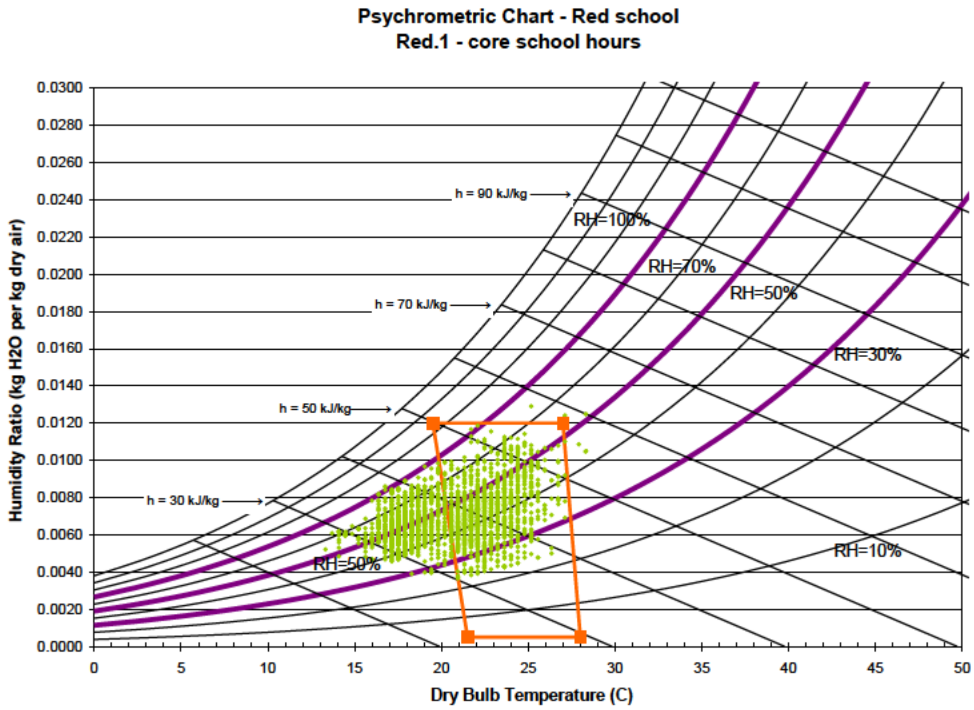


Appendix Figure 42: Psychrometric chart for core school hours: Orange.6 (DS-C-OL-A)

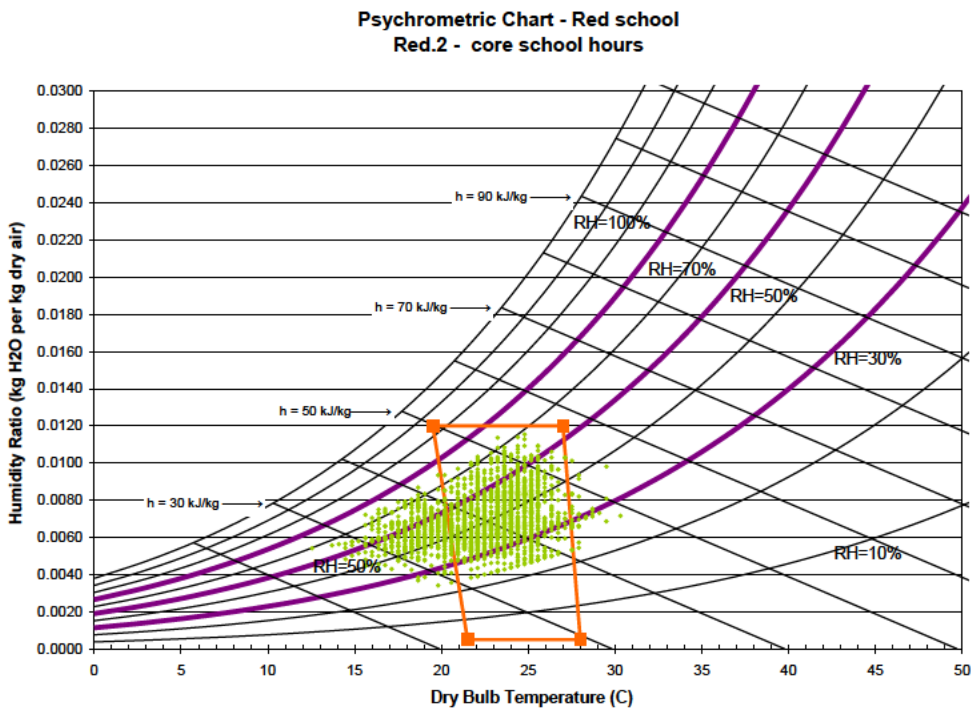


Appendix Figure 43: Psychrometric chart for core school hours: Orange.7 (DS-C-OL-A)

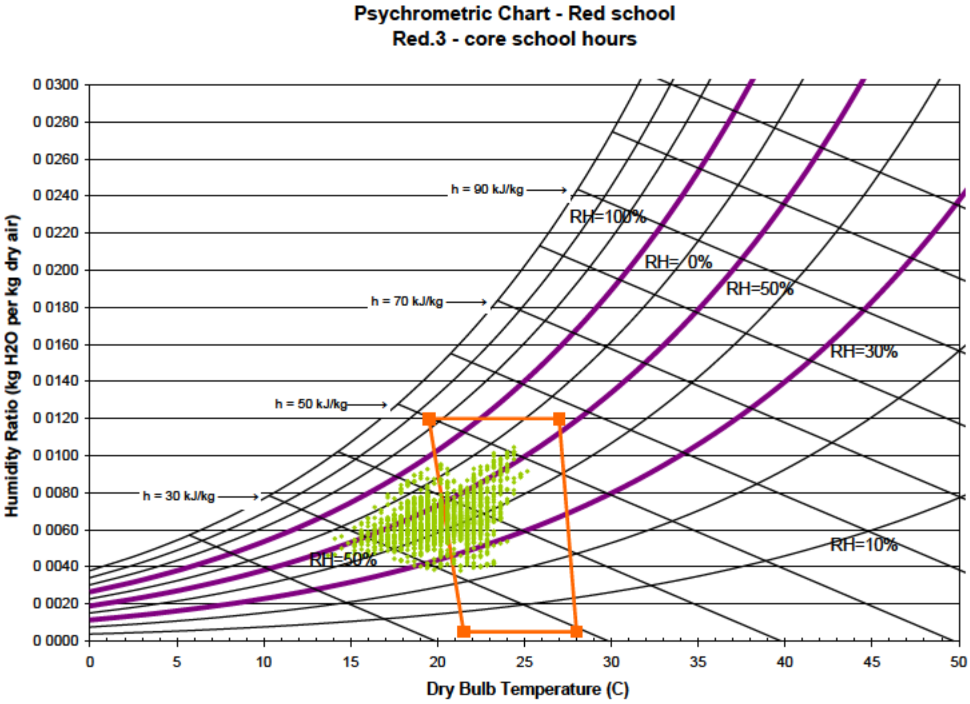
H.9.5 Red School



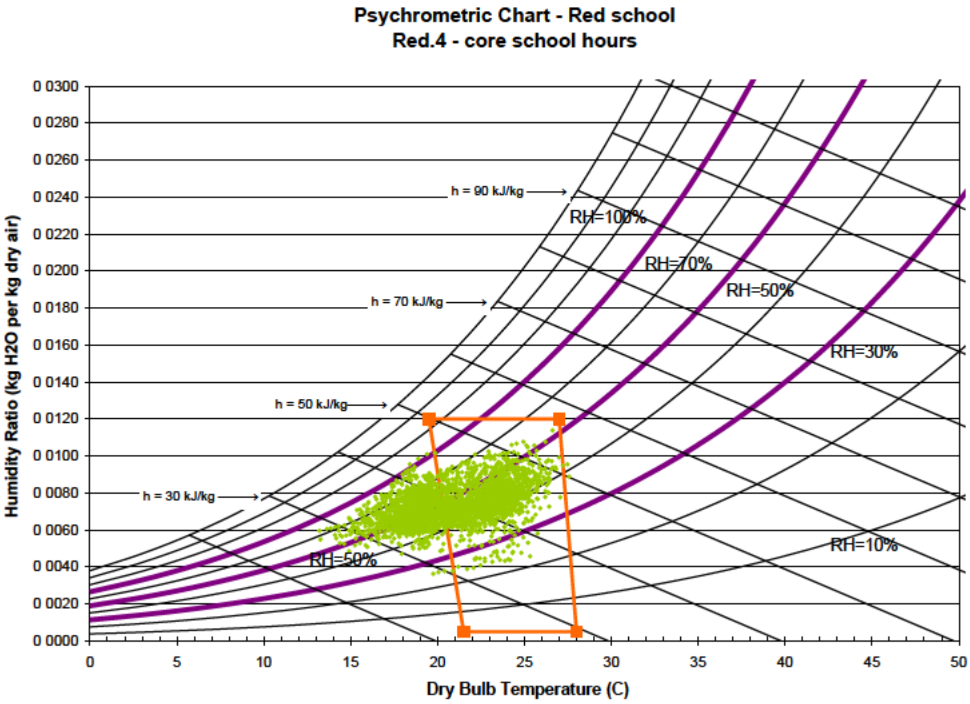
Appendix Figure 44: Psychrometric chart for core school hours: Red.1 (DS-C-OL-A)



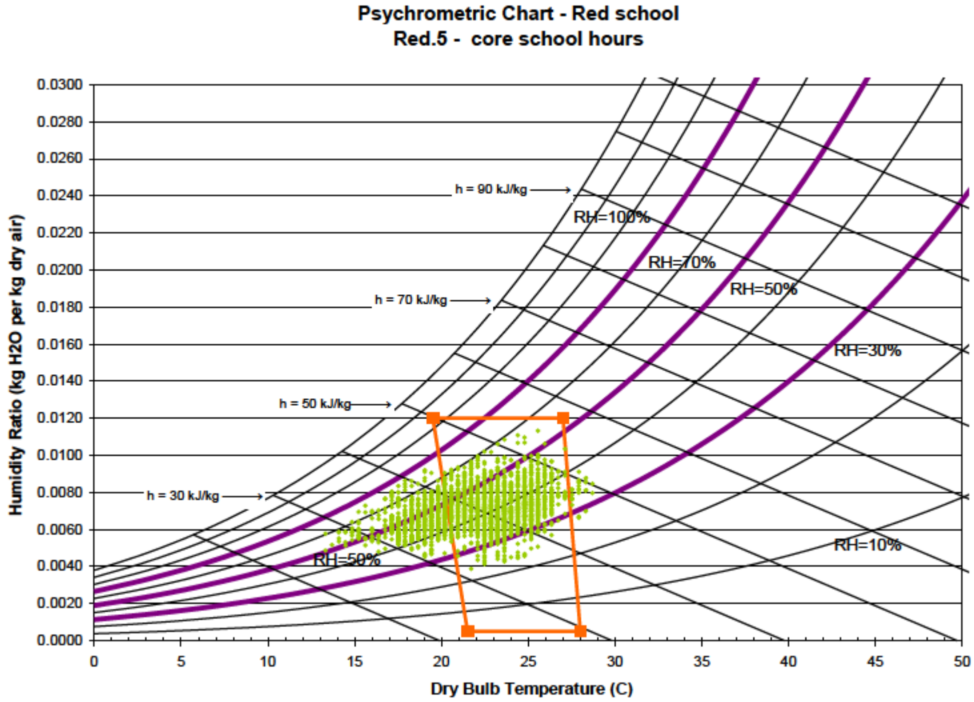
Appendix Figure 45: Psychrometric chart for core school hours: Red.2 (DS-C-OL-A)



Appendix Figure 46: Psychrometric chart for core school hours: Red.3 (DS-C-OL-A)

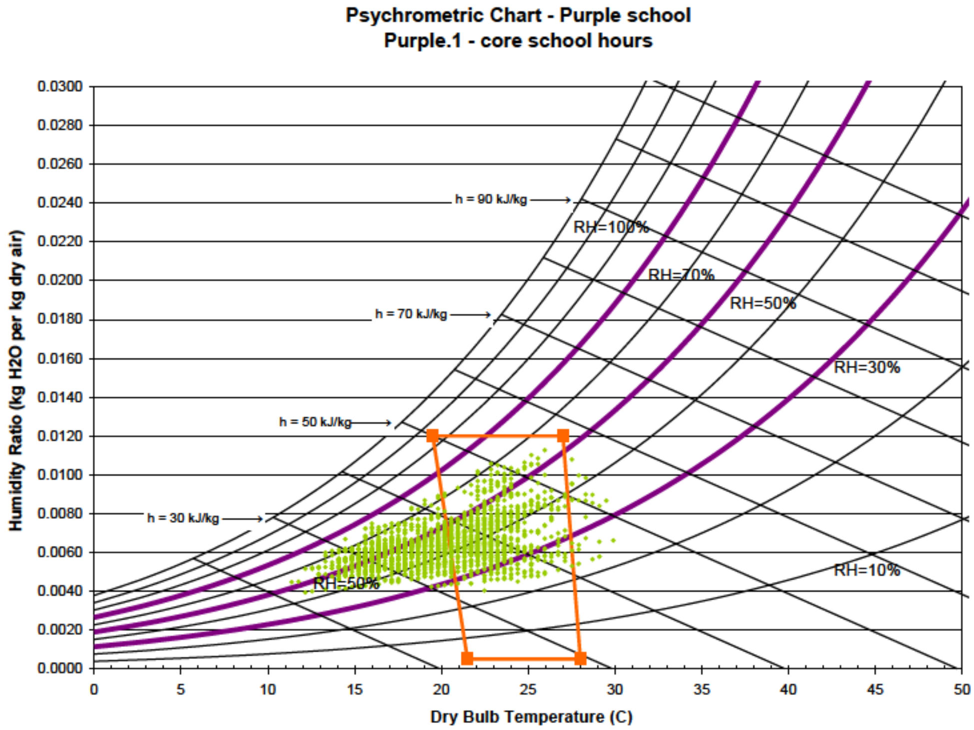


Appendix Figure 47: Psychrometric chart for core school hours: Red.4 (DS-C-OL-A)

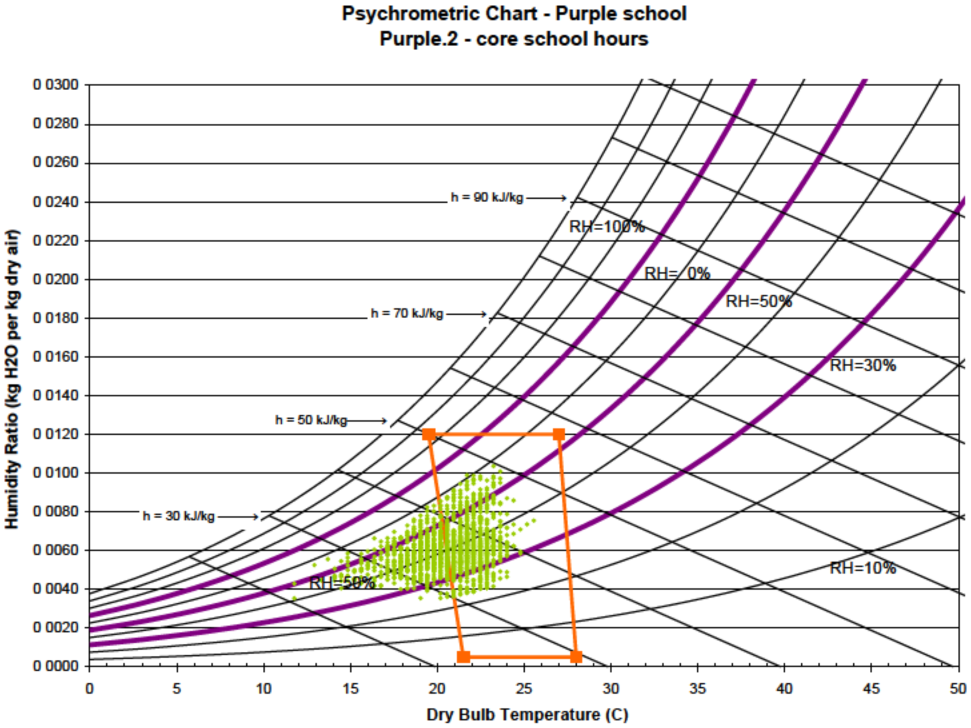


Appendix Figure 48: Psychrometric chart for core school hours: Red.5 (DS-C-OL-A)

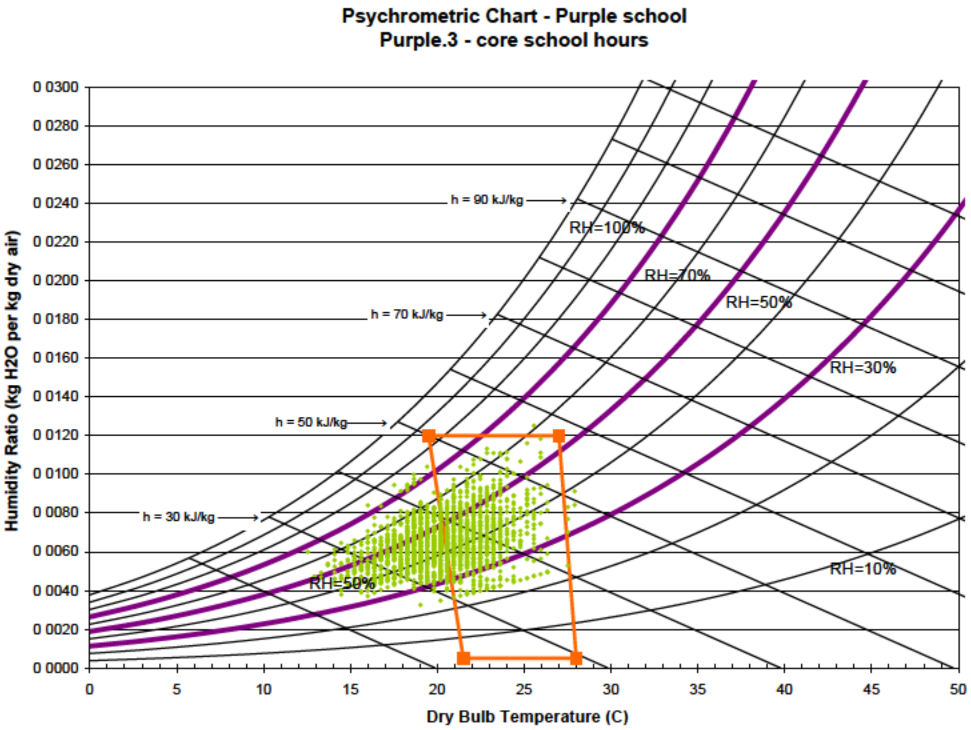
H.9.6 Purple School



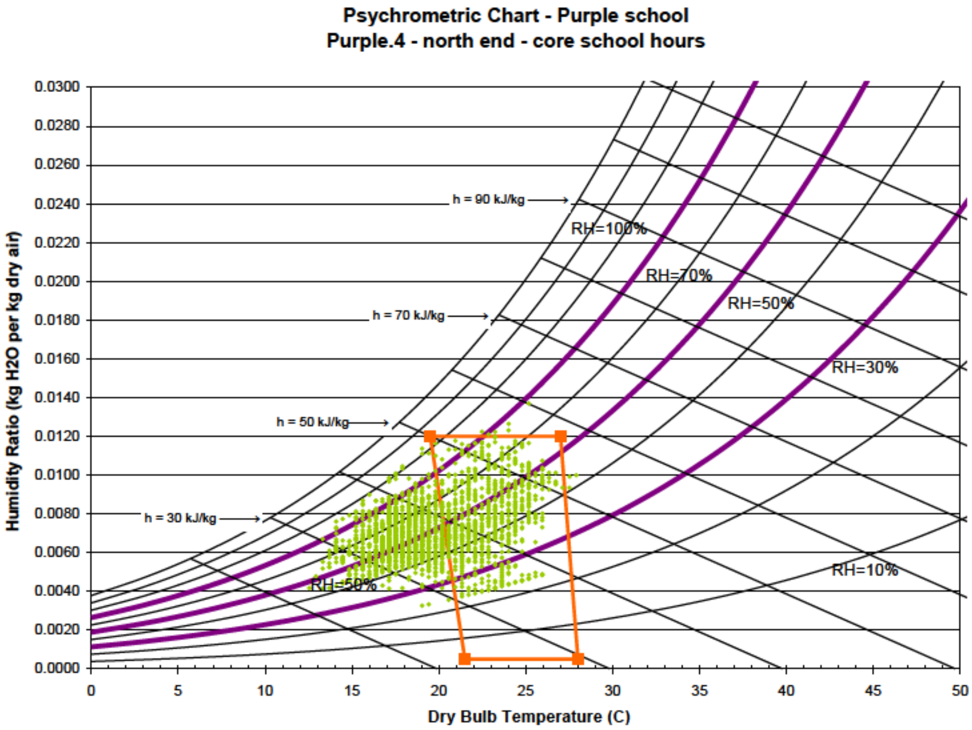
Appendix Figure 49: Psychrometric chart for core school hours: Purple.1 (DS-C-OL-A)



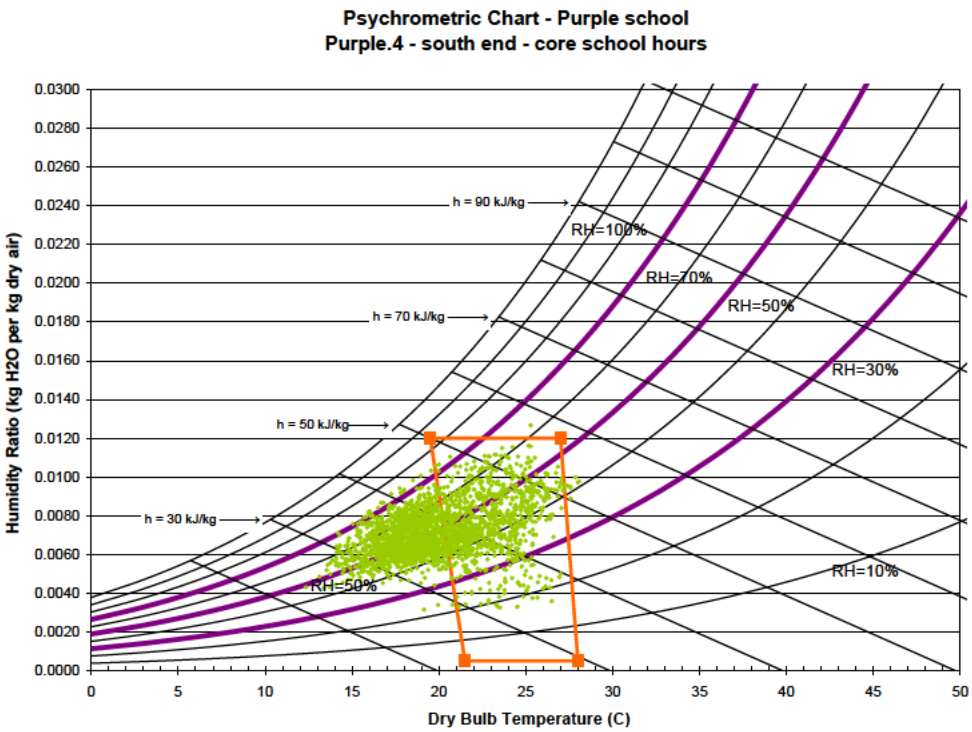
Appendix Figure 50: Psychrometric chart for core school hours: Purple.2 (DS-C-OL-A)



Appendix Figure 51: Psychrometric chart for core school hours: Purple.3 (DS-C-OL-A)



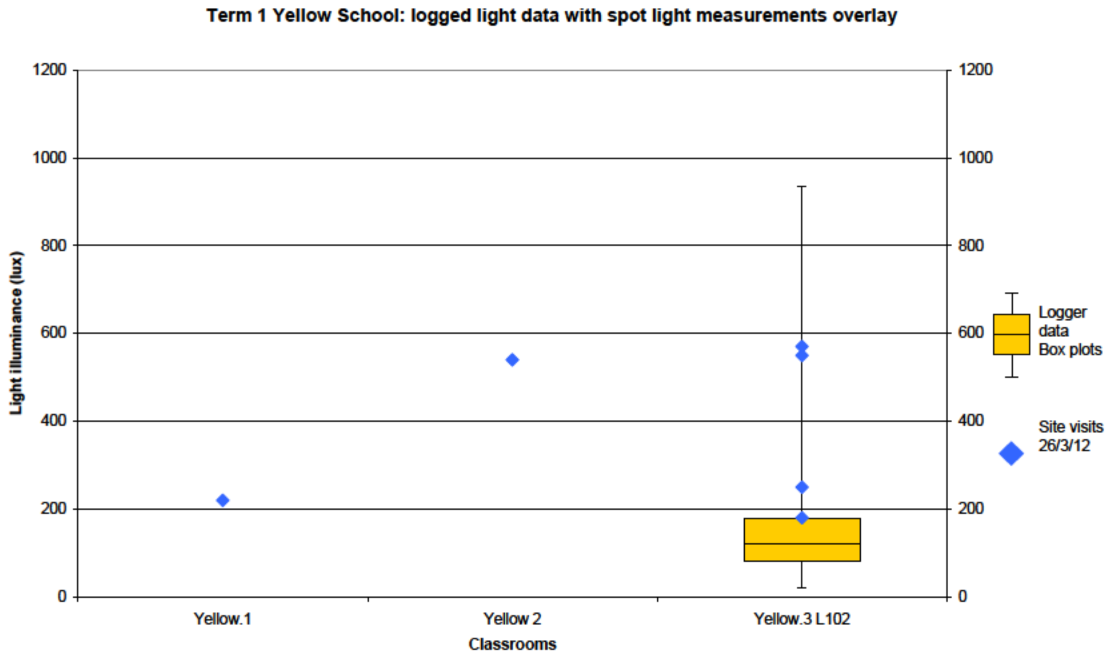
Appendix Figure 52: Psychrometric chart for core school hours: Purple.4 north end of the space (DS-C-OL-A)



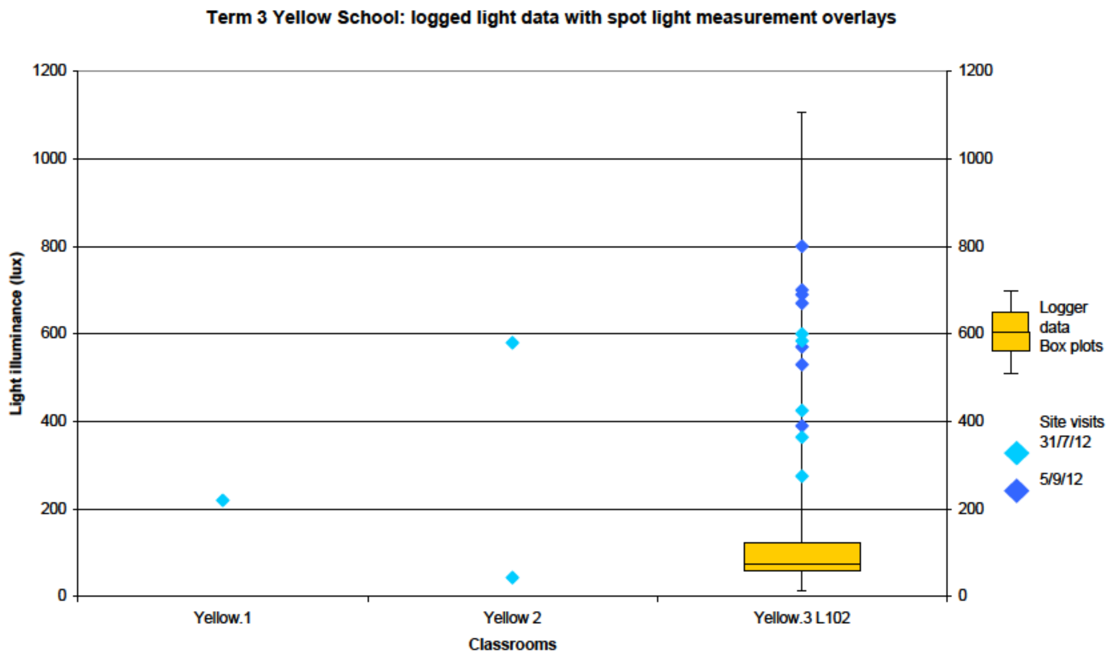
Appendix Figure 53: Psychrometric chart for core school hours: Purple.4 South End (DS-C-OL-A)

H.10 Light measurements

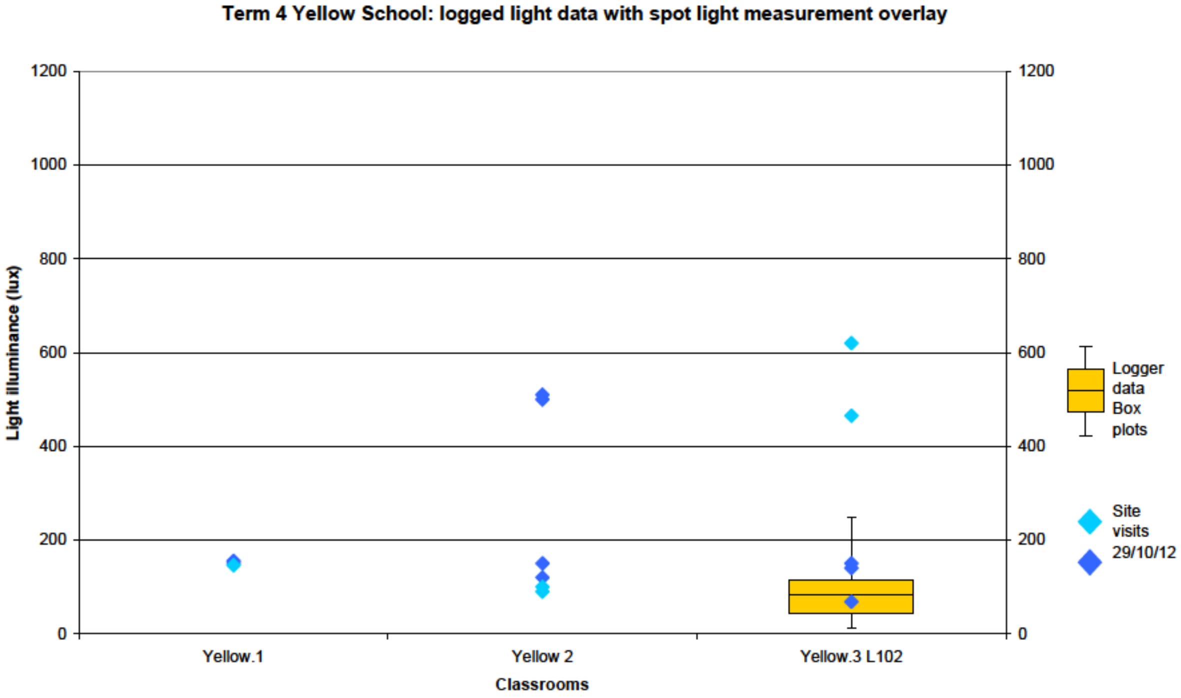
H.10.1 Yellow School



Appendix Figure 54: Light illuminance box plots and spot measurements: Yellow School Term 1 (DS-C-OL-A)

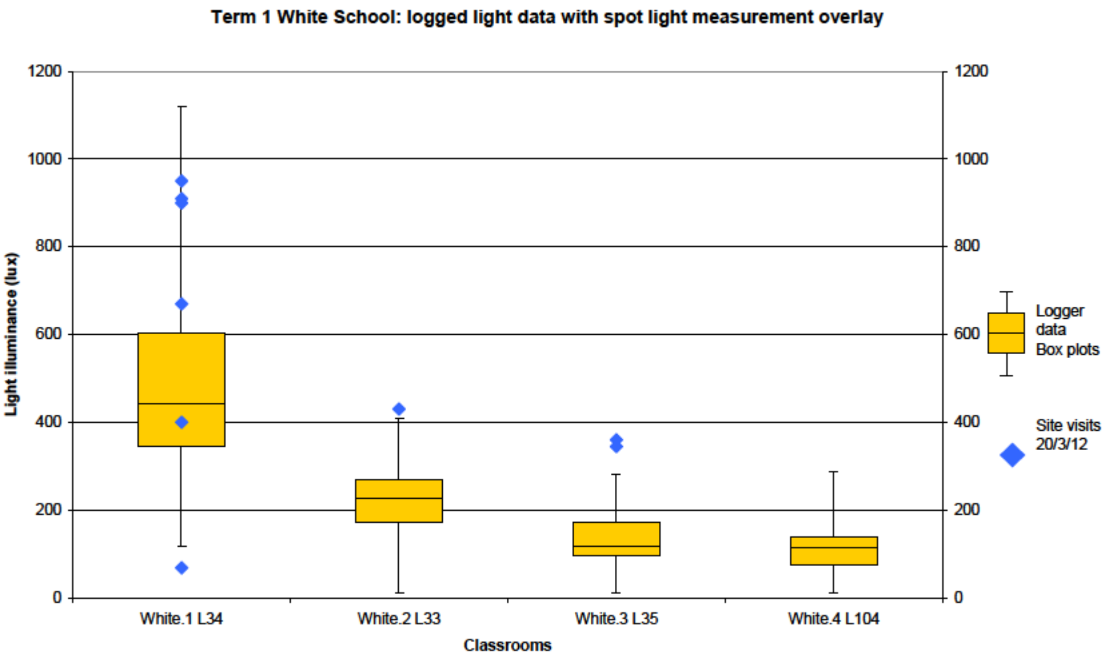


Appendix Figure 55: Light illuminance box plots and spot measurements: Yellow School Term 3 (DS-C-OL-A)

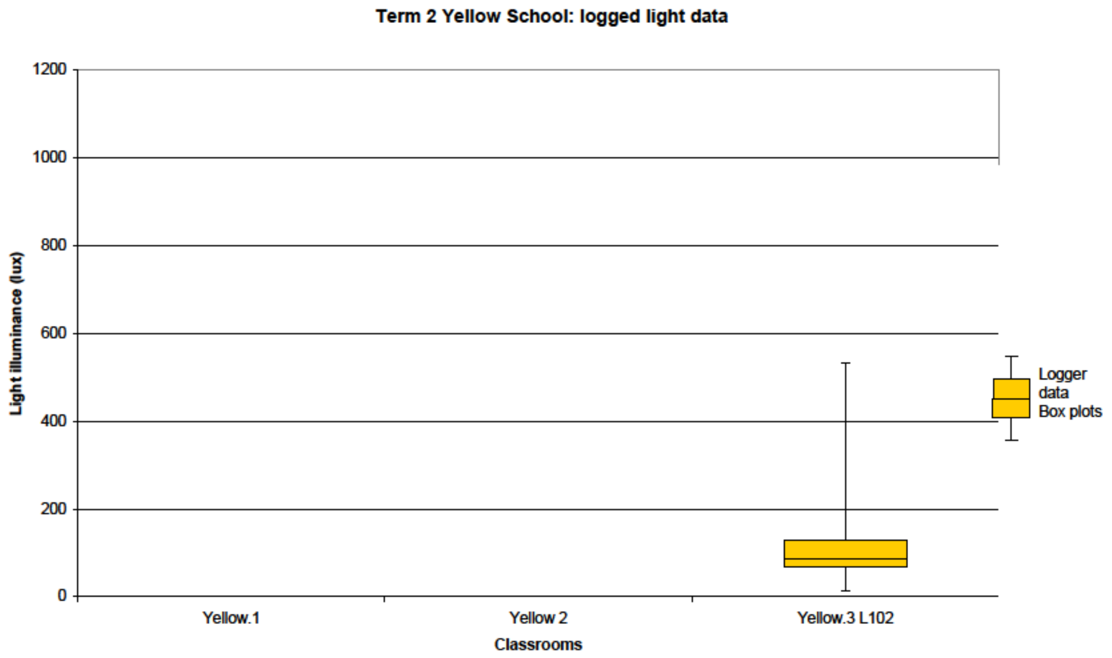


Appendix Figure 56: Light illuminance box plots and spot measurements: Yellow School Term 4 (DS-C-OL-A)

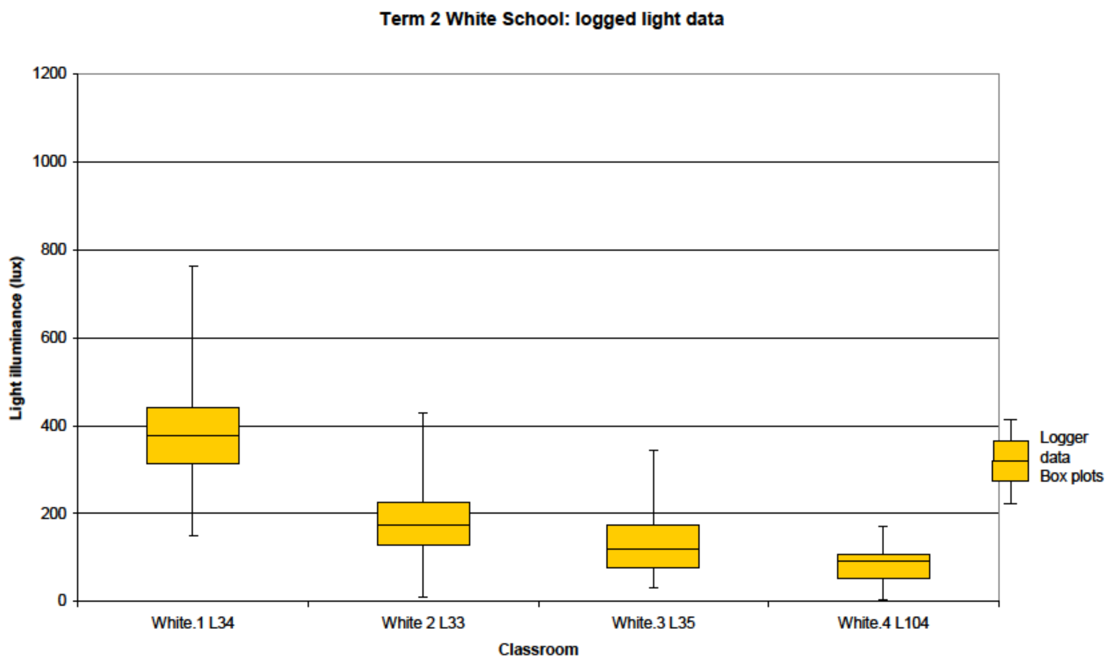
H.10.2 White School



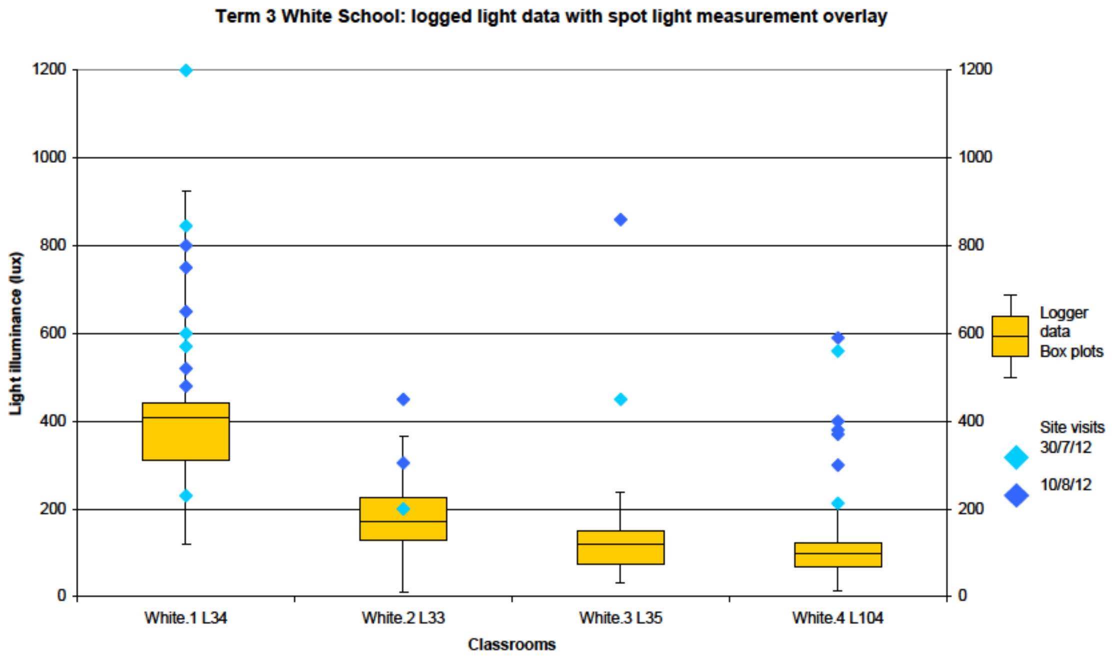
Appendix Figure 57: Light illuminance box plots and spot measurements: White School Term 1 (DS-C-OL-A)



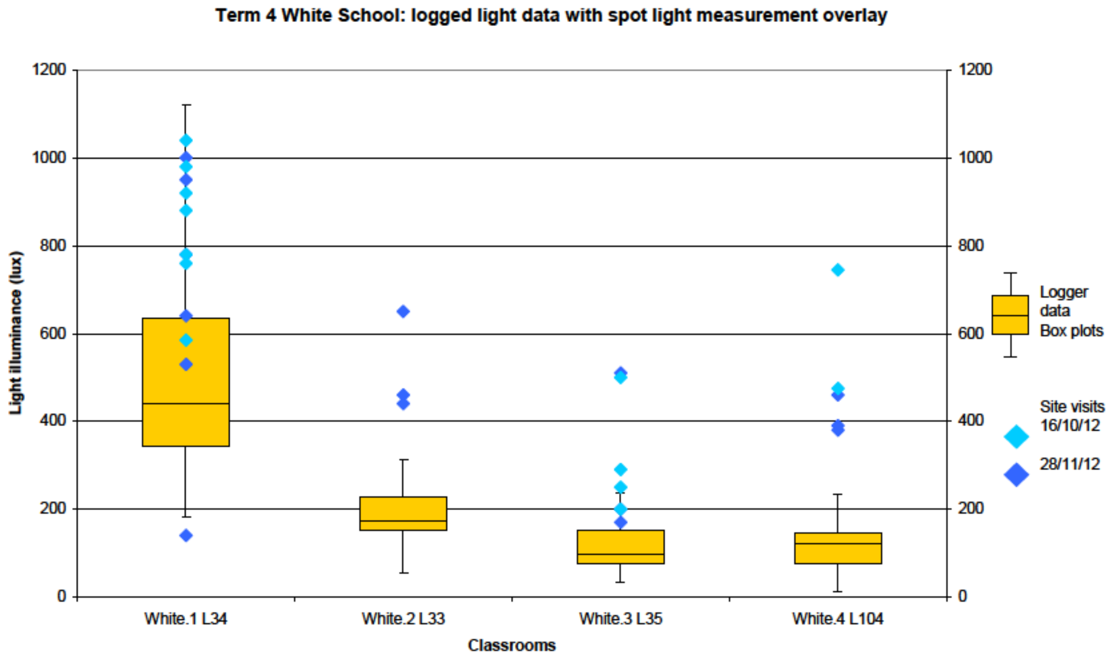
Appendix Figure 58: Light illuminance box plots and spot measurements: Yellow School Term 2 (DS-C-OL-A)



Appendix Figure 59: Light illuminance box plots and spot measurements: White School Term 2 (DS-C-OL-A)

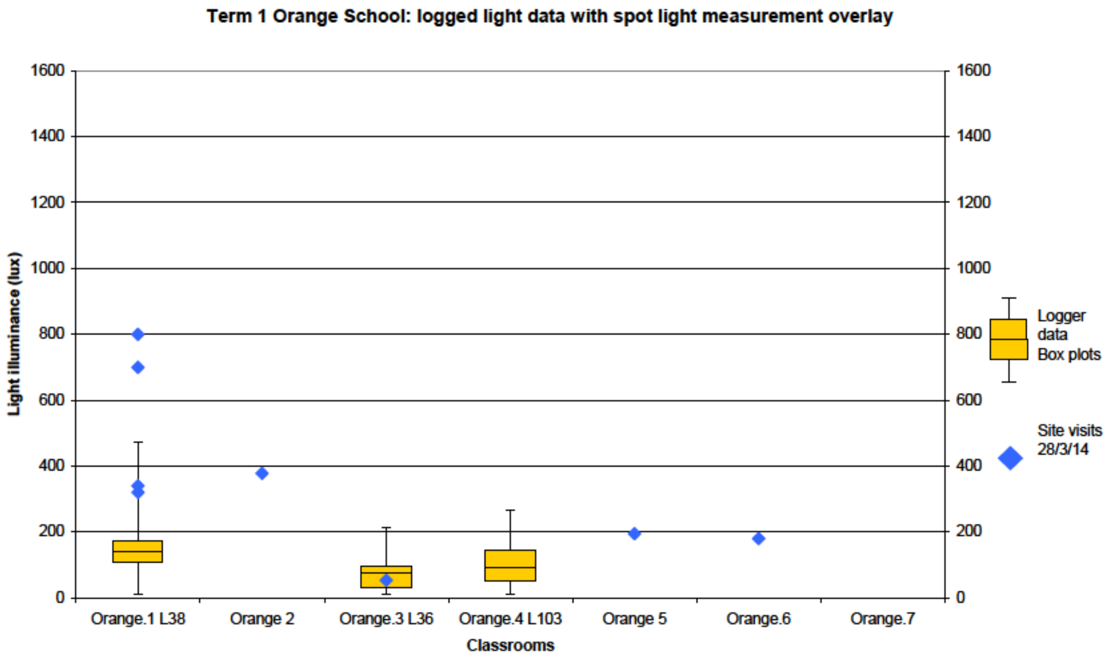


Appendix Figure 60: Light illuminance box plots and spot measurements: White School Term 3 (DS-C-OL-A)

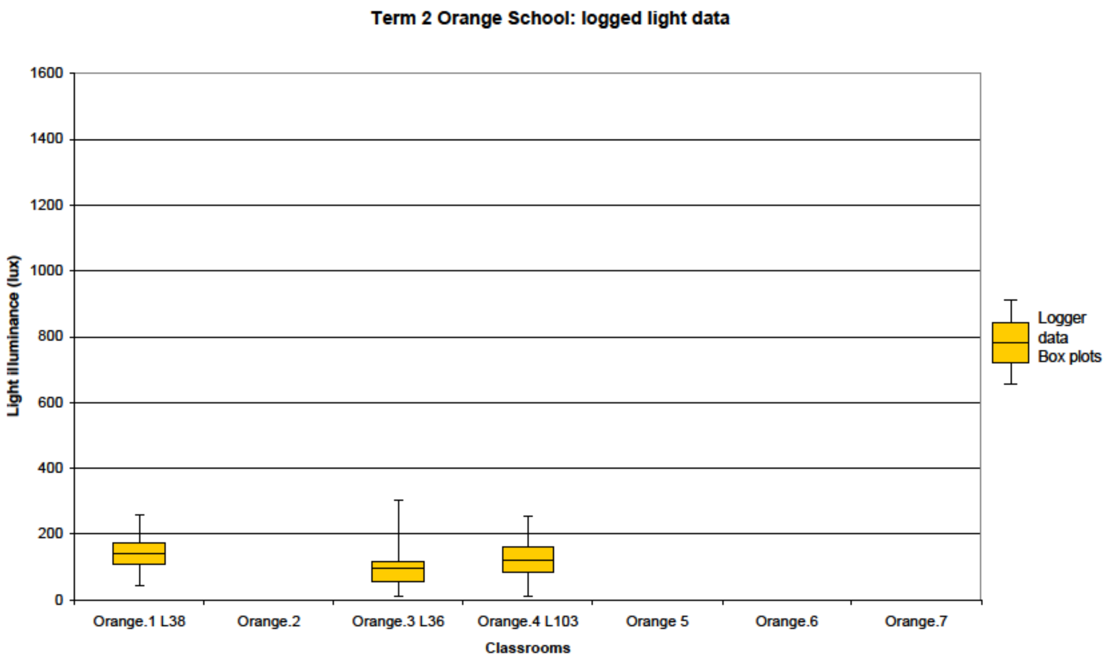


Appendix Figure 61: Light illuminance box plots and spot measurements: White School Term 4 (DS-C-OL-A)

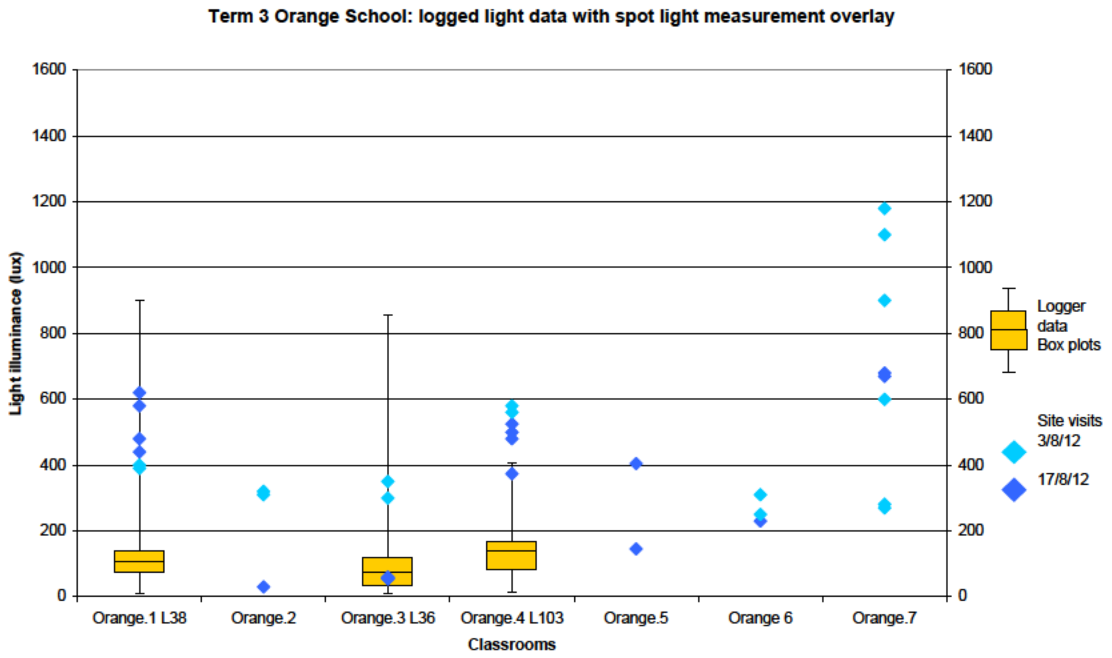
H.10.3 Orange School



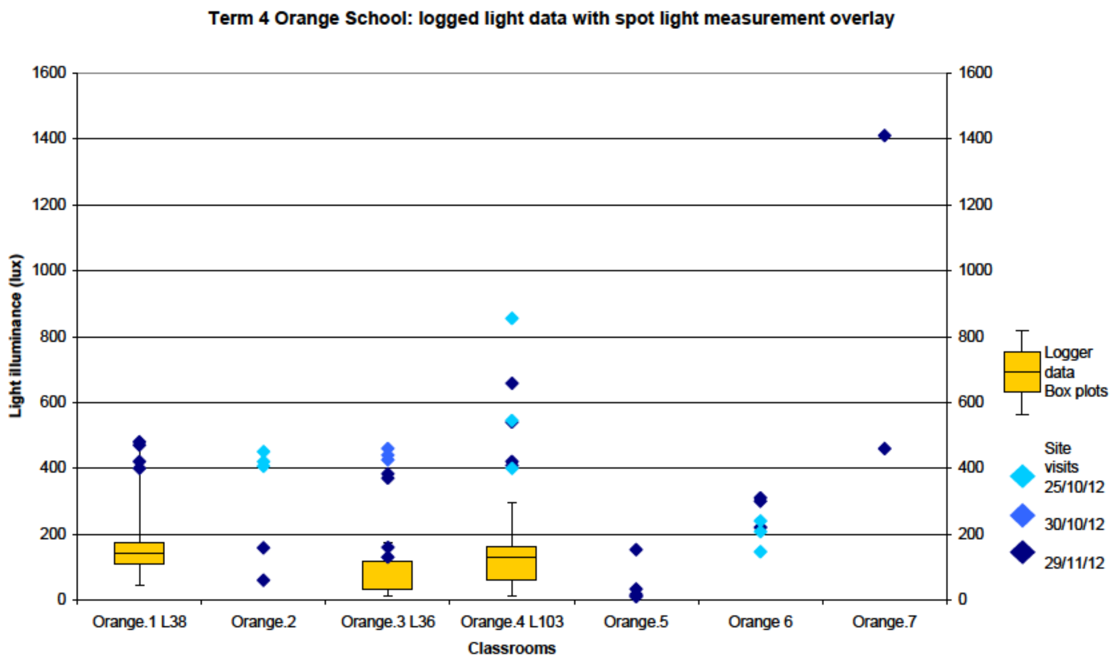
Appendix Figure 62: Light illuminance box plots and spot measurements: Orange School Term 1 (DS-C-OL-A)



Appendix Figure 63: Light illuminance box plots and spot measurements: Orange School Term 2 (DS-C-OL-A)

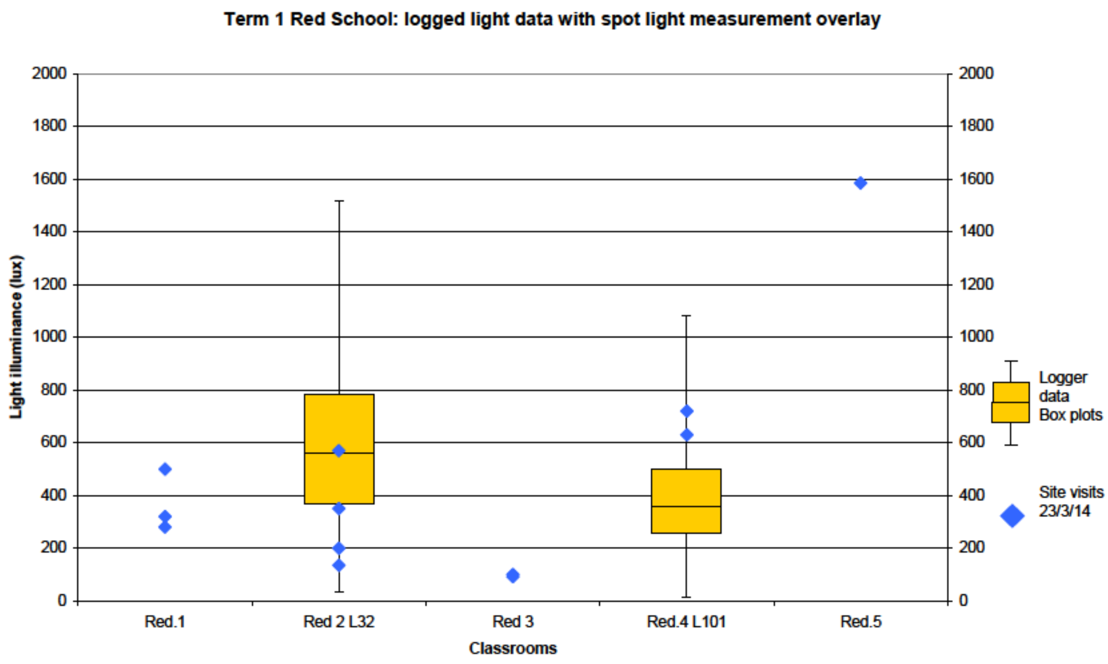


Appendix Figure 64: Light illuminance box plots and spot measurements: Orange School Term 3 (DS-C-OL-A)

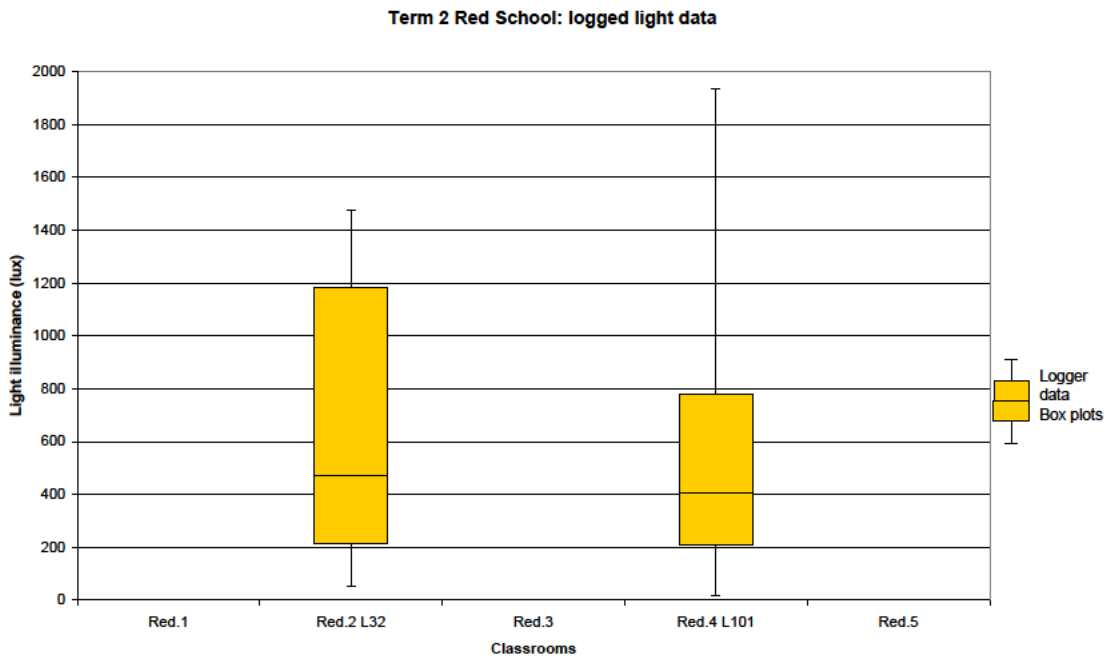


Appendix Figure 65: Light illuminance box plots and spot measurements: Orange School Term 4 (DS-C-OL-A)

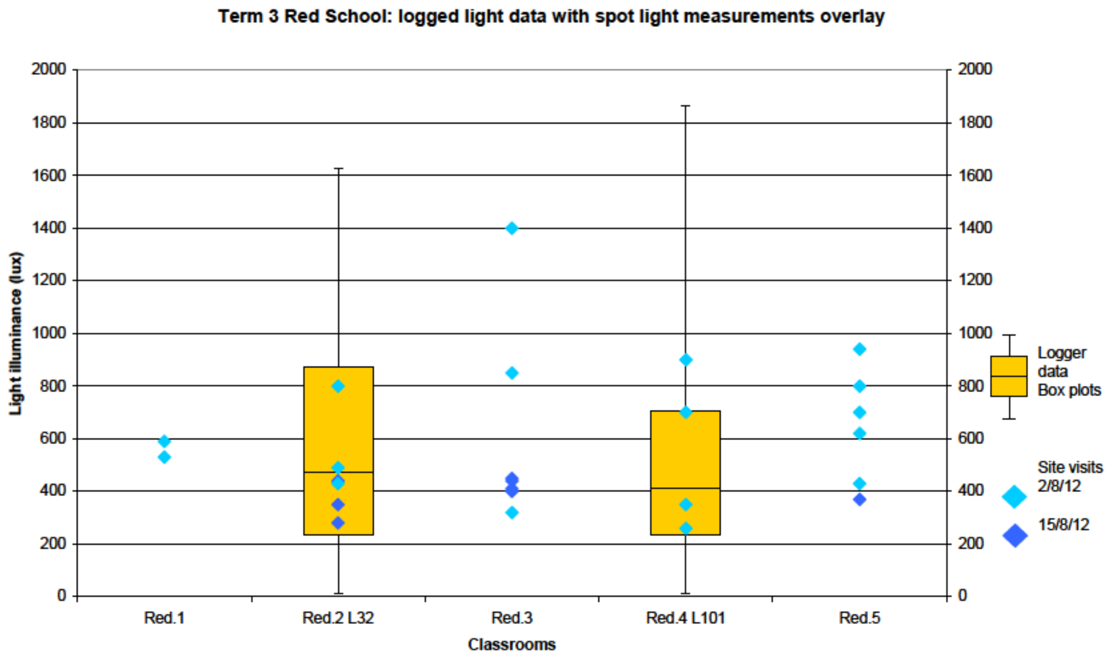
H.10.4 Red School



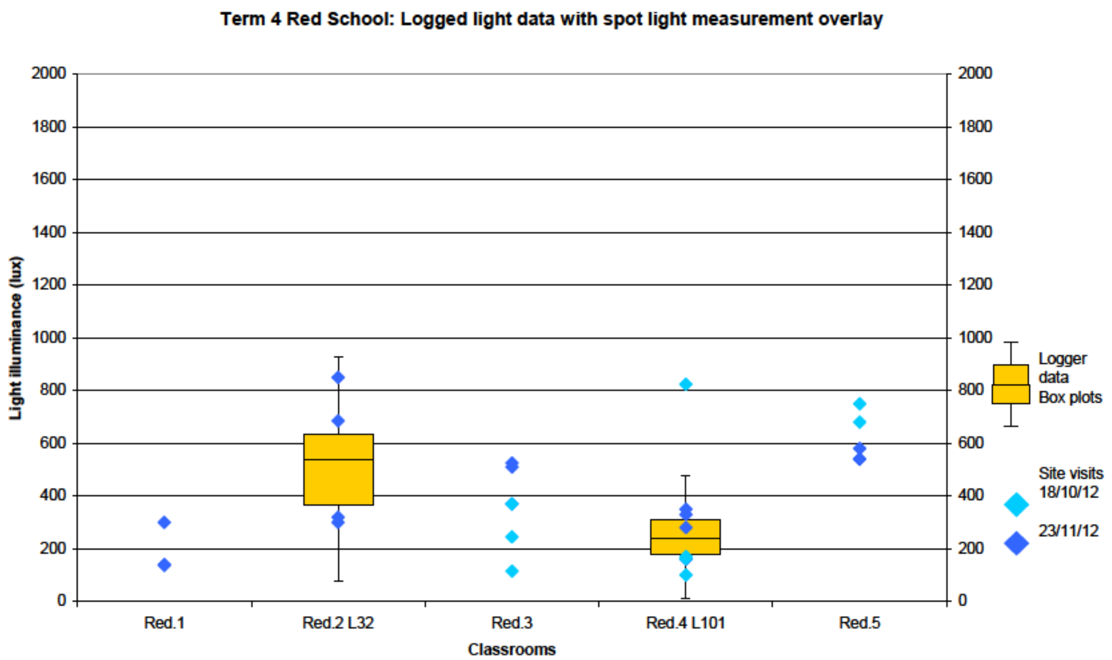
Appendix Figure 66: Light illuminance box plots and spot measurements: Red School Term 1 (DS-C-OL-A)



Appendix Figure 67: Light illuminance box plots and spot measurements: Red School Term 2 (DS-C-OL-A)

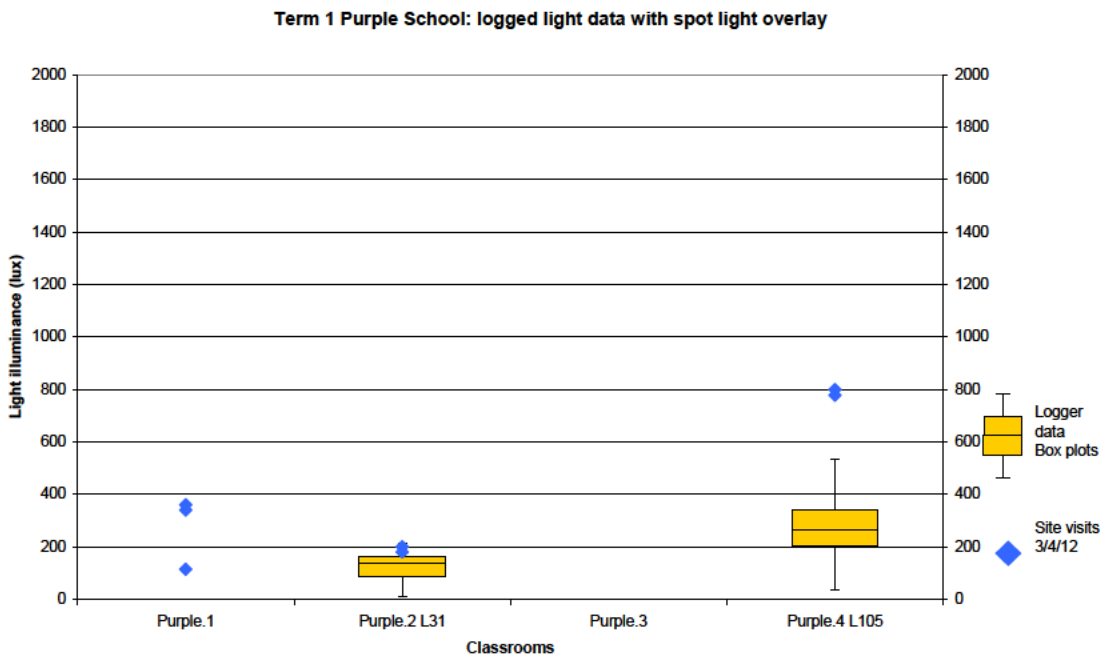


Appendix Figure 68: Light illuminance box plots and spot measurements: Red School Term 3 (DS-C-OL-A)

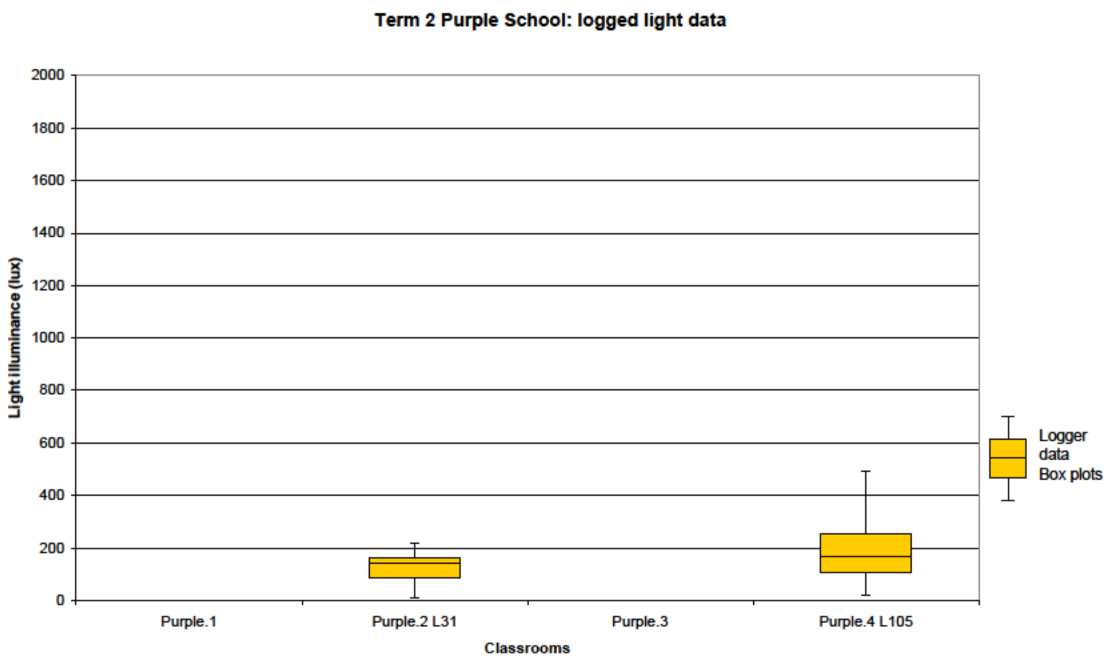


Appendix Figure 69: Light illuminance box plots and spot measurements: Red School Term 4 (DS-C-OL-A)

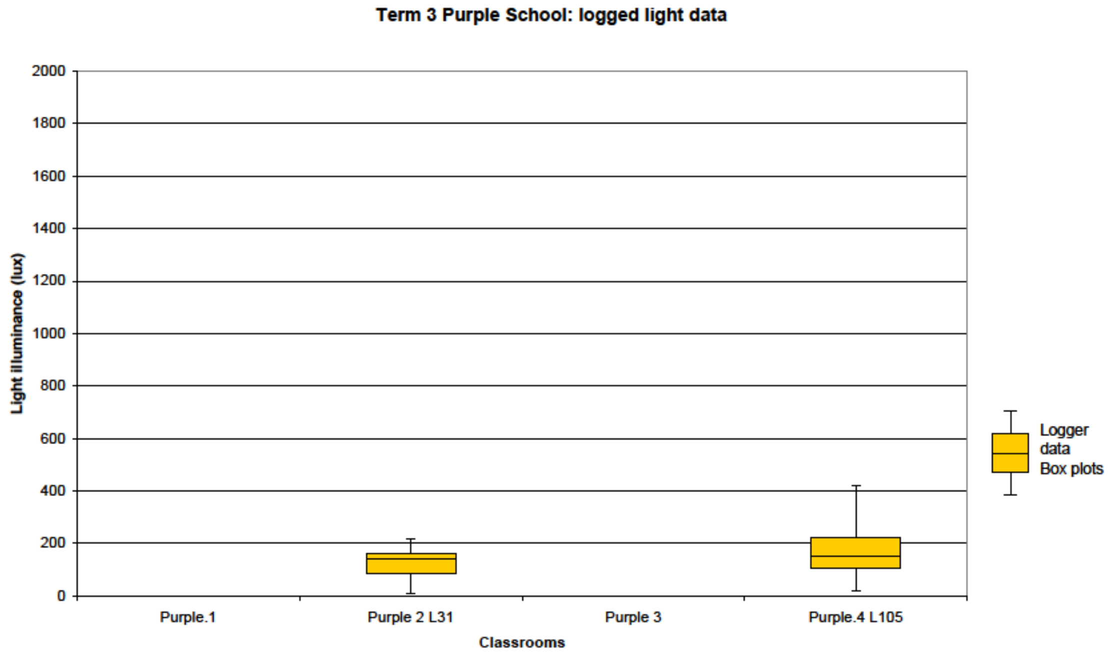
H.10.5 Purple School



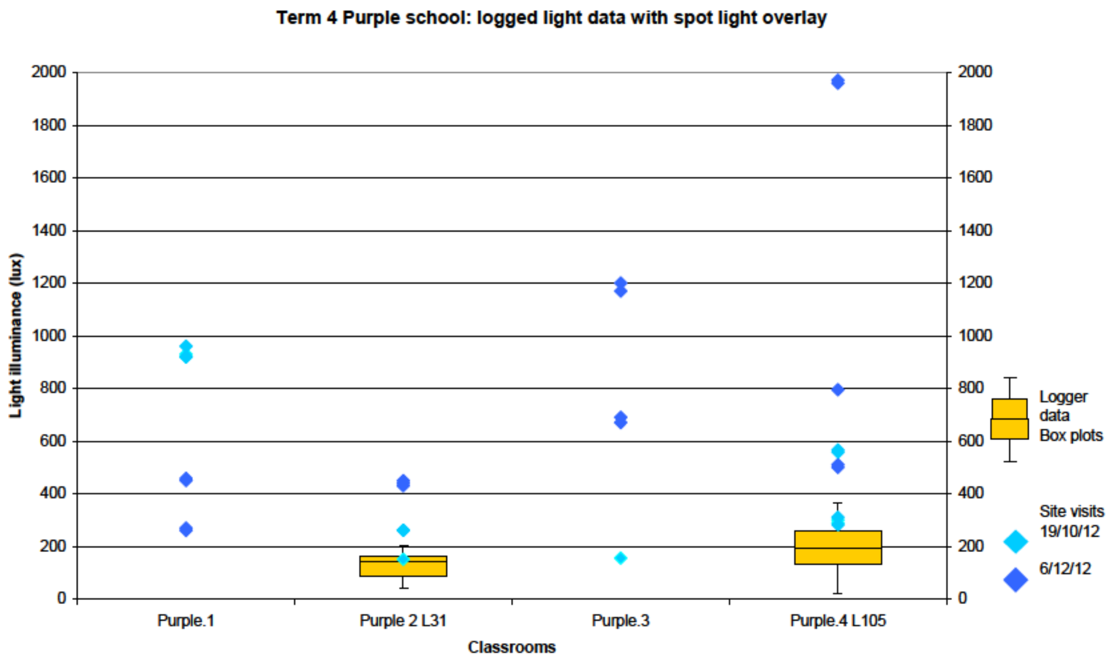
Appendix Figure 70: Light illuminance box plots and spot measurements: Purple School Term 1 (DS-C-OL-A)



Appendix Figure 71: Light illuminance box plots and spot measurements: Purple School Term 2 (DS-C-OL-A)



Appendix Figure 72: Light illuminance box plots and spot measurements: Purple School Term 3 (DS-C-OL-A)



Appendix Figure 73: Light illuminance box plots and spot measurements: Purple School Term 4 (DS-C-OL-A)

Appendix I Survey test instruments

I.1 Printed surveys

I.1.1 Student survey

School Building Evaluation students V1.10

THE UNIVERSITY *of* ADELAIDE

This questionnaire is part of a PhD research project in architecture by Linda Pearce, now in progress at the University of Adelaide. As an architect, Linda would like to hear more about your experience of school buildings.

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This is NOT compulsory. Please answer as many questions as you feel comfortable with. Also, **this is NOT a test**. There is no right or wrong. The research assumes that occupants are experts in their buildings. Linda is interested in ALL of your answers, whatever they are.

Please **circle** only one scale diamond *Often* ◆ ◆ ◆ ◆ ◆ *Rarely*
and **tick** the multiple choice boxes ☑ Yes ☐ No

All of your responses will be kept confidential (secret), but your school will be given a summary. Linda will also analyse them as a group and write about them. If you have any queries please send them to linda.pearce@adelaide.edu.au. Thanks! ☺

School Background

Please describe how your school is unique or special

In the list below, please tick the three learning activities you do most during class.
☐ Sit at your desk and work alone
☐ Sit on the floor and work alone
☐ Work alone somewhere else
☐ Work in a group at your desk
☐ Work in a group on the floor
☐ Work in a group somewhere else
☐ Work on a computer at your desk
☐ Work on a computer somewhere else

Please list any sustainability design features, activities, items, or other aspects present at your school?

How do you **expect** your school to be sustainable?

Do you consider your **school** to be 'sustainable'?
Not at all ◆ ◆ ◆ ◆ ◆ extremely

School buildings and grounds please circle ◆ or tick ☑

How much do the following describe your **school buildings**?

			Don't Know
A landmark	◆ ◆ ◆ ◆ ◆	Just some ordinary buildings	◆
Dirty	◆ ◆ ◆ ◆ ◆	Clean	◆
Interesting	◆ ◆ ◆ ◆ ◆	Boring	◆
Well maintained	◆ ◆ ◆ ◆ ◆	Needs some work	◆
Feels safe and secure	◆ ◆ ◆ ◆ ◆	Does not feel safe and secure	◆
Good for my learning	◆ ◆ ◆ ◆ ◆	Bad for my learning	◆
Healthy	◆ ◆ ◆ ◆ ◆	Unhealthy	◆
Nothing to be proud of	◆ ◆ ◆ ◆ ◆	Something to be proud of	◆
Make saving energy easy	◆ ◆ ◆ ◆ ◆	Make saving energy difficult	◆
Make saving water easy	◆ ◆ ◆ ◆ ◆	Make saving water difficult	◆

What do you **like** most about the exterior of your school? This includes the buildings, play areas, areas with plants or trees, or anything outside you can see or use.

How important is it that a school looks visually attractive?
Not at all ◆ ◆ ◆ ◆ ◆ extremely

What does your school (buildings and grounds) **look** like? (tick all that are relevant)
☐ a typical school
☐ a factory
☐ a group of houses
☐ some office buildings
☐ looks different to other schools - please explain how...

Comfort & Control

please circle ◆ or tick ☑

Classroom Noise & Sound

I find that the noise level during class is generally	Quiet	◆	◆	◆	◆	◆	Loud
It is easy for me to understand what is being said	Rarely	◆	◆	◆	◆	◆	Nearly always
The noise level through the walls / windows from adjacent classes is	Quiet	◆	◆	◆	◆	◆	Loud
The noise level through the walls / windows from outside is generally	Quiet	◆	◆	◆	◆	◆	Loud
I have to raise my voice to be understood by my teacher or classmates	Rarely	◆	◆	◆	◆	◆	Nearly always
I would prefer the overall class noise levels to be	Quieter	◆	◆	◆	◆	◆	Louder

Optional question
Any other comments about noise or sound quality in your classroom or the school?

Classroom temperature and air

Generally, in **summer** in my classroom...

the temperature is	Cold	◆	◆	◆	◆	◆	Hot
I would prefer the temperature to be	Cooler	◆	◆	◆	◆	◆	Warmer
the air is	Fresh	◆	◆	◆	◆	◆	Stuffy / stale
the air smells	Clean	◆	◆	◆	◆	◆	Dirty/dusty

Generally, in **winter** in my classroom...

the temperature is	Cold	◆	◆	◆	◆	◆	Hot
I would prefer the temperature to be	Cooler	◆	◆	◆	◆	◆	Warmer
the air is	Fresh	◆	◆	◆	◆	◆	Stuffy / stale
the air smells	Clean	◆	◆	◆	◆	◆	Dirty/dusty

Optional question
Any other comments about the temperature or the air quality in your classroom or the school?

Temperature & Ventilation Control

Do you see your teachers **using** any of the following:

- ☐ The heating
- ☐ The cooling
- ☐ Air vents in the walls or roof
- ☐ A ceiling fan
- ☐ Windows that open and close
- ☐ Don't know
- ☐ Other____________________

Lighting

In my classroom...

the lighting makes it easy for me to learn
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

the natural (sun) light suits me
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

there is glare (light is too bright or reflects off shiny surfaces)
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

the electrical (artificial) light suits me
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

Optional question
Any other comments about lighting and your learning?

Learning & teaching
please circle ◆ or tick ☑

How important is a well designed classroom for your learning?
Important ◆ ◆ ◆ ◆ ◆ not important

Is your current classroom
Too small ◆ ◆ ◆ ◆ ◆ Too big

Can you move the furniture to meet your needs
Not at all ◆ ◆ ◆ ◆ ◆ easily

How would you describe the views out of your classroom?
Attractive ◆ ◆ ◆ ◆ ◆ Ugly
Distracting ◆ ◆ ◆ ◆ ◆ Calming

What parts of your **classroom** help you most with your learning?

What do you most **like** most about the **interior** (inside) of your classroom?

Do you ever discuss any the following aspects of your school buildings and grounds in lessons?
(please tick all that you talk about)

☐ the walls & roof ☐ gardens
☐ history of school ☐ building design
☐ rainwater tanks ☐ solar (photovoltaic) panels
☐ air conditioning ☐ building materials
☐ windows ☐ other, please say.
____

Optional question - only if you have time
How important are computers in your current learning
Not important ◆ ◆ ◆ ◆ ◆ Important

How important do you think computers at school will be by the time you are in year 12?
Less important ◆ ◆ ◆ ◆ ◆ More important

How do you change your classroom to help with learning?

Design

If you could re-design the **outside** of your school what would you change or improve?

If you could re-design the **inside** of your classroom what would you change or improve?

Optional question - only if you have time
Have you ever been involved in the design process of a new school building or a renovation?
☐ Yes ☐ No → If **NO**, would you want to be involved?
☐ Yes ☐ No
If **YES**, was it the school you are at now?
☐ Yes ☐ No
If **YES**, what did you learn about buildings, design or your school?

Please use this space to make any comments about your school toilets.

Please list your top three ideas that should be included in the design of future school buildings and classrooms:

1.____________________

2.____________________

3.____________________

About you
How many years have you been at your current school
☐ 1-2 years ☐ 3-5 years ☐ 5-7 years

What year are you in?
☐ Year 5 ☐ Year 6 ☐ Year 7

How old are you?
☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13

Generally, do you like school
Most of the time ◆ ◆ ◆ ◆ ◆ not much
☐ don't wish to say

Are you ☐ Female ☐ Male

Please use this space to write about ANYTHING about school design and school sustainability that you think might be useful for Linda's research about school architecture.

If you run out of room, please use the back of the page

Thank you again for your time and effort! The school will receive a summary of the results of this survey ☺

I.1.2 Staff survey

School Building Evaluation Adults V1.13

THE UNIVERSITY of ADELAIDE

This questionnaire is part of a PhD research project in architecture by Linda Pearce, now in progress at the University of Adelaide. The research assumes that occupants are experts in their buildings and work, so, as an architect, Linda would like to hear more about your experience of school buildings.

The research has been designed to conform with *Australian Code for the Responsible Conduct of Research*. All responses will be kept confidential. Each participating school will be given summaries. Linda will also analyse the responses and use the results in her research. If you have any queries please send them to *linda.pearce@adelaide.edu.au*.

Please answer as many questions as you feel comfortable with. **If you need to prioritise your time start with the blue areas then move onto grey.**
Please **circle** only one scale, e.g., *Often* ◆ ◆ ◆ ◆ ◆ *Rarely*
and **tick** multiple choice boxes e.g., ☑ Yes ☐ No
If you run out of space, and would like to contribute more, please feel free to use the back of the pages Thank you! ☺

School Background

Please describe how your school is unique or special.

Please describe briefly the pedagogy (teaching and learning) you, or your school, use.

Please list any sustainability design features, activities, items, initiatives, or other aspects present at your school?

How do you **expect** your school to be sustainable?

Do you consider your **school** to be 'sustainable'?

Not at all	◆	◆	◆	◆	◆	extremely

School buildings and grounds

please circle ◆ or tick ☑

To what extent do the following describe your **school buildings**?

							Don't Know / N/A
A landmark	◆	◆	◆	◆	◆	Just some ordinary buildings	◆
Dirty	◆	◆	◆	◆	◆	Clean	◆
Interesting	◆	◆	◆	◆	◆	Boring	◆
Well maintained	◆	◆	◆	◆	◆	Needs some work	◆
Building problems are fixed quickly	◆	◆	◆	◆	◆	Building problems take some time to fix	◆
Feels secure for all users	◆	◆	◆	◆	◆	Does not feel secure for all users	◆
Enhances my teaching effectiveness	◆	◆	◆	◆	◆	Reduces my teaching effectiveness	◆
Does not match the pedagogy	◆	◆	◆	◆	◆	Matches the pedagogy	◆
Healthy	◆	◆	◆	◆	◆	Unhealthy	◆
Is good architecture	◆	◆	◆	◆	◆	Isn't good architecture	◆
Nothing to be proud of	◆	◆	◆	◆	◆	Something to be proud of	◆
Good for learning	◆	◆	◆	◆	◆	Bad for learning	◆
Make saving energy easy	◆	◆	◆	◆	◆	Make saving energy difficult	◆
Make saving water easy	◆	◆	◆	◆	◆	Make saving water difficult	◆

What do you **like** most about the exterior of the school?

What does your school (buildings and grounds) **look** like?
☐ a typical school ☐ a factory
☐ a group of houses ☐ some office buildings
☐ looks different to other schools - please explain how…

How do school buildings and grounds contribute most to teaching and learning?

How important is it that a school looks visually attractive?

Not at all	◆	◆	◆	◆	◆	extremely

Comfort & Control

please circle ◆ or tick ☑

Noise & Sound

*For **all staff***

I find that the noise level in my main work area is generally	Quiet	◆	◆	◆	◆	◆	Loud
It is easy for me to understand what is being said by others	Rarely	◆	◆	◆	◆	◆	Nearly always
The noise level through the wall / window from adjacent rooms is	Quiet	◆	◆	◆	◆	◆	Loud
The noise level through the wall / window from outside is	Quiet	◆	◆	◆	◆	◆	Loud

*For **teaching staff only***

During class, all students can understand what is being said	Rarely	◆	◆	◆	◆	◆	Nearly always
During class, I have to raise my voice to be understood	Rarely	◆	◆	◆	◆	◆	Nearly always
I would prefer the overall class noise levels to be	Quieter	◆	◆	◆	◆	◆	Louder

*For **all**:* Any other comments about noise or sound quality in your workplace?

Temperature & air

Generally, in **summer** in my main work area...

the temperature is	Cold	◆	◆	◆	◆	◆	Hot
I would prefer the temperature to be	Cooler	◆	◆	◆	◆	◆	Warmer
the air is	Fresh	◆	◆	◆	◆	◆	Stuffy / stale
the air smells	Clean	◆	◆	◆	◆	◆	Dirty / dusty
*For **teaching staff only**:* for students I believe that the temperature is	Too cold	◆	◆	◆	◆	◆	Too hot

Generally, in **winter** in my main work area...

the temperature is	Cold	◆	◆	◆	◆	◆	Hot
I would prefer the temperature to be	Cooler	◆	◆	◆	◆	◆	Warmer
the air is	Fresh	◆	◆	◆	◆	◆	Stuffy / stale
the air smells	Clean	◆	◆	◆	◆	◆	Dirty / dusty
*For **teaching staff only**:* for students I believe that the temperature is	Too cold	◆	◆	◆	◆	◆	Too hot

*For **all**:* Any other comments about the temperature or the air quality in your workplace?

Temperature & Ventilation Control

Tick all that you have in your main work space

- ☐ Heating
- ☐ Cooling
- ☐ Ceiling fan(s)
- ☐ Windows that open
- ☐ Air vents in the walls or roof
- ☐ Don't know
- ☐ Other_______________

Control of **ventilation** is

- ☐ Fully automatic
- ☐ Mixed auto & manual
- ☐ I have full control
- ☐ Don't know
- ☐ other_______________

Control of **heating** is

- ☐ Fully automatic
- ☐ Mixed auto & manual
- ☐ I have full control
- ☐ Don't know
- ☐ other_______________

Control of **cooling** is

- ☐ Fully automatic
- ☐ Mixed auto & manual
- ☐ I have full control
- ☐ Don't know
- ☐ other_______________

Any further comments about temperature & ventilation control?

Lighting

Tick all that you have in your main work space

- ☐ Internal blinds
- ☐ External blinds
- ☐ Skylight without controls
- ☐ Skylight with controls
- ☐ Other natural light controls_______________

In my main work area....

the lighting suits my activities
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

the natural (sun) light is appropriate
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

there is glare
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

the electrical (artificial) lighting is appropriate
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

I have good control over the lighting
Rarely ◆ ◆ ◆ ◆ ◆ Nearly always

Any other comments about lighting & school activities?

Learning & teaching

FOR TEACHING STAFF AND TEACHING LEADERS ONLY please circle ◆ or tick ☑

What aspects of your **classroom** contribute most to learning and teaching?

What do you **like** most about the interior of your classroom?

How important is a well designed classroom for teaching and learning

Important ◆ ◆ ◆ ◆ ◆ not important

Is your current classroom

Too small ◆ ◆ ◆ ◆ ◆ Too big

How would you describe the views out of your classroom?

Attractive ◆ ◆ ◆ ◆ ◆ Ugly

Distracting ◆ ◆ ◆ ◆ ◆ Calming

Can you move the furniture to meet your needs

Not at all ◆ ◆ ◆ ◆ ◆ easily

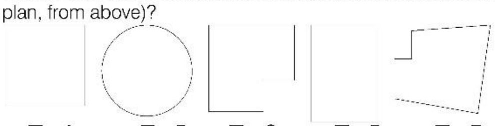
How do you or the students modify your classroom to enhance teaching and learning?

Do you ever discuss any the following aspects of your school buildings and grounds in lessons?
(please tick all that you talk about)

- ☐ the walls & roof
- ☐ History of school
- ☐ rainwater tanks
- ☐ air conditioning
- ☐ windows
- ☐ gardens
- ☐ building design
- ☐ solar (photovoltaic) panels
- ☐ building materials
- ☐ other, please say. ____________________

Please use this space to make any comments about staff & student toilets.

What is your preferred classroom shape to teach in (viewed in plan, from above)?



☐ A ☐ B ☐ C ☐ D ☐ E

Why?

Of the above shapes, which best describes your current classroom shape?

☐ A ☐ B ☐ C ☐ D ☐ E

Do you use the following for **display** of teaching and learning materials (please tick all in use)

- ☐ Pinboards
- ☐ Walls
- ☐ Ceiling/overhead
- ☐ Doors
- ☐ Windows
- ☐ Not applicable
- ☐ Other ____________

If you use the windows please say why you find windows to be good places for display.

Do you have the following in your teaching space

- ☐ An operable wall (panel wall that can be moved)
- ☐ A large solid sliding door
- ☐ A large sliding door with glass
- ☐ Other________________________________

If yes, how often do you move the wall/doors

- ☐ Always open
- ☐ Daily
- ☐ Weekly
- ☐ Occassionally
- ☐ Always closed

How important is information and communication technology (ICT) in current teaching & learning

Not important ◆ ◆ ◆ ◆ ◆ Important

How important do you believe ICT will be to teaching & learning in 5 years time?

Less important ◆ ◆ ◆ ◆ ◆ More important

Any further comments about the relationship between the classroom and teaching and learning?

Design

If you could redesign your school **exterior** what would you change or improve?

If you could redesign your school / classroom **interior** what would you change or improve?

Please list your top three ideas that should be included in the design of future school buildings and classrooms:

1.____________________________________

2.____________________________________

3.____________________________________

How is your school important or useful to the **community** in ways other than as a place of learning?

About you

How many years have you been at your current school
☐ <1 ☐ 1-2 ☐ 3-5 ☐ 5-10 ☐ >10 years

How many years have you been working in your current room
☐ <1 ☐ 1-2 ☐ 3-5 ☐ 5-10 ☐ >10 years

Are you ☐ full time ☐ part time ☐ casual

Generally, do you find your job
Satisfactory ◆ ◆ ◆ ◆ ◆ less satisfactory
☐ don't wish to say

Are you ☐ Female ☐ Male
☐ Don't wish to say

Which best describes you?
☐ Administration ☐ Facilities
☐ Management ☐ Teaching staff

How long have you been working in the education sector?
☐ Less than 5 years ☐ 5-20 years ☐ over 20 years

For staff who are involved in teaching:
please indicate which years you mainly work with
☐ ELC ☐ R-2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

Have you ever been involved in the design process of a new school building or a renovation?
☐ Yes ☐ No → If **NO** would you want to be involved?
☐ Yes ☐ No

If **YES**, was it the school you are at now?
☐ Yes ☐ No
If **YES** please describe any benefits to teaching and learning, challenges or outcomes you experienced.

Were **students** involved in the design process?
☐ Yes ☐ No
If **yes**, please describe any learning opportunities for the students (both involved and not involved) you observed.

How did any learning benefits last beyond the student cohort involved, if at all?

Please use this space to write about ANY other aspects of school design and school sustainability that you think might be useful for this research about school architecture.

Thank you again for your time and effort! The school will receive a summary of the results of this survey ☺

I.2 Survey code tables

I.2.1 Student survey question code table

No	Type	Category	Full text / summary text	Full text MC	Question codes	Reversed scale
		School			X0School	
		Classroom			X1Classroom	
1	MC	Background	In the list below, please tick the three learning activities you do most during class.	Sit at your desk and work alone	Q01SitDeskWorkAlone	
2	MC	Background		Sit on the floor and work alone	Q02SitFloorWorkAlone	
3	MC	Background		Work alone somewhere else	Q03WorkAlone SomewhereElse	
4	MC	Background		Work in a group at your desk	Q04WorkGroupYrDesk	
5	MC	Background		Work in a group on the floor	Q05WorkGroupFloor	
6	MC	Background		Work in a group somewhere else	Q06WorkGroup SomewhereElse	
7	MC	Background		Work on a computer at your desk	Q07WorkComputerYrDesk	
8	MC	Background		Work on a computer somewhere else	Q08WorkComputer SomewhereElse	
9	Qual	Background	Please describe how your school is unique or special	Open-Ended Response	Q09HowSpecialSCL	
10	Scale	Background	Do you consider your school to be 'sustainable'? Not at all vs Extremely / School is sustainable		Q10YoursSCLsustainable NoVsYes	
11	Qual	Background	How do you expect your school be sustainable?	Open-Ended Response	Q11ExpectSCLsustainable	
12	Qual	Background	Please list any sustainability design features, activities, items, or other aspects present at your school?	Open-Ended Response	Q12SustFeatatSCL	
13	Scale	Buildings	To what extent do the following describe your school buildings? A landmark vs just some ordinary buildings / School buildings are a landmark		fQ13OrdinaryVsLandmark	Reversed scale
14	Scale	Buildings	Dirty vs Clean / Buildings are clean		Q14DirtyVsClean	
15	Scale	Buildings	Interesting vs Boring / School buildings are interesting		fQ15BoringVsInteresting	
16	Scale	Buildings	Well maintained vs Needs some work / Buildings well maintained		fQ16Needswork VsWellmaintained	Reversed scale
17	Scale	Buildings	Feels safe and secure vs Does not feel safe and secure. / Buildings are safe		fQ17NotSafeVsSafe	Reversed scale
18	Scale	Buildings	Good for my learning vs Bad for my learning. / Buildings good for learning		fQ18Badforlearning VsGoodforlearning	Reversed scale
19	Scale	Buildings	Healthy vs Unhealthy. School buildings are healthy		fQ19UnhealthyVsHealthy	Reversed scale
20	Scale	Buildings	Nothing to be proud of vs Something to be proud of. / Proud of school buildings		Q20NotProudofVsProudof.	Reversed scale
21	Scale	Buildings	Make saving energy easy vs Make saving energy difficult. / Easy to save energy		fQ21EnergySaving DifficultVsEasy	Reversed scale
22	Scale	Buildings	Make saving water easy vs Make saving water difficult. / Easy to save water		fQ22WaterSaving DifficultVsEasy	Reversed scale
23	MC	Buildings	What does your school (buildings and grounds) look like (select all that apply)?	a typical school	Q23LooksLike TypicalSchool	
24	MC	Buildings		a factory	Q24LooksLike Factory	
25	MC	Buildings		a group of houses	Q25LooksLike GroupHouses	

No	Type	Category	Full text / summary text	Full text MC	Question codes	Reversed scale
26	MC	Buildings		some office buildings	Q26LooksLike Office Buildings	
27	MC/ Qual	Buildings		looks different to other schools - please describe	Q27LooksLike DifferentOtherSchools	
28	Scale	Buildings	How important is it that a school looks visually attractive? Not at all vs Extremely / Important school looks attractive		Q28ImportantSCL AttractiveNotVsExtremely	
29	Qual	Buildings	What do you like most about the exterior (outside) of the school? This includes buildings, play areas, areas with plants or trees, or anything outside you can see or use.	Open-Ended Response	Q29LikeOutside	
30	Scale	Comfort	I find that the noise level during class is generally: Quiet vs Loud / Noise is loud		Q30NoiseQuietVsLoud	
31	Scale	Comfort	It is easy for me to understand what is being said: Rarely vs Nearly always / Easy to understand speech		Q31UndersandVoice RarelyVsNearlyAlways	
32	Scale	Comfort	The noise level through the walls / windows from adjacent classes is: Quite vs Loud / Loud noise from adjacent room		Q32NoiseBetweenRooms QuietVsLoud	
33	Scale	Comfort	The noise level through the walls / windows from outside is : Quite vs Loud		Q33NoiseFromOutside QuietVsLoud	
34	Scale	Comfort	I have to raise my voice to be understood by my teacher or classmates: Rarely vs Nearly always/ Student needs to raise voice		Q34RaiseVoice RarelyVsNearlyalways	
35	Scale	Comfort	I would prefer the overall class noise levels to be: Quieter vs Louder / Prefer overall noise louder		Q35PreferNoise QuieterVsLouder	
36	Qual	Comfort	Any other comments about noise or sound quality in your classroom or the school?	Open-Ended Response	Q36NoiseandSound	
37	Scale	Comfort	Generally in SUMMER in my classroom... The temperature is: Cold vs Hot		Q37SumTempColdVsHot	
38	Scale	Comfort	I would prefer the temperature to be: Cooler vs Warmer		Q38SumTempPrefer CoolerVsWarmer	
39	Scale	Comfort	The air is: Fresh vs Stuffy / Stale / Summer air stale		Q39SumAirFreshVsStale	
40	Scale	Comfort	The air smells: Clean vs Dirty / Dusty		Q40SumAirSmells CleanVsDirty	
41	Scale	Comfort	Now, in WINTER, generally in my classroom... The temperature is Cold vs Hot / Winter temp is hot		Q41WintTempColdVsHot	
42	Scale	Comfort	I would prefer the temperature to be: Cooler vs Warmer / Prefer Winter temp warmer		Q42WintTempPrefer CoolerVsWarmer	
43	Scale	Comfort	The air is: Fresh vs Stuffy / Stale		Q43WintAirFreshVsStale	
44	Scale	Comfort	The air smells: Clean vs Dirty / Dusty / Winter air smells dirty		Q44WintAirSmells CleanVsDirty	
45	Qual	Comfort	Any other comments about the temperature or the air quality in your classroom or the school?	Open-Ended Response	Q45ThermalComfort	
46	MC	Comfort	Do you see your teachers using any of the following:	The heating	Q46SeeUsedHeating	
47	MC	Comfort		The cooling	Q47SeeUsedCooling	
48	MC	Comfort		Air vents in the walls or roof	Q48SeeUsed AirVentsWallsRoof	
49	MC	Comfort		A ceiling fan	Q49SeeUsedCeilingFan	
50	MC	Comfort		Windows that open and close	Q50SeeUsed WindowsOpenClose	

No	Type	Category	Full text / summary text	Full text MC	Question codes	Reversed scale
51	MC	Comfort		Don't know	Q51SeeUsedDontKnow	
52	Qual	Comfort		Other (please specify)	Q52SeeUsedOther	
53	Scale	Comfort	Generally, in my classroom / Lighting helps learning	The lighting in the classroom makes it easy for me to learn	Q53LightingHelps LearningRarelyVsNearlyAlways	
54	Scale	Comfort	/ Daylight suitable	The natural (sun) light suits me	Q54NatLightSuitsMe RarelyVsNearlyAlways	
55	Scale	Comfort	/ Glare occurs	There is glare (light is too bright or reflects off shiny surfaces)	Q55GlareRarelyVsAlways	
56	Scale	Comfort	/ artificial light suitable	The electrical (artificial) lighting suits me	Q56ArtLightOK RarelyVsAlways	
57	Qual	Comfort	Any other comments about lighting and your learning?	Open-Ended Response	Q57Lighting	
58	Scale	Classroom	How important is a well designed classroom for your learning? Important vs not important / Well-designed classroom important		fQ58WellDesignedCR NotVsImportant	
59	Qual	Classroom	What parts of the classroom help you most with your learning?	Open-Ended Response	Q59PartsCRHelpLearn	
60	Qual	Classroom	What do you most like about the interior (inside) of the classroom?	Open-Ended Response	Q60LikeInside	
61	Qual	Classroom	How do you change your classroom to help with learning?	Open-Ended Response	Q61changeCR	
62	Scale	Classroom	Is your current classroom: Too small vs Too big / Classroom too big		Q62CRToosmallVsToobig	
63	Scale	Classroom	Can you move the furniture to meet your needs: Not at all vs easily / Furniture moves easily		Q63FurnMovesNoVsEasily	
64	Scale	Classroom	How would you describe the views out of your classroom? Attractive vs Ugly / Views are attractive		fQ64ViewsUglyVsAttractive	Reversed scale
65	Scale	Classroom	Views: Distracting vs Calming. / Views are calming		Q65ViewsDistractVsCalm	
66	Scale	Classroom	How important are computers in your current learning? Not important vs Important / ICT important now		Q66COMP NotImportantVsImportant	
67	Scale	Classroom	How important do you think computers at school will be by the time you are in year 12? Less important vs More important / ICT important in the future		Q67FutureCOMP LessVSMoreImportant	
68	MC	Classroom	Do you ever discuss any of the following aspects of your school buildings and grounds in lessons? (please tick all that you talk about)	the walls & roof	Q68TalkAboutWallsRoof	
69	MC	Classroom		history of school	Q69TalkAboutHistorySchool	
70	MC	Classroom		rainwater tanks	Q70TalkAbout RainwaterTanks	
71	MC	Classroom		air conditioning	Q71TalkAboutAC	
72	MC	Classroom		windows	Q72TalkAboutWindows	
73	MC	Classroom		gardens	Q73TalkAboutGardens	
74	MC	Classroom		building design	Q74TalkAboutBuildingDesign	
75	MC	Classroom		solar (photovoltaic) panels	Q75TalkAbout SolarPVPanels	
76	MC	Classroom		building materials	Q76TalkAboutBuildingMaterials	
77	MC	Classroom		Other (please say)	Q77DiscussedinClass	
77a	Qual	Toilets	Please use this space to make any comments about your school toilets.	Open-Ended Response	Q77TalkAboutOther	
78	Yes/ No	Design Participation	Have you ever been involved in the design process of a new school building or a renovation?	Response	Q78Toilets	

No	Type	Category	Full text / summary text	Full text MC	Question codes	Reversed scale
79	Yes/ No	Design Participation	If no, would you want to be involved?	Response	Q79SchoolDesign Involvedin	
80	Yes/ No	Design Participation	If YES, was it the school you are at now?	Response	Q80SchoolDesign IfNoLiketo	
81	Qual	Design Participation	If YES, what did you learn about buildings, design or your school.	Open-Ended Response	Q81SchoolDesign IfYesatcurrent	
82		Not used				
83	Qual	Design Participation	If you could redesign your the outside of your school what would you change or improve?	Open-Ended Response	Q83RedesignOutside	
84	Qual	Design Participation	If you could redesign the inside of your classroom what would you change or improve?	Open-Ended Response	Q84RedsignInside	
85	Qual	Design Participation	Please list your top three ideas that should be included in the design of future school buildings and classrooms:	1	Q85to87FutureSchools	
86	Qual	Design Participation		2	Q85to87FutureSchools	
87	Qual	Design Participation		3	Q85to87FutureSchools	
88	Qual	Final Comments	Please use this space to write ANYTHING about schoo design and school sustainability that you think might be useful for Linda's research about school architecture	Open-Ended Response	Q88OtherComments	
89	Scale	About	How many years have you been at your current school	Response	Q89YearsAtSchool	
90	Scale	About	What year are you in?	Response	Q90Year	
91	Scale	About	How old are you?	Response	Q91Age	
92	Scale	About	Generally, do like school: Most of the time vs Not much / Student satisfaction with school		fQ92LikeSCL NotmuchVsMostly	Reversed scale
93	Scale	About	Are you	Response	Q93Gender	

I.2.2 Staff Survey question code table

No	Type	Category	Full text / summary text	Full text MC	Question Codes	Reversed scale
					X0School	
				case study room	X1Classroom	
1	Qual	Background	Please describe briefly the pedagogy (teaching and learning) you, or your school, use.	Open-Ended Response	Q01DescribePedagogy	
2-8		Not used				
9	Qual	Background	Please describe how your school is unique or special.	Open-Ended Response	Q09HowSpecialSCL	
10	Scale	Background	Do you consider your school to be 'sustainable'? / School is sustainable		Q10YoursSCL sustainableNoVsYes	
11	Qual	Background	How do you expect your school be sustainable?	Open-Ended Response	Q11ExpectSCLsustainable	
12	Qual	Background	Please list any sustainability design features, activities, items, initiatives, or other aspects present at your school?	Open-Ended Response	Q12SustFeatatSCL	
13	Scale	Buildings	To what extent do the following describe your school buildings? Landmark vs just some ordinary buildings / School buildings are a landmark		fQ13OrdinaryVsLandmark	Reversed scale
13a	Scale	Buildings	Is good architecture vs Isn't good architecture / Buildings are good architecture		fQ13BadArchVsGoodArch	Reversed scale
14	Scale	Buildings	Dirty vs Clean / Buildings are clean		Q14DirtyVsClean	
15	Scale	Buildings	Interesting vs Boring / School buildings are interesting		fQ15BoringVsInteresting	Reversed scale

No	Type	Cateogry	Full text / summary text	Full text MC	Question Codes	Reversed scale
16	Scale	Buildings	Well maintained vs Needs some work. / Buildings well maintained		fQ16Needswork VsWellmaintained	Reversed scale
16a	Scale	Buildings	Building problems are fixed quickly vs take some time to fix / Building problems fixed		fQ16aBuildProblems FixedSlowlyvsQuickly	Reversed scale
17	Scale	Buildings	Feels secure for all users vs does not feel secure for all users / Buildings are safe		fQ17NotSafeVsSafe	Reversed scale
18	Scale	Buildings	Good for learning vs Bad for learning / Buildings good for learning		fQ18Badforlearning VsGoodforlearning	Reversed scale
18a	Scale	Buildings	Enhances my teaching effectiveness vs Reduces my teaching effectiveness / Buildings good for teaching		fQ18aBadforTeaching VsGoodforTeaching	Reversed scale
18b	Scale	Buildings	Does not match the pedagogy vs Matches the pedagogy / Buildings match pedagogy		Q18bPedagogy NotmatchedVsMatched	Reversed scale
19	Scale	Buildings	Healthy vs Unhealthy / School buildings are healthy		fQ19UnhealthyVsHealthy	Reversed scale
20	Scale	Buildings	Nothing to be proud of vs Something to be proud of / Proud of school buildings		Q20NotProudofVsProudof.	
21	Scale	Buildings	Make saving energy easy vs Make saving energy difficult		fQ21EnergySaving DifficultVsEasy	Reversed scale
22	Scale	Buildings	Make saving water easy vs Make saving water difficult / Easy to save water (Q22)		fQ22WaterSaving DifficultVsEasy	Reversed scale
23	MC	Buildings	What does your school (buildings and grounds) look like (select all that apply)?	a typical school	Q23LooksLike TypicalSchool	
24	MC	Buildings		a factory	Q24LooksLikeFactory	
25	MC	Buildings		a group of houses	Q25LooksLike GroupHouses	
26	MC	Buildings		some office buildings	Q26LooksLike Office Buildings	
27	MC/ Qual	Buildings		looks different to other schools - please explain how...	Q27LooksLike DifferentOtherSchools	
28	Scale	Buildings	How important is it that a school looks visually attractive? / Important school looks attractive		Q28ImportantSCL AttractiveNotVsExtremely	
29	Qual	Buildings	What do you like most about the exterior of the school?	Open-Ended Response	Q29LikeOutside	
59a	Qual	Buildings	How do school buildings and grounds contribute most to teaching and learning?	Open-Ended Response	Q59aBuildingsGrounds HelpLearn	
30	Scale	Comfort	For all staff: I find that the noise level in my main work area is generally / Noise is loud		Q30NoiseQuietVsLoud	
31	Scale	Comfort	For all staff: It is easy for me to understand what is being said by others / Easy to understand speech		Q31UndersandVoice RarelyVsNearlyAlways	
31a	Scale	Comfort	For teaching staff only: During class, all students can understand what is being said / Students understand speech		Q31aStdUndersand VoiceRarelyVsNearlyAlways	
32	Scale	Comfort	For all staff: The noise level through the wall / window from adjacent rooms is / Loud noise from adjacent room		Q32NoiseBetween RoomsQuietVsLoud	
33	Scale	Comfort	For all staff: The noise level through the wall / window from outside is / Loud noise from outside		Q33NoiseFromOutside QuietVsLoud	
34	Scale	Comfort	For teaching staff only: I have to raise my voice to be understood / Teacher needs to raise voice		Q34RaiseVoice RarelyVsNearlyalways	

No	Type	Cateogry	Full text / summary text	Full text MC	Question Codes	Reversed scale
35	Scale	Comfort	For teaching staff only: I would prefer the overall class noise levels to be: Quieter or louder / Prefer overall noise louder		Q35PreferNoise QuieterVsLouder	
36	Qual	Comfort	For all: Any other comments about noise or sound quality in your workplace?	Open-Ended Response	Q36NoiseandSound	
37	Scale	Comfort	Generally, in SUMMER in my main work area... The temperature is / Summer temp is hot		Q37SumTempColdVsHot	
37a	Scale	Comfort	For teaching staff only: For students I believe that the temperature is / Too hot in summer for students		Q37aStudSumTemp TooColdVsTooHot	
38	Scale	Comfort	I would prefer the temperature to be Prefer summer temp warmer		Q38SumTempPrefer CoolerVsWarmer	
39	Scale	Comfort	The air is / Summer air is stale		Q39SumAirFreshVsStale	
40	Scale	Comfort	The air smells / Summer air smells dirty		Q40SumAirSmells CleanVsDirty	
41	Scale	Comfort	Now, in WINTER, generally in my main work area... The temperature is / Winter temp is hot		Q41WintTempColdVsHot	
41a	Scale	Comfort	For teaching staff only: for students I believe that the temperature is Too hot in winter for students		Q41aStuWintTemp TooColdVsTooHot	
42	Scale	Comfort	I would prefer the temperature to be / Prefer Winter temp warmer		Q42WintTemp PreferCoolerVsWarmer	
43	Scale	Comfort	The air is / Winter air is stale		Q43WintAirFreshVsStale	
44	Scale	Comfort	The air smells / Winter air smells dirty		Q44WintAirSmells CleanVsDirty	
45	Qual	Comfort	For all: Any other comments about the temperature or the air quality in your workplace?	Open-Ended Response	Q45ThermalComfort	
46	MC	Comfort	Tick all that you have in your main work space	Heating	Q46PresentHeating	
47	MC	Comfort		Cooling	Q47PresentCooling	
48	MC	Comfort		Air vents in the walls or roof	Q48Present AirVentsWallsRoof	
49	MC	Comfort		Ceiling fan(s)	Q49PresentCeilingFan	
50	MC	Comfort		Windows that open	Q50Present WindowsOpenClose	
51	MC	Comfort		Don't know	Q51PresentDontKnow	
52	Qual	Comfort		Other (please specify)	Q52PresentOther	
100	MC	Comfort	Control of heating is	Fully automatic	Q100HeatingControlAuto	
101	MC	Comfort		Mixed auto & manual	Q101HeatingControlMixed	
102	MC	Comfort		I have full control	Q102HeatingControlFull	
103	MC	Comfort		Don't know	Q103HeatingControl Dontknow	
104	MC / Qual	Comfort		Other (please specify)	Q104HeatingControlOther	
105	MC	Comfort	Control of cooling is	Fully automatic	Q105CoolingControlAuto	
106	MC	Comfort		Mixed auto & manual	Q106CoolingControlMixed	
107	MC	Comfort		I have full control	Q107CoolingControlFull	
108	MC	Comfort		Don't know	Q108CoolingControl DontKnow	
109	MC / Qual	Comfort		Other (please specify)	Q109CoolingControlOther	
110	MC	Comfort	Control of ventilation is	Fully automatic	Q110VentControlAuto	
111	MC	Comfort		Mixed auto & manual	Q111VentControlMixed	
112	MC	Comfort		I have full control	Q112VentControlFull	
113	MC	Comfort		Don't know	Q113VentControlDontKnow	
114	MC / Qual	Comfort		Other (please specify)	Q114VentControlOther	
115	Qual	Comfort	Any further comments about temperature & ventilation control?	Open-Ended Response	Q115ControlComments	

No	Type	Cateogry	Full text / summary text	Full text MC	Question Codes	Reversed scale
116	MC	Comfort	Tick all that you have in your main work space	Internal blinds	Q116DayLightControl IntBlinds	
117	MC	Comfort		Skylight without controls	Q117DayLightControl SkylightFixed	
118	MC	Comfort		External blinds	Q118DayLightControl ExtBlinds	
119	MC	Comfort		Skylight with controls	Q119DayLightControl SkylightOp	
120	MC	Comfort		Other (please specify)	Q120DayLightControlOther	
53	Scale	Comfort	In my main work area ... / Lighting suits activities	The lighting suits my activities	Q53LightingSuitsActivities RarelyVsNearlyAlways	
53a	Scale	Comfort	/ Good control of lighting	I have good control over the lighting	Q53aLightControl RarelyVsAlways	
54	Scale	Comfort	/ Daylight suitable	The natural (sun) light is appropriate	Q54NatLightSuitsMe RarelyVsNearlyAlways	
55	Scale	Comfort	/ Glare occurs	There is glare	Q55GlareRarelyVsAlways	
56	Scale	Comfort		The electrical (artificial) lighting is appropriate	Q56ArtLightOK RarelyVsAlways	
57	Qual	Comfort	Any other comments about lighting & school activities?	Open-Ended Response	Q57Lighting	
58	Scale	Classroom	How important is a well designed classroom for teaching and learning? Not important vs Important / Well-designed classroom important		fQ58WellDesignedCR NotVsImportant	Reversed scale
59	Qual	Classroom	What aspects of your classroom contribute most to learning and teaching?	Open-Ended Response	Q59PartsCRHelpLearn	
60	Qual	Classroom	What do you like most about the interior of your classroom?	Open-Ended Response	Q60LikeInside	
61	Qual	Classroom	How do you or the students modify your classroom to enhance teaching and learning?	Open-Ended Response	Q61changeCR	
62	Scale	Classroom	Is your current classroom / Classroom too big		Q62CRToosmallVsToobig	
63	Scale	Classroom	Can you move the furniture to meet your needs		Q63FurnMovesNoVsEasily	
64	Scale	Classroom	How would you describe the views out of your classroom? Attractive vs Ugly / Views are attractive		fQ64ViewsUglyVsAttractive	Reversed scale
65	Scale	Classroom	Views: Distracting vs Calming / Views are calming		Q65ViewsDistractVsCalm	
66	Scale	Classroom	How important is information and communication technology (ICT) in current teaching & learning / ICT important now (Q66)		Q66COMP NotImportantVsImportant	
67	Scale	Classroom	How important do you believe ICT will be to teaching & learning in 5 years time?		Q67FutureCOMP LessVSMoreImportant	
68	MC	Classroom	Do you ever discuss any of the following aspects of your school buildings and ground in lessons	the walls & roof	Q68TalkAboutWallsRoof	
69	MC	Classroom		history of school	Q69TalkAboutHistorySchool	
70	MC	Classroom		rainwater tanks	Q70TalkAbout RainwaterTanks	
71	MC	Classroom		air conditioning	Q71TalkAboutAC	
72	MC	Classroom		windows	Q72TalkAboutWindows	
73	MC	Classroom		gardens	Q73TalkAboutGardens	
74	MC	Classroom		building design	Q74TalkAboutBuildingDesig n	
75	MC	Classroom		solar (photovoltaic) panels	Q75TalkAboutSolarPVPanel s	
76	MC	Classroom		building materials	Q76TalkAbout BuildingMaterials	
77	MC / Qual	Classroom		Other (please say)	Q77DiscussedinClass	

No	Type	Cateogry	Full text / summary text	Full text MC	Question Codes	Reversed scale
77a	MC / Qual	Classroom			Q77aTalkAboutOther	
78	Qual	Toilets	Please use this space to make any comments about staff & student toilets.	Open-Ended Response	Q78Toilets	
121	MC	Classroom	Of the above, what is your preferred classroom shape to teach in?.	A	Q121PrefSquareCR	
122	MC	Classroom		B	Q122PrefCircularCR	
123	MC	Classroom		C	Q123PrefLshapedCR	
124	MC	Classroom		D	Q124PrefRectCR	
125	MC	Classroom		E	Q125PrefIrregularCR	
125a	Qual	Classroom		Why?	Q125aWhyCRPreference	
126	MC	Classroom	Of the above shapes, which best describes your current classroom shape?	A	Q126NowSquareCR	
127	MC	Classroom		B	Q127NowCircularCR	
128	MC	Classroom		C	Q128NowLshapedCR	
129	MC	Classroom		D	Q129NowRectCR	
130	MC	Classroom		E	Q130NowIrregularCR	
131	MC	Classroom	Do you use the following for display of teaching and learning materials (please select all in use)	Pinboards	Q131DisplayPB	
132	MC	Classroom		Doors	Q132DisplayDoors	
133	MC	Classroom		Walls	Q133DisplayWalls	
134	MC	Classroom		Windows	Q134DisplayWindows	
135	MC	Classroom		Ceiling / overhead	Q135DisplayOH	
136	MC	Classroom		Not applicable	Q136DisplayNA	
137	MC / Qual	Classroom		Other (please specify)	Q137DisplayOther	
138	Qual	Classroom	If you use the windows please say why you find windows to be good places for display.	Open-Ended Response	Q138DisplayWindowsWhy	
139	MC	Classroom	Do you have the following in your teaching space	An operable wall (panel wall that can be moved)	Q139FlexibleOpWall	
140	MC	Classroom		A large solid sliding door	Q140FlexibleIntSlider Solid	
141	MC	Classroom		A large sliding door with glass	Q141FlexibleIntSlider Glazed	
142	MC	Classroom		Other (please specify)	Q142FlexibleOther	
143	MC	Classroom	If yes, how often do you move the wall/doors	Always open	Q143FlexOpAlwaysOpen	
144	MC	Classroom		Daily	Q144FlexOpDaily	
145	MC	Classroom		Weekly	Q145FlexOpWeekly	
146	MC	Classroom		Occasionally	Q146FlexOpOccasionally	
147	MC	Classroom		Always closed	Q147FlexOpClosed	
149	Qual	Classroom	Any further comments about the relationship between the classroom and teaching and learning?	Open-Ended Response	Q149FurtherComments CRandTeach	
79	Yes/ No	Design Participation	Have you ever been involved in the design process of a new school building or a renovation?	Response	Q79SchoolDesign Involvedin	
79a	Qual	Design Participation	If YES please describe any benefits to teaching and learning, challenges or outcomes you experienced.	Open-Ended Response	Q79aSchoolDesign TeachingBenefits	
80	Yes/ No	Design Participation	If NO, would you want to be involved?	Response	Q80SchoolDesign IfNoLiketo	
81	Yes/ No	Design Participation	If YES, was it the school you are at now?	Response	Q81SchoolDesign IfYesatcurrent	
82	Qual	Design Participation	If yes, please describe any learning opportunities for the students (both involved and not involved) you observed.	Open-Ended Response	Q82DesignParticipation StudBenefits	
82a	Yes/ No	Design Participation	If YES, were students involved in the design process?	Response	Q82aStudentsInvolved	
82b	Qual	Design Participation	If yes, how did any learning benefits last beyond the student cohort involved, if at all?	Open-Ended Response	Q82bDesignParticipation BenefitsLasting	

No	Type	Cateogry	Full text / summary text	Full text MC	Question Codes	Reversed scale
83	Qual	Design Participation	If you could redesign your school exterior what would you change or improve?	Open-Ended Response	Q83RedesignOutside	
84	Qual	Design Participation	If you could redesign your schoo/classrooml interior what would you change or improve?	Open-Ended Response	Q84RedsignInside	
85	Qual	Design Participation	Please list your top three ideas that should be included in the design of future school buildings and classrooms:	1	Q85to87FutureSchools	
86	Qual	Design Participation		2	Q85to87FutureSchools	
87	Qual	Design Participation		3	Q85to87FutureSchools	
88	Qual	Final Comments	Please use this space to write about ANY other aspects of school design and school sustainability that you think might be useful for this research about school architecture.	Open-Ended Response	Q88OtherComments	
88a	Qual	Community	How is your school important or useful to the community in ways other than as a place of learning?	Open-Ended Response	Q88aCommunity	
89	Scale	About	How many years have you been at your current school	Response	Q89YearsAtSchool	
90a	Scale	About	How many years have you been working in your current room / Years in current room	Response	Q90YearsInCurrentRoom	
91	MC	About	Are you full time, part time, casual	Response	Q91EmploymentType	
92	Scale	About	Generally, do you find your job: Less satisfactory vs Satisfactory / Staff satisfaction with job		fQ92JOBisLessSatisfactory vsSatisfactory	Reversed scale
93	Scale	About	Are you	Response	Q93Gender	
94a	MC	About	Which best describes you?	Administration	Q94aJobAdmin	
94b	MC	About		Management	Q94bJobManagement	
94c	MC	About		Facilities	Q94cJobFacilities	
94d	MC	About		Teaching staff	Q94dJobTeaching	
95	Scale	About	How long have you been working in the education sector? / Job experience	Response	Q95JobExperience	
96a	MC	About	For staff who are involved in teaching: please indicate which years you mainly work with	ELC	Q96aTeacherELC	
96b	MC	About		R-2	Q96bTeacherR2	
96c	MC	About		3	Q96cTeacherYr3	
96d	MC	About		4	Q96dTeacherYr4	
96e	MC	About		5	Q96eTeacherYr5	
96f	MC	About		6	Q96fTeacherYr6	
96g	MC	About		7	Q96gTeacherYr7	

Appendix J Response rate and demographics

J.1 Student survey participant sample rates by school enrolment

School		**Years surveyed**						**totals**			
		Year 5		**Year 6**		**year 7**					
	Total en-rolled	*enrolled*	survey response	*enrolled*	survey response	*enrolled*	survey response	surveys with stated years	surveys with year not stated	Totals	% sample of 5,6,7
Yellow	*178*	*20*		*4*		*11*				*35*	
			8		2		10	20	3	23	65.7%
White	*613*	*80**		*64*		*70*				*134**	
			0		16		35	51	1	52	38.5%
Orange	597	*83*		*77*		*81*				*241*	
			1		18		27	46	1	47	19.5%
Red	324	*33*		*43*		*27*				*103*	
			12		10		2	24	1	25	24.3%
Totals		*216*	21	*188*	46	*189*	74	141	*Total 5,6,7 enrolment*	*513**	
									Total surveys	147	28.7%

*No Year 5 students in available case study classrooms, so excluded from totals

J.2 Staff participant rates by school

School	**Staff (FT & PT) at school[a]**	**Participant staff**	**%**	**Participant classrooms**	**Participant classroom teachers**	**%**	**Survey delivery method**
Yellow	31[b]	4	12.9%	3	2	66.7%	Distributed by principal
White	50	22	44.0%	5	1	20.0%	Distributed by principal
Orange	59	12	20.3%	7	5	71.4%	Distributed by principal
Red	24	6	25.0%	5	1	20.0%	Distributed by principal
total	***134***	***44***	***26.8%***	***20***	***9***	***45.0%***	

[a]approximate based on staff numbers reported as either staff or FTE in 2012 context statements (OrangePD 2012a, WhitePD 2012b, RedPD 2012a, YellowPD 2012a).

[b]includes early learning staff

J.3 Staff characteristics

Time working in the education sector

	Frequency	**Percent**
< 5 years	3	6.8
5-20 years	15	34.1
> 20 years	26	59.1
Total	44	100.0

Employment status

	Frequency	**Percent**
Full time	26	59.1
Part time	10	22.7
Casual	3	6.8
Total	**39**	**88.6**
Missing	5	11.4
Total	**44**	**100.0**

	Years at current school		Years in currentroom	
	Frequency	Percent	Frequency	Percent
<1 year	6	13.6	19	43.2
1-5 years	13.0	29.5	17	38.6
5-10 years	20	45.5	6	13.6
>10 years	5	11.4	1	2.3
Total	**44**	**100**	**43**	**98**
Missing	0	0	1	2.3
Total	**44**	**100**	**44**	**100**

J.4 Staff and Student gender of participants

	female	male	no response / did not wish to say	Total participants
Students				
Yellow Students	10	10	3	23
White Students	24	26	2	52
Orange Students	27	17	3	47
Red Students	10	15	0	25
Total Students	***71***	***68***	***8***	***147***
Staff				
Yellow Staff	2	2	0	4
White Staff	18	3	1	22
Orange staff	11	1	0	12
Red Staff	6	0	0	6
Total Staff	***37***	***6***	***1***	***44***

Appendix K Quantitative statistics

K.1 Descriptive statistics tables

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q37SumTempColdVsHot	147	1	5	3.12	1.225
Q38SumTempPreferCoolerVsWarmer	146	1	5	1.94	.984
Q39SumAirFreshVsStale	146	1	5	2.75	1.224
Q40SumAirSmellsCleanVsDirty	145	1	5	2.45	1.130
Q41WintTempColdVsHot	143	1	5	2.92	1.123
Q42WintTempPreferCoolerVsWarmer	144	1	5	3.75	1.087
Q43WintAirFreshVsStale	144	1	5	2.44	1.102
Q44WintAirSmellsCleanVsDirty	143	1	5	2.36	1.097

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q53LightingHelpsLearningRarelyVsNearlyAlways	144	1	5	3.80	1.168
Q54NatLightSuitsMeRarelyVsNearlyAlways	144	1	5	3.54	1.273
Q55GlareRarelyVsAlways	143	1	5	2.76	1.283
Q56ArtLightOKRarelyVsAlways	141	1	5	3.23	1.197

K.2 Tests for differences between staff and student means

Differences between means were tested using a two tail Z-test for difference between means at total $\alpha = 0.01$, $Z_\alpha = \pm 2.58$ (Wisniewski 1997, pp. 213-216). H_0 (u1-u2) = 0 accepted where $Z_{calc} =< \pm 2.58$, and rejected where $Z_{calc} > \pm 2.58$.

Ques No.	Variable	Mean	N	SD	Mean	N	SD	Mstaff - Mstud	Zcalc	Reject Ho
Q37	Q37SumTempColdVsHot	3.67	42	1.07	3.12	147	1.23	0.55	2.84	yes
Q38	Q38SumTempPreferCoolerVsWarmer	2.02	43	0.86	1.94	146	0.98	0.08	0.52	
Q39	Q39SumAirFreshVsStale	3.58	43	1.20	2.75	146	1.22	0.83	3.97	yes
Q40	Q40SumAirSmellsCleanVsDirty	3.30	43	1.12	2.45	145	1.13	0.85	4.36	yes
Q37a	Q37aStudSumTempTooColdVsTooHot	3.74	38	1.06						
Q41	Q41WintTempColdVsHot	2.88	43	1.00	2.92	143	1.12	-0.04	-0.22	
Q42	Q42WintTempPreferCoolerVsWarmer	3.02	43	0.71	3.75	144	1.09	-0.73	-5.17	yes
Q43	Q43WintAirFreshVsStale	3.40	42	1.21	2.44	144	1.10	0.96	4.61	yes
Q44	Q44WintAirSmellsCleanVsDirty	3.28	43	1.03	2.36	143	1.10	0.92	5.06	yes
Q41a	Q41aStuWintTempTooColdVsTooHot	2.76	38	0.94						
Q53	Q53LightingSuitsActivitiesRarely VsNearlyAlways	3.79	43	1.06	3.80	144	1.17	-0.01	-0.05	
Q54	Q54NatLightSuitsMeRarely VsNearlyAlways	3.35	43	1.11	3.54	144	1.27	-0.19	-0.95	
Q55	Q55GlareRarelyVsAlways	2.81	43	1.26	2.76	143	1.28	0.05	0.23	
Q56	Q56ArtLightOKRarelyVsAlways	3.84	43	0.81	3.23	141	1.20	0.61	3.83	yes
Q53a	Q53aLightControlRarelyVsAlways	3.55	42	1.17						
Q30	Q30NoiseQuietVsLoud	3.41	44	1.19	3.36	146	0.98	0.05	0.25	
Q31	Q31UndersandVoiceRarely VsNearlyAlways	3.25	44	1.35	3.89	145	0.98	-0.64	-2.92	yes
Q32	Q32NoiseBetweenRoomsQuietVsLoud	3.05	44	1.48	2.61	145	1.19	0.44	1.80	
Q33	Q33NoiseFromOutsideQuietVsLoud	2.80	44	1.30	2.95	146	1.17	-0.15	-0.69	
Q34	Q34RaiseVoiceRarelyVsNearlyalways	3.24	38	1.38	2.40	146	1.23	0.84	3.42	yes
Q35	Q35PreferNoiseQuieterVsLouder	1.92	38	0.82	2.32	146	1.02	-0.40	-2.54	
Q31a	Q31aStdUndersandVoiceRarely VsNearlyAlways	3.50	36	1.21						
Q10	Q10YoursSCLsustainableNoVsYes	3.06	35	0.91	3.27	134	0.85	-0.21	-1.23	

Ques No.	Variable	Mean	N	SD	Mean	N	SD	Mstaff - Mstud	Zcalc	Reject Ho
Q28	Q28ImportantSCLAttractiveNot VsExtremely	4.30	40	0.69	3.98	144	0.98	0.32	2.35	
Q13	Q13OrdinaryVsLandmark	3.76	42	0.88	2.97	141	1.16	0.79	4.72	yes
Q14	Q14DirtyVsClean	3.55	42	1.09	3.36	146	0.98	0.19	1.02	
Q15	Q15BoringVsInteresting	3.76	42	1.10	3.28	144	1.16	0.48	2.46	
Q16	Q16NeedsworkVsWellmaintained	3.31	42	1.22	3.49	142	1.05	-0.18	-0.87	
Q17	Q17NotSafeVsSafe	3.33	43	1.23	3.92	144	1.09	-0.59	-2.83	yes
Q18	Q18BadforlearningVsGoodforlearning	2.76	43	1.13	4.05	145	0.89	-1.29	-6.88	yes
Q19	Q19UnhealthyVsHealthy	3.00	43	1.16	3.86	141	0.88	-0.86	-4.48	yes
Q20	Q20NotProudofVsProudof	3.41	41	1.14	3.48	143	1.11	-0.07	-0.35	
Q21	Q21EnergySavingDifficultVsEasy	2.56	41	1.07	3.29	118	0.93	-0.73	-3.88	yes
Q22	Q22WaterSavingDifficultVsEasy	2.74	39	0.91	3.30	116	0.95	-0.56	-3.28	yes
Q13a	Q13aBadArchVsGoodArch	2.91	43	1.34						
Q16a	Q16aBuildProblemsFixedSlowly vsQuickly	2.79	42	1.37						
Q18a	Q18aBadforTeaching VsGoodforTeaching	2.71	42	1.13						
Q18b	Q18bPedagogyNotmatched VsMatched	2.98	41	1.19						
Q58	Q58WellDesignedCRNotVsImportant	4.75	42	0.48	4.12	144	1.04	0.63	5.52	yes
Q62	Q62CRToosmallVsToobig	1.98	41	0.88	2.47	142	0.87	-0.49	-3.15	yes
Q63	Q63FurnMovesNoVsEasily	3.28	40	1.11	3.04	134	1.16	0.24	1.19	
Q64	Q64ViewsUglyVsAttractive	3.36	42	1.06	3.16	140	1.01	0.20	1.08	
Q65	Q65ViewsDistractVsCalm	2.98	40	0.97	3.42	139	1.08	-0.44	-2.47	
Q66	Q66COMPNotImportantVsImportant	4.78	41	0.42	4.30	126	0.91	0.48	4.62	yes
Q67	Q67FutureCOMPLessVSMoreImportant	4.95	40	0.22	4.54	124	0.81	0.41	5.08	yes

K.3 Q10 School is sustainable

Descriptives					Post Hoc Homogeneous Subsets		
School is sustainable (Q10)					Tukey HSD a,b		
						Subset for alpha = 0.05	
Schools	N	Mean	Std. Deviation	Std. Error		1	2
Students							
Yellow	19	2.84	.602	.138		2.84	
White	51	3.16	.857	.120		3.16	3.16
Orange	41	3.49	.978	.153			3.49
Red	23	3.48	.593	.124			3.48
Total	134	3.27	.851	.074	Sig.	.480	.435
Staff							
Yellow	3	3.00	1.732	1.000			
White	15	2.87	.516	.133			
Orange	11	3.55	1.128	.340			
Red	6	2.67	.516	.211			
Total	35	3.06	.906	.153			

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 28.549 (Students)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Not at all, 5= Extremely

K.4 Q13 School buildings are a landmark

Descriptives					Post-Hoc Homogeneous Subsets		
School buildings are a landmark (Q13)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
School	***N***	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	23	3.13	.968	.202		3.13	3.13
White	52	2.90	.995	.138		2.90	
Orange	43	2.58	1.239	.189		2.58	
Red	23	3.70	1.222	.255			3.70
Total	141	2.97	1.158	.098	Sig.	.214	.192
Staff							
Yellow	4	4.50	1.000	.500			4.50
White	20	3.30	.657	.147		3.30	
Orange	12	4.00	.853	.246		4.00	4.00
Red	6	4.33	.816	.333		4.33	4.33
Total	42	3.76	.878	.136	Sig.	.067	.607

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 30.902 (Students), = 7.273 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= just some ordinary buildings, 5= A landmark

K.5 Q13a School buildings are good architecture

Descriptives					Post Hoc Homogeneous Subsets		
Buildings are good architecture (Q13a)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
Schools	**N**	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Yellow	4	3.25	1.258	.629		3.25	3.25
White	21	2.00	1.000	.218		2.00	
Orange	12	3.75	.965	.279			3.75
Red	6	4.17	.983	.401			4.17
Total	43	2.91	1.342	.205	Sig.	.101	.321

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 7.304.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Isn't good architecture, 5= Is good architecture

K.6 Q14 Buildings are clean

Descriptives					Post Hoc Homogeneous Groups		
Buildings are clean (Q14)					Tukey HSDa,b		
						Subset for alpha = 0.05	
	N	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	23	3.78	.902	.188		3.78	3.78
White	52	3.25	.860	.119		3.25	
Orange	47	3.77	1.108	.162		3.77	3.77
Red	24	4.04	.751	.153			4.04
Total	146	3.63	.976	.081	Sig.	.111	.645
Staff							
Yellow	3	5.00	.000	.000			5.00
White	21	3.14	.910	.199		3.14	
Orange	12	3.83	1.115	.322		3.83	3.83
Red	6	3.67	1.211	.494		3.67	3.67
Total	42	3.55	1.087	.168	Sig.	.608	.097

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.834 (Students), = 6.340 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= dirty, 5= clean

K.7 Q15 School buildings are interesting

Descriptives					Post Hoc Homogeneous Subsets		
School buildings are interesting (Q15)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
Schools	*N*	Mean	Std. Deviation	Std. Error		1	2
Students							
Yellow	23	2.96	1.107	.231		2.96	
White	51	3.24	1.124	.157		3.24	
Orange	45	3.02	1.055	.157		3.02	
Red	25	4.12	1.130	.226			4.12
Total	144	3.28	1.161	.097	Sig	.743	1.000
Staff							
Yellow	4	4.25	.957	.479		4.25	4.25
White	20	3.10	1.021	.228		3.10	
Orange	12	4.33	.888	.256		4.33	4.33
Red	6	4.50	.548	.224			4.50
Total	42	3.76	1.100	.170	Sig	.070	.955

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.921 (Students). = 7.273 (Staff).
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Boring, 5= Interesting

K.8 Q16 Buildings are well maintained

Descriptives					Post Hoc Homogeneous Subsets		
Buildings are well maintained (Q16)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
Schools	N	Mean	Std. Deviation	Std. Error		1	2
Students							
Yellow	22	3.27	.985	.210		3.27	
White	50	3.24	1.021	.144		3.24	
Orange	46	3.57	1.148	.169		3.57	3.57
Red	24	4.04	.751	.153			4.04
Total	142	3.49	1.050	.088	Sig.	.593	.260
Staff							
Yellow	3	4.67	.577	.333			4.67
White	21	2.57	.978	.213		2.57	
Orange	12	4.08	.900	.260			4.08
Red	6	3.67	1.211	.494		3.67	3.67
Total	42	3.31	1.220	.188	Sig.	.205	.276

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.041 (Students), 6.340 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= needs some work, 5= Well maintained

K.9 Q16a Building problems fixed

Descriptives					Post Hoc Homogeneous Subsets		
Building problems fixed (Q16a)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
School	N	Mean	Std. Deviation	Std. Error		1	2
Staff							
Yellow	3	4.33	1.155	.667			4.33
White	21	2.00	1.049	.229		2.00	
Orange	12	3.75	1.055	.305			3.75
Red	6	2.83	1.329	.543		2.83	2.83
Total	42	2.79	1.371	.212	Sig.	.536	.088

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 6.340.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= problems take some time to fix, 5= are fixed quickly

K.10 Q17 Buildings are safe

It is noted that, strictly, the student dataset failed the test of homogeneity of variances (Levene statistic $F(3, 140) = 2.95$, $p = 0.035$); however, before rejecting the data set for regression it should be noted that the direction of the data is towards all students feeling safe, i.e., all lower 95% confidence bounds for the mean are above the midpoint of the five point scale. Furthermore, the Red school is responsible for the Levene test fail due to its high mean and low standard deviation, and it is noted that a police station is located directly opposite the school grounds, thus making it an atypical urban environment when compared to the other case studies. Given these real-world considerations and the statistic restrictions of working with a five-point scale, it is proposed to accept this data as appropriate.

Descriptives					**Post Hoc Homogeneous Subsets**		
Buildings are safe (Q17)					**Tukey HSD[a,b]**		
						Subset for alpha = 0.05	
Schools	***N***	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	23	3.70	.765	.159		3.70	
White	51	3.75	1.093	.153		3.75	
Orange	46	3.89	1.269	.187		3.89	3.89
Red	24	4.54	.779	.159			4.54
Total	144	3.92	1.094	.091	Sig.	.885	.077
Staff							
Yellow	4	4.25	.957	.479		4.25	
White	21	2.81	1.209	.264		2.81	
Orange	12	3.92	.996	.288		3.92	
Red	6	3.33	1.211	.494		3.33	
Total	43	3.33	1.229	.187	Sig.	.089	

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.623 (Students), = 7.304 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Does not feel safe and secure, 5= Feels safe and secure

K.11 Q18 Buildings good for learning

Descriptives					**Post Hoc Homogeneous Subsets**		
Buildings good for learning (Q18)					**Tukey HSD[a,b]**		
						Subset for alpha = 0.05	
Schools	***N***	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	23	3.70	.876	.183		3.70	
White	52	3.85	.802	.111		3.85	
Orange	46	4.22	.964	.142		4.22	4.22
Red	24	4.50	.722	.147			4.50
Total	145	4.05	.892	.074	Sig.	.077	.556
Staff							
Yellow	3	3.33	1.528	.882		3.33	3.33
White	22	2.14	.889	.190		2.14	
Orange	12	3.58	.900	.260			3.58
Red	6	3.33	.816	.333		3.33	3.33
Total	43	2.79	1.125	.171	Sig.	.115	.963

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.717 (students), = 6.361 (staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1=Bad for my learning, 5=Good for my learning

K.12 **Q18a Buildings good for teaching – staff only**

Descriptives					Post Hoc Homogeneous Subsets	
Buildings good for teaching (18a)					Tukey HSD[a,b]	
						Subset for alpha = 0.05
Schools	***N***	**Mean**	**Std. Deviation**	**Std. Error**		**1**
Yellow	3	2.67	2.082	1.202		2.67
White	22	2.18	.907	.193		2.18
Orange	11	3.45	.820	.247		3.45
Red	6	3.33	1.033	.422		3.33
Total	42	2.71	1.132	.175	Sig.	.127

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 6.286.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Reduces my teaching effectiveness, 5= Enhances my teaching effectiveness

K.13 **Q18b Buildings match pedagogy – staff only**

Descriptives				
Buildings match pedagogy (18b)				
Schools	***N***	**Mean**	**Std. Deviation**	**Std. Error**
Yellow	4	2.75	1.708	.854
White	21	2.71	1.056	.230
Orange	10	3.40	1.174	.371
Red	6	3.33	1.366	.558
Total	41	2.98	1.193	.186

5 point scale: 1=Does not match the pedagogy, 5=Matches the pedagogy

K.14 **Q19 School buildings are healthy**

Descriptives					Post Hoc Homogeneous Subsets		
School buildings are healthy (Q19)					Tukey HSD[a,b]		
						Subset for alpha = 0.05	
Schools	**N**	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	22	3.68	.780	.166		3.68	
White	50	3.56	.861	.122		3.56	
Orange	45	4.00	.905	.135		4.00	4.00
Red	24	4.38	.711	.145			4.38
Total	141	3.86	.883	.074	Sig.	.172	.300
Staff							
Yellow	4	3.50	1.000	.500		3.50	
White	21	2.43	1.028	.224		2.43	
Orange	12	3.67	.985	.284		3.67	
Red	6	3.33	1.211	.494		3.33	
Total	43	3.00	1.155	.176	Sig.	.121	

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 30.925 (Students), = 7.304 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Unhealthy, 5= Healthy

K.15 **Q20 Pride in school buildings**

Descriptives					Post Hoc Homogeneous Subsets		
Proud of school buildings (Q20)					Tukey HSD[a,b]		
Schools	N	Mean	Std. Deviation	Std. Error		Subset for alpha = 0.05	
						1	2
Students							
Yellow	23	3.13	1.140	.238		3.13	
White	51	3.29	1.026	.144		3.29	
Orange	45	3.47	1.100	.164		3.47	
Red	24	4.21	1.021	.208			4.21
Total	143	3.48	1.112	.093	Sig.	.596	1.000
Staff							
Yellow	3	3.67	1.528	.882		3.67	
White	20	3.10	.788	.176		3.10	
Orange	12	3.50	1.382	.399		3.5	
Red	6	4.17	1.329	.543		4.17	
Total	41	3.41	1.140	.178	Sig.	.341	

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.502 (students), 6.316 (staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Not proud, 5= proud of

K.16 **Q21 Buildings make it easy to save energy**

Descriptives				
Easy to save energy (Q21)				
Schools	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	19	3.11	.737	.169
White	34	3.06	.919	.158
Orange	41	3.46	1.075	.168
Red	24	3.46	.779	.159
Total	118	3.29	.935	.086
Staff				
Yellow	3	2.33	.577	.333
White	20	2.15	.988	.221
Orange	12	3.33	.985	.284
Red	6	2.50	1.049	.428
Total	41	2.56	1.074	.168

5 point scale: 1= Make saving energy difficult, 5= Make saving energy easy

K.17 **Q22 Buildings make it easy to save water**

Descriptives				
Easy to save water (Q22)				
Schools	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	17	3.18	.728	.176
White	38	3.18	.926	.150
Orange	39	3.23	1.038	.166
Red	22	3.73	.935	.199
Total	116	3.30	.953	.088
Staff				
Yellow	3	2.67	.577	.333
White	18	2.61	.916	.216
Orange	12	2.75	1.138	.329
Red	6	3.17	.408	.167
Total	39	2.74	.910	.146

5 point scale: 1= Make saving water difficult, 5= Make saving water easy

K.18 **Q21-Q22 Linear regressions**

Stepwise linear regression was undertaken on both Q21 and Q22 using all other variables for both student and staff participants. The models generated were not convincing because they contained many (up to eight) independent variables, with variables included without significant coefficients.

Models with significant coefficients are reported in the table below. Models for both students and staff perspectives of ability to save energy easily were predicted by the perspective that it was easy to save water and, in the case of students, the school was sustainable. For the staff model, perspectives of the ability to save energy were predicted by length of time in their room, buildings as being good for learning, and perspectives of winter temperature being cold, i.e., that energy is saved possibly through winter temperature discomfort.

The model for staff responses to water saving as easy was predicted solely by the perspective that energy saving was easy. The student model was more complex and included other disparate environmental independent variables (winter air clean, winter temperature is cold, prefer winter temperature cooler, good natural light, low glare) and the non-environmental variable indicating perceptions of buildings as being healthy. This suggests that either there is some connection with winter comfort and water saving.

Dependent variables	R^2	*F*, *p*	Coefficients	Beta	*p*
Student participants					
Easy to save energy (Q21)	0.27	$F(2,93) = 17.46$	Easy to save water (Q22)	0.38	< 0.0005
		$p < 0.0005$	School is sustainable (Q10)	0.57	0.005
Easy to save water (Q22)	0.48	$F(7,88) = 11.52$	School buildings are healthy (Q19)	0.30	< 0.0005
		$p < 0.0005$	Easy to save energy (Q21)	0.19	0.033
			Winter air smells dirty (Q44)	-0.22	0.012
			Prefer Winter temp warmer (Q42)	-0.22	0.007
			Daylight suitable (Q54)	0.18	0.027
			Glare occurs (Q55)	-0.17	0.040
			Winter temp is hot (Q41)	-0.16	0.049
Staff participants					
Easy to save energy (Q21)	0.64	$F(4,24) = 10.60$	Buildings good for learning (Q18)	0.44	0.003
		$p < 0.0005$	Years in current room (Q90)	0.43	0.002
			Easy to save water (Q22)	0.32	0.021
			Winter temp is hot (Q41)	-0.26	0.049
Easy to save water (Q22)	0.16	$F(1,27) = 5.134$	Easy to save energy (Q21)	0.40	0.032
		$p = 0.032$			

K.19 **Q28 Important that school looks attractive**

Descriptives

Important school looks attractive

School	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	22	3.59	1.098	.234
White	51	4.08	.935	.131
Orange	47	4.06	.919	.134
Red	24	3.96	1.042	.213
Total	144	3.98	.979	.082
Staff				
Yellow	4	4.50	1.000	.500
White	20	4.10	.641	.143
Orange	11	4.36	.674	.203
Red	5	4.80	.447	.200
Total	40	4.30	.687	.109

5 point scale: 1=not at all, 5=extremely

K.20 **Q30-35 Noise perspectives**

K.20.1 **Frequency tables**

Descriptives – Students – 5 point scale
I find that the noise level during class is generally: 'Quiet' vs 'Loud' (Q30)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	23	3.96	.767	.160	3.62	4.29
White	52	3.10	.955	.132	2.83	3.36
Orange	46	3.52	.937	.138	3.24	3.80
Red	25	3.08	1.038	.208	2.65	3.51
Total	146	3.36	.982	.081	3.20	3.52

Descriptives – Staff – 5 point scale
For all staff: I find that the noise level in my main work area is generally: Quiet vs Loud (Q30)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	4	3.75	1.258	.629	1.75	5.75
White	22	3.82	1.053	.224	3.35	4.28
Orange	12	3.00	1.044	.302	2.34	3.66
Red	6	2.50	1.378	.563	1.05	3.95
Total	44	3.41	1.187	.179	3.05	3.77

Descriptives – Students – 5 point scale
It is easy for me to understand what is being said: 'Rarely' vs 'Nearly Always' (Q31)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	23	3.65	.832	.173	3.29	4.01
White	52	4.04	1.102	.153	3.73	4.35
Orange	46	3.83	.973	.143	3.54	4.12
Red	24	3.92	.830	.169	3.57	4.27
Total	145	3.89	.980	.081	3.73	4.05

Descriptives – Staff – 5 point scale
For all staff: It is easy for me to understand what is being said by others: Rarely vs Nearly always (Q31)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.00	.816	.408	.70	3.30
White	22	2.91	1.411	.301	2.28	3.53
Orange	12	3.83	.937	.271	3.24	4.43
Red	6	4.17	1.169	.477	2.94	5.39
Total	44	3.25	1.349	.203	2.84	3.66

Descriptives – Staff – 5 point scale
For teaching staff only: During class, all students can understand what is being said: Rarely vs Nearly always (Q31a)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.75	1.708	.854	.03	5.47
White	19	3.11	1.100	.252	2.57	3.64
Orange	8	4.00	.756	.267	3.37	4.63
Red	5	4.80	.447	.200	4.24	5.36
Total	36	3.50	1.207	.201	3.09	3.91

Descriptives – Students – 5 point scale
The noise level through the walls / windows from adjacent classes is: 'Quiet' vs 'Loud' (Q32)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	22	2.91	1.231	.262	2.36	3.45
White	52	2.58	1.091	.151	2.27	2.88
Orange	46	2.67	1.283	.189	2.29	3.06
Red	25	2.28	1.137	.227	1.81	2.75
Total	145	2.61	1.186	.099	2.41	2.80

Descriptives – Staff – 5 point scale
For all staff: The noise level through the wall / window from adjacent rooms is: Quiet vs Loud (Q32)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.25	1.708	.854	.53	5.97
White	22	3.68	1.323	.282	3.10	4.27
Orange	12	2.00	1.206	.348	1.23	2.77
Red	6	2.67	1.366	.558	1.23	4.10
Total	44	3.05	1.478	.223	2.60	3.49

Descriptives – Students – 5 point scale
The noise level through the walls / windows from outside is: 'Quiet' vs 'Loud' (Q33)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	2.74	1.054	.220	2.28	3.19
White	52	3.02	1.129	.157	2.70	3.33
Orange	46	3.30	1.263	.186	2.93	3.68
Red	25	2.32	.945	.189	1.93	2.71
Total	146	2.95	1.173	.097	2.75	3.14

Descriptives – Staff – 5 point scale
For all staff: The noise level through the wall / window from outside is: Quiet vs Loud (Q33)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.25	1.893	.946	-.76	5.26
White	22	3.36	1.093	.233	2.88	3.85
Orange	12	2.25	1.138	.329	1.53	2.97
Red	6	2.17	1.329	.543	.77	3.56
Total	44	2.80	1.304	.197	2.40	3.19

Descriptives – Students – 5 point scale
I have to raise my voice to be understood by my teacher or classmates: 'Rarely' vs 'Nearly Always' (Q34)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	3.17	1.230	.257	2.64	3.71
White	52	1.98	1.057	.147	1.69	2.28
Orange	46	2.78	1.263	.186	2.41	3.16
Red	25	1.88	.927	.185	1.50	2.26
Total	146	2.40	1.229	.102	2.20	2.61

Descriptives – Staff – 5 point scale
For teaching staff only: I have to raise my voice to be understood: Rarely vs Nearly always (Q34)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.75	1.893	.946	.74	6.76
White	21	3.48	1.250	.273	2.91	4.05
Orange	8	3.00	1.069	.378	2.11	3.89
Red	5	2.20	1.789	.800	-.02	4.42
Total	38	3.24	1.384	.225	2.78	3.69

Descriptives – Students – 5 point scale
I would prefer the overall class noise levels to be: 'Quieter' vs 'Louder' (Q35)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	1.78	.736	.153	1.46	2.10
White	52	2.54	.959	.133	2.27	2.81
Orange	46	2.41	1.107	.163	2.08	2.74
Red	25	2.20	1.080	.216	1.75	2.65
Total	146	2.32	1.023	.085	2.15	2.49

Descriptives – Staff – 5 point scale
For teaching staff only: I would prefer the overall class noise levels to be: Quieter vs Louder (Q35)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.00	.816	.408	.70	3.30
White	21	1.62	.805	.176	1.25	1.99
Orange	8	2.38	.744	.263	1.75	3.00
Red	5	2.40	.548	.245	1.72	3.08
Total	38	1.92	.818	.133	1.65	2.19

K.21 Q37-Q44 Temperature and ventilation perspectives

K.21.1 Frequency tables

Descriptives – Students – 5 point scale
Generally in SUMMER in my classroom... The temperature is: 'Cold' vs 'Hot' (Q37)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	2.65	1.027	.214	2.21	3.10
White	52	3.67	1.216	.169	3.33	4.01
Orange	47	2.70	1.140	.166	2.37	3.04
Red	25	3.16	1.143	.229	2.69	3.63
Total	147	3.12	1.225	.101	2.92	3.32

Descriptives – Staff – 5 point scale
In Summer... The temperature is: Cold vs Hot (Q37)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.50	1.000	.500	1.91	5.09
White	21	3.90	1.136	.248	3.39	4.42
Orange	12	3.17	.835	.241	2.64	3.70
Red	5	4.00	1.225	.548	2.48	5.52
Total	42	3.67	1.074	.166	3.33	4.00

Descriptives – Staff – 5 point scale
In Summer... For teaching staff only: For students I believe that the temperature is: Too Cold vs Too Hot (Q37a)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.25	.500	.250	2.45	4.05
White	20	4.00	1.298	.290	3.39	4.61
Orange	8	3.50	.535	.189	3.05	3.95
Red	6	3.50	.837	.342	2.62	4.38
Total	38	3.74	1.057	.172	3.39	4.08

Descriptives – Students – 5 point scale
Generally in SUMMER in my classroom... I would prefer the temperature to be: 'Cooler' vs 'Warmer' (Q38)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	2.09	1.203	.251	1.57	2.61
White	51	1.73	.777	.109	1.51	1.94
Orange	47	2.02	1.011	.147	1.72	2.32
Red	25	2.08	1.077	.215	1.64	2.52
Total	146	1.94	.984	.081	1.78	2.10

Descriptives – Staff – 5 point scale
In Summer... I would prefer the temperature to be: Cooler vs Warmer (Q38)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.50	1.000	.500	.91	4.09
White	21	1.90	.889	.194	1.50	2.31
Orange	12	2.17	.718	.207	1.71	2.62
Red	6	1.83	.983	.401	.80	2.87
Total	43	2.02	.859	.131	1.76	2.29

Descriptives – Students – 5 point scale
Generally in SUMMER in my classroom... The air is: 'Fresh' vs 'stuffy/stale' (Q39)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	2.35	.982	.205	1.92	2.77
White	51	3.29	1.188	.166	2.96	3.63
Orange	47	2.70	1.250	.182	2.34	3.07
Red	25	2.12	1.013	.203	1.70	2.54
Total	146	2.75	1.224	.101	2.55	2.95

Descriptives – Staff – 5 point scale
In Summer... The air is: Fresh vs Stale (Q39)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.00	1.826	.913	.09	5.91
White	21	4.00	1.049	.229	3.52	4.48
Orange	12	3.08	.996	.288	2.45	3.72
Red	6	3.50	1.378	.563	2.05	4.95
Total	43	3.58	1.200	.183	3.21	3.95

Descriptives – Students – 5 point scale
Generally in SUMMER in my classroom... The air smells: 'Clean' vs 'Dirty/dusty' (Q40)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	2.39	1.076	.224	1.93	2.86
White	51	2.55	1.064	.149	2.25	2.85
Orange	46	2.63	1.254	.185	2.26	3.00
Red	25	1.96	.978	.196	1.56	2.36
Total	145	2.45	1.130	.094	2.26	2.63

Descriptives – Staff – 5 point scale
In Summer... The air smells: Clean vs Dirty (Q40)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.25	1.500	.750	-.14	4.64
White	21	3.62	.973	.212	3.18	4.06
Orange	12	3.08	.996	.288	2.45	3.72
Red	6	3.33	1.366	.558	1.90	4.77
Total	43	3.30	1.124	.171	2.96	3.65

Descriptives – Students – 5 point scale
Generally in WINTER in my classroom... The temperature is: 'Cold' vs 'Hot' (Q41)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	23	3.00	1.087	.227	2.53	3.47
White	49	2.71	1.242	.177	2.36	3.07
Orange	46	3.02	1.105	.163	2.69	3.35
Red	25	3.04	.935	.187	2.65	3.43
Total	143	2.92	1.123	.094	2.73	3.10

Descriptives – Staff – 5 point scale
In Winter... The temperature is: Cold vs Hot (Q41)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	4	3.00	.000	.000	3.00	3.00
White	21	2.71	1.271	.277	2.14	3.29
Orange	12	3.17	.389	.112	2.92	3.41
Red	6	2.83	1.169	.477	1.61	4.06
Total	43	2.88	1.005	.153	2.57	3.19

Descriptives – Staff – 5 point scale
In Winter... For teaching staff only: For students I believe that the temperature is: Too Cold vs Too Hot (Q41a)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	4	3.00	.000	.000	3.00	3.00
White	21	2.67	1.155	.252	2.14	3.19
Orange	7	3.00	.000	.000	3.00	3.00
Red	6	2.67	1.033	.422	1.58	3.75
Total	38	2.76	.943	.153	2.45	3.07

Descriptives – Students – 5 point scale
Generally in WINTER in my classroom... I would prefer the temperature to be: 'Cooler' vs 'Warmer' (Q42)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	23	3.57	.992	.207	3.14	3.99
White	50	3.90	.974	.138	3.62	4.18
Orange	46	3.72	1.277	.188	3.34	4.10
Red	25	3.68	1.030	.206	3.26	4.10
Total	144	3.75	1.087	.091	3.57	3.93

Descriptives – Staff – 5 point scale
In Winter... I would prefer the temperature to be: Cooler vs Warmer (Q42)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	4	3.00	.000	.000	3.00	3.00
White	21	3.00	.894	.195	2.59	3.41
Orange	12	3.00	.000	.000	3.00	3.00
Red	6	3.17	.983	.401	2.13	4.20
Total	43	3.02	.707	.108	2.81	3.24

Descriptives – Students – 5 point scale
Generally in WINTER in my classroom... The air is: 'Fresh' vs 'stuffy/stale' (Q43)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Yellow	23	2.39	.941	.196	1.98	2.80
White	50	2.36	1.045	.148	2.06	2.66
Orange	46	2.65	1.233	.182	2.29	3.02
Red	25	2.28	1.100	.220	1.83	2.73
Total	144	2.44	1.102	.092	2.26	2.63

Descriptives – Staff – 5 point scale
In Winter... The air is: Fresh vs Stale (Q43)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
Yellow	4	2.75	1.500	.750	.36	5.14
White	20	3.80	1.152	.258	3.26	4.34
Orange	12	3.17	1.030	.297	2.51	3.82
Red	6	3.00	1.414	.577	1.52	4.48
Total	42	3.40	1.211	.187	3.03	3.78

Descriptives – Students – 5 point scale
Generally in WINTER in my classroom... The air smells: 'Clean' vs 'Dirty/dusty' (Q44)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
Yellow	23	2.17	.778	.162	1.84	2.51
White	50	2.38	1.048	.148	2.08	2.68
Orange	46	2.50	1.243	.183	2.13	2.87
Red	24	2.21	1.179	.241	1.71	2.71
Total	143	2.36	1.097	.092	2.18	2.54

Descriptives – Staff – 5 point scale
In Winter... The air smells: Clean vs Dirty (Q44)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
Yellow	4	2.75	1.258	.629	.75	4.75
White	21	3.67	.966	.211	3.23	4.11
Orange	12	2.92	.996	.288	2.28	3.55
Red	6	3.00	.894	.365	2.06	3.94
Total	43	3.28	1.031	.157	2.96	3.60

K.21.2 Student summer and winter perspectives compared to mean monitored temperatures

	Summer								Winter							
	Temperature		**Perception[b]**			**Preference**			**Temperature**		**Perception**			**Preference**		
	Term 1 school hours		Q37SumTemp ColdVsHot			Q38SumTempPrefer CoolerVsWarmer			Term 3 school hours		Q41WintTemp ColdVsHot			Q42WintTempPrefer CoolerVsWarmer		
	mean	sd	**mean**	sd	N	**mean**	sd	N	mean	sd	**mean**	sd	N	**mean**	sd	N
Kent Town	*23.3*	*5.0*							*14.6*	*3.3*						
Yellow 3 L19 N	23 2	1.5	**2.65**	1.03	23	**2.09**	1 20	23	20.4	2.0	**3.00**	1.09	23	**3.57**	0.99	23
White.3 L35 [a]	22.7	1.1	**3.85**	1.41	13	**1.38**	0.65	13	20.9	1.7	**2.69**	1 32	13	**4.08**	0.76	13
White.4 L104	22.8	1.1	**3.32**	1.25	25	**1.92**	0.72	24	21.1	1.9	**2.45**	1 36	22	**3.74**	1.18	23
White.5 L25 [a]			**4.14**	0.77	14	**1.71**	0 97	14			**3.14**	0 95	14	**4.00**	0.78	14
Orange.4 L103	24 3	1.8	**3.00**	0.82	7	**1.43**	0.79	7	19.7	1.9	**3.14**	0.69	7	**3.43**	1.81	7
Orange 5 L7	23 5	2.1	**2.65**	1.19	40	**2.13**	1.02	40	19.9	3.1	**3.00**	1.17	39	**3.77**	1.18	39
Red.4 L101	23 5	1.2	**2.88**	1.13	8	**2.00**	1.07	8	18.6	1.6	**3.38**	0.74	8	**3.88**	0.84	8
Red.5 L1	24 2	1.4	**3.29**	1.16	17	**2.12**	1.11	17	19.1	1.8	**2.88**	0 99	17	**3.59**	1.12	17
All			*3.12*	*1.23*	*147*	*1.94*	*0.98*	*146*			**2.92**	*1.12*	*143*	*3.75*	*1.09*	*144*

a. White 3 and White.5 are a double class with observed frequent movement between the home rooms so L35 is representative of both. L25 was installed in Terrm 4.

Levene Test: No survey sets breach the homogeneity of variances

b. Post Hoc Homogeneous Subsets: 2 sets.
Set 1 (cooler perception) Yellow.3, White.3, White.4, Orange.4, Orange.5, Red.4, Red.5
Set 2 (warmer perception) White.3, White.4, White.5, Orange.4, Red.4, Red.5

No differences detected in other variable responses.

K.21.3 Staff summer and winter perspectives temperatures by school

Variable	Levene test homogeneity of variances	One Way ANOVA	Homogeneous subsets (using Tukey HSD for unequal group sizes)			
			Group 1 (mean, N)		Group 2 (mean, N)	Harmonic Mean Sample Size
Summer temp is hot (Q37)	p = 0.851	F(3, 38) = 1.45 p = 0.244	Orange Yellow White Red	(3.17, 12) (3.50, 4) (3.90, 21) (4.00, 5)		6.89
Too hot in summer for students (Q37)	p = 0.129	F(3, 34) = 0.92 p = 0.440	Yellow Orange Red White	(3.25, 4) (3.50, 8) (3.5, 6) (4.00, 20)		6.76
Prefer summer temp warmer (Q38)	p = 0.690	F(3, 39) = 0.74 p = 0.535	Red White Orange Yellow	(1.83, 6) (1.90, 21) (2.17, 12) (2.50, 4)		7.30
Summer air is stale (Q39)	p = 0.115	F(3, 39) = 2.00 p = 0.130	Yellow Orange Red White	(3.00, 4) (3.08, 12) (3.50, 6) (4.00, 21)		7.30
Summer air smells dirty (Q40)	p = 0.286	F(3, 39) = 2.01 p = 0.128	Yellow Orange Red White	(2.25, 4) (3.08, 12) (3.33, 6) (3.62, 21)		7.30
Winter temp is hot (Q41)	p = 0.001 Welsh fail – one group zero variance	F(3, 39) = 0.52 p = 0.671	White Red Yellow Orange	(2.71, 21) (2.83, 6) (3.00, 4) (3.17, 12)		7.30
Too hot in winter for students (Q41a)	p < 0.0005 Welsh fail – one group zero variance	F(3, 34) = 0.31 p = 0.820	White Red Yellow Orange	(2.67, 21) (2.67, 6) (3.00, 4) (3.00, 7)		6.59
Prefer Winter temp warmer (Q42)	p = 0.018 Welsh fail – one group zero variance	F(3, 39) = 0.09 p = 0.965	Yellow White Orange Red	(3.00, 4) (3.00, 21) (3.00, 12) (3.17, 6)		7.30
Winter air is stale (Q43)	p = 0.722	F(3, 38) = 1.54 p = 0.221	Yellow Red Orange White	(2.75, 4) (3.00, 6) (3.17, 12) (3.80, 20)		7.27
Winter air smells dirty (Q44)	p = 0.914	F(3, 39) = 2.14 p = 0.110	Yellow Orange Red White	(2.75, 4) (2.92, 12) (3.00, 6) (3.67, 21)		7.30

K.22 Q53-56 Light perspectives

K.22.1 Frequency tables

Descriptives – Students – 5 point scale
In my classroom...the lighting makes it easy for me to learn: 'Rarely' vs 'Nearly always' (Q53)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	22	3.68	.894	.191	3.29	4.08
White	52	3.65	1.118	.155	3.34	3.97
Orange	46	3.72	1.344	.198	3.32	4.12
Red	24	4.38	1.013	.207	3.95	4.80
Total	144	3.80	1.168	.097	3.61	3.99

Descriptives – Staff – 5 point scale
The lighting suits my activities: Rarely vs Nearly always (Q53)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.25	1.258	.629	1.25	5.25
White	21	4.00	1.095	.239	3.50	4.50
Orange	12	3.75	.866	.250	3.20	4.30
Red	6	3.50	1.225	.500	2.21	4.79
Total	43	3.79	1.059	.162	3.46	4.12

Descriptives – Staff – 5 point scale
I have good control over the lighting: Rarely vs Nearly always (Q53a)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.75	.957	.479	2.23	5.27
White	21	3.24	1.300	.284	2.65	3.83
Orange	11	3.91	.831	.251	3.35	4.47
Red	6	3.83	1.329	.543	2.44	5.23
Total	42	3.55	1.173	.181	3.18	3.91

Descriptives – Students – 5 point scale
In my classroom...the natural (sun) light suits me: 'Rarely' vs 'Nearly always' (Q54)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	22	3.55	1.503	.320	2.88	4.21
White	52	3.50	1.196	.166	3.17	3.83
Orange	46	3.26	1.255	.185	2.89	3.63
Red	24	4.17	1.090	.223	3.71	4.63
Total	144	3.54	1.273	.106	3.33	3.75

Descriptives – Staff – 5 point scale
The natural (sun) light is appropriate: Rarely vs Nearly always (Q54)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.50	1.000	.500	1.91	5.09
White	21	3.43	1.121	.245	2.92	3.94
Orange	12	3.33	1.303	.376	2.51	4.16
Red	6	3.00	.894	.365	2.06	3.94
Total	43	3.35	1.110	.169	3.01	3.69

Descriptives – Students – 5 point scale
In my classroom...there is glare (light is too bright or reflects off shiny surfaces): 'Rarely' vs 'Nearly always' (Q55)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	22	3.77	1.110	.237	3.28	4.26
White	52	2.63	1.205	.167	2.30	2.97
Orange	46	2.33	1.136	.168	1.99	2.66
Red	23	2.96	1.397	.291	2.35	3.56
Total	143	2.76	1.283	.107	2.55	2.97

Descriptives – Staff – 5 point scale
There is glare: Rarely vs Nearly always (Q55)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	2.75	1.258	.629	.75	4.75
White	21	3.05	1.322	.288	2.45	3.65
Orange	12	2.17	.937	.271	1.57	2.76
Red	6	3.33	1.366	.558	1.90	4.77
Total	43	2.81	1.258	.192	2.43	3.20

Descriptives – Students – 5 point scale
In my classroom...the electrical (artificial) lighting suits me: 'Rarely' vs 'Nearly always' (Q56)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	22	3.09	1.109	.236	2.60	3.58
White	52	3.17	1.098	.152	2.87	3.48
Orange	44	3.14	1.357	.205	2.72	3.55
Red	23	3.65	1.152	.240	3.15	4.15
Total	141	3.23	1.197	.101	3.03	3.43

Descriptives – Staff – 5 point scale
The electrical (artificial) lighting is appropriate: Rarely vs Nearly always (Q56)

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Yellow	4	3.25	1.258	.629	1.25	5.25
White	21	3.81	.680	.148	3.50	4.12
Orange	12	4.00	.853	.246	3.46	4.54
Red	6	4.00	.894	.365	3.06	4.94
Total	43	3.84	.814	.124	3.59	4.09

K.23 **Q58 Well-design classroom importance**

Descriptives					**Post Hoc homogeneous Subsets**		
Well-designed classroom important (Q58)					**Tukey HSD[a,b]**		
						Subset for alpha = 0.05	
Schools	**N**	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students							
Yellow	23	4.04	1.147	.239		4.04	
White	52	4.00	.929	.129		4.00	
Orange	47	3.98	1.189	.173		3.98	
Red	22	4.77	.528	.113			4.77
Total	144	4.12	1.041	.087	Sig.	.994	1.000
Staff							
Yellow	4	4.75	.500	.250		4.75	
White	22	4.91	.294	.063		4.91	
Orange	10	4.40	.699	.221		4.40	
Red	6	4.83	.408	.167		4.83	
Total	42	4.76	.484	.075	Sig.	0.165	

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 30.902 (Students), 7.116 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= not important, 5= important

K.24 **Q62 Classroom size perspectives**

Descriptives					**Post Hoc Homogeneous Subsets**		
Classroom size perspectives (Q62)					**Tukey HSD[a,b]**		
						Subset for alpha = 0.05	
School	**N**	**Mean**	**Std. Deviation**	**Std. Error**		**1**	**2**
Students						**2.17**	
Yellow	23	2.17	1.114	.232		2.42	
White	52	2.42	.667	.093		2.55	
Orange	47	2.55	.951	.139		2.75	
Red	20	2.75	.786	.176		2.47	
Total	142	2.47	.873	.073	Sig.	.054	
Staff							
Yellow	4	1.25	.500	.250		1.25	
White	21	1.76	.768	.168		1.76	1.76
Orange	10	2.40	.966	.306		2.40	2.40
Red	6	2.50	.837	.342			2.50
Total	41	1.98	.880	.137	Sig.	.053	.334

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 29.854 (Students), 7.089 (Staff)
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
5 point scale: 1= Too small, 5= Too big

K.25 **Q53 Furniture moves easily**

Descriptives - students

Furniture moves easily (Q63)

School	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	23	2.96	.928	.194
White	50	3.12	1.118	.158
Orange	47	3.00	1.268	.185
Red	14	3.07	1.328	.355
Total	134	3.04	1.156	.100
Staff				
Yellow	4	2.50	1.000	.500
White	21	3.38	.973	.212
Orange	9	3.44	1.014	.338
Red	6	3.17	1.722	.703
Total	40	3.28	1.109	.175

5 point scale: 1= Not at all, 5= easily

K.26 **Q64 Views are attractive**

Descriptives — Views are attractive; **Post Hoc Homogeneous Subsets** — Tukey HSDa,b

Schools	N	Mean	Std. Deviation	Std. Error		Subset for alpha = 0.05: 1	2
Students							
Yellow	23	3.35	.885	.184		3.35	3.35
White	51	2.92	1.055	.148		2.92	
Orange	46	3.13	1.002	.148		3.13	3.13
Red	20	3.65	.875	.196			3.65
Total	140	3.16	1.008	.085	Sig.	.348	.184
Staff							
Yellow	4	4.00	1.155	.577		4.00	
White	22	3.14	1.037	.221		3.14	
Orange	10	3.20	.789	.249		3.20	
Red	6	4.00	1.265	.516		4.00	
Total	42	3.36	1.055	.163	Sig.	0.400	

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.668 (Students), 7.116 (Staff)

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

5 point scale: 1= ugly, 5= attractive

K.27 **Q64 Views are calming**

Descriptives

Views are calming (65)

School	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	21	3.38	.973	.212
White	51	3.41	.983	.138
Orange	46	3.46	1.168	.172
Red	20	3.40	1.273	.285
Total	138	3.42	1.079	.092
Staff				
Yellow	4	3.50	1.291	.645
White	20	2.70	.923	.206
Orange	10	3.00	.667	.211
Red	6	3.50	1.225	.500
Total	40	2.98	.974	.154

5 point scale: 1= distracting, 5= calming

K.28 **Q66 ICT is important now**

Descriptives

ICT important now

Schools	N	Mean	Std. Deviation	Std. Error
Students				
Yellow				
White	47	4.15	1.083	.158
Orange	44	4.39	.841	.127
Red	12	4.58	.515	.149
Total	126	4.30	.906	.081
Staff				
Yellow	4	4.75	.500	.250
White	22	4.77	.429	.091
Orange	9	4.78	.441	.147
Red	6	4.83	.408	.167
Total	41	4.78	.419	.065

5 point scale: 1= Not important, 5= Important

K.29 **Q67 ICT is important in the future**

Descriptives

ICT important in the future

Schools	N	Mean	Std. Deviation	Std. Error
Students				
Yellow	23	4.57	.728	.152
White	46	4.72	.544	.080
Orange	44	4.36	.990	.149
Red	11	4.45	1.036	.312
Total	124	4.54	.810	.073
Staff				
Yellow	4	5.00	.000	.000
White	21	4.90	.301	.066
Orange	9	5.00	.000	.000
Red	6	5.00	.000	.000
Total	40	4.95	.221	.035

5 point scale: 1= less important, 5= more important

K.30 **Q92 Satisfaction with School**

K.30.1 **Students – frequency table and post-hoc tests**

Descriptives — **Post Hoc Homogeneous Subsets**

Q92 Student satisfaction with school — **Tukey HSD**[a,b]

School	*N*	Mean	Std. Deviation	Std. Error		Subset for alpha = 0.05: 1	2
Yellow	21	2.90	1.261	.275		2.90	
White	49	3.39	1.187	.170		3.39	3.39
Orange	42	2.93	1.386	.214		2.93	
Red	25	3.80	1.354	.271			3.80
Total	137	3.25	1.322	.113	Sig.	.467	.601

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 30.341.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

5 point scale: 1=not much, 5=most of the time

K.30.2 **Staff – frequency table**

Descriptives

Q92 – Staff satisfaction with job

School	*N*	Mean	Std. Deviation	Std. Error
Yellow	4	4.25	.957	.479
White	19	3.68	1.157	.265
Orange	12	4.25	1.055	.305
Red	6	4.33	.816	.333
Total	41	4.00	1.072	.167

5 point scale: 1= less satisfactory, 5= satisfactory

K.31 **Factor extraction – Students only**

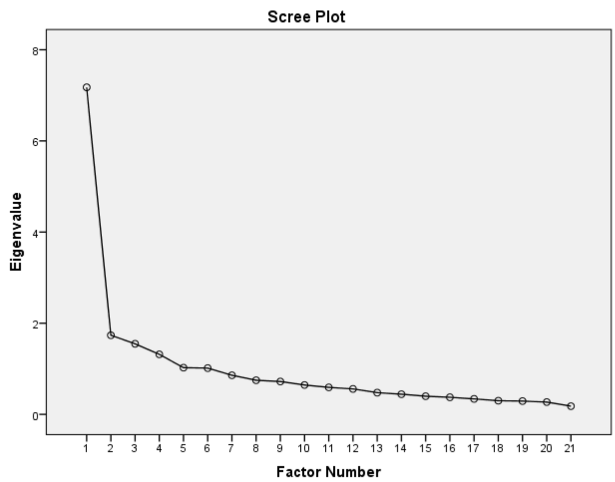
K.31.1 **Factor extraction results**

The following tables are the full results for the summary Table 6.61

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadingsa
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.175	34.169	34.169	6.705	31.929	31.929	5.058
2	1.736	8.265	42.433	1.351	6.435	38.364	4.447
3	1.548	7.370	49.803	1.062	5.055	43.419	2.512
4	1.317	6.270	56.073	.786	3.742	47.161	3.329
5	1.023	4.873	60.946	.520	2.478	49.640	2.484
6	1.014	4.830	65.775				
7	.857	4.082	69.857				
8	.748	3.562	73.420				
9	.720	3.430	76.850				
10	.644	3.067	79.917				
11	.591	2.816	82.732				
12	.558	2.658	85.391				
13	.476	2.266	87.657				
14	.442	2.106	89.763				
15	.397	1.891	91.654				
16	.374	1.783	93.437				
17	.339	1.615	95.052				
18	.299	1.425	96.478				
19	.291	1.385	97.862				
20	.269	1.283	99.145				
21	.180	.855	100.000				

Extraction Method: Principal Axis Factoring.
a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.



Factor Matrix[a]

	Factor				
	1	2	3	4	5
Q18BadforlearningVsGoodforlearning	.737	.056	.249	-.096	.024
Q19UnhealthyVsHealthy	.690	.108	.479	-.107	-.101
Q44WintAirSmellsCleanVsDirty	-.643	.621	.056	-.009	.083
Q40SumAirSmellsCleanVsDirty	-.642	.474	.171	-.103	.027
Q16NeedsworkVsWellmaintained	.633	.146	.217	-.070	.251
Q17NotSafeVsSafe	.632	.009	.250	-.257	.003
Q15BoringVsInteresting	.631	.386	-.213	.044	-.369
Q20NotProudofVsProudof	.625	.260	.036	.189	-.153
Q22WaterSavingDifficultVsEasy	.586	-.020	.092	-.139	-.015
Q64ViewsUglyVsAttractive	.554	.139	-.074	.331	.106
Q43WintAirFreshVsStale	-.548	.416	.109	.026	.146
Q14DirtyVsClean	.545	.065	.386	.181	-.077
Q39SumAirFreshVsStale	-.542	.363	.012	-.191	-.004
Q10YoursSCLsustainableNoVsYes	.541	.033	-.086	.018	.354
Q92LikeSCLNotmuchVsMostly	.501	.283	-.322	-.034	-.152
Q21EnergySavingDifficultVsEasy	.462	.021	.038	-.011	.083
Q65ViewsDistractVsCalm	.458	.193	-.197	.437	.137
Q53LightingHelpsLearningRarelyVsNearlyAlways	.445	.128	-.155	.033	.199
Q31UndersandVoiceRarelyVsNearlyAlways	.444	.150	-.251	-.357	-.005
Q30NoiseQuietVsLoud	-.440	-.052	.303	.155	.024
Q34RaiseVoiceRarelyVsNearlyalways	-.418	-.006	.275	.320	-.162

Extraction Method: Principal Axis Factoring.
a. 5 factors extracted. 15 iterations required.

Pattern Matrix[a]

	Factor				
	1	2	3	4	5
Q19UnhealthyVsHealthy	.882	-.009	.080	-.102	-.095
Q18BadforlearningVsGoodforlearning	.651	-.107	-.088	.057	-.045
Q17NotSafeVsSafe	.645	-.091	-.183	-.120	-.001
Q14DirtyVsClean	.604	-.081	.285	.115	-.097
Q16NeedsworkVsWellmaintained	.595	.076	-.166	.255	.123
Q22WaterSavingDifficultVsEasy	.408	-.178	-.157	-.017	-.063
Q21EnergySavingDifficultVsEasy	.267	-.104	-.105	.151	-.006
Q44WintAirSmellsCleanVsDirty	-.044	.917	.009	.091	-.074
Q40SumAirSmellsCleanVsDirty	.062	.798	.043	-.101	-.006
Q43WintAirFreshVsStale	-.018	.695	.060	.104	.074
Q39SumAirFreshVsStale	-.060	.613	-.108	-.158	-.042
Q34RaiseVoiceRarelyVsNearlyalways	-.030	.102	.552	-.049	-.019
Q31UndersandVoiceRarelyVsNearlyAlways	.117	.005	-.535	-.055	-.191
Q30NoiseQuietVsLoud	.040	.158	.376	-.068	.207
Q65ViewsDistractVsCalm	-.083	-.065	.077	.653	-.175
Q64ViewsUglyVsAttractive	.108	-.108	.064	.520	-.140
Q10YoursSCLsustainableNoVsYes	.177	-.080	-.269	.427	.174
Q53LightingHelpsLearningRarelyVsNearlyAlways	.079	-.014	-.237	.356	-.017
Q15BoringVsInteresting	.160	.005	-.124	.093	-.706
Q92LikeSCLNotmuchVsMostly	-.009	-.006	-.290	.160	-.464
Q20NotProudofVsProudof	.333	-.024	.075	.246	-.387

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 33 iterations.

Structure Matrix

	Factor				
	1	2	3	4	5
Q19UnhealthyVsHealthy	.849	-.401	-.184	.285	-.318
Q18BadforlearningVsGoodforlearning	.767	-.485	-.341	.406	-.312
Q17NotSafeVsSafe	.694	-.422	-.375	.230	-.226
Q16NeedsworkVsWellmaintained	.677	-.333	-.352	.478	-.169
Q14DirtyVsClean	.637	-.351	.028	.361	-.274
Q22WaterSavingDifficultVsEasy	.555	-.437	-.347	.280	-.264
Q21EnergySavingDifficultVsEasy	.414	-.325	-.257	.329	-.189
Q44WintAirSmellsCleanVsDirty	-.435	.891	.274	-.240	.124
Q40SumAirSmellsCleanVsDirty	-.382	.816	.301	-.374	.204
Q43WintAirFreshVsStale	-.355	.702	.278	-.197	.220
Q39SumAirFreshVsStale	-.382	.656	.134	-.366	.146
Q34RaiseVoiceRarelyVsNearlyalways	-.259	.306	.601	-.228	.163
Q31UndersandVoiceRarelyVsNearlyAlways	.310	-.247	-.600	.188	-.336
Q30NoiseQuietVsLoud	-.242	.331	.481	-.270	.344
Q65ViewsDistractVsCalm	.255	-.278	-.121	.681	-.364
Q64ViewsUglyVsAttractive	.404	-.363	-.165	.636	-.357
Q10YoursSCLsustainableNoVsYes	.422	-.368	-.411	.539	-.107
Q53LightingHelpsLearningRarelyVsNearlyAlways	.312	-.262	-.357	.458	-.221
Q15BoringVsInteresting	.453	-.311	-.362	.426	-.815
Q92LikeSCLNotmuchVsMostly	.292	-.260	-.439	.385	-.585
Q20NotProudofVsProudof	.546	-.343	-.185	.506	-.561

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4	5
1	1.000	-.490	-.298	.421	-.311
2	-.490	1.000	.318	-.365	.232
3	-.298	.318	1.000	-.246	.239
4	.421	-.365	-.246	1.000	-.335
5	-.311	.232	.239	-.335	1.000

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

Appendix L Qualitative response code frequency and multiple choice tables

L.1 Q01 School pedagogy and learning activities

L.1.1 Students – Q1-8 learning activity multple response multiple choice

$LearningActivities*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Sit at your desk and work alone	Count	18	46	35	17	116
	% within $LearningActivities	15.5%	39.7%	30.2%	14.7%	
	% within CaseStudySchool	78.3%	88.5%	74.5%	70.8%	
	% of Total	12.3%	31.5%	24.0%	11.6%	79.5%
Sit on the floor and work alone	Count	0	2	0	1	3
	% within $LearningActivities	0.0%	66.7%	0.0%	33.3%	
	% within CaseStudySchool	0.0%	3.8%	0.0%	4.2%	
	% of Total	0.0%	1.4%	0.0%	0.7%	2.1%
Work alone somewhere else	Count	2	3	4	3	12
	% within $LearningActivities	16.7%	25.0%	33.3%	25.0%	
	% within CaseStudySchool	8.7%	5.8%	8.5%	12.5%	
	% of Total	1.4%	2.1%	2.7%	2.1%	8.2%
Work in a group at your desk	Count	14	40	42	14	110
	% within $LearningActivities	12.7%	36.4%	38.2%	12.7%	
	% within CaseStudySchool	60.9%	76.9%	89.4%	58.3%	
	% of Total	9.6%	27.4%	28.8%	9.6%	75.3%
Work in a group on the floor	Count	4	12	5	7	28
	% within $LearningActivities	14.3%	42.9%	17.9%	25.0%	
	% within CaseStudySchool	17.4%	23.1%	10.6%	29.2%	
	% of Total	2.7%	8.2%	3.4%	4.8%	19.2%
Work in a group somewhere else	Count	1	12	5	3	21
	% within $LearningActivities	4.8%	57.1%	23.8%	14.3%	
	% within CaseStudySchool	4.3%	23.1%	10.6%	12.5%	
	% of Total	0.7%	8.2%	3.4%	2.1%	14.4%
Work on a computer at your desk	Count	8	11	26	0	45
	% within $LearningActivities	17.8%	24.4%	57.8%	0.0%	
	% within CaseStudySchool	34.8%	21.2%	55.3%	0.0%	
	% of Total	5.5%	7.5%	17.8%	0.0%	30.8%
Work on a computer somewhere else	Count	13	23	13	16	65
	% within $LearningActivities	20.0%	35.4%	20.0%	24.6%	
	% within CaseStudySchool	56.5%	44.2%	27.7%	66.7%	
	% of Total	8.9%	15.8%	8.9%	11.0%	44.5%
Total	Count	23	52	47	24	146
	% of Total	15.8%	35.6%	32.2%	16.4%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.1.2 Response rates by school – staff

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	4	100.0%
White	22	16	72.7%
Orange	12	11	91.7%
Red	6	6	100.0%
frequency	*44*	*37*	84.1%

L.1.3 Staff – open question

Category Code	Detail Code	Total	Yellow	White	Orange	Red
Constructivist	Constructivist	7	1	1	3	2
Group / collaborative inquiry	Group / collaborative inquiry	7	0	5	2	0
Student centred	Student centred - inquiry	7	3	0	2	2
Student centred	Student Centred - whole child, start from where they are	7	0	1	2	4
Early years	Early years	6	0	6	0	0
Teaching – traditional	Teaching - whole class / 'traditional' / large classes	5	1	4	0	0
Architecture	Architecture - does not match pedagogy	4	0	4	0	0
Teaching – team teaching	Team teaching / composite classes	4	0	0	4	0
Inqury based	Inqury based	3	0	0	0	3
SA TeFL	SA 'Teaching for Effective Learning'	3	1	2	0	0
Specialist subjects	Specialist subjects	3	0	0	2	1
Teaching - explicit	Teaching - explicit	3	0	0	0	3
Australian Curriculum	Australian Curriculum	2	0	1	1	0
Learning	Learning - Expert learners, active learning	2	0	0	0	2
Literacy / numeracy	Literacy / numeracy	2	0	0	1	1
Student centred	Student centred - Negotiated education plan	2	0	0	1	1
Teaching – traditional	Teaching - teacher directed	2	2	0	0	0
21st century learning	21st century learning	1	0	0	0	1
Architecture	Architecture - Pedagogy modification to match classroom	1	1	0	0	0
Architecture	Architecture - group work difficult, impossible	1	1	0	0	0
ICT	ICT - computers	1	0	0	1	0
ICT	ICT - IWB	1	0	0	1	0
Learning	Learning - differentiated learning	1	0	0	1	0
Mixed T&L	Mixed T&L - reason not given	1	1	0	0	0
Mixed T&L	Mixed T&L - due to different staff styles	1	0	0	1	0

L.2 Q09 School uniqueness

L.2.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	17	73.9%	4	4	100.0%
White	52	39	75.0%	22	22	100.0%
Orange	47	44	93.6%	12	12	100.0%
Red	25	16	64.0%	6	6	100.0%
frequency	*147*	*116*	*78.9%*	*44*	*44*	*100.0%*

L.2.2 Students

category code	code detail	Total Freq	Yellow	White	Orange	Red
Facilities - Grounds	Facilities - Grounds - ecosystem	19	0	18	0	1
History / age	History / age - "old"	17	15	0	0	2
Facilities - Grounds	Facilities - Grounds - site plan	13	0	7	6	0
History / age	History / age - History	11	5	0	0	6
Culture	Culture - people described positively	7	1	3	3	0
Facilities - Buildings	Facilities - Buildings - Gym	7	0	2	5	0
Visual appearance	Visual appearance - shape	7	0	6	1	0
Other - dissenting	Other - dissenting	6	0	2	4	0
Size	Size - large	6	0	2	4	0
Size	Size - small - good	6	1	0	0	5
Teaching / learning	Teaching / learning - teachers described positively	6	1	2	3	0
Visual appearance	Visual appearance - colour	5	0	0	4	1
Buildings - elements	Buildings - elements - Heritage / old	4	2	0	0	2
Community - school	Community - school - community/parents	4	0	1	0	3
Facilities - Buildings	Facilities - Buildings - different types	4	0	0	3	1
Teaching / learning	Teaching / Learning - helps students learn	4	0	0	3	1
Teaching / learning	Teaching / Learning - co-teaching	4	0	0	4	0
Visual appearance	Visual appearance - style description	4	1	1	2	0
Buildings - elements	Buildings - elements - materials	3	0	0	3	0
Facilities - Grounds	Facilities - Grounds - playgrounds / ovals	3	0	0	3	0
History / age	History / age - development	3	1	0	1	1
Sustainability	Sustainability - "focus", "carbon neutral"	3	0	0	1	2

category code	code detail	Total Freq	Yellow	White	Orange	Red
Teaching / learning	Teaching / Learning - special program	3	0	0	0	3
Buildings - elements	Buildings - elements - ventilation	2	0	2	0	0
Buildings - elements	Buildings - elements - skylights	2	0	0	2	0
Culture	Culture - Friendship	2	1	0	1	0
Culture	Culture - "fun"	2	0	0	2	0
Culture	Culture - multicultural	2	0	2	0	0
Culture	Culture - outdoors	2	0	2	0	0
Facilities - Classrooms	Facilities - classrooms - good for learning	2	0	0	1	1
Facilities - Classrooms	Facilities - Classrooms - layout	2	0	0	2	0
Facilities - Classrooms	Facilities - Classrooms - size - large	2	0	0	2	0
ICT	ICT - IWB	2	0	0	2	0
Culture	Culture -"normal"	1	0	0	1	0
Culture	Culture - building identity	1	0	0	1	0
Facilities - Classrooms	Facilities - Classrooms - good thermal comfort	1	0	0	1	0
Facilities - General	Facilities - general - different to other schools	1	0	1	0	0
Facilities - Grounds	Facilities - Grounds - clean	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - general positive	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - "garden"	1	0	0	1	0
Other - assenting	Other - assenting	1	0	0	1	0
Other - indeterminate	Other - indeterminate	1	0	0	1	0
Policy	Policy - zoned	1	0	0	0	1
Visual appearance	Visual appearance - good	1	1	0	0	0

L.2.3 Staff

category code	code detail	Total	Yellow	White	Orange	Red
Facilities - Grounds	Facilities - Grounds - site plan - different campuses	19	0	13	6	0
Facilities - Grounds	Facilities - Grounds - ecosystem	18	0	18	0	0
Buildings - elements	Buildings - elements - materials	7	0	0	7	0
Buildings - elements	Buildings - elements - Heritage / old	7	2	0	0	5
History / age	History / age - History	7	1	0	0	6
Location	Location - close to community & facilities	6	2	2	0	2
Size	Size - large	6	0	3	3	0
Buildings - elements	Buildings - elements - ventilation	4	0	0	4	0
Culture	Culture - multicultural & english as language or dialect	4	0	3	0	1
Facilities - General	Facilities - General - shared	4	0	0	4	0
Facilities - Grounds	Facilities - Grounds - flooding, restricted access	4	0	4	0	0
Sustainability	Sustainability - sustainable development	3	0	1	2	0
Visual appearance	Visual appearance - good	3	0	0	1	2
Visual appearance	Visual appearance - style description - contemporary, modern	3	0	2	1	0
Buildings - elements	Buildings - elements - windows large	2	0	0	1	1
Buildings - elements	Buildings - elements - automated HVAC/Windows	2	0	1	1	0
Community - school	Community - school - community/parents	2	1	0	0	1
Culture	Culture - classroom groups create identities	2	0	0	2	0
History / age	History / age - new	2	0	2	0	0
Visual appearance	Visual appearance - shape, form	2	0	0	2	0
Buildings - elements	Buildings - elements - skylights	1	0	0	1	0
Facilities - Buildings	Facilities - Buildings - prep and wet areas as well as classrooms	1	0	0	1	0
Facilities - Classrooms	Facilities - Classrooms - grouped	1	0	0	1	0
Facilities - Classrooms	Facilities - Classrooms - layout	1	0	0	1	0
Facilities - General	Facilities - General - well resourced	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - limited play/sports areas	1	1	0	0	0
Facilities - Grounds	Facilities - Grounds - site plan - compact	1	1	0	0	0
Other - assenting	Other - assenting	1	0	0	0	1
Security / safety	Security / safety - fencing good	1	0	0	1	0
Security / safety	Security / safety - unsafe due to flooding	1	0	1	0	0
Size	Size - small - good	1	0	0	0	1
Teaching / learning	Teaching / learning - teachers described positively	1	0	0	0	1
Teaching / learning	Teaching / learning - sports	1	0	0	1	0
Visual appearance	Visual appearance - new	1	0	1	0	0
Visual appearance	Visual appearance - landscape	1	0	0	1	0
Visual appearance	Visual appearance - old and new	1	0	0	0	1

L.3 Q11 Expectations of school sustainability

L.3.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	10	43.5%	4	4	100.0%
White	52	26	50.0%	22	13	59.1%
Orange	47	26	55.3%	12	9	75.0%
Red	25	14	56.0%	6	3	50.0%
Frequency	*147*	*76*	*51.7%*	*44*	*29*	*65.9%*

L.3.2 Students

category code	response type code	code detail	Total Freq	Yellow	White	Orange	Red
Daily management	expectation	Daily Management - to be clean, no litter	11	0	8	0	3
Energy	expectation	Energy - Photovoltaic panels	11	2	2	3	4
Energy	expectation	Energy - Saving (non-PV)	8	3	0	1	4
Recycling / waste reduction	expectation	Recycling / waste reduction	8	3	1	0	4
Facilities - Grounds	observation	Facilities - Grounds - outdoor ecosystem	7	0	7	0	0
Other - don't know	unclear	Other - don't know	6	1	1	4	0
Water	expectation	Water - save / reduce use / turn off taps	5	1	2	0	2
Facilities - Grounds	expectation	Facilities - Grounds - plants	4	1	2	1	0
Buildings - Elements	observation	Buildings - Elements - materials observed	3	0	0	3	0
Buildings - Elements	expectation	Buildings - Elements - windows / skylights	3	0	1	1	1
Daily management	expectation	Daily Management - need more outdoor bins	3	0	3	0	0
Facilities - Buildings	expectation	Facilities - buildings - good quality	3	0	1	2	0
Facilities - Grounds	expectation	Facilities - Grounds - food production	3	0	1	0	2
Facilities - Grounds	expectation	Facilities - Grounds - shade	3	0	0	3	0
Other - assenting	expectation	Other - assenting	3	1	1	1	0
Other - indeterminate	unclear	Other - indeterminate	3	0	1	2	0
Sustainability	expectation	Sustainability - needs more	3	1	1	1	0
Visual appearance	expectation	Visual perceptions - buildings more attractive / "modern"	3	0	0	3	0
Water	expectation	Water - RWT	3	1	0	1	1
Buildings - Elements	expectation	Buildings - Elements - materials expected	2	0	1	1	0
Culture	observation	Culture - follow school rules	2	1	0	1	0
Daily management	observation	Daily Management - needs cleaning	2	0	2	0	0
Other - dispute premise	expectation	Other - dispute premise - no expectations	2	1	0	1	0
Water	expectation	Water - recycle	2	0	2	0	0
Buildings - Elements	expectation	Buildings - Elements - insulation	1	0	0	0	1
Facilities - Buildings	expectation	Facilities - Buildings - sustainable	1	0	0	0	1
Facilities - Grounds	expectation	Facilities - Grounds - play areas / equipment	1	0	0	1	0
Facilities maintenance / repair	expectation	FM - Heritage - maintain	1	0	0	0	1
Facilities maintenance / repair	expectation	FM - maintenance / remair - good	1	0	0	1	0
Student activity	observation	Student Activity - cleaning	1	0	1	0	0
Teaching	expectation	Teaching - help with learning	1	0	0	1	0
Teaching	expectation	Teaching - need more about pollution	1	0	1	0	0

L.3.3 Staff

category code	response type code	code detail	Total	Yellow	White	Orange	Red
Energy	expectation	Energy - Saving (non-PV)	9	0	3	3	3
Energy	expectation	Energy - energy efficiency	6	1	5	0	0
Recycling / waste reduction	expectation	Recycling / waste reduction	6	1	3	1	1
Water	expectation	Water - save / reduce use / turn off taps	6	0	2	3	1
Energy	expectation	Energy - Photovoltaic panels	4	1	1	2	0
Energy	expectation	Energy - use monitoring and management	4	1	1	2	0
Water	expectation	Water - RWT or other collection	4	0	1	2	1
Water	expectation	Water - recycle	3	1	1	1	0
Energy	observation	Energy - saving - timers	2	0	0	1	1
Facilities - Grounds	expectation	Facilities - Grounds - low maintenance and water design	2	0	2	0	0
ICT / technology	expectation	ICT / technology - innovative use	2	1	0	1	0
Buildings - Elements	expectation	Buildings - Elements - blinds	1	0	0	0	1
Buildings - Elements	expectation	Buildings - Elements - ceiling fans	1	0	0	1	0
Culture	expectation	Culture - community contribution	1	1	0	0	0
Design	expectation	Design - located to serve community	1	0	0	1	0
Design	expectation	Design - optimise available space	1	0	0	1	0
Design	expectation	Design - restrict size	1	0	0	1	0
Facilities - Buildings	observation	Facilities - Buildings - use of temporary buildings	1	0	0	1	0
Facilities - Grounds	expectation	Facilities - Grounds - food production	1	0	0	0	1
Facilities - Grounds	expectation	Facilities - Grounds - trees and tree growth	1	0	1	0	0
Facilities maintenance / repair	observation	FM - HVAC Systems - ensure working correctly	1	0	1	0	0
Other - assenting	expectation	Other - assenting	1	0	0	1	0
Other - don't know	unclear	Other - don't know	1	1	0	0	0
Other - indeterminate	unclear	Other - indeterminate	1	0	1	0	0
Procurement	expectation	Procurement - purchase recyclable consumables	1	0	0	0	1
Teaching	expectation	Teaching - garden & nutrition program	1	0	0	0	1
Teaching	expectation	Teaching - excellence in teaching and learning	1	1	0	0	0
Water	expectation	Water - subsurface irrigation	1	0	0	1	0

L.4 Q12 Sustainaiblity features at school

L.4.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	8	34.8%	4	4	100.0%
White	52	43	82.7%	22	18	81.8%
Orange	47	32	68.1%	12	12	100.0%
Red	25	14	56.0%	6	6	100.0%
Frequency	*147*	*97*	*66.0%*	*44*	*40*	*90.9%*

L.4.2 Students

category code	code detail	Total Freq	Yellow	White	Orange	Red
Recycling / waste reduction	Recycling / waste reduction	24	0	14	0	10
Energy	Energy - lights - timers / automatic	13	0	1	7	5
Buildings - Elements	Buildings - Elements - windows / skylights / nat light	12	1	4	6	1
Energy	Energy - PV	11	2	2	3	4
Student activity	Student activity - composting / gardening	11	0	3	0	8
Facilities - Grounds	Facilities - Grounds - gardens / plants	10	1	5	0	4
Facilities - Grounds	Facilities - Grounds - ecosystem	9	0	9	0	0
Student activity	Student activity - clean up	9	1	6	0	2
Facilities - Grounds	Facilities - Grounds - playground / equipment / furniture	8	1	1	6	0
Energy	Energy - AC - timers / automatic	7	0	4	0	3
Facilities - Buildings	Facilities - Buildings - Gym / Hall	7	1	2	4	0
Buildings - Elements	Buildings - Elements - windows automatic	6	0	6	0	0
Other - don't know	Other - don't know	6	2	1	2	1
Energy	Energy - use reduced by building design	5	1	2	2	0
Facilities - Buildings	Facilities - Buildings - not specified	4	2	0	2	0
Facilities - Grounds	Facilities - Grounds - sports	4	0	0	4	0
Water	Water - recycled	4	0	4	0	0
Buildings - Elements	Buildings - Elements - materials	3	0	0	3	0
Daily management	Daily Management - not littering	3	0	3	0	0
Facilities - Buildings	Facilities - Buildings - library	3	0	0	3	0
Teaching	Teaching - non-environment topics	3	1	0	1	1
Water	Water - RWT	3	1	0	0	2
Culture	Culture - identity	2	0	0	2	0
Facilities - Buildings	Facilities - Buildings - new	2	0	1	1	0
Facilities - Grounds	Facilities - Grounds - food production	2	0	0	0	2
Facilities - Grounds	Facilities - Grounds - site plan	2	0	1	1	0
ICT	ICT	2	0	0	2	0
Other - assenting	Other - assenting	2	0	1	1	0
Other - indeterminate	Other - indeterminate	2	2	0	0	0
Teaching	Teaching - sustainability	2	0	1	0	1
Buildings - Elements	Buildings - Elements - window orientation	1	0	1	0	0
Buildings - Elements	Buildings - Elements - Ventilation	1	0	0	1	0
Buildings - Elements	Buildings - Elements - verandahs	1	0	0	1	0
Buildings - Elements	Buildings - Elements - sliders between classrooms	1	0	1	0	0
Daily management	Daily Management - easily cleaned	1	0	1	0	0
Facilities - Buildings	Facilities - Buildings - transportables	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - fake grass	1	1	0	0	0
Facilities - Grounds	Facilities - Grounds - grass / fake grass	1	0	0	1	0
Student activity	Student activity - youth environment forum	1	0	1	0	0
Water	Water - saving devices	1	0	1	0	0

L.4.3 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Energy	Energy - PV	16	2	6	6	2
Recycling / waste reduction	Recycling / waste reduction	14	2	7	1	4
Energy	Energy - AC - timers / automatic	13	0	5	6	2
Water	Water - recycled	12	0	10	0	2
Energy	Energy - lights - timers / automatic	9	0	1	4	4
Buildings - Elements	Buildings - Elements - Ventilation	6	0	1	5	0
Buildings - Elements	Buildings - Elements - materials	6	0	0	6	0
Student activity	Student activity - composting / gardening	5	0	3	1	1
Water	Water - RWT and other storage	5	1	0	0	4
Buildings - Elements	Buildings - Elements - windows automatic	4	0	4	0	0
Buildings - Elements	Buildings - Elements - windows / skylights / nat light	3	0	1	2	0
Design	Design - building orientation	3	0	2	1	0
Teaching	Teaching - sustainability	3	0	3	0	0
Buildings - Elements	Buildings - Elements - blinds	2	1	0	0	1
Facilities - Grounds	Facilities - Grounds - food production	2	0	0	0	2
Other - don't know	Other - don't know	2	2	0	0	0
Student activity	Student activity - recycling group	2	0	0	2	0
Buildings - Elements	Buildings - Elements - window tinting	1	0	0	1	0
Buildings - Elements	Buildings - Elements - security	1	0	1	0	0
Culture	Culture - artwork	1	0	0	0	1
Design	Design - activity specific space in buildings	1	0	0	1	0
Energy	Energy - use reduced by building design	1	0	1	0	0
Facilities - Buildings	Facilities - Buildings - old buildings recycled	1	0	0	0	1
Facilities - Buildings	Facilities - Buildings - transportables	1	0	0	1	0
Facilities - Buildings	Facilities - Buildings - not specified	1	0	0	1	0
Facilities - Buildings	Facilities - Buildings - Gym / Hall	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - gardens / plants	1	1	0	0	0
Facilities - Grounds	Facilities - Grounds - sports	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - playground / equipment / furniture	1	0	0	1	0
Facilities - Grounds	Facilities - Grounds - trees and tree growth	1	1	0	0	0
Other - indeterminate	Other - indeterminate	1	0	1	0	0
Teaching	Teaching - non-environment topics	1	1	0	0	0
Teaching	Teaching - excellence in teaching and learning	1	1	0	0	0
Teaching	Teaching - ecosystems	1	0	1	0	0
Water	Water - saving devices	1	0	1	0	0

L.5 Q23-27 What does your school look like?

L.5.1 Students

What does your school look like?*Case Study School Crosstabulation

		Case Study School				Total
		Yellow	White	Orange	Red	
a typical school	Count	14	8	29	9	60
	% within What does your school look like?	23.3%	13.3%	48.3%	15.0%	
	% within Case Study School	63.6%	15.4%	61.7%	47.4%	
	% of Total	10.0%	5.7%	20.7%	6.4%	42.9%
a factory	Count	1	24	3	0	28
	% within What does your school look like?	3.6%	85.7%	10.7%	0.0%	
	% within Case Study School	4.5%	46.2%	6.4%	0.0%	
	% of Total	0.7%	17.1%	2.1%	0.0%	20.0%
a group of houses	Count	0	1	7	4	12
	% within What does your school look like?	0.0%	8.3%	58.3%	33.3%	
	% within Case Study School	0.0%	1.9%	14.9%	21.1%	
	% of Total	0.0%	0.7%	5.0%	2.9%	8.6%
some office buildings	Count	2	10	13	3	28
	% within What does your school look like?	7.1%	35.7%	46.4%	10.7%	
	% within Case Study School	9.1%	19.2%	27.7%	15.8%	
	% of Total	1.4%	7.1%	9.3%	2.1%	20.0%
looks different to other schools – please describe	Count	8	27	10	6	51
	% within What does your school look like?	15.7%	52.9%	19.6%	11.8%	
	% within Case Study School	36.4%	51.9%	21.3%	31.6%	
	% of Total	5.7%	19.3%	7.1%	4.3%	36.4%
Total	Count	22	52	47	19	140
	% of Total	15.7%	37.1%	33.6%	13.6%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.5.2 Staff

What does your school look like*Case Study School Crosstabulation

		Case Study School				Total
		Yellow	White	Orange	Red	
a typical school	Count	0	0	1	2	3
	% within What does your school look like	0.0%	0.0%	33.3%	66.7%	
	% within Case Study School	0.0%	0.0%	8.3%	33.3%	
	% of Total	0.0%	0.0%	2.4%	4.8%	7.1%
a group of houses	Count	0	1	0	0	1
	% within What does your school look like	0.0%	100.0%	0.0%	0.0%	
	% within Case Study School	0.0%	4.8%	0.0%	0.0%	
	% of Total	0.0%	2.4%	0.0%	0.0%	2.4%
a factory	Count	0	18	2	0	20
	% within What does your school look like	0.0%	90.0%	10.0%	0.0%	
	% within Case Study School	0.0%	85.7%	16.7%	0.0%	
	% of Total	0.0%	42.9%	4.8%	0.0%	47.6%
some office buildings	Count	0	0	0	0	0
	% within What does your school look like	0.0%	0.0%	0.0%	0.0%	
	% within Case Study School	0.0%	0.0%	0.0%	0.0%	
	% of Total	0.0%	0.0%	0.0%	0.0%	0.0%
looks different to other schools	Count	3	3	9	4	19
	% within What does your school look like	15.8%	15.8%	47.4%	21.1%	
	% within Case Study School	100.0%	14.3%	75.0%	66.7%	
	% of Total	7.1%	7.1%	21.4%	9.5%	45.2%
Total	Count	3	21	12	6	42
	% of Total	7.1%	50.0%	28.6%	14.3%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.6 Q27 Does your school look different to other schools - please say how

L.6.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	8	34.8%	4	3	75.0%
White	52	27	51.9%	22	3	13.6%
Orange	47	10	21.3%	12	9	75.0%
Red	25	6	24.0%	6	4	66.7%
Frequency	*147*	*51*	*34.7%*	*44*	*19*	*43.2%*

L.6.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
History / age	History / age - old	11	6	0	0	5
Facilities - grounds	Facilities - grounds - districts	9	0	5	4	0
Visual appearance	Visual appearance - "odd", "odd shaped", "weird shapes", "different", "strange"	8	0	7	0	1
Facilities - grounds	Facilities - grounds - large	6	0	4	2	0
Visual appearance	Visual appearance - "factory", "triangualar", "slanted"	6	0	6	0	0
Description	Description - "lovely", "charm", "nice", "looks friendly", "good atmosphere"	5	1	0	0	4
Facilities - grounds	Facilities - grounds - ecosystem	5	0	5	0	0
Visual appearance	visual appearance - "modern"	5	1	3	0	1
Buildings - elements	Buildings - elements - materials	4	1	0	2	1
Facilities - buildings	Facilities - buildings - outdoor circulation	3	0	2	1	0
Other - indeterminate	Other - indeterminate	3	1	1	1	0
Visual appearance	Visual appearance - old and new mixture	2	1	0	0	1
Buildings - elements	Buildings - elements - many windows	1	0	1	0	0
Safety / security	Safety / security - better than other schools	1	0	0	1	0
Facilities - buildings	Facilities - buildings - large gym	1	0	1	0	0
Facilities - grounds	Facilities - grounds - well maintained	1	0	1	0	0
Facilities - grounds	Facilities - grounds - mostly hardstand	1	0	1	0	0
Facilities - grounds	Facilities - grounds - playgrounds	1	0	1	0	0
Facilities - grounds	Facilities - grounds - oval	1	0	1	0	0
Facilities - grounds	Facilities - grounds - shared with community	1	0	0	1	0
Facilities - grounds	Facilities - grounds - legible	1	0	1	0	0
History / age	History / age - new	1	0	1	0	0
Visual appearance	Visual appearance - "castle"	1	1	0	0	0
Visual appearance	Visual appearance - "big house"	1	1	0	0	0
Visual appearance	Visual appearance - grounds - attractive	1	0	1	0	0

L.6.3 Staff

Category Code	Detail Code	Total	Yellow	White	Orange	Red
History / age	History / age - old	7	3	0	0	4
Buildings - elements	Buildings - elements - materials	5	1	0	4	0
Buildings - elements	Buildings - elements - roof vents	5	0	0	5	0
Visual appearance	Visual appearance - "factory", "triangular", "slanted"	3	0	1	2	0
Visual appearance	Visual appearance - old	3	1	0	0	2
Facilities - grounds	Facilities - grounds - site plan building groups	2	0	0	2	0
History / age	History / age - new	2	1	0	1	0
Visual appearance	visual appearance - "modern"	2	2	0	0	0
Visual appearance	Visual appearance - old and new mixture	2	2	0	0	0
Buildings - elements	Buildings - elements - many windows	1	1	0	0	0
Description	Description – pleasant, "fresh"	1	0	0	1	0
Visual appearance	Visual appearance - fresh, inviting	1	0	0	1	0

L.7 Q29 What do you like most about the exterior of your school?

L.7.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	17	73.9%	4	4	100.0%
White	52	49	94.2%	22	17	77.3%
Orange	47	39	83.0%	12	12	100.0%
Red	25	21	84.0%	6	6	100.0%
Frequency	*147*	*126*	*85.7%*	*44*	*39*	88.6%

L.7.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Facilities - grounds - used	Facilities - grounds - Playgrounds, play area	40	0	26	10	4
Facilities - grounds - viewed	Facilities - grounds - trees, plants, non-productive gardens	23	3	4	9	7
Facilities - buildings	Facilities - buildings - hall / gym	17	3	7	6	1
Facilities - grounds - used	Facilities - grounds - ovals	15	0	8	6	1
Visual appearance	Visual appearance - 'design', style, 'look'	11	1	3	3	4
Facilities - grounds - used	Facilities - grounds - grass, grass areas	10	2	6	0	2
Facilities - grounds - used	Facilities - grounds - fake grass	9	9	0	0	0
Facilities - grounds - viewed	Facilities - grounds - large school	9	0	2	4	3
Activity	Activity - fun	8	0	3	5	0
Facilities - grounds - used	Facilities - grounds - hardplay, outdoor courts areas	7	0	3	2	2
Facilities - grounds - used	Facilities - grounds - ecosystem	6	0	6	0	0
Facilities - grounds - used	Facilities - grounds - seating, tables	6	0	2	2	2
Places	Places - for different social groups	5	3	2	0	0
Safety / security	Safety / security - school perceived as safe	5	0	1	3	1
Facilities - buildings	Facilities - buildings - generally liked	4	1	3	0	0
Facilities - grounds - used	Facilities - grounds - food production garden	4	2	0	1	1
Facilities - grounds - used	Facilities - grounds - variety, exploration, choice	4	0	2	2	0
Other - dispute premise	Other - dispute premise - like nothing	4	0	2	2	0
Visual appearance	Visual appearance - old	4	0	0	0	4
Facilities - buildings	Facilities - buildings - library / resources	3	1	0	2	0
Other - dissenting	Other - dissenting	3	0	2	1	0
Visual appearance	Visual appearance - the form and colour	3	0	1	1	1
Activity	Activity - sit, 'hang out' in places	2	1	0	1	0
Activity	Activity - walking around	2	0	0	2	0
Activity	Activity - with others	2	1	0	1	0
Buildings - elements	Buildings - elements - wall material	2	1	0	0	1
Other - indeterminate	Other - indeterminate	2	1	1	0	0
Visual appearance	Visual appearance - new, 'modern'	2	0	0	2	0
Activity	Activity - planting gardens	1	1	0	0	0
Culture	Culture - 'outside school'	1	0	1	0	0
Daily management	Daily management - lost balls	1	0	1	0	0
Facilities - grounds - used	Facilities - grounds - courtyards	1	0	1	0	0
Facilities - grounds - used	Facilities - grounds - shade	1	0	0	1	0
Facilities - grounds - used	Facilities - grounds - water fountains accessible	1	0	1	0	0
Facilities maintenance / repair	Facilities maintenance / repair - good	1	0	0	1	0
Other - don't know	Other - don't know	1	0	0	1	0
Visual appearance	Visual appearance - soft landscaping	1	0	0	1	0
Visual appearance	Visual appearance - uniform style	1	0	0	1	0
Visual appearance	Visual appearance - variety - old and new	1	0	0	0	1

L.7.3 Staff

category code	code detail	Total	Yellow	White	Orange	Red
Visual appearance	Visual appearance - old	8	4	0	0	4
Visual appearance	Visual appearance - the form and colour	8	0	1	5	2
Buildings - elements	Buildings - elements - wall material	7	1	0	4	2
Facilities - grounds - viewed	Facilities - grounds - trees, plants, non-productive gardens	7	0	2	5	0
Facilities maintenance / repair	Facilities maintenance / repair - good	4	0	1	3	0
Visual appearance	Visual appearance - 'design', style, 'look'	4	0	0	2	2
Visual appearance	Visual appearance - 'different', 'unique'	4	0	3	1	0
Facilities - grounds	Facilities - grounds - unspecified	3	0	3	0	0
Site plan	Site plan - open, un-fenced	3	0	2	0	1
Daily management	Daily management - clean	2	0	1	1	0
Feeling	Feeling - space	2	0	1	0	1
Feeling	Feeling - solid, impressive	2	0	0	0	2
Other - dissenting	Other - dissenting	2	0	1	0	1
Sustainability	Sustainability - ecological / environmental features	2	0	2	0	0
Visual appearance	Visual appearance - new, 'modern'	2	0	1	1	0
Visual appearance	Visual appearance - variety - materials	2	0	1	1	0
Building - Elements	Building - Elements - Windows - many	1	0	0	1	0
Building - Elements	Building - Elements - Windows - tinted	1	0	0	1	0
Facilities - grounds - used	Facilities - grounds - used - circulation	1	0	1	0	0
Facilities - grounds - used	Facilities - grounds - courtyards	1	0	1	0	0
Facilities - grounds - used	Facilities - grounds - grass, grass areas	1	0	1	0	0
Facilities - grounds - used	Facilities - grounds - seating, tables	1	0	0	1	0
Facilities - grounds - used	Facilities - grounds - shade	1	0	0	1	0
Facilities - grounds - viewed	Facilities - grounds - large school	1	0	1	0	0
Feeling	Feeling - inviting	1	0	0	1	0
Site plan	Site plan - improved car parking	1	0	0	1	0
Visual appearance	Visual appearance - art, sculpture	1	0	1	0	0
Visual appearance	Visual appearance - variety - old and new	1	1	0	0	0

L.8 Q36 Any other comments about noise and sound

L.8.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	7	30.4%	4	2	50.0%
White	52	8	15.4%	22	8	36.4%
Orange	46	18	39.1%	12	5	41.7%
Red	25	5	20.0%	6	3	50.0%
Total frequency	*147*	*38*	*25.9%*	*44*	*18*	*40.9%*

L.8.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Noise level	Noise level - loud	15	6	0	8	1
Noise source (classroom)	Noise source - adjacent class shared room	8	6	0	0	2
Other - No further comments	Other - No further comments	8	1	2	5	0
Noise source (classroom)	Noise source - own class	5	0	0	5	0
Sound quality	Sound quality - echos	5	1	1	2	1
Learning disruption	Learning disruption	4	2	0	1	1
Noise ingress	Noise ingress - from outside learning activities	4	0	1	3	0
Facilities - building design	Facilities - building design - causes noise ingress	3	0	2	1	0
Facilities - building design	Facilities - building design - acoustic panels	2	0	0	0	2
Noise ingress	Noise ingress - nature	2	0	2	0	0
Noise ingress	Noise ingress - when door / window open	2	0	1	1	0
Other - assenting	Other - assenting	2	0	2	0	0
Behaviour - others	Behaviour - others - banging on wall	1	0	0	1	0
Behaviour - own	behaviour - own - yell	1	0	0	1	0
Behaviour - own	behaviour - own - whisper	1	0	0	1	0
Behaviour - own	behaviour - own - close up the room to stop ingress	1	0	0	1	0
Facilities - building design	Facilities - building design - high ceilings cause echo	1	1	0	0	0
Facilities - building design	Facilities - building design - walls block out sound	1	0	1	0	0
Noise ingress	Noise ingress - traffic	1	0	1	0	0
Other - indeterminate	Other - indeterminate	1	0	0	0	1
Preference	Preference - want silence	1	0	0	1	0
Sound quality	Sound quality - speech clarity - can't hear teacher	1	0	0	1	0

L.8.3 Staff

Category Code	Detail Code	Total	Yellow	White	Orange	Red
Facilities - building design	Facilities - building design - open space learning poor	4	2	2	0	0
Learning / teaching	Learning / teaching - impacted by noise	4	2	2	0	0
Other - assenting	Other - assenting	4	0	1	2	1
Facilities - building design	Facilities - building design - large volume of room	3	2	1	0	0
Learning / teaching	Learning / teaching - sound needs complex - hearing loss, pedagogy	2	0	1	1	0
Noise ingress	Noise ingress - from outside learning activities	2	0	1	1	0
Noise ingress	Noise ingress - from decking construction adj room	2	0	0	2	0
Noise level	Noise level - loud	2	2	0	0	0
Noise source (classroom)	Noise source - adjacent class shared room	2	0	1	0	1
Noise source (classroom)	Noise source - own class	2	0	1	0	1
Facilities - building design	Facilities - building design - single classroom	1	0	1	0	0
Facilities - building design	Facilities - building design - acoustic panels	1	0	0	0	1
Noise ingress	Noise ingress - from adj music class enjoyable	1	0	0	0	1
Noise ingress	Noise ingress - via wall vents	1	0	0	1	0
Other - indeterminate	Other - indeterminate	1	0	1	0	0
Preference	Preference - want silence, quieter	1	0	1	0	0
Sound quality	Sound quality - improved by amplification system	1	1	0	0	0
Sound quality	Sound quality - varies between building types	1	0	1	0	0
Sound quality	Sound quality - better in transportables	1	0	1	0	0
Sound quality	Sound quality - worse in transportables	1	0	0	1	0

L.9 Q45 For both summer and winter, any other comments about thermal comfort and school activities

L.9.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	6	26.1%	4	1	25.0%
White	52	8	15.4%	22	10	45.5%
Orange	46	16	34.8%	12	4	33.3%
Red	25	2	8.0%	6	3	50.0%
frequency	*147*	*32*	*21.8%*	*44*	*18*	*40.9%*

L.9.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Other - No further comments	Other - No further comments	8	2	1	5	0
Air conditioning	Air conditioning - operates poorly, not controlled	6	0	5	1	0
Air conditioning	Air conditioning - temperatures are acceptable	5	0	1	3	1
Air	Air - stuffy	3	0	1	2	0
Temperature	Temperature - cold in winter	3	0	1	2	0
Preferences	Preference - want cooler in summer	2	1	0	0	1
Temperature	Temperature - hot in summer	2	0	2	0	0
Adaptive behaviour	Adaptive behaviour - winter	1	0	1	0	0
Adaptive behaviour	Behaviour - AC used to reduce stuffy air	1	0	0	1	0
Adaptive behaviour	Behaviour - open door to reduce stuffy air	1	0	0	1	0
Air conditioning	Air conditioning - want better distribution of air	1	0	0	0	1
Air conditioning	Air conditioning - prefer AC over opening door	1	0	0	1	0
Air conditioning	Air conditioning - needs upgrading	1	1	0	0	0
Learning / Teaching	Learning / Teaching - disrupted by heat in summer	1	0	1	0	0
Other - indeterminate	Other - indeterminate	1	0	0	1	0
Outdoor	Outdoor - equipment too hot to play on	1	0	0	1	0
Perception	Perception - unhealthy	1	0	0	1	0
Preferences	Preferences - different preferences within class	1	1	0	0	0
Preferences	Preference - want it warmer	1	0	0	1	0

L.9.3 Staff

Category Code	Detail Code	Total	Yellow	White	Orange	Red
Air conditioning	Air conditioning - operates poorly, not controlled	3	0	3	0	0
Air conditioning	Air conditioning - want better distribution of air	2	0	1	1	0
Control	control - no control, want manual control AC	2	0	1	0	1
Other - indeterminate	Other - indeterminate	2	0	2	0	0
Students	Students - some students affected by poor air distribution	2	0	1	1	0
Temperature	Temperature - hot in summer	2	0	2	0	0
Adaptive behaviour	Behaviour - AC used to reduce stuffy air	1	1	0	0	0
Adaptive behaviour	Behaviour - open door to reduce stuffy air	1	0	1	0	0
Air	Air - stuffy, not fresh	1	0	1	0	0
Air	Air - smells from toilets	1	0	1	0	0
Air conditioning	Air conditioning - temperatures are acceptable	1	0	1	0	0
Air conditioning	Air conditioning - needed when outdoor temperatures comfortable	1	0	0	1	0
Control	Control - want manual control of windows	1	0	1	0	0
Fabric	Fabric - mould reported and rectified	1	0	0	1	0
Learning / Teaching	learning / Teaching - impacted by discomfort	1	0	0	1	0
Temperature	Temperature - cold in winter	1	0	1	0	0
Ventilation	Ventilation - want alternative to AC	1	1	0	0	0
Ventilation	Ventilation - wall vents allow noise ingress from outdoors	1	0	0	1	0
Ventilation	Ventilation - windows are opened	1	0	0	0	1
Ventilation	Ventilation - not enough due to lack of room use	1	0	0	0	1
Windows	Windows - too much glass	1	0	1	0	0

L.10 Q46-Q52 Components present in classroom - staff

$ComponentsPresent*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Heating	Count	4	19	12	6	41
	% within $ComponentsPresent	9.8%	46.3%	29.3%	14.6%	
	% within CaseStudySchool	100.0%	90.5%	100.0%	100.0%	
	% of Total	9.3%	44.2%	27.9%	14.0%	95.3%
Ceiling fan(s)	Count	0	3	0	5	8
	% within $ComponentsPresent	0.0%	37.5%	0.0%	62.5%	
	% within CaseStudySchool	0.0%	14.3%	0.0%	83.3%	
	% of Total	0.0%	7.0%	0.0%	11.6%	18.6%
Air vents in the walls or roof	Count	2	9	9	1	21
	% within $ComponentsPresent	9.5%	42.9%	42.9%	4.8%	
	% within CaseStudySchool	50.0%	42.9%	75.0%	16.7%	
	% of Total	4.7%	20.9%	20.9%	2.3%	48.8%
Cooling	Count	4	19	12	6	41
	% within $ComponentsPresent	9.8%	46.3%	29.3%	14.6%	
	% within CaseStudySchool	100.0%	90.5%	100.0%	100.0%	
	% of Total	9.3%	44.2%	27.9%	14.0%	95.3%
Windows that open	Count	2	11	10	4	27
	% within $ComponentsPresent	7.4%	40.7%	37.0%	14.8%	
	% within CaseStudySchool	50.0%	52.4%	83.3%	66.7%	
	% of Total	4.7%	25.6%	23.3%	9.3%	62.8%
Other	Count	0	2	2	1	5
	% within $ComponentsPresent	0.0%	40.0%	40.0%	20.0%	
	% within CaseStudySchool	0.0%	9.5%	16.7%	16.7%	
	% of Total	0.0%	4.7%	4.7%	2.3%	11.6%
Total	Count	4	21	12	6	43
	% of Total	9.3%	48.8%	27.9%	14.0%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.11 Q46-Q52 Components observed used – Students

Do you see your teachers using...[a] $TeacherUsesBuildingElement*CaseStudySchool Crosstabulation

		Case Study School				Total
		Yellow	White	Orange	Red	
The heating	Count	15	0	36	21	72
	% within $TeacherUsesBuildingElement	20.8%	0.0%	50.0%	29.2%	
	% within CaseStudySchool	71.4%	0.0%	78.3%	91.3%	
	% of Total	10.8%	0.0%	25.9%	15.1%	51.8%
The cooling	Count	16	1	39	23	79
	% within $TeacherUsesBuildingElement	20.3%	1.3%	49.4%	29.1%	
	% within CaseStudySchool	76.2%	2.0%	84.8%	100.0%	
	% of Total	11.5%	0.7%	28.1%	16.5%	56.8%
Air vents in the walls or roof	Count	6	3	20	4	33
	% within $TeacherUsesBuildingElement	18.2%	9.1%	60.6%	12.1%	
	% within CaseStudySchool	28.6%	6.1%	43.5%	17.4%	
	% of Total	4.3%	2.2%	14.4%	2.9%	23.7%
A ceiling fan	Count	1	0	2	19	22
	% within $TeacherUsesBuildingElement	4.5%	0.0%	9.1%	86.4%	
	% within CaseStudySchool	4.8%	0.0%	4.3%	82.6%	
	% of Total	0.7%	0.0%	1.4%	13.7%	15.8%
Windows that open and close	Count	16	5	17	14	52
	% within $TeacherUsesBuildingElement	30.8%	9.6%	32.7%	26.9%	
	% within CaseStudySchool	76.2%	10.2%	37.0%	60.9%	
	% of Total	11.5%	3.6%	12.2%	10.1%	37.4%
Don’t know	Count	4	15	7	0	26
	% within $TeacherUsesBuildingElement	15.4%	57.7%	26.9%	0.0%	
	% within CaseStudySchool	19.0%	30.6%	15.2%	0.0%	
	% of Total	2.9%	10.8%	5.0%	0.0%	18.7%
Other (please specify)	Count	1	34	9	1	45
	% within $TeacherUsesBuildingElement	2.2%	75.6%	20.0%	2.2%	
	% within CaseStudySchool	4.8%	69.4%	19.6%	4.3%	
	% of Total	0.7%	24.5%	6.5%	0.7%	32.4%
Total	Count	21	49	46	23	139
	% of Total	15.1%	35.3%	33.1%	16.5%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.12 Q57 Any other comments about lighting and learning

L.12.1 Response rates by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	6	26.1%	4	1	25.0%
White	52	23	44.2%	22	6	27.3%
Orange	47	16	34.0%	12	4	33.3%
Red	25	2	8.0%	6	5	83.3%
frequency	*147*	*47*	*32.0%*	*44*	*16*	*36.4%*

L.12.2 **Students**

category code	code detail	Total freq	Yellow	White	Orange	Red
Light level	Light level - too bright	18	0	18	0	0
Glare	Glare - Nat/Art light level too high for IWB	8	1	7	0	0
Other - No further comments	Other - No further comments	7	2	2	3	0
Preference	Preference - Want lights off and more natural light	5	1	1	3	0
Learning / Teaching	Learning / Teaching - nat light helps	4	1	1	2	0
Blinds	Blinds - not installed, needed	3	0	3	0	0
Artificial light	Artificial light - always used	2	0	0	2	0
Blinds	Blinds - always down but want open	2	0	0	2	0
Other - assenting	Other - assenting	2	0	0	2	0
Other - indeterminate	Other - indeterminate	2	0	0	2	0
Windows	Windows - too small to provide enough nat light	2	0	0	2	0
Artificial light	Artificial light - not needed	1	0	1	0	0
Artificial light	Artificial light - needs improving	1	0	1	0	0
Artificial light	Artificial light - hurts eyes	1	0	0	1	0
Behaviour	Behaviour - Artificial light turned off deliberately	1	1	0	0	0
Blinds	Blinds - need them extended to full length	1	0	0	0	1
Energy	Energy - saved with large windows	1	0	1	0	0
Energy	Energy - saved with timer	1	0	0	1	0
Glare	Glare - Natural light level too high	1	0	0	0	1
Other - don't know	Other - don't know	1	0	0	1	0
Preference	Preference - want tinted glass	1	0	1	0	0
Windows	Windows - large	1	0	1	0	0

L.12.3 **Staff**

Category Code	Detail Code	Total	Yellow	White	Orang e	Red
Control	Control - need more room zones	3	0	3	0	0
Glare	Glare - Natural light level too high	3	0	0	1	2
Control	Control - not enough	2	0	2	0	0
Control	Control - timers annoying	2	0	0	0	2
Daylight	Daylight - makes room 'uncomfortable', overheating	2	0	1	1	0
Daylight	Daylight - overlit due to north elevation windows	2	0	0	0	2
Artificial light	Artificial light - not needed, over designed	1	0	0	1	0
Artificial light	Artificial light - hurts eyes	1	0	0	0	1
Blinds	Blinds - need to be closed due to glare	1	0	0	1	0
Control	Control - is good	1	1	0	0	0
Control	Control - switches not in room	1	0	1	0	0
Control	Control - timers	1	0	0	1	0
Daylight	Daylight - not enough during power failure	1	0	0	1	0
Energy	Energy - saved with timer	1	0	0	0	1
Glare	Glare - Nat/Art light level too high for IWB	1	0	0	0	1
Light level	Light level - too bright, want darker	1	0	1	0	0
Windows	Windows - tinting retrofit useful	1	0	0	1	0

L.13 Q59 What part of the classroom helps most with learning?

L.13.1 Response rates by school

	Students			Staff		
	Possible responses	**Responses provided**	**Percentage by School**	**Possible responses**	**Responses provided**	**Percentage by School**
Yellow	23	16	69.6%	4	4	100.0%
White	52	44	84.6%	22	15	68.2%
Orange	47	43	91.5%	12	8	66.7%
Red	25	20	80.0%	6	5	83.3%
frequency	*147*	*123*	*83.7%*	*44*	*32*	*72.7%*

L.13.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
ICT / IWB	ICT / IWB - interactive white boards	62	1	28	23	10
Furniture	Furniture - desks	22	6	3	8	5
ICT / IWB	ICT / IWB - computers	20	1	11	8	0
Fixtures	Fixtures - whiteboard	18	6	8	2	2
Display	Display- on walls	7	1	1	3	2
Other - don't know	Other - don't know	6	1	2	2	1
Teachers	Teachers	6	1	1	4	0
Acoustics	Acoustics - low level noise	5	0	1	2	2
Air conditioning	Air conditioning	5	0	0	1	4
Other - dispute premise	Other - dispute premise - nothing	5	1	3	1	0
Furniture	Furniture - chairs	4	0	1	1	2
Space / Layout	Space / Layout - Student groups	4	0	0	2	2
Walls	Walls	4	0	0	4	0
Acoustics	Acoustics - noised controlled by panels, walls	3	0	0	1	2
Other - assenting	Other - assenting	3	1	1	1	0
Space / Layout	Space / Layout	3	0	2	0	1
Learning materials	Learning materials - resources, books	2	0	0	2	0
Lighting	Lighting	2	0	1	0	1
Location	Location - adjacent windows	2	0	0	1	1
Other - indeterminate	Other - indeterminate	2	2	0	0	0
Ventilation	Ventilation - Ceiling fan	2	0	0	0	2
Windows	Windows - natural light	2	0	0	0	2
Activity	Activity - lesson	1	0	0	1	0
Activity	Activity - moving around	1	0	0	1	0
Fixtures	Fixtures - storage	1	0	0	0	1
Floor	Floor	1	0	0	1	0
Furniture	Furniture - sofa	1	0	1	0	0
Lighting	Lighting - dimmed or off	1	0	1	0	0
Location	Location - middle	1	0	0	1	0
Other personalisation	Other personalisation - class pet	1	0	0	0	1
Temperature	Temperature	1	0	0	0	1
Ventilation	Ventilation - not stuffy	1	0	0	0	1
Visual appearance	Visual appearance - colour good	1	0	0	0	1
Visual appearance	Visual appearance - design	1	0	1	0	0
Windows	Windows - open	1	0	0	1	0

L.13.3 Staff

category code	code detail	Total	Yellow	White	Orange	Red
ICT / IWB	ICT / IWB - interactive white boards	14	0	5	6	3
Floor	Floor - floor seating	7	0	3	1	3
Space / Layout	Space / Layout - variety of spaces / student groups	6	1	0	3	2
Furniture	Furniture - desks	5	0	3	1	1
Display	Display	4	0	1	2	1
Space / Layout	Space / Layout - large space	4	0	1	1	2
Space / Layout	Space / Layout	4	0	3	1	0
Teaching & learning	Teaching & learning - pedagogy	4	3	1	0	0
Fixtures	Fixtures - wet sink	3	0	1	1	1
Fixtures	Fixtures - storage	3	0	1	2	0
ICT / IWB	ICT / IWB - computers	3	0	1	2	0
Lighting	Lighting - daylight	3	0	0	0	3
Temperature	Temperature	3	0	2	0	1
Ventilation	Ventilation - not stuffy	3	0	1	0	2
Fixtures	Fixtures - whiteboard	2	0	1	1	0
Floor	Floor - carpet	2	0	1	1	0
Furniture	Furniture - chairs	2	0	1	1	0
Space / Layout	Space / Layout - good circulation	2	0	1	1	0
Space / Layout	Space / Layout - closed space	2	0	1	0	1
Teaching & learning	Teaching & learning - adjusted to match space & IWB constraints	2	1	0	1	0
Acoustics	Acoustics - noise controlled by carpet	1	0	0	1	0
Acoustics	Acoustics - electronic voice amplification	1	1	0	0	0
Air conditioning	Air conditioning	1	0	0	0	1
Furniture	Furniture - staff bring own	1	0	0	1	0
Learning materials	Learning materials - resources, books	1	0	1	0	0
Lighting	Lighting	1	0	1	0	0
Lighting	Lighting - controlled glare	1	0	0	0	1
Other personalisation	Other personalisation	1	0	0	0	1
Teaching & learning	Teaching & learning - relationships	1	1	0	0	0
Walls	Walls	1	0	1	0	0
Windows	Windows - natural light	1	0	0	1	0

L.14 Q59a how do school buildings and grounds contribute most to teaching and learning?

L.14.1 Response rate by school: staff

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	4	100.0%
White	22	17	77.3%
Orange	12	12	100.0%
Red	6	6	100.0%
frequency	*44*	*39*	88.6%

L.14.2 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Learning environment	Learning environment - need variety of space for group and individual learning	8	2	0	3	3
Design	Design - classrooms feel comfortable, 'cosy', not sterile, pleasant, peaceful	7	0	2	4	1
Size	Size - large learning spaces give flexibility	7	1	0	2	4
Teaching	Teaching - facilitate team teaching	4	0	0	3	1
Circulation	Circulation - equitable, convenient exits	3	0	2	0	1
Comfort	Comfort - must have fresh air	3	0	1	2	0
Culture	Culture - contributes to school pride	3	0	2	1	0
Daily management	Daily management - must be clean	3	0	1	2	0
Environmental	Environmental - facilities, factors, opportunities	3	0	3	0	0
Learning effectiveness	Learning effectiveness - improved by design which relaxes students	3	0	0	3	0
Spatial design strategy	Space - need ability to close off double classroom	3	0	0	3	0
Spatial design strategy	Space - need flexibility	3	2	1	0	0
Storage	Storage - good	3	0	2	1	0
Acoustics	Acoustics - good sound design for teaching and learning	2	0	2	0	0
Age of facilities	Age - new facilities	2	0	1	0	1
Circulation	Circulation - connect to other classes, shared areas	2	0	0	2	0
Culture	Culture - pleasant place to work, positive	2	0	0	1	1
Facilties - grounds	Facilties - grounds - pleasant	2	0	0	2	0
Facilties - grounds	Facilties - grounds - space, means to exercise	2	0	0	0	2
ICT - computers	ICT - computers - accessible	2	0	0	1	1
Lighting	Lighting - good, bright needed	2	0	0	2	0
Other - indeterminate	Other - indeterminate	2	0	2	0	0
Site plan	Site plan - large enough for all students	2	0	0	1	1
Visual appearance	Visual appearance - must be attractive, inviting	2	0	1	1	0
Acoustics	Acoustics - reduce noise	1	0	1	0	0
Acoustics	Acoustics - quiet areas and collaborative areas	1	1	0	0	0
Building conservation	Building conservation - repurpose for current learning	1	1	0	0	0
Circulation	Circulation - design out conflict with learning space	1	0	1	0	0
Circulation	Circulation - impacts on teaching, grouping	1	0	0	1	0
Comfort	Comfort - good temperature	1	0	1	0	0
Design	Design - stimulating, engaging	1	0	1	0	0
Design	Design - good	1	0	1	0	0
Design	Design - for different simultaneous learning activities	1	1	0	0	0
Design	Design - easy to rearrange furniture and space	1	0	0	1	0
Design	Design - for age integration	1	1	0	0	0
Doors	Doors - internal slider allows collaboration	1	0	1	0	0
Facilities - buildings	Facilities - gym / hall - space for whole school integration	1	1	0	0	0
Facilities - buildings	Facilities - building - library	1	0	0	0	1
Facilities - buildings	Facilities - buildings - transportables preferred over other building types	1	0	1	0	0
Floor	Floor - need floor learning space	1	0	0	1	0
Learning environment	Learning environment - not just a building	1	0	0	0	1
Pedagogy	Pedagogy - 'traditional' teaching difficult in contemporary buildings	1	0	1	0	0
Pedagogy	Pedagogy - changed due to space	1	0	0	1	0
Security / safety	Security / safety - must feel safe	1	0	0	1	0
Site plan	Site plan - keep small enough to reduce delay due to movement	1	0	1	0	0
Site plan	Site plan - common facilities away from classrooms	1	0	0	1	0
Spatial design strategy	Space - some subjects need subject-specific space, e.g., arts	1	0	1	0	0
Spatial design strategy	Space - flexibility to teach different subjects in same space	1	0	1	0	0
Technology	Technology - easy to use, 'friendly'	1	0	1	0	0
Visual appearance	Visual appearance - 'modern'	1	0	1	0	0

L.15 Q60 What do you like most about the interior of your classroom?

L.15.1 Response rate by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	14	60.9%	4	4	100.0%
White	52	41	78.8%	22	15	68.2%
Orange	47	38	80.9%	12	9	75.0%
Red	25	17	68.0%	6	6	100.0%
frequency	*147*	*110*	*74.8%*	*44*	*34*	*77.3%*

L.15.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
ICT / IWB	ICT / IWB - IWB and WB/projector	29	1	15	9	4
Visual appearance	Visual appearance - colour, non-white, decorated	14	0	12	0	2
Other - dispute premise	Other - dispute premise - nothing	8	0	5	3	0
Furniture	Furniture - desks, their arrangement	7	4	0	3	0
Furniture	Furniture - swivel chairs	7	0	7	0	0
Visual appearance	Visual appearance - design; positive about style or look	7	1	2	2	2
Space / Layout	Space / Layout - good size	6	1	0	4	1
Display	Display - student work, colourful	5	2	0	2	1
Feeling	Feeling - friendly, welcoming, calm, good environment	5	0	3	0	2
Other - indeterminate	Other - indeterminate	5	2	1	1	1
Air conditioning	Air conditioning	4	1	0	1	2
Display	Display - teaching materials	4	1	0	2	1
ICT / IWB	ICT / IWB - computers	4	0	2	2	0
Other - assenting	Other - assenting	4	0	1	2	1
Other - don't know	Other - don't know	4	0	2	1	1
Windows	Windows - daylight	4	1	1	1	1
Ceiling	Ceiling - high	3	0	0	0	3
Space / Layout	Space / Layout - good; neat arrangement	3	0	0	3	0
Temperature	Temperature - cool in summer	3	0	1	2	0
Temperature	Temperature - controlled, acceptable	3	0	2	1	0
Ceiling	Ceiling - generally	2	0	1	1	0
Fixtures	Fixtures - carpet	2	0	2	0	0
Furniture	Furniture - sofa	2	0	2	0	0
Lighting	Lighting - general	2	0	1	1	0
Other personalisation	Other personalisation - class pet	2	0	0	0	2
Walls	Walls - generally	2	0	0	2	0
Ceiling	Ceiling - acoustic	1	0	0	1	0
Display	Display - covers blank walls	1	1	0	0	0
Doors	Doors - vision panels	1	0	0	0	1
Fixtures	Fixtures - pin boards	1	0	0	1	0
Fixtures	Fixtures - storage	1	0	0	0	1
Heating	Heating	1	0	0	1	0
Other personalisation	Other personalisation - plants	1	0	0	0	1
Space / Layout	Space / Layout - floor seating area	1	0	1	0	0
Space / Layout	Space / Layout - good circulation space	1	0	0	1	0
Space / Layout	Space / Layout - teacher desks in middle double classroom	1	0	0	1	0
Space / Layout	Space / Layout - double classroom	1	0	0	1	0
Temperature	Temperature - hot in summer	1	0	1	0	0
Windows	Windows - view	1	0	1	0	0
Windows	Windows - shape	1	0	0	1	0

L.15.3 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Visual appearance	Visual appearance - colour, non-white, decorated	7	0	4	1	2
Windows	Windows - daylight	6	1	0	2	3
Fixtures	Fixtures - wet area	5	1	1	3	0
Fixtures	Fixtures - pin boards	3	0	2	1	0
Fixtures	Fixtures - storage	3	0	0	3	0
Floor	Floor - carpeted	3	0	2	1	0
Space / Layout	Space / Layout - good size	3	0	0	2	1
Space / Layout	Space / Layout - floor seating area	3	0	1	2	0
Space / Layout	Space / Layout - double classroom; open space	3	1	1	1	0
Air conditioning	Air conditioning	2	0	0	1	1
Ceiling	Ceiling - high	2	0	0	0	2
Display	Display - area available	2	1	0	1	0
Display	Display - student work, colourful	2	0	1	1	0
ICT / IWB	ICT / IWB - IWB and WB/projector	2	0	0	2	0
Lighting	Lighting - general	2	0	1	0	1
Other - dispute premise	Other - dispute premise - nothing, not much	2	1	1	0	0
Space / Layout	Space / Layout - closed space	2	0	1	0	1
Windows	Windows - view	2	1	0	1	0
Ceiling	Ceiling - acoustic	1	0	0	0	1
Facilities - Buildings	Facilities - Buildings - new	1	0	1	0	0
Facilities - Buildings	Facilities - Buildings - office	1	0	1	0	0
Facilities - Buildings	facilities - Buildings - courtyards	1	0	1	0	0
Feeling	Feeling - friendly, welcoming, calm, good environment	1	0	0	0	1
Fixtures	Fixtures - overhead display catenary lines	1	0	0	1	0
Furniture	Furniture - matching, colourful	1	0	0	1	0
ICT / IWB	ICT / IWB - computers	1	0	0	1	0
Other - assenting	Other - assenting	1	0	0	0	1
Other - indeterminate	Other - indeterminate	1	0	1	0	0
Space / Layout	Space / Layout - flexible partition	1	0	1	0	0
Visual appearance	Visual appearance - design; positive about style or look	1	0	1	0	0
Walls	Walls - generally	1	0	1	0	0
Windows	Windows - blinds	1	0	1	0	0

L.16 Q61 How do occupants change their classroom?

L.16.1 Response rate by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	8	34.8%	4	3	75.0%
White	52	21	40.4%	22	15	68.2%
Orange	47	24	51.1%	12	8	66.7%
Red	25	3	12.0%	6	5	83.3%
frequency	*147*	*56*	*38.1%*	*44*	*31*	*70.5%*

L.16.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Other - indeterminate	Other - indeterminate - don't answer question	16	1	9	6	0
Computers	Computers	10	2	6	2	0
Desks	Desks - rearrange; only for NAPLAN	8	1	1	4	2
Other - don't know	Other - don't know	7	2	3	2	0
Other - dispute premise	Other - dispute premise - no changes	7	0	2	4	1
Seats	Seats - move around	5	2	1	2	0
Noise	Noise - less talk / noise	3	1	0	2	0
Behaviour	Behaviour - other students	2	0	0	2	0
Display	Display	2	0	1	1	0
Student groups	Student groups - size, composition	2	0	0	2	0

L.16.3 Staff

category code	code detail	Total	Yellow	White	Orange	Red
Desks	Desks - rearranged regularly	8	1	2	2	3
Furniture	Furniture - rearranged	7	1	4	2	0
Desks	Desks - rearranged to create floor space	5	0	4	0	1
Restrictions	Restrictions - due to lack of space	5	1	2	0	2
Display	Display	3	0	1	2	0
Student groups	Student groups - group work spaces	3	0	1	2	0
Desks	Desks - rearrange groups	2	0	2	0	0
Learning areas	Learning areas	2	0	1	1	0
Layout / Space	Layout / Space - try out different use options	2	1	0	1	0
Other - dispute premise	Other - dispute premise - no changes	2	1	1	0	0
Desks	Desks - oriented to stop distraction	1	1	0	0	0
Doors	Doors - open to change ventilation & temperature	1	0	1	0	0
Furniture	Furniture - soft furnishings	1	0	0	1	0
Layout / Space	Layout / Space - needs partitions	1	0	1	0	0
Seats	Seats - move around	1	0	0	1	0
Timetabling	Timetabling - manage access to shared facilities	1	0	0	1	0
Windows	Windows - blinds kept down due to daylight	1	0	0	0	1

L.17 Q68-Q77 Sustainability elements discussed in class

Do you ever discuss buildings in lessons* Case Study School Crosstabulation

		Case Study School - Students					Case Study School - Staff				
		Yellow	White	Orange	Red	Total	Yellow	White	Orange	Red	Total
the walls & roof	Count	1	1	8	3	13	2	1	3	1	7
	% within 'discuss buildings'	7.7%	7.7%	61.5%	23.1%		28.6%	14.3%	42.9%	14.3%	
	% within Case Study School	6.3%	2.1%	20.0%	15.8%		66.7%	5.3%	37.5%	20.0%	
	% of Total	0.8%	0.8%	6.6%	2.5%	10.7%	5.7%	2.9%	8.6%	2.9%	20.0%
history of school	Count	13	12	13	11	49	3	7	2	3	15
	% within 'discuss buildings'	26.5%	24.5%	26.5%	22.4%		20.0%	46.7%	13.3%	20.0%	
	% within Case Study School	81.3%	25.5%	32.5%	57.9%		100.0%	36.8%	25.0%	60.0%	
	% of Total	10.7%	9.8%	10.7%	9.0%	40.2%	8.6%	20.0%	5.7%	8.6%	42.9%
rainwater tanks	Count	2	4	0	6	12	0	0	0	0	
	% within 'discuss buildings'	16.7%	33.3%	0.0%	50.0%		0.0%	0.0%	0.0%	0.0%	
	% within Case Study School	12.5%	8.5%	0.0%	31.6%		0.0%	0.0%	0.0%	0.0%	
	% of Total	1.6%	3.3%	0.0%	4.9%	9.8%	0.0%	0.0%	0.0%	0.0%	0.0%
air conditioning	Count	5	33	14	12	64	1	8	4	1	14
	% within 'discuss buildings'	7.8%	51.6%	21.9%	18.8%		7.1%	57.1%	28.6%	7.1%	
	% within Case Study School	31.3%	70.2%	35.0%	63.2%		33.3%	42.1%	50.0%	20.0%	
	% of Total	4.1%	27.0%	11.5%	9.8%	52.5%	2.9%	22.9%	11.4%	2.9%	40.0%
windows	Count	8	24	7	5	44	0	10	0	1	11
	% within 'discuss buildings'	18.2%	54.5%	15.9%	11.4%		0.0%	90.9%	0.0%	9.1%	
	% within Case Study School	50.0%	51.1%	17.5%	26.3%		0.0%	52.6%	0.0%	20.0%	
	% of Total	6.6%	19.7%	5.7%	4.1%	36.1%	0.0%	28.6%	0.0%	2.9%	31.4%
gardens	Count	12	34	20	13	79	2	13	4	4	23
	% within 'discuss buildings'	15.2%	43.0%	25.3%	16.5%		8.7%	56.5%	17.4%	17.4%	
	% within Case Study School	75.0%	72.3%	50.0%	68.4%		66.7%	68.4%	50.0%	80.0%	
	% of Total	9.8%	27.9%	16.4%	10.7%	64.8%	5.7%	37.1%	11.4%	11.4%	65.7%
building design	Count	6	8	8	6	28	0	6	2	0	8
	% within 'discuss buildings'	21.4%	28.6%	28.6%	21.4%		0.0%	75.0%	25.0%	0.0%	
	% within Case Study School	37.5%	17.0%	20.0%	31.6%		0.0%	31.6%	25.0%	0.0%	
	% of Total	4.9%	6.6%	6.6%	4.9%	23.0%	0.0%	17.1%	5.7%	0.0%	22.9%
solar (photovoltaic) panels	Count	5	10	5	7	27	0	2	2	0	4
	% within 'discuss buildings'	18.5%	37.0%	18.5%	25.9%		0.0%	50.0%	50.0%	0.0%	
	% within Case Study School	31.3%	21.3%	12.5%	36.8%		0.0%	10.5%	25.0%	0.0%	
	% of Total	4.1%	8.2%	4.1%	5.7%	22.1%	0.0%	5.7%	5.7%	0.0%	11.4%
building materials	Count	4	3	14	3	24	1	2	3	1	7
	% within 'discuss buildings'	16.7%	12.5%	58.3%	12.5%		14.3%	28.6%	42.9%	14.3%	
	% within Case Study School	25.0%	6.4%	35.0%	15.8%		33.3%	10.5%	37.5%	20.0%	
	% of Total	3.3%	2.5%	11.5%	2.5%	19.7%	2.9%	5.7%	8.6%	2.9%	20.0%
Other (please say)	Count	2	22	8	1	33	0	0	0	2	2
	% within 'discuss buildings'	6.1%	66.7%	24.2%	3.0%		0.0%	0.0%	0.0%	100.0%	
	% within Case Study School	12.5%	46.8%	20.0%	5.3%		0.0%	0.0%	0.0%	40.0%	
	% of Total	1.6%	18.0%	6.6%	0.8%	27.0%	0.0%	0.0%	0.0%	5.7%	5.7%
Total	Count	16	47	40	19	122	3	19	8	5	35
	% of Total	13.1%	38.5%	32.8%	15.6%	100.0%	8.6%	54.3%	22.9%	14.3%	100.0%

Percentages and totals are based on respondents.

a. Dichotomy group tabulated at value 1.

L.18 Q77 Other sustainability elements discussed in class - student

category code	frequency	Yellow	White	Orange	Red
Facilities - grounds	17	0	17	0	0
Other - dispute premise	4	0	3	1	0
Other - indeterminate	3	1	0	2	0
Facilities - buildings	2	0	0	2	0
Acoustics	1	0	0	1	0
Other - don't know	1	0	1	0	0
Space / Layout	1	0	0	1	0
Sustainability	1	0	0	0	1
Visual appearance	1	1	0	0	0
Waste	1	0	1	0	0
Water	1	0	0	1	0

L.19 Q78 Toilets

L.19.1 Response rate by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	16	69.6%	4	4	100.0%
White	52	46	88.5%	22	17	77.3%
Orange	47	40	85.1%	12	9	75.0%
Red	25	15	60.0%	6	6	100.0%
frequency	*147*	*117*	*79.6%*	*44*	*36*	*81.8%*

L.19.2 Students

category code	response type code	code detail	Total Freq	Yellow	White	Orange	Red
Daily Management	observation - general	Daily Management - dirty (slightly to very) / not clean	31	4	12	7	8
Description	observation - general	Description - negative - 'bad', 'unhygienic', 'disgusting', 'gross', 'feral'	27	3	8	8	8
Ventilation	observation - general	Ventilation - unpleasant smell	26	1	8	10	7
Facilities Management / repair	observation - specific problem	FM - damage to walls	13	8	1	3	1
Capacity	suggestion for action	Capacity - more pans, basins needed	11	2	3	6	0
Daily Management	suggestion for action	Daily Management - need cleaning / to be cleaner	11	0	2	6	3
Daily Management	observation - general	Daily Management - clean / mostly clean	8	1	4	2	1
Daily Management	observation - specific problem	Daily Management - consumables - on floor, ceiling	8	1	0	5	2
Daily Management	observation - specific problem	Daily Management - consumables - poor quality, not available	8	1	2	5	0
Daily Management	observation - specific problem	Daily Management - sewer waste not in pan / urinal	8	3	2	2	1
Behaviour	behaviour - others	Behaviour - others - toilet paper thrown around	7	0	0	5	2
Behaviour	behaviour - others	Behaviour - others - vandalism, graffiti	6	1	2	2	1
Daily Management	observation - specific problem	Daily Management - wet floor; taps leaking, left on	6	1	2	1	2
Daily Management	observation - general	Daily Management - messy	5	0	3	1	1
Description	observation - general	Description - 'nice', 'fine', 'OK', 'nothing wrong', 'good'	5	0	4	0	1
Fixtures	observation - specific problem	Fixtures - too small	5	0	4	1	0
Space / Layout	observation - general	Space / Layout - too small	5	1	2	2	0

category code	response type code	code detail	Total Freq	Yellow	White	Orange	Red
Behaviour	behaviour - others	Behaviour - others - people don't flush	4	2	1	1	0
Daily Management	observation - specific problem	Daily Management - spiders / insects	4	0	2	0	2
Space / Layout	suggestion for action	Space / Layout - larger	4	0	3	1	0
Visual appearance	observation - general	Visual appearance - 'ugly', dated, needs painting	4	0	0	4	0
Behaviour	behaviour - others	Behaviour - others - sewer waste not in pan / urinal	3	2	1	0	0
Facilities Management / repair	observation - specific problem	FM - doors, fixtures broken	3	0	3	0	0
Facilities Management / repair	observation - general	FM - need more	3	0	0	0	3
Safety / security	observation - specific problem	Safety / security - unsafe	3	0	1	1	1
Ventilation	suggestion for action	Ventilation - rectification - reduce smell	3	0	0	3	0
Visual appearance	suggestion for action	Visual appearance - update - more 'like shops' etc	3	0	1	2	0
Capacity	observation - specific problem	Capacity - queue / crowding	2	1	0	1	0
Culture	behaviour - others	Culture - lack of respect	2	0	1	1	0
Daily Management	observation - general	Daily management - blocked drains, issues	2	0	2	0	0
Daily Management	observation - specific problem	Daily Management - sanitary bins	2	0	0	0	2
Facilities Management / repair	observation - general	FM - maintenance / repair is good	2	0	0	0	2
Fixtures	suggestion for action	Fixtures - perceived end of life	2	0	1	1	0
Privacy	observation - specific problem	Privacy - Design - partitions too small, gaps	2	0	1	1	0
Privacy	observation - general	Privacy - management - doors broken, kept open	2	0	1	1	0
Ventilation	observation - specific problem	Ventilation - unpleasant smell - urine	2	0	1	1	0
Access	observation - specific problem	Access - not open during all school hours	1	0	0	1	0
Acoustics	observation - general	Acoustics - loud	1	1	0	0	0
Behaviour	behaviour - own	Behaviour - own - avoiding	1	0	0	0	1
Other - assenting	observation - general	Other - assenting	1	0	1	0	0
Other - don't know	observation - general	Other - don't know	1	0	1	0	0
Other - no further comments	observation - general	Other - no further comments	1	0	1	0	0
Space / Layout	suggestion for action	Space / Layout - separate ages	1	0	0	0	1

L.19.3 **Staff**

category code	response type code	code detail	Total	Yellow	White	Orange	Red
Student toilets			15	1	6	4	4
Staff toilets			15	0	5	6	4
Toilets not specified			13	3	8	2	0
Capacity	suggestion for action	Capacity - more pans, basins needed	19	0	10	6	3
Ventilation	observation - general	Ventilation - unpleasant smell	9	0	5	3	1
Space / Layout	observation - specific problem	Space / Layout - not distributed around school	5	0	1	0	4
Capacity	observation - specific problem	Capacity - queue / crowding	4	0	0	3	1
Daily Management	observation - general	Daily Management - clean / mostly clean	4	3	1	0	0
Other - assenting	observation - general	Other - assenting	3	2	0	0	1
Capacity	observation - general	Capacity - adequate	2	0	1	1	0
Daily Management	observation - general	Daily Management - dirty (slightly to very) / not clean	2	0	2	0	0
Description	observation - general	Description - negative - 'bad', 'unhygienic', 'disgusting', 'gross', 'feral'	2	0	1	1	0
Safety / security	observation - specific problem	Safety / security - difficult to manage supervision	2	1	0	1	0
Space / Layout	observation - general	Space / Layout - too small	2	1	1	0	0
Access	observation - specific problem	Access - not open during all school hours	1	0	0	1	0
Acoustics		Acoustics - lack of acoustic separation	1	0	1	0	0
Behaviour	behaviour - others	Behaviour - others - toilet paper thrown around	1	0	0	1	0
Behaviour	behaviour - own	Behaviour - own - use disabled toilet in lieu of staff toilet	1	0	1	0	0
Capacity	observation - specific problem	Capacity - has been reduced but more students	1	0	0	0	1
Daily Management	observation - general	Daily management - blocked drains, issues	1	0	1	0	0
Daily Management	suggestion for action	Daily Management - need cleaning / to be cleaner	1	0	0	1	0
Daily Management	observation - specific problem	Daily Management - spiders / insects	1	0	1	0	0
Facilities Management / repair	observation - specific problem	FM - dripping taps and soap dispensers	1	0	0	1	0
Fixtures	observation - specific problem	Fixtures - no urinals	1	0	1	0	0
Light	observation - specific problem	Light - no daylight	1	0	0	1	0
Privacy	observation - general	Privacy - good	1	1	0	0	0
Privacy	observation - specific problem	Privacy - acoustics - poor, embarrassing	1	0	1	0	0
Safety / security	observation - specific problem	Safety / security - no access during "lock in"	1	0	0	1	0
Space / Layout	observation - specific problem	Space / Layout - access via inside buildings, not direct from exterior	1	0	1	0	0
Space / Layout	observation - specific problem	Space / Layout - next to eating area	1	0	1	0	0
Space / Layout	observation - general	Space / Layout - accessible	1	1	0	0	0
Ventilation	observation - specific problem	Ventilation - not operating	1	0	1	0	0
Visual appearance	observation - general	Visual appearance - functional	1	0	0	1	0

L.20 Q83 If you could redesign the exterior of your school what would you change or improve?

L.20.1 Response rate by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	20	87.0%	4	4	100.0%
White	52	38	73.1%	22	20	90.9%
Orange	47	43	91.5%	12	8	66.7%
Red	25	13	52.0%	6	6	100.0%
frequency	*147*	*114*	*77.6%*	*44*	*38*	*86.4%*

L.20.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Facilities - grounds	Facilities - grounds - more or redesignd soft landscape	16	6	0	7	3
Other - nothing	Other - nothing	15	2	3	5	5
Facilities - grounds	Facilities - grounds - oval, larger, upgraded	9	0	4	5	0
Facilities - grounds	Facilities - grounds - playground different location or ages	8	2	0	2	4
Visual appearance	Visual appearance - more interesting, exciting, colourful	7	0	6	1	0
Facilities - grounds	Facilities - grounds - playground - change not specified	6	2	1	3	0
Facilities - grounds	Facilities - grounds - more sports courts / fields	6	0	3	2	1
Other - response about interior	Response about interior	6	1	4	1	0
Facilities - grounds	Facilities - grounds - more grassed play	5	0	4	1	0
Facilities - buildings	Facilities - buildings - use different materials	4	0	3	1	0
Facilities - grounds	Facilities - grounds - play equipment - more, exciting	4	1	1	2	0
Other - don't know	Other - don't know	4	1	3	0	0
Visual appearance	Visual appearance - more attractive / colourful plants	4	0	0	4	0
Visual appearance	Visual appearance - more 'modern'	4	0	1	3	0
Daily management	Daily management - cleaner, more bins	3	1	1	1	0
Facilities - buildings	Facilities - buildings - larger	3	0	1	2	0
Facilities - grounds	Facilities - grounds - more seating	3	0	0	2	1
Other - assenting	Other - assenting	3	0	0	3	0
Other - indeterminate	Other - indeterminate	3	1	1	1	0
Facilities - buildings	Facilities - buildings - change detail not specified	2	0	1	1	0
Facilities - buildings	Facilities - buildings - enclose circulation	2	0	2	0	0
Facilities - grounds	Facilities - grounds - more outdoor space	2	2	0	0	0
Facilities - grounds	Facilities - grounds - add water sports	2	1	0	1	0
Facilities - grounds	Facilities - grounds - more shade	2	1	0	0	1
Health	Health - less plant allergens	2	0	0	2	0
Lighting	Lighting - less, controllable natural light	2	0	1	1	0
Security / safety	Security / safety - add / change perimeter fence	2	0	1	1	0
Site plan	Site plan - Layout	2	0	1	1	0
Visual appearance	Visual appearance - Change building shape	2	1	1	0	0
Facilities - buildings	Facilities - buildings - permanent, not transportable	1	0	1	0	0
Facilities - grounds	Facilities - grounds - improve circulation networks	1	0	1	0	0
Facilities - grounds	Facilities - grounds - less trees	1	0	1	0	0
Facilities - student services	Facilities - student services - canteen	1	0	1	0	0
Hydraulics	Hydraulics - more drinking fountains	1	0	0	0	1
Renewable energy	Renewable energy - 'solar panels'	1	0	1	0	0
Security / safety	Security / safety - add lockers	1	0	0	1	0
Site plan	Site plan - parking	1	0	0	1	0
Views	Views - inside to outside	1	1	0	0	0
Visual appearance	Visual appearance - upgrade heritage buildings	1	0	0	0	1
Visual appearance	Visual appearance - more uniform	1	0	0	1	0
Water	Water - rain water tank	1	0	1	0	0

L.20.3 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Visual appearance	Visual appearance - more interesting, exciting, colourful, less ugly	8	0	7	1	0
Other - nothing	Other - nothing, no change	5	2	0	0	3
Security / safety	Security / safety - add / change perimeter fence	5	0	5	0	0
Learning / Teaching	Learning / Teaching - outdoor areas more appropriate for learning	4	0	2	1	1
Facilities - grounds	Facilities - grounds - more seating	3	0	0	3	0
Facilities - grounds	Facilities - grounds - more / larger play areas	3	1	2	0	0
Control	Control - more local control of windows	2	0	2	0	0
Facilities - buildings	Facilities - buildings - larger	2	0	0	2	0
Facilities - grounds	Facilities - grounds - playground different location or ages	2	1	0	1	0
Facilities - grounds	Facilities - grounds - more sports courts / fields	2	1	0	0	1
Facilities - grounds	Facilities - grounds - more shade / cover	2	0	0	2	0
Visual appearance	Visual appearance - remove ventilation chimneys	2	0	2	0	0
Visual appearance	Visual appearance - Change building shape	2	0	2	0	0
Air conditioning	Air conditioning - change (not specified how)	1	0	1	0	0
Control	Control - more local control of HVAC	1	0	1	0	0
Daily management	Daily management - cleaner, more bins	1	0	1	0	0
Design	Design - columns, corners hazard to students	1	0	0	1	0
Facilities - buildings	Facilities - buildings - permanent, not transportable	1	0	0	1	0
Facilities - buildings	Facilities - buildings - add verandahs	1	0	1	0	0
Facilities - grounds	Facilities - grounds - functioinal art / sensory gardens	1	0	0	1	0
Facilities - grounds	Facilities - grounds - improved play surfaces	1	0	1	0	0
Facilities - grounds	Facilities - grounds - oval, larger, upgraded	1	0	0	0	1
Facilities - grounds	Facilities - grounds - improve circulation networks	1	0	1	0	0
Facilities - grounds	Facilities - grounds - more grassed play	1	0	0	0	1
Facilities - grounds	Facilities - grounds - more or redesignd soft landscape	1	0	0	1	0
Facilities - grounds	Facilities - grounds - water saving gardens	1	0	1	0	0
Facilities maintenance	Facilities maintenance - maintain gardens better	1	0	1	0	0
Other - indeterminate	Other - indeterminate	1	1	0	0	0
Security / safety	Security / safety - lock doors	1	0	0	1	0
Security / safety	Security / safety - add or upgrade lockers	1	0	0	1	0
Site plan	Site plan - larger	1	0	0	0	1
Site plan	Site plan - better growth planning	1	0	0	1	0
Site plan	Site plan - remove central ecosystem	1	0	1	0	0
Site plan	Site plan - move library to site (now 2 strees away)	1	0	1	0	0
Site plan	site plan - staff room more central	1	0	0	1	0
Site plan	Site plan - parking	1	0	0	0	1
Visual appearance	Visual appearance - change new building to match existing	1	0	0	0	1
Visual appearance	Visual appearance - natural colours and textures	1	0	1	0	0
Water	Water - use on landscape reduced	1	0	1	0	0

L.21 Q84 If you could redesign the interior of your classroom what would you change or improve?

L.21.1 Response rate by school

	Students			Staff		
	Possible responses	Responses provided	Percentage by School	Possible responses	Responses provided	Percentage by School
Yellow	23	18	78.3%	4	4	100.0%
White	52	44	84.6%	22	20	90.9%
Orange	47	40	85.1%	12	11	91.7%
Red	25	12	48.0%	6	6	100.0%
frequency	*147*	*114*	*77.6%*	*44*	*41*	93.2%

L.21.2 Students

category code	code detail	Total freq	Yellow	White	Orange	Red
Size	Size - larger	30	2	19	7	2
Other - nothing	Other - nothing	13	3	4	4	2
ICT / IWB	ICT / IWB - more PC, tablets, wireless	9	0	1	5	3
Visual appearance	Visual appearance - update, more colour	9	1	4	3	1
Airconditioning	Airconditioning - Improved	8	0	6	1	1
Furniture	Furniture - desks, more, larger	6	1	1	4	0
Furniture	Furniture - redesign, more comfortable	6	0	2	3	1
Display	Display - more student work display areas	5	1	0	3	1
Design	Design - update; more exciting, fun	4	0	0	3	1
Fixtures	Fixtures - more storage	4	0	3	0	1
Other - don't know	Other - don't know	4	2	2	0	0
Other - indeterminate	Other - indeterminate	4	2	1	0	1
Space / layout	Space / layout - no shared classrooms	4	2	0	1	1
Walls	Walls - detail not specified	4	0	0	4	0
Control	Control - AC/windows - by students/teachers	3	0	3	0	0
Fixtures	Fixtures - different, softer carpet	3	0	2	0	1
Other - assenting	Other - assenting	3	1	1	1	0
Size	Size - change size (not specified)	3	1	2	0	0
Windows	Windows - add blinds	3	0	3	0	0
Acoustics	Acoustics - only one class per room	2	2	0	0	0
Ceiling	Ceiling - change rake to flat	2	0	2	0	0
Ceiling	Ceiling - higher	2	0	0	2	0
Fixtures	Fixtures - install white boards	2	0	2	0	0
Furniture	Furniture - not specified	2	0	0	2	0
Furniture	Furniture - move desks	2	1	0	0	1
ICT / IWB	ICT / IWB - larger IWB	2	0	0	2	0
Lighting	Lighting - detail not specified	2	0	2	0	0
Space / layout	Space / layout - change layout	2	0	1	0	1
Space / layout	Space / layout - change shape	2	0	1	0	1
Walls	Walls - paint; less marked	2	0	0	2	0
Windows	Windows - detail not specified	2	0	1	0	1
Acoustics	Acoustics - reduce rain noise	1	0	0	1	0
Display	Display - not overhead	1	0	0	1	0
ICT / IWB	ICT / IWB - move IWB	1	0	1	0	0
Lighting	Lighting - use the daylight	1	0	0	1	0
Space / layout	Space / layout - more circulation	1	0	0	1	0
Visual appearance	Visual appearance - No exposed AC ducts	1	1	0	0	0
Windows	Windows - smaller	1	1	0	0	0
Windows	Windows - larger	1	0	0	1	0

L.21.3 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Size	Size - larger classroom	16	2	7	5	2
Fixtures	Fixtures - more storage, shelves	9	0	3	4	2
Space / layout	Space / layout - no shared classrooms, single classes only	8	2	4	0	2
Size	Size - larger storage area	6	0	3	3	0
Control	Control - AC/windows - by students/teachers	4	0	3	0	1
Airconditioning	Airconditioning - Improved	3	0	2	0	1
Electrical	Electrical - more GPOs and wire data connections	3	0	2	1	0
Fixtures	Fixtures - wet area	3	0	2	0	1
Fixtures	Fixtures - pinboards increased, all walls	3	0	2	1	0
Space / layout	Space / layout - flexible open up / close off space	3	1	2	0	0
Space / layout	Space / layout - kitchen area add / improve layout	2	1	0	1	0
Space / layout	Space / layout - all dual-class units	2	0	2	0	0
Toilets	Toilets - in all class blocks	2	0	0	0	2
Visual appearance	Visual appearance - update, more colour	2	0	2	0	0
Windows	Windows - add blinds, increase coverage	2	0	1	0	1
Acoustics	Acoustics - more absorbant soft furnishings	1	0	1	0	0
Control	Control - lighting - more manual control	1	0	1	0	0
Design	Design - more consultation with administration / foyer	1	0	0	1	0
Display	Display - flexible panels	1	0	1	0	0
Doors	Doors - change heritage doors to glazed sliders	1	1	0	0	0
Doors	Doors - stop internal door swings infringing on space	1	0	0	1	0
Electrical	Electrical - no floor boxes	1	0	1	0	0
Enrolment	Enrolment - limit to stop over crowding	1	0	0	0	1
Fixtures	Fixtures - less fixed furniture	1	0	0	1	0
Furniture	Furniture - different shapes, less space consuming	1	1	0	0	0
Furniture	Furniture - matching, better aesthetics	1	0	0	1	0
ICT / IWB	ICT / IWB - new IWB	1	0	1	0	0
Lighting	Lighting - natural	1	0	0	1	0
Lighting	Lighting - improved	1	0	0	0	1
Other - nothing	Other - nothing	1	0	0	1	0
Size	Size - larger wet area	1	0	1	0	0
Security / safety	Security / safety - blinds for lockdowns	1	0	0	1	0
Security / safety	Security / safety - better first aid in school reception	1	0	0	1	0
Space / layout	Space / layout - change circulation to learning space	1	1	0	0	0
Space / layout	Space / layout - change shape	1	0	0	0	1
Space / layout	Space / layout - more flexibility with furniture	1	0	0	1	0
Space / layout	Space / layout - mezzanine	1	1	0	0	0
Space / layout	Space / layout - groupwork specific space	1	0	1	0	0
Space / layout	Space / layout - learning support space	1	0	0	0	1
Space / layout	Space / layout - more open space	1	0	1	0	0
Ventilation	Ventilation	1	0	0	0	1
Visual appearance	Visual appearance - no bright, warm colours	1	0	1	0	0
Windows	Windows - update old to make useable	1	0	0	0	1
Windows	Windows - improved external shading (verandah)	1	0	1	0	0

L.22 **Q88 Any other comments?**

L.22.1 **Response rate by school**

	Students			Staff		
	Possible responses	**Responses provided**	**Percentage by School**	**Possible responses**	**Responses provided**	**Percentage by School**
Yellow	23	6	26.1%	4	2	50.0%
White	52	14	26.9%	22	8	36.4%
Orange	47	22	46.8%	12	7	58.3%
Red	25	5	20.0%	6	3	50.0%
frequency	*147*	*47*	*32.0%*	*44*	*20*	*45.5%*

L.22.2 **Students**

category code	code detail	Total freq	Yellow	White	Orange	Red
Classroom	Classroom - size or shape change	7	1	2	3	1
Other - don't know	Other - don't know	6	1	2	3	0
Visual appearance	Visual appearance - needs updating	5	0	1	4	0
Facilities - buildings	Facilities - buildings - other than classrooms	3	1	0	2	0
Other - indeterminate	Other - indeterminate	3	1	0	2	0
Other - no further comments	Other - no further comments	3	1	1	1	0
Sustainability	Sustainability	3	0	1	2	0
Toilets	Toilets - need improvement	3	0	0	3	0
Toilets	Toilets - daily management	3	1	0	2	0
Visual appearance	Visual appearance - is good	3	0	1	2	0
Acoustics	Acoustics - improve	2	0	0	2	0
Facilities - grounds	Facilities - grounds - play	2	1	0	1	0
Facilities - grounds	Facilities - grounds - sports	2	0	0	2	0
Heritage / History	Heritage / History	2	0	0	0	2
ICT / IWB	ICT / IWB - more computers	2	0	1	1	0
Safety / Security	Safety / Security - lockers	2	0	2	0	0
Visual appearance	Visual appearance - is not good	2	0	1	1	0
Acoustics	Acoustics - awareness of panels	1	0	0	0	1
Buildings - elements	Buildings - elements - windows	1	0	1	0	0
Classroom	Classroom - better for learning	1	0	0	1	0
Classroom	Classroom - size OK	1	0	1	0	0
Control	Control - want automatic	1	0	0	0	1
Control	Control - want manual control	1	0	1	0	0
Facilities - buildings	Facilities - buildings - transportables	1	0	0	1	0
Facilities - buildings	Facilities - buildings - variety good	1	0	0	1	0
Facilities - student services	Facilities - student services	1	0	1	0	0
Facilities maintenance / repair	Facilities maintenance / repair - good	1	0	1	0	0
ICT / IWB	ICT / IWB - IWB issues	1	0	0	1	0
Lighting	Lighting - needs improving	1	0	0	0	1
Photovoltaics	Photovoltaics	1	0	1	0	0
Rain water tanks	Rain water tanks	1	0	1	0	0
Thermal comfort	Thermal comfort - good	1	0	1	0	0

L.22.3 **Staff**

category code	code detail	Total	Yellow	White	Orange	Red
Classroom	Classroom - flexible space for different learning activities	5	2	1	1	1
Classroom	Classroom - designed for group, collaborative learning	4	1	2	0	1
Control	Control - want manual control	4	0	3	1	0
Classroom	Classroom - larger to fit all furniture, storage, floor work, ICT	3	0	2	1	0
Buildings - elements	Buildings - elements - windows operable and at accessible height	2	0	1	1	0
Classroom	Classroom - permanent floor sitting area	2	0	2	0	0
Classroom	Classroom - good access to water / wet areas	2	0	0	1	1
Facilities - buildings	Facilities - buildings - specialist teaching and subject spaces	2	0	0	2	0
Facilities - grounds	Facilities - grounds - JP specific play area	2	0	0	2	0
Facilities - grounds	Facilities - grounds - food production gardens by students	2	0	0	2	0
Rain water tanks	Rain water tanks - for use on gardens	2	0	1	1	0
Spaces other than learning	Spaces other than learning - meditation, peaceful	2	1	0	1	0
Views	Views - need more	2	0	0	1	1
Acoustics	Acoustics - design for quieter learning space	1	0	0	1	0
Acoustics	Acoustics - foot traffic noise from raised decks	1	0	0	1	0
Buildings - elements	Buildings - elements - doors - stay open when needed	1	0	1	0	0
Buildings - elements	Buildings - elements - verandah decks noisy	1	0	0	1	0
Circulation	Circulation - equitable to all are areas	1	0	1	0	0
Circulation	Circulation - design not to impact on other classes	1	0	1	0	0
Classroom	Classroom - feels comfortable and inviting	1	1	0	0	0
Classroom	Classroom - easy to supervise different learning activities	1	1	0	0	0
Classroom	Classroom - access to multipurpose space for large groups	1	0	1	0	0
Comfort	Comfort - good ventilation	1	0	1	0	0
Comfort	Comfort - air movement, ceiling fans	1	0	1	0	0
Display	Display - pinboards on all wall space	1	0	1	0	0
Facilities - buildings	Facilities - buildings - old and new good	1	0	0	0	1
Facilities - buildings	Facilities - buildings - all permanent buildings	1	0	1	0	0
Facilities - buildings	Facilities - buildings - space specific OSHC	1	0	1	0	0
Facilities - grounds	Facilities - grounds - generally larger play and sport	1	0	0	0	1
Facilities - grounds	Facilities - grounds - more shade	1	0	0	1	0
Facilities - grounds	Facilities - grounds - sculpture, texture play	1	0	0	1	0
Facilities maintenance / repair	Facilities maintenance / repair - need much more	1	0	0	0	1
Heritage / History	Heritage / History	1	0	0	0	1
ICT / IWB	ICT / IWB - more data points	1	0	1	0	0
Lighting	Lighting - daylight important	1	0	0	1	0
Lighting	Lighting - daylight good but conflicts with screen / IWB use	1	0	0	1	0
Other - no further comments	Other - no further comments	1	0	0	1	0
Recycling / waste reduction	Recycling / waste reduction - student activities	1	0	0	1	0
Site plan	Site plan - not too large so time lost walking between facilities	1	0	1	0	0
Site plan	Site plan - dual use community facilities within safe walking distance for children	1	0	1	0	0
Storage	Storage - more and varied	1	0	1	0	0
Sustainability teaching	Sustainability teaching - future programs planned	1	0	1	0	0
Sustainability teaching	Sustainability teaching - very important	1	0	0	1	0
Visual appearance	Visual appearance - classrooms look inviting, 'cosy'	1	1	0	0	0

L.23 Q88a School as community assesst

L.23.1 Response rate by school: staff

	Staff		
	Possible responses	**Responses provided**	**Percentage by School**
Yellow	4	4	100.0%
White	22	15	68.2%
Orange	12	9	75.0%
Red	6	6	100.0%
frequency	*44*	*34*	*77.3%*

L.23.2 Staff

category code	code detail	Total	Yellow	White	Orange	Red
Community activities	Community - sports	18	1	8	8	1
Public amenity	Public amenity - grounds open	12	0	10	1	1
Community activities	Community - activities - not specified, various	9	2	4	1	2
Parents	Parents - meeting place, social gathering	8	2	0	5	1
Facilities for hire	Facilities for hire - gym / hall	7	1	2	3	1
Description as community hub	Description - meeting place	3	2	0	1	0
Public amenity	Public amenity - history	3	0	0	0	3
Classes	Classes - parenting	2	1	0	1	0
Classes	Classes - yoga, sports	2	1	0	1	0
Environmental	Environmental - ecosystem interpretaion trail	2	0	2	0	0
Facilities for hire	Facilities for hire - meeting rooms	2	0	2	0	0
Governance	Governance - council, parent	2	0	0	2	0
Public amenity	Public amenity - landmark	2	0	0	1	1
Time capacity	Time capacity - used 7 days a week	2	1	1	0	0
Time capacity	Time capacity - Simultaneous use - library, gym	2	0	2	0	0
Volunteers	Volunteers - at school	2	0	0	1	1
Classes	Classes - computers	1	0	0	1	0
Classes	Classes - languages	1	1	0	0	0
Classes	Classes - not specified	1	0	0	0	1
Classes	Classes - playgroup	1	0	1	0	0
Classes	Classes - safety	1	0	0	1	0
Co-located facilities	Co-located facilities - ELC	1	0	1	0	0
Description as community hub	Description - builds the community	1	0	0	0	1
Description as community hub	Description as community hub - a focus	1	1	0	0	0
Description as community hub	Description - gathering place	1	0	0	0	1
Description as community hub	Description - hub	1	0	1	0	0
Description as community hub	Description - village square	1	1	0	0	0
Facilities for hire	Facilities for hire - tours	1	0	0	0	1
Medical	Medical - nurse visits	1	1	0	0	0
OSHC	OSHC	1	0	0	1	0
Other - dispute premise	Other - dispute premise - safety issues	1	0	0	1	0
Suggestion	Suggestion - café for parents	1	1	0	0	0

L.24 Q100-Q104 Perceive heating control - Staff

$HeatingControl*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Heating: Fully automatic	Count	0	7	3	1	11
	% within $HeatingControl	0.0%	63.6%	27.3%	9.1%	
	% within CaseStudySchool	0.0%	33.3%	25.0%	20.0%	
	% of Total	0.0%	16.7%	7.1%	2.4%	26.2%
Heating: Mixed auto & manual	Count	2	5	6	2	15
	% within $HeatingControl	13.3%	33.3%	40.0%	13.3%	
	% within CaseStudySchool	50.0%	23.8%	50.0%	40.0%	
	% of Total	4.8%	11.9%	14.3%	4.8%	35.7%
Heating: I have full control	Count	3	8	3	2	16
	% within $HeatingControl	18.8%	50.0%	18.8%	12.5%	
	% within CaseStudySchool	75.0%	38.1%	25.0%	40.0%	
	% of Total	7.1%	19.0%	7.1%	4.8%	38.1%
Heating: Don't Know	Count	0	0	0	0	0
	% within $HeatingControl	0.0%	0.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	0.0%	0.0%	0.0%	
	% of Total	0.0%	0.0%	0.0%	0.0%	0.0%
Heating: Other (please specify)	Count	0	1	0	0	1
	% within $HeatingControl	0.0%	100.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	4.8%	0.0%	0.0%	
	% of Total	0.0%	2.4%	0.0%	0.0%	2.4%
Total	Count	4	21	12	5	42
	% of Total	9.5%	50.0%	28.6%	11.9%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.25 Q105-Q109 Perceived cooling control - Staff

$CoolingControl*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Cooling: Fully automatic	Count	0	5	2	1	8
	% within $CoolingControl	0.0%	62.5%	25.0%	12.5%	
	% within CaseStudySchool	0.0%	29.4%	18.2%	20.0%	
	% of Total	0.0%	13.5%	5.4%	2.7%	21.6%
Cooling: Mixed auto & manual	Count	2	4	6	3	15
	% within $CoolingControl	13.3%	26.7%	40.0%	20.0%	
	% within CaseStudySchool	50.0%	23.5%	54.5%	60.0%	
	% of Total	5.4%	10.8%	16.2%	8.1%	40.5%
Cooling: I have full control	Count	3	7	3	1	14
	% within $CoolingControl	21.4%	50.0%	21.4%	7.1%	
	% within CaseStudySchool	75.0%	41.2%	27.3%	20.0%	
	% of Total	8.1%	18.9%	8.1%	2.7%	37.8%
Cooling: Don't Know	Count	0	0	0	0	0
	% within $CoolingControl	0.0%	0.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	0.0%	0.0%	0.0%	
	% of Total	0.0%	0.0%	0.0%	0.0%	0.0%
Cooling: Other (please specify)	Count	0	1	0	0	1
	% within $CoolingControl	0.0%	100.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	5.9%	0.0%	0.0%	
	% of Total	0.0%	2.7%	0.0%	0.0%	2.7%
Total	Count	4	17	11	5	37
	% of Total	10.8%	45.9%	29.7%	13.5%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.26 Q110-Q114 Perceived ventilation control - Staff

$VentilationControl*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Ventilation: Fully automatic	Count	0	7	2	1	10
	% within $VentilationControl	0.0%	70.0%	20.0%	10.0%	
	% within CaseStudySchool	0.0%	33.3%	16.7%	16.7%	
	% of Total	0.0%	16.3%	4.7%	2.3%	23.3%
Ventilation: Mixed auto & manual	Count	2	5	5	4	16
	% within $VentilationControl	12.5%	31.3%	31.3%	25.0%	
	% within CaseStudySchool	50.0%	23.8%	41.7%	66.7%	
	% of Total	4.7%	11.6%	11.6%	9.3%	37.2%
Ventilation: I have full control	Count	2	7	3	1	13
	% within $VentilationControl	15.4%	53.8%	23.1%	7.7%	
	% within CaseStudySchool	50.0%	33.3%	25.0%	16.7%	
	% of Total	4.7%	16.3%	7.0%	2.3%	30.2%
Ventilation: Don't know	Count	1	1	2	1	5
	% within $VentilationControl	20.0%	20.0%	40.0%	20.0%	
	% within CaseStudySchool	25.0%	4.8%	16.7%	16.7%	
	% of Total	2.3%	2.3%	4.7%	2.3%	11.6%
Ventilation: Other (please specify)	Count	0	1	1	0	2
	% within $VentilationControl	0.0%	50.0%	50.0%	0.0%	
	% within CaseStudySchool	0.0%	4.8%	8.3%	0.0%	
	% of Total	0.0%	2.3%	2.3%	0.0%	4.7%
Total	Count	4	21	12	6	43
	% of Total	9.3%	48.8%	27.9%	14.0%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.27 Q115 Further comments: temperature and ventilation control

L.27.1 Response rate by school

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	1	25.0%
White	22	12	54.5%
Orange	12	7	58.3%
Red	6	5	83.3%
Total frequency	*44*	*25*	*56.8%*

L.27.2 Staff

Category Code	Detail Code	Total	Yellow	White	Orange	Red
Control	Control - poor, no control of work environment	5	0	3	1	1
Comfort	Comfort - poor thermal comfort	4	0	2	1	1
Control	Control - on / off only, not temp	4	0	0	1	3
Control	Control - want more local control, easier	4	0	3	1	0
Windows	Windows - should but don't open	4	0	4	0	0
Ventilation	Ventilation - poor, is stuffy	2	0	1	1	0
Windows	Windows - difficult to open or close	2	1	0	0	1
Building management system	BMS - difficult to access, not accessible	1	0	1	0	0
Building management system	BMS - inaccurate readings	1	0	1	0	0
Comfort	Comfort - does not work on days 35 deg C	1	0	1	0	0
Comfort	Comfort - winter draughts	1	0	0	0	1
Door	Door - external door used for ventilation	1	0	1	0	0
Evaporative AC	Evaporative AC - not enough venting	1	0	0	1	0
Evaporative AC	Evaporative AC - too much humidity	1	0	0	1	0
Fans	Fans - more energy efficient	1	0	0	1	0
Fans	Fans - want option of a fan for ventilation	1	0	0	1	0
Feeling	Feeling - frustration	1	0	1	0	0
Gas heaters	Gas heaters - installed at ceiling height, poor heating	1	0	0	1	0
Health	Health - staff watch student fluid intake on hot days	1	0	0	1	0
Health	Health - students overheat on hot days in class	1	0	0	1	0
Preferences	Preferences - vary between staff in same space	1	0	0	1	0
Productivity	Productivity - reduced by poor comfort	1	0	1	0	0
Room volume	Room volume - high ceiling difficult to heat / cool	1	0	0	0	1
Smell	Smell - improved after renovations	1	0	0	0	1
Smell	Smell - poor - like dead animal	1	0	1	0	0
'split' AC	'split' AC	1	0	1	0	0
Windows	Windows - want to use them but cant	1	1	0	0	0
Zones	Zones - more than one temp zone, but should be uniform	1	0	1	0	0

L.28 Q116-Q120 Perceived daylight control - Staff

$DaylightControl*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Internal blinds	Count	3	11	4	5	23
	% within $DaylightControl	13.0%	47.8%	17.4%	21.7%	
	% within CaseStudySchool	100.0%	68.8%	36.4%	83.3%	
	% of Total	8.3%	30.6%	11.1%	13.9%	63.9%
External blinds	Count	0	0	0	0	0
	% within $DaylightControl	0.0%	0.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	0.0%	0.0%	0.0%	
	% of Total	0.0%	0.0%	0.0%	0.0%	0.0%
Skylight without controls	Count	0	7	6	1	14
	% within $DaylightControl	0.0%	50.0%	42.9%	7.1%	
	% within CaseStudySchool	0.0%	43.8%	54.5%	16.7%	
	% of Total	0.0%	19.4%	16.7%	2.8%	38.9%
Skylight with controls	Count	0	0	0	0	0
	% within $DaylightControl	0.0%	0.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	0.0%	0.0%	0.0%	
	% of Total	0.0%	0.0%	0.0%	0.0%	0.0%
Other daylight control (please specify)	Count	0	2	4	1	7
	% within $DaylightControl	0.0%	28.6%	57.1%	14.3%	
	% within CaseStudySchool	0.0%	12.5%	36.4%	16.7%	
	% of Total	0.0%	5.6%	11.1%	2.8%	19.4%
Total	Count	3	16	11	6	36
	% of Total	8.3%	44.4%	30.6%	16.7%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.29 Q121 - Q130 Current and preferred classroom shape

L.29.1 Q121-Q125 Preferred classroom shape

$PreferredCRShape*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Square classroom preferred	Count	1	12	4	5	22
	% within $PreferredCRShape	4.5%	54.5%	18.2%	22.7%	
	% within CaseStudySchool	33.3%	54.5%	50.0%	83.3%	
	% of Total	2.6%	30.8%	10.3%	12.8%	56.4%
Circular classroom preferred	Count	0	1	0	0	1
	% within $PreferredCRShape	0.0%	100.0%	0.0%	0.0%	
	% within CaseStudySchool	0.0%	4.5%	0.0%	0.0%	
	% of Total	0.0%	2.6%	0.0%	0.0%	2.6%
L-shaped classroom preferred	Count	2	3	0	0	5
	% within $PreferredCRShape	40.0%	60.0%	0.0%	0.0%	
	% within CaseStudySchool	66.7%	13.6%	0.0%	0.0%	
	% of Total	5.1%	7.7%	0.0%	0.0%	12.8%
Rectangular classroom preferred	Count	0	9	4	3	16
	% within $PreferredCRShape	0.0%	56.3%	25.0%	18.8%	
	% within CaseStudySchool	0.0%	40.9%	50.0%	50.0%	
	% of Total	0.0%	23.1%	10.3%	7.7%	41.0%
Irregular classroom	Count	1	1	2	0	4
	% within $PreferredCRShape	25.0%	25.0%	50.0%	0.0%	
	% within CaseStudySchool	33.3%	4.5%	25.0%	0.0%	
	% of Total	2.6%	2.6%	5.1%	0.0%	10.3%
Total	Count	3	22	8	6	39
	% of Total	7.7%	56.4%	20.5%	15.4%	100.0%

Percentages and totals are based on respondents. a. Dichotomy group tabulated at value 1.

L.29.2 Q127-Q130 Current classroom shape

$CurrentCRShape*CaseStudySchool Crosstabulation

		Case Study School				
		Yellow	White	Orange	Red	Total
Square classroom	Count	3	13	2	2	20
	% within $CurrentCRShape	15.0%	65.0%	10.0%	10.0%	
	% within CaseStudySchool	75.0%	68.4%	22.2%	40.0%	
	% of Total	8.1%	35.1%	5.4%	5.4%	54.1%
L-shaped classroom	Count	0	1	0	1	2
	% within $CurrentCRShape	0.0%	50.0%	0.0%	50.0%	
	% within CaseStudySchool	0.0%	5.3%	0.0%	20.0%	
	% of Total	0.0%	2.7%	0.0%	2.7%	5.4%
Rectangular classroom	Count	1	3	5	2	11
	% within $CurrentCRShape	9.1%	27.3%	45.5%	18.2%	
	% within CaseStudySchool	25.0%	15.8%	55.6%	40.0%	
	% of Total	2.7%	8.1%	13.5%	5.4%	29.7%
Irregular classroom	Count	0	2	2	0	4
	% within $CurrentCRShape	0.0%	50.0%	50.0%	0.0%	
	% within CaseStudySchool	0.0%	10.5%	22.2%	0.0%	
	% of Total	0.0%	5.4%	5.4%	0.0%	10.8%
Total	Count	4	19	9	5	37
	% of Total	10.8%	51.4%	24.3%	13.5%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.30 Q126 Reason for selecting preferred classroom shape

L.30.1 Response rate

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	3	75.0%
White	22	14	63.6%
Orange	12	8	66.7%
Red	6	6	100.0%
frequency	*44*	*31*	*70.5%*

L.30.2 Staff

Category Code	Preferred shape	Detail code	Total	Yellow	White	Orange	Red
Reconfiguration	Square	Reconfiguration - easy	7	0	3	1	3
Flexibility	Square	Flexibility - generally, best, easy	6	1	4	0	1
Floor seating	Rectangular	Floor seating - easier	5	0	2	2	1
Furniture	Square	Furniture - space use depends on furniture size / shape	5	0	3	1	1
Reconfiguration	Rectangular	Reconfiguration - easy	5	0	4	0	1
Furniture	Rectangular	Furniture - space use depends on furniture size / shape	4	0	2	1	1
Visibility	Square	Visibility - supervision and IWB	4	0	0	3	1
Flexibility	Rectangular	Flexibility - generally, best, easy	3	0	2	1	0
Floor seating	Square	Floor seating - easier	3	0	1	0	2
Learning areas	Square	learning areas - create different areas, stations, groups	3	1	1	0	1
Flexibility	L-shaped	Flexibility - generally, best, easy	2	2	0	0	0
Learning areas	Irregular	learning areas - create different areas, stations, groups	2	1	0	1	0
Learning areas	L-shaped	learning areas - create different areas, stations, groups	2	1	1	0	0
Learning areas	Rectangular	learning areas - create different areas, stations, groups	2	0	1	1	0
Other - dispute premise	Irregular	Other - dispute premise - size more important	2	0	2	0	0
Space	Irregular	Space - want corners	2	0	1	1	0
Space efficiency	Square	Space efficiency - maximised use	2	0	1	0	1
Flexibility	Irregular	Flexibility - generally, best, easy	1	1	0	0	0
Other - dispute premise	L-shaped	Other - dispute premise - depends on furniture	1	0	1	0	0
Other - don't know		Other - don't know	1	0	0	1	0
Space	Circle	Space - want no corners	1	0	1	0	0
Space	Rectangular	Space - want corners	1	0	1	0	0
Space efficiency	Rectangular	Space efficiency - maximised use	1	0	0	0	1
Visibility	Irregular	Visibility - supervision and IWB	1	0	0	1	0
Visibility	Rectangular	Visibility - supervision and IWB	1	0	0	1	0

L.31 Q131-Q137 locations used for teaching and learning display

$DisplayLocation*CaseStudySchool Crosstabulation

		Case Study School				Total
		Yellow	White	Orange	Red	
Pinboards	Count	4	22	10	6	42
	% within $DisplayLocation	9.5%	52.4%	23.8%	14.3%	
	% within CaseStudySchool	100.0%	100.0%	100.0%	100.0%	
	% of Total	9.5%	52.4%	23.8%	14.3%	100.0%
Doors	Count	3	16	7	6	32
	% within $DisplayLocation	9.4%	50.0%	21.9%	18.8%	
	% within CaseStudySchool	75.0%	72.7%	70.0%	100.0%	
	% of Total	7.1%	38.1%	16.7%	14.3%	76.2%
Walls	Count	2	20	9	6	37
	% within $DisplayLocation	5.4%	54.1%	24.3%	16.2%	
	% within CaseStudySchool	50.0%	90.9%	90.0%	100.0%	
	% of Total	4.8%	47.6%	21.4%	14.3%	88.1%
Windows	Count	1	19	10	5	35
	% within $DisplayLocation	2.9%	54.3%	28.6%	14.3%	
	% within CaseStudySchool	25.0%	86.4%	100.0%	83.3%	
	% of Total	2.4%	45.2%	23.8%	11.9%	83.3%
Ceiling / overhead	Count	3	14	7	2	26
	% within $DisplayLocation	11.5%	53.8%	26.9%	7.7%	
	% within CaseStudySchool	75.0%	63.6%	70.0%	33.3%	
	% of Total	7.1%	33.3%	16.7%	4.8%	61.9%
Other (please specify)	Count	0	2	2	2	6
	% within $DisplayLocation	0.0%	33.3%	33.3%	33.3%	
	% within CaseStudySchool	0.0%	9.1%	20.0%	33.3%	
	% of Total	0.0%	4.8%	4.8%	4.8%	14.3%
Total	Count	4	22	10	6	42
	% of Total	9.5%	52.4%	23.8%	14.3%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.32 Q138 Reason for window display

L.32.1 Response rate by school

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	0	0.0%
White	22	15	68.2%
Orange	12	9	75.0%
Red	6	5	83.3%
frequency	*44*	*29*	*93.2%*

L.32.2 **Staff**

Category Code	Detail Code	Total	Yellow	White	Orange	Red
Display space	Display space - lacking, need more	17	0	8	5	4
Communication	Communication - to people outside of class	9	0	4	5	0
Communication	Communication - to people inside of class	6	0	2	4	0
Display type	Display type - transparent / translucent	6	0	0	4	2
Display type	Display type - student work	5	0	1	4	0
Display type	Display type - art work	3	0	1	2	0
Obstruction	Obstruction - solar control	3	0	2	0	1
Display type	Display type - double sided	2	0	0	2	0
Access	Access - needs to be at student eye level	1	0	0	1	0
Access	Access - window easier than overhead / ceiling	1	0	1	0	0
Access	Access - windows used because walls surface texture not good for display	1	0	0	1	0
Display space	Display space - only display space available	1	0	1	0	0
Obstruction	Obstruction - bad view	1	0	0	0	1
Obstruction	Obstruction - privacy	1	0	1	0	0
Obstruction	Obstruction - remove distractions	1	0	0	0	1
Visual appearance	Visual appearance - makes room attractive	1	0	0	1	0

L.33 **Q139-147 Internal door types and operation frequency**

L.33.1 **Q139-142 Internal doors and operable walls - Staff**

$CRInternalDoors*CaseStudySchool Crosstabulation

		Case Study School			
		White	Orange	Red	Total
An operable wall (panel wall that can be moved)	Count	6	3	1	10
	% within $CRInternalDoors	60.0%	30.0%	10.0%	
	% within CaseStudySchool	66.7%	37.5%	50.0%	
	% of Total	31.6%	15.8%	5.3%	52.6%
A large solid sliding door	Count	3	5	1	9
	% within $CRInternalDoors	33.3%	55.6%	11.1%	
	% within CaseStudySchool	33.3%	62.5%	50.0%	
	% of Total	15.8%	26.3%	5.3%	47.4%
A large sliding door with glass	Count	2	0	0	2
	% within $CRInternalDoors	100.0%	0.0%	0.0%	
	% within CaseStudySchool	22.2%	0.0%	0.0%	
	% of Total	10.5%	0.0%	0.0%	10.5%
Other (please specify)	Count	3	1	0	4
	% within $CRInternalDoors	75.0%	25.0%	0.0%	
	% within CaseStudySchool	33.3%	12.5%	0.0%	
	% of Total	15.8%	5.3%	0.0%	21.1%
Total	Count	9	8	2	19
	% of Total	47.4%	42.1%	10.5%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.33.2 Q143-Q147 Operation frequency of internal doors & walls - Staff

$CRFlexibilityOperation*CaseStudySchool Crosstabulation

		Case Study School			Total
		White	Orange	Red	
Always open	Count	2	2	1	5
	% within $CRFlexibilityOperation	40.0%	40.0%	20.0%	
	% within CaseStudySchool	25.0%	25.0%	50.0%	
	% of Total	11.1%	11.1%	5.6%	27.8%
Opened daily	Count	4	4	1	9
	% within $CRFlexibilityOperation	44.4%	44.4%	11.1%	
	% within CaseStudySchool	50.0%	50.0%	50.0%	
	% of Total	22.2%	22.2%	5.6%	50.0%
Opened occasionally	Count	0	3	0	3
	% within $CRFlexibilityOperation	0.0%	100.0%	0.0%	
	% within CaseStudySchool	0.0%	37.5%	0.0%	
	% of Total	0.0%	16.7%	0.0%	16.7%
Always closed	Count	2	1	0	3
	% within $CRFlexibilityOperation	66.7%	33.3%	0.0%	
	% within CaseStudySchool	25.0%	12.5%	0.0%	
	% of Total	11.1%	5.6%	0.0%	16.7%
Total	Count	8	8	2	18
	% of Total	44.4%	44.4%	11.1%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.33.3 Operation frequency by door type - Staff

$InternalDoorType*$InternalDoorOperation Crosstabulation

		Internal door operation[a]				Total
		Always open	Opened daily	Opened occasionally	Always closed	
An operable wall (panel wall that can be moved)	Count	3	4	1	2	9
	% within $InternalDoorType	33.3%	44.4%	11.1%	22.2%	
	% within $InternalDoorOperation	60.0%	44.4%	33.3%	66.7%	
	% of Total	16.7%	22.2%	5.6%	11.1%	50.0%
A large solid sliding door	Count	2	5	2	1	9
	% within $InternalDoorType	22.2%	55.6%	22.2%	11.1%	
	% within $InternalDoorOperation	40.0%	55.6%	66.7%	33.3%	
	% of Total	11.1%	27.8%	11.1%	5.6%	50.0%
A large sliding door with glass	Count	1	1	0	0	2
	% within $InternalDoorType	50.0%	50.0%	0.0%	0.0%	
	% within $InternalDoorOperation	20.0%	11.1%	0.0%	0.0%	
	% of Total	5.6%	5.6%	0.0%	0.0%	11.1%
Other (please specify)	Count	0	2	0	2	3
	% within $InternalDoorType	0.0%	66.7%	0.0%	66.7%	
	% within $InternalDoorOperation	0.0%	22.2%	0.0%	66.7%	
	% of Total	0.0%	11.1%	0.0%	11.1%	16.7%
Total	Count	5	9	3	3	18
	% of Total	27.8%	50.0%	16.7%	16.7%	100.0%

Percentages and totals are based on respondents.
a. Dichotomy group tabulated at value 1.

L.34 Q149 Further comments about classrooms and teaching

L.34.1 Response rate by school: staff

	Staff		
	Possible responses	Responses provided	Percentage by School
Yellow	4	2	50.0%
White	22	6	27.3%
Orange	12	6	50.%
Red	6	4	66.7%
frequency	*44*	*18*	40.9%

L.34.2 Staff

category code	code detail	Total	Yellow	White	Orange	Red
Size	Size - classroom too small, needs to be larger	7	2	2	3	0
Learning environment	Learning environment - need variety of space for group and individual learning	5	0	2	3	0
Acoustics	Acoustics - loud noise level	4	2	1	0	1
Design	Design - classrooms feel comfortable, 'cosy', not sterile	3	0	1	1	1
Floor	Floor - need floor learning space	3	0	0	3	0
Space	Space - no flexibility, need flexibility	3	1	0	1	1
Wet areas	Wet areas - need more, specialised	3	0	2	1	0
Comfort	Comfort - must have fresh air	2	0	1	0	1
Learning effectiveness	Learning effectiveness - reduced by space design	2	0	2	0	0
Pedagogy	Pedagogy - changed due to space	2	2	0	0	0
Space	Space - need ability to close off	2	1	1	0	0
Capacity	Capacity - all spaces booked	1	1	0	0	0
Comfort	Comfort - good temperature	1	0	0	0	1
Daily management	Daily management - must be clean	1	0	1	0	0
Design	Design - rooms for play during inclement weather	1	0	0	1	0
Design	Design - room shape for optimised IWB visibility	1	0	0	0	1
Design	Design - easy to rearrange furniture and space	1	0	0	1	0
Electrical	Electrical - need more GPOs	1	0	1	0	0
ICT - IWB	ICT - IWB - floor vibrations affect IWB	1	0	0	1	0
ICT - IWB	ICT - IWB - must be visible to all	1	0	0	0	1
Learning environment	Learning environment - facilitate active learning	1	0	0	0	1
Learning environment	Learning environment - supportive	1	0	0	0	1
Lighting	Lighting - good, bright needed	1	0	1	0	0
Security / safety	Security / safety - must feel safe	1	0	0	0	1
Site plan	Site plan - too big, spread out restricts access to facilities	1	0	1	0	0
Size	Size - more space needed for older students	1	0	1	0	0
Size	Size - overcrowded	1	1	0	0	0
Space	Space - flexibility to teach different subjects in same space	1	0	0	1	0
Storage	Storage - need more, better designed	1	0	0	1	0
Storage	Storage - need storage for ongoing student work and projects	1	0	1	0	0
Teaching	Teaching - compromised	1	1	0	0	0
Views	Views - lockers unpleasant	1	0	0	1	0

Appendix M Triangulation array

This array is presented to demonstrate the grounded development of the final themes. The original workings included an interim column called 'interpretation notes and queries' which included notes and memos on the results summary. It has been omitted due to space limitations.

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
4	**Architecture of Case studies**			
4.2	Architectural configuration			
4.2.1	Site plans	Different outdoor facilities Open vs closed fence All had edible gardens, except Yellow (there but no access)	Safety and wellbeing	
4.2.2	Form, character and fabric, classroom descriptions	Range in ages and building types. Range in classrooms in architecturally recognised buildings (10/24) and no award buildings (14/24) Mass buildings in both older (stone) and new (rammed earth)		
4.2.3	ESD, Eco- and 'sustainability' design features	All schools had evidence of ESD design features or components, either integrated or retrofitted	Consideration of the environment	
4.2.4	Indoor environment control components	Manual control or override available in all except White. White BMS not easily used. Operable windows not observed to be used for ventilation Doors observed to be used in lieu of windows	Query usability	
4.2.5	Artificial lighting and daylight design	Variations in design and use across classrooms Older buildings without external shading	Query usability	
4.3	Public descriptions of case study schools	Architects describe design vision that are not comparable with school vision. Architects and school pedagogy descriptions are similar Facilities descriptions similar Architects provide more details about sustainability elements than schools School newsletters describe activities, new or upgraded facilities	Difference of importance of school as place and public architecture Activity is important in schools	
4.4	Permanent building fabric modifications			
4.4.1	Retrofitted 'sustainability' demonstration appliances	'demonstration appliances' not always visible to students	Functionality problem in design	
4.4.2	Reconfigured 'sustainability' components	Sustainability components are changed after occupation	Functionality problem in design	
4.4.3	Modifications to control daylight	Daylight controls were retrofitted – blinds, verandah extensions, film	Functionality problem in design	
4.4.4	Retrofitting Interactive Whiteboards	IWBs retrofitted. Some fabric changes. Evidence of layout changes. Re-introduction of a 'teaching wall'	Change in functionality needs / degradation of teaching space quality	
4.4.5	Acoustic modifications	Acoustic treatment observed in all – either integrated or retrofitted.	Sound is important Change in functionality needs	

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
4.4.6	Modifications to increase display opportunities	Observed during study year	Change in functionality needs	
4.5	Use of school space			
4.5.1	Area per student	Average area per student 2.44 in classrooms – wall to wall i.e., not all useable space minimum Red.5 1.85 Maximum Yellow.2 3.75, White.1 3.52		
4.5.2	Sustainability education programmes	Little written about sustainability programmes in schools	Environment not explicit in curriculum	
4.5.3	Classroom observations			
4.5.3.1	Dynamic space	Desk rearrangements observed. Size per classroom not relevant Flexible space via internal partition flexibility – variable use Operable walls observed as fixed open or closed	Functionality and useability	
4.5.3.2	Borrowed space	Space used at expense of circulation	Functionality Space and flexibility	
4.5.3.3	Display	Display observed on more than pinboards Display has direction – facing in and facing out	Functionality Individuality and flexibility	
4.5.3.4	Computers	Computers found in classrooms and dedicated computer rooms. Mostly fixed, some laptops	Functionality Flexibility and slow wireless take up	
4.5.3.5	View control	Different types of view control via glazing obstruction observed	Functionality Wellbeing	
4.5.3.6	Other personalisation	Other novel personalisation – songs not sirens, cubby house, pinboard decoration, streamers on vents	Functionality Wellbeing	
4.5.3.7	Dirt, mess and Cleaning up	Facilities and daily maintenance Window dirt and vacuum cleaner	Maintenance	
4.5.3.8	Storage	Exists, but not always used	Functionality	
4.5.4	Toilets	Facilities and daily maintenance Observed mess and dirt	Functionality / maintenance	
5	Environmental results			
5.2	Temperature			
5.2.1	Temperature guidelines and regulations for schools	Selected temp design guidelines, standards, and statutory inputs reported. Some variation between them	Environment – excessive energy use in winter?	
5.2.2	Temperature measured by environmental loggers	Variation in classrooms meeting design temperature. Temp measured as colder than prescribed comfort	Environment Comfort and wellbeing – cold in winter – is this a problem?	
5.2.3	Temperature measured by portable instruments	Consistent with logger temps		
5.2.4	Unexpected observed temperature logging data	Example of incorrect set points of automatic systems in white.3 Example of weekend use	Functionality Place and community use	
5.2.5	Temperature and humidity	Outside of comfort at low temperatures Orange.1 humidity above 70%	Comfort and Wellbeing	
5.3	Light			

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
5.3.1	Lighting guidelines and regulations for schools	Various guidelines for specific tasks. Primary classes do various things. IWB not mentioned	Functionality	
5.3.2	Measured light levels	Light against walls much lower than spot measurements, as expected, wanted Large variations between schools (Purple vs others) and within schools (White.1 vs others	Functionality	
5.4	Noise and sound			
5.4.1	Noise and sound guidelines and regulations for schools	Levels and reverberation times as prescriptive standards		
5.4.2	Measured noise levels	Reverb time not measured Noise rarely measured above 75 dBA regardless of acoustic treatment Some examples of noise ingress and AC noise above guidelines	Functionality Noise stress contribution to wellbeing	
6	User perceptions			
6.2	Student and staff participant characteristics			
6.2.1	Response rate and demographics	Acceptable Demographics reflect population		
6.2.2	Satisfaction with school and work (Q92)	Students – m=3.25 ie not strongly one way or another. (Red sig. higher). R^2=0.40 Correlated with some other variables – regression based on boring buildings and nat light Staff m=4 i.e. respondents find job satisfactory Regression – less problems with noise, pride in school, calmer views R^2=0.55	Suggestive that satisfaction is influenced by building quality Architectural design?	Visual and place quality
6.3	Perspectives of the school built environment			
6.3.1	Perspectives of school uniqueness (Q09)	Staff – building elements, grounds, visual appearance, i.e., more about physical detail Students – culture, facilities, history, teaching, i.e. more about whole facilities, and people connections	Different cohorts obvious Aspects of place and architecture (Visual quality) Meaning and place and identity Sustainability and environmental aspects missing	Cohort differences BE Interaction differences Functional quality Visual and place quality Environmental quality (lack of)
6.3.2	Perspectives of school buildings and grounds			
6.3 2.1	School buildings as contributing to teaching and learning (Q59a)	Greater than 5%: Circulation, Culture, Design, learning environment, Size, space	Very wide range of responses. Functionality and facilitation of learning	Functional quality
6.3 2.2	School buildings as place and architecture			
6.3.2.2.1	*School buildings as attractive is important (Q28)*	Students m=3.98 (Red sig. higher) Staff m = 4.3 Regression – students = well maintained R^2=0.092 Regression – staff = interesting R^2=0.21 Yes important, but weakly related to anything	Different cohorts obvious Staff understand visual quality Students more facility management (FM) Lack of correlations surprising	Cohort differences Wellbeing quality Visual and place quality

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.3.2.2.2	*School buildings as landmarks (Q13)*	Cohort sig difference (Q13 landmark) Students m=2.97 (Red sig. higher) Staff m=3.79 (White sig. lower) Regression – students = interesting R^2 = 0.18 Regression – staff = interesting **R^2=0.52**	Cohort sig difference (cf. Q15 interesting Architecture and place – staff do not agree with architectural judgement (arch juries) Different cohorts obvious Notion of 'landmark' was expected to be stronger when compared to Q09 and Q28 responses.	Cohort differences Visual and place quality
6.3.2.2.3	*School buildings as interesting (Q15)*	Students m=3.28 (Red sig. higher) Staff m=3.76 (Red sig. higher) Regression – students = proud, like attending school, little noise ingress from other rooms **R^2=0.5** Regression – staff = landmark, well maintained **R^2= 0.61**	Cohort difference but not sig (cf Q13 landmark) Visual vs emotional predictors for staff and students. Age changes architectural interpretation? Staff liked what they saw (Q29)	Cohort differences BE Interaction differences Visual and place quality
6.3.2.2.4	*Pride in school buildings (Q20)*	Students m=3.48 (Red sig. higher) Staff m=3.41 Regression – students = interesting, good for learning, views calm, clean, female, important CR well designed **R^2=0.54** Regression – staff – does not work	Pride is holistic – grouped around wellbeing Student mean higher than landmark or interesting. Pride about buildings as interesting (visual) and wellbeing.	Wellbeing quality Visual and place quality
6.3.2.2.5	*School buildings as architecture*	**School buildings as good architecture (Q13a)** Staff m=2.91 (White sig. lower) Regression – staff – does not work **School architecture typology multiple choice (Q23-27)** Students – depends on school, some relation to form Staff – depends on school – staff more identify difference from 'a typical' school more than students With other – staff identify building elements, students identify grounds as different. Both identify visual appearance aspects	Cohort differences – seen vs used Q27, also different interactions (cf Q59a contribution to teaching and learning Place and architecture Consistent with landmark judgement Consistent with observed architecture	Visual and place quality
6.3.2.2.6	*What is liked about school buildings (Q29)*	**What do you like about school grounds** Students – grounds facilities that they use, Staff – visual appearance, specific building elements	Cohort differences – seen vs used Viewed vs used Visual quality	Cohort differences BE Interaction differences Functional quality Visual and place quality
6.3.2.3	School buildings as functional space	**Good for learning (Q18)** Cohort sig differences (Q18 good for learning) Students m=4.05 (Red sig. higher) Staff m=2.79 (Orange sig. higher, White sig. lower) Regression – students – healthy, safe, proud, winter air smells clean **R^2=0.55** Regression – staff – good for teaching, healthy **R^2=0.83** **Good for teaching effectiveness (Q18a)** Staff m=2.71 (White sig. lower) Regression – staff – good for learning, pedagogy matched, perceptions understand what is being said in class **R^2=0.86** **Matched pedagogy (Q18b)** Staff m=2.98 Regression – staff – good for teaching effectiveness R^2 = 0.48	Cohort sig differences Different cohorts obvious – learning place quality vs workplace quality Users don't agree with architects Good for learning is not about space, size, attractiveness – more about functionality and wellbeing Functionality – pedagogy not necessary correlated with spatiality Size mentioned as contributing to poor teaching due to inability to mitigate other classroom issues such as noise (Q60, Q149).	Cohort differences Functional quality Wellbeing quality Visual and place quality Environmental quality (missing)
6.3.2.4	School buildings as healthy and safe space		Note – I previously described this as 'school buildings quality of space'	

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.3.2.4.1	*Cleanliness (Q14)*	**Buildings are clean** Students m=3.63 Staff m=3.55 Regression – students – healthy, proud R^2=0.37 Regression – staff – healthy, building problems fixed quickly **R^2=0.61**	Perspective of wellbeing as related to maintenance and cleanliness	Functional quality Wellbeing quality
6.3.2.4.2	*Maintenance*	**Well maintained (Q16)** Students m=3.49 (Red sig. higher) Staff m=3.31 (White sig. lower) Regression – students – healthy, less noise, attractive views, importance of looking attractive, safe, lighting helps learning **R^2=0.55** Regression – staff – healthy, building problems fixed quickly **R^2=0.67** **Building problems fixed quickly (Q16a)** Staff m=2.79 (White sig. lower) Regression – staff – building well maintained **R^2=0.51**	Wellbeing Wellbeing and functionality of holistic learning environment Facilities management	Wellbeing quality
6.3.2.4.3	*Safety (Q17)*	**Buildings are safe** Cohort sig difference (Q17 safety) Students m=3.92 variances not homogeneous (Red sig. higher – police station across road) Staff m=3.33 Regression – students – good for learning, well maintained, computers important, too big, water saving easy, noise outside quiet **R^2=0.52** Regression – students – good for learning, well maintained **R^2=0.43** Regression – staff – well maintained, too cold in winter for students **R^2=0.44**	Cohort sig difference Safe design important for wellbeing and learning	Cohort differences Wellbeing quality
6.3.2.4.4	*Healthy buildings (Q19)*	**Buildings are healthy** Cohort sig difference (Q19 healthy) Students m=3.86 (Red sig. higher) Staff m=3 (White sig. lower) Regression – students – good for learning, clean, water saving easy, well maintained **R^2=0.56** Regression – staff – good for learning, clean, low glare, preference for quieter classrooms. **R^2=0.82**	Cohort sig difference Wellbeing and learning space quality and workplace quality.	Cohort differences Functional quality Wellbeing quality
6.3 2.5	School redesign preferences (Q83)	> 5%, peaks in bold Students – **buildings**, **grounds**, visual appearance, **nothing** Staff - buildings, grounds, learning / teaching, nothing, security / safety, site plan, **visual appearance**.	Cohorts difference – seen vs used Cohort interaction with grounds as a learning and teaching issue (Q83) Some concerns about security and safety with White open school plan Request for change to visual appearance of White even though a winner of architectural awards Architecture and Place	Cohort differences BE Interaction differences Functional quality Wellbeing quality Visual and place quality
6.3.3	School as community asset (Q88a)	Community, public amenity, medical, parents, volunteers, used after hours All schools had some form of extension into the community beyond school core activities	Consistent with measured AH temperature suggesting AC use. Place for wider community	

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.3.4	Perspectives of school sustainability	Cohort sig differences (Q21 energy saving, Q22 water saving) **School is sustainable (Q10)** Students – m=3.27 (Yellow sig. lower) Staff – m=3.06 Regression – students – well maintained, energy saving easy, light helps with learning. R^2=0.26 Regression – staff – no mathematical solution **Expected (Q11) and experience (Q12)** Students – more about daily management, grounds, other student activities Staff, - design, energy, water Biggest discrepancy between expected and actual is daily management and student activities – expect more of the former, experience more of the latter **Saving energy easy (Q21)** Students – m=3.29 Staff – m=2.56 Regression – students – too many coefficients Regression – staff – too many coefficients **Saving water easy (Q22)** Students – m=3.3 Staff – m=2.74 Regression – students – too many coefficients Regression – staff – too many coefficients **Discussed in lesson (Q68-77)** Students – history, air conditioning, gardens Staff – history, air conditioning, gardens, other	Cohort sig differences (Q21 energy saving, Q22 water saving) Environmental – student user responses are not consistent with sustainable architecture intentions. Environment – student activities not expected but reported by students (Q11, Q12) Staff more aware of component driven sustainability. Visual sustainability quality ≠ sustainability teaching More about activities. Differences between cohorts in scales for just energy and water. Rough agreement of wider range of what is discussed in class. Generally, little reporting of anything to do with sustainability in any form in other open questions. (cf Q59a) Q68-77 – classroom sustainability more around gardens.	Cohort differences BE Interaction differences Functional quality Environmental quality
6.4	Perspectives of the classroom environment			
6.4.1	Teaching and learning			
6.4.1.1	Pedagogy and learning activities	**Student learning activities (Q01-08)** Students work at their desk alone or in a group. Computers use at desk and elsewhere **Teachers/staff describe pedagogy (Q01)** Many. >5% conflicts with architecture, constructivist, early years, group/collaboration, student centred	'21C' learning not in place at time of fieldwork. Pedagogy more complex than stated by architects Functionality – but ICT not mentioned, yet considered important (Q66)	Functional quality
6.4.1.2	Classroom contribution to teaching and learning (Q59)	**CR parts that help with learning and teaching (Q59)** >5% Students – fixtures, furniture, **ICT/IWB**, Staff – fixtures, **floor**, furniture, ICT/IWB, lighting, **space/layout**, **teaching/learning/staff**	Cohort differences – interaction of learning facilities Cohort similarities for design coincides with comments about what is considered important (Q60) Functionality Wellbeing – students talk about calmness and help with learning	Cohort differences BE Interaction differences Functional quality Wellbeing quality
6.4.1.3	Teaching and classroom shape (Q121-130)	**Current shape to teach in** Square, rectangular, irregular, L-shaped (in order) **Preferred shape to teach in** Square, rectangular, L-shape, irregular, circular **Selections based on** >5% flexibility, floor seating, furniture, learning areas, reconfiguration, space, visibility	Functionality and design	Functional quality

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.4.1.4	ICT in the classroom	Cohort sig difference (Q66 ICT important now, Q67 ICT important in the future) **Importance of ICT in current teaching (Q66)** Students – m=4.30 Staff – m=4.78 **Importance of ICT in current teaching (Q67)** Students – m=4.54 Staff – m=4.95	Cohort sig difference Relate back to observed ICT facilities. Questions about where learning occurs suggests full flexibility not available yet. Not mentioned in pedagogy Q01	Functional quality
6.4.2	Classroom design			
6.4 2.1	The importance of a well-designed classroom (Q58)	Cohort sig difference (Q58 importance of well designed CR) Students m=4.12 Staff m=4.76 Regression – students – proud, important looks attractive, sustainable. R^2=0.16 Regression – staff – job experience. R^2=0.25	Cohort sig difference (Q58 importance of well designed CR) Low correlation with other variables – not as expected by architects	Cohort differences BE Interaction differences Functional quality
6.4 2.2	Classroom size (Q62)	Cohort sig difference (Q62 CR size) Staff m=2.47 Students m=1.98 (Yellow sig. lower) Regression – students – furniture moves easily, safe, computers not important R^2=0.29 Regression – staff – students understand speech R^2=0.30	Cohort sig difference Functionality Wellbeing.	Cohort differences BE Interaction differences Functional quality
6.4 2.3	Classroom views	**Classroom Views – attractive (Q64)** Students m=3.16 (Red sig. higher) Staff m=3.36 Regression – students – view calm, well maintained, summer air fresh, female R^2=0.42 Regression – staff – view calm, winter temp cold R^2=0.37 **Classroom Views – calm (Q65)** Students m=3.42 Staff m=2.98 Regression – students – view attractive, low glare, older, proud – R^2=0.44 Regression – staff – buildings interesting, views attractive – R^2=0.44	Lack of extremes is consistent with observed architecture (section 6.4.3.2). Preferences for trees in views (Q83) Possibly differences by age / experience. Learning and workplace quality	Functional quality Wellbeing quality Visual and place quality
6.4 2.4	What occupants like	**What occupants like about CR (Q60)** >5%, peaks in bold Students – Display, **Furniture**, **ICT/IWB**, dispute premise, space/layout, visual appearance Staff – Display, **Fixtures**, **Space/layout**, Visual appearance, **Windows**	Cohort differences obvious – seen vs used Functionality as liked – acoustics cf Q36 Cohort similar around visual aspects cf Q59 Important design	Cohort differences BE Interaction differences Functional quality Wellbeing quality
6.4.3	Classrooms as dynamic space			
6.4 3.1	Matching space with teaching and learning (Q61)	**Open question about changing room to help with teaching** >5%, peaks in bold Students – **computers**, desks, **don't know**, dispute premise, indeterminate, groups Staff – **desks**, **furniture layout/space**, **restrictions**, groups	Cohort differences obvious Lack of response in students consistent with low frequency of classroom rearrangements observed in survey participant classrooms. Functionality – flexibility in layout (staff) cf. Q84, but observed to small active use (section 4.5.3.1). Observed rectilinear floor plans preferred (Q126). Built in flexibility observed not to be used (section 6.4.3.3).	Cohort differences Functional quality

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.4.3.2	Moving furniture (Q63)	**Move furniture** Staff m=3.04 Students m=3.28	Lack of response in students consistent with low frequency of classroom rearrangements observed in survey participant classrooms.	Functional quality (absence)
6.4.3.3	Internal doors and operable walls (Q138-147)	**Door type** Nothing in yellow. 10 operable walls, 9 sliding doors, 2 glass doors, 4 other. **Operation frequency** Always open 5, opened daily 9, opened occasionally 3, always closed 3,	Functionality, flexibility	Functional quality
6.4.3.4	Dynamic display	**Display (Q131-137)** Everywhere + other overhead written as ropes, wires **Display use windows (Q138)** >10% communication, display space, display type, obstruction	Functionality, flexibility – windows used for more than light, but against student expressed preference (Q57)	Functional quality
6.4.4	Classroom thermal, light and aural environment			
6.4.4.1	Perceived temperature and ventilation (Q37-45)	Cohort sig differences (Q37 summer temp, Q39 summer air freshness, Q40 summer air smell, Q42 winter temp pref, Q43 winter air freshness, Q44 winter air smell) **Summer** Temp cold-hot students m=3.1 staff m=3.7 Temp preference students m=1.9 staff m=2.0 cooler Air fresh-stale students m=2.8 staff m=3.6 Air smell clean-dirty students m=2.5 staff m=3.3 For students air temp – staff m=3.7 **Winter** Temp cold-hot students m=2.9 staff m=2.9 Temp preference students m=3.8 staff m=3.0 Air fresh-stale students m=2.4 staff m=3.4 Air smell clean-dirty students m=2.4 staff m=3.3 For students air temp – staff m=2.8 Perceptions not consistent with measurements. Mild correlation between student perceptions and preferences **Other comments (Q45)** Common – adaptive behaviour, air, air conditioning, temperature Students – preferences Staff – control, fabric, students, ventilation, windows	Cohort differences Students more critical of toilet smell (Q78) than classroom smell Comfort and wellbeing Environment Cohort used – familiarity with individual classroom circumstances Control problems reported consistent with observations of door openings and measured temperatures. Students feel neutral but want it warmer in winter. Consistent with measured low temperatures. Wellbeing Concern by teachers (Q45, also Q115) Temperature NOT in FA (section 6.6)	Cohort differences Functional quality Wellbeing quality Environmental quality
6.4.4.2	Perceived light quality (Q53-57)	Cohort sig differences (Q56 artificial light appropriate) – students less satisfied **Scales** All responses between 2.8 and 3.8 **Light helps with learning** Regression – students – art light ok, nat light ok, glare ok, R^2=0.34 **Other comments (Q57)** Students – light level and preferences Staff – control and daylight	Cohort sig differences – students less satisfied with artificial light Cohort interactions – student and staff interactions with blinds and lighting control (Q57) Consistent with observed daylight changes and measured levels Light in FA (section 6.6) as factor around vision of school – correlated with wellbeing, but only 3.7% loading. Descriptions of Q57 suggest wellbeing (seizures, 'hard on eyes') Functionality of learning environment	Cohort differences Wellbeing quality Functional quality

Section	Title	Results summary	Triangulation and theme development notes (first pass post-coding)	Final themes
6.4.4.3	Perceived sound quality Q30-36	Cohort sig differences (Q31 understand speech, Q34 need to raise voice) **Scales** Students – levels not perceived as loud or quiet, can understand, don't raise voice, but would prefer it quieter Staff – levels not loud or quiet. staff have to raise their voice and want noise level to be much quieter **Levene tests** All failed. But normality difficult in 5 scale? **Other comments (Q36)** Students – more about noise level and noise in classroom and behaviour Staff - more about building design and impact on learning / teaching	Cohort sig differences (Q31 understand speech, Q34 need to raise voice) – students also less judgemental about smell in classrooms (see 6.4.4.2) Also cohort similarities in narrative (Q36). Cohort interactions – noise as wellbeing issue (students) vs learning issue (staff) Q36 Wellbeing, Functionality Sound construct in FA 5% loading, negatively correlated with wellbeing. Comments around volume of space and connection to pedagogy. Not mentioned as part of classroom contributing to teaching and learning (Q59).	Cohort differences Wellbeing quality Functional quality
6.4.4.4	School building components as environmental modelling tools	**Other comments – temp/vent control (Q115)** >5% - comfort, control problems, windows dont operate **Students (Q46-52)** >20% See teachings using heating and cooling, windows, vents, other **Other comments – what students see (Q52)** Open the door, teacher has no control, auto timed	Environmental – modelling reported (timer, vents, fans), but not complex components such as BMS. – used not seen, c.f. Q11 Wellbeing within in the context of used controls (Q115 and Q45)	Environmental quality Functional quality Wellbeing quality
6.4.5	Classroom redesign preferences (Q84)	**Redesign classroom** >5%, peaks in bold Students – **air conditioning**, **design**, fixtures, **furniture**, **ICT/IWB**, **nothing**, size, space/layout, **visual appearance** Staff - **control**, **fixtures**, **size**, **space/layout**	Cohort differences – staff responses more complex, seen vs used Functionality cf. Q61 Architecture / design	Cohort differences BE Interaction differences Functional quality
6.5	Spaces other than classrooms			
6.5.1	Perceptions of the toilets (Q78)	**Toilet perceptions** >5% Students – **behaviour**, capacity, **daily management**, **description**, **FM**, ventilation Staff – **capacity**, daily management, **space/layout**, ventilation	Cohort difference – students more judgemental (cf. Q39 summer air smell – students less judgemental) FM is a problem (Context – toilets observed messy, not pristine but classrooms quite messy too) Would design quality help this? Wellbeing – would design quality improve wellbeing of all users?	Cohort differences Wellbeing quality
6.6	Latent variable extraction	Five constructs Wellbeing, Smell, Acoustics, Vision, Satisfaction	Wellbeing grouping is highest loaded factor, and consistent with emotional response in toilets (Q78) and classroom environment responses (6.4.1)→ make this a theme	