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A critical issue?

Educating for sustainability in the architectural design studio

Grover, Robert

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A critical issue? Educating for sustainability in the architectural design studio

Robert John Grover

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University of Bath

Department of Architecture and Civil Engineering

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Abstract

Preparing future architects for the challenges of rapidly shifting global, regional and local environments should be at the forefront of architectural education. This research considers sustainability as a contestable concept that requires critical engagement to develop innovative and successful means of addressing its issues. This research examines the place of sustainability in the architectural design studio and suggests that holistic, collaborative and integrated approaches are necessary to successful learning. It asks how *deep learning* for sustainability may be enhanced in students about to enter the architectural profession through new pedagogic approaches. and asks how *deep learning* for sustainability may be enhanced in students about to enter the architectural profession.

The research develops a conceptual framework for integrating deep learning for sustainability in the architectural design studio. It allowed learners to critically map conceptual approaches to environmental sustainability. The framework was informed by an ethnographic study of the architectural design studio, interviews with architectural practitioners, a participatory action group with students and a Delphi technique with sustainability experts. The framework was tested and applied in the design studio through an action research methodology with final year MArch studio at the University of Bath. Through this participatory approach the research developed strategies to engender *deep learning* for sustainability in the design studio.

The research shows traditional architectural pedagogies limit the learning and thinking necessary to deal with the unique challenges of sustainable design. Current incarnations of the design studio have limited capacity for encouraging deep learning for sustainability. Alternative teaching interactions, including structured workshops and seminars, can increase the range of learning experiences. Structured tools, facilitated by educators, can enable critical understanding. The research contributes a novel framework for integrating sustainable learning into the design studio. It also provides a series of recommendations for implementation at the University of Bath, as well as all courses that adopt a design studio pedagogy.

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Definitions and abbreviations

Abbreviations

AR – Action Research

ARB – Architects' Registration Board

BREEAM – Building Research Establishment Environmental Assessment Method

BSc – Bachelor of Science (degree)

BSRIA – Building Services Research and Information Association

CM – Critical Method

CoP – Community of Practice

LEED – Leadership in Energy and Environmental Design

MArch – Master of Architecture (degree)

RIBA – Royal Institute of British Architects

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organization

Definitions

Crit – A teaching activity in the design studio typically involving the student presenting their work in front of a penal of tutors or practitioners. Also described as a *design review* or *jury* in the literature.

Design studio – The design studio refers to the pedagogy, environment and associated teaching activities. This is clarified where necessary in the thesis.

Deep learning – A mode of learning characterised by high learner motivation, critical evaluation and the questioning of assumptions.

Framework – A clearly defined structure or system for achieving a particular goal.

Model – A representation, often visual, of a specific phenomenon or possible future state.

Sustainability - The principles of futurity, equity, global environmentalism and bio-diversity that underpin *sustainable development*. This thesis adopts a pluralist interpretation of sustainability understanding it as a critical and contestable field.

Sustainable design – The application of sustainable principles to a building design proposal.

Sustainable development – "Development that meets the needs of the present without compromising the ability of future generations." (Brundtland et al., 1987) The principle that human development may be met without undermining the integrity of natural systems.

Desktop tutorial – A teaching interaction between educators and students often in a one-to-one format. It typically uses the student's project work as a basis to critique existing proposals and develop new ideas often through drawing and discussion.

Chapter 1. Introduction

This research examines the place of sustainability in the architectural design studio and suggests that critical engagement is necessary to successful learning. The research shows traditional architectural pedagogies limit the learning and thinking necessary to deal with the unique challenges of sustainable design. Considering sustainability as a contestable concept that requires holistic, collaborative and integrated learning, the research asks how students of architecture may critically engage with these issues through new pedagogic approaches.

My motivation for the research stems from both my experience as an architect in practice as well as five years of teaching in the design studio at the University of Bath. I have personally observed an undervaluing of the role of sustainability in student design projects, often considered a technological addition or ignored entirely. In my experience, this is not linked to student motivation, which is often environmentally conscious, but embedded within a studio culture that does not fully embrace the challenges of environmental sustainability. Viewed as peripheral to the architectural agenda, the term sustainability is often misunderstood and misused. Its interpretation as a single all-encompassing concept undermines the critical and sceptical approach that is required to adequately address the environmental concerns of the future.

1.2 Sustainability in architectural education

1.2.1 UK architecture education

Architectural education must respond to the complex field that is sustainable design through embracing its pluralist agenda (Guy & Moore, 2007). This research draws from the findings of the European wide study environmental design in university curricula and architectural training in Europe (EDUCATE) conducted by an international team led by the university of Nottingham. Among the major findings produced was a white paper called *Sustainable Architectural Education* (EDUCATE, 2012) which advocated the notion of *deep learning* for sustainability as means to dealing with this complexity. A more recent comparative study of curricula by Ismail, Keumala, and Dabdoob (2017) develops the work of EDUCATE and suggests more work needs to be done considering student perceptions of learning for sustainability. Building on the work of these large

scale curricula studies, this research takes a more focussed approach, considering learning for sustainability from a student perspective and the role of pedagogy in facilitating change.

In 2019, the RIBA published the findings of the Ethics and Sustainable Development Commission (RIBA, 2018). The report highlighted the knowledge gap in ethics and sustainability and suggested that architecture schools do not give sufficient emphasis to these issues. As well as strengthening validation procedures, the report also recommends that "all teaching staff in validated schools of architecture have appropriate knowledge of ethics and sustainable development" (p.14). It is within this context of institutional change that this research makes proposals, seeking to address the issues of emphasising sustainable design in schools of architecture, as well as providing a mechanism for enhanced teaching practice.

1.2.2 Deep learning for sustainability

Integrating sustainability into education has been consistently linked to deep learning (Buckingham-Hatfield & Evans, 1996; Warburton, 2003) including in the field of architecture (Clune, 2014; EDUCATE, 2012). *Deep-level* and *surface-level* learning was described by Marton and Säaljö (1976b) and refers to the "qualitative difference" in how people learn. Surface-level learning is a reproductive approach which focuses attention on the specific learning material presented (i.e. the sign). By contrast, a deep-level learner is concerned with underlying meaning (i.e. what is signified) and its principles. Deep learning is particularly relevant to educating for sustainability due to its interdisciplinary, interconnected and holistic nature (Buckingham-Hatfield & Evans, 1996).

Deep learning is closely related to critical pedagogy (Pettit, 2010) which describes a dialogical relationship between learner and teacher seeking transformative change through questioning (Darder & Baltodano, 2003). This approach has been advocated by Crysler (1995) as an alternative to the *transmission* model of architectural education which embraces competing interpretations informed by personal and individual experience. Experiential learning is a similar approach which describes a cycle of reflective and active process through which learners alternately perceive and process knowledge, constantly referring back to their own concrete experiences (Kolb, 1984).

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Literature on deep learning has linked it to learner motivation and a desire to understand (Warburton, 2003). Accordingly, this requires student centred pedagogies to take prominence and reflective educators to enable this (Clune, 2014). As Clune (2014) asserts, the design studio should be the ideal context for deep learning for sustainability. This research examines that claim and questions the role of sustainability in the design studio.

1.2.1 Professional regulation and sustainable design

The integration of sustainability in UK courses of architecture is governed by a set of regulations set out by both the Architects' Registration Board (ARB) and the Royal Institute of British Architects (RIBA). These organisations publish shared "graduate attributes" of a specific candidate at the end of an RIBA validated Part 1, Part 2 or Part 3 course (Architects' Registration Board, 2010; Royal Institute of British Architects, 2010).

This research is specifically concerned with an RIBA Part 2 course. The RIBA and ARB specify general criteria for Part 1 and Part 2 as well as specific attributes for graduates of each. Of the 30 general criteria specified, four are explicitly related to sustainable design.

> GC 5.2 The graduate will have understanding of the impact of buildings on the environment, and the precepts of sustainable design.
> GC8.3 the graduate will have understanding of the physical properties and characteristics of building materials, components and systems, and the environmental impact of specification choices.
> GC9.1 The graduate will have knowledge of principles associated with designing optimum visual, thermal and acoustic environments.
> GC9.2 The graduate will have knowledge systems for environmental comfort realised within relevant precepts of sustainable design.
> (Royal Institute of British Architects, 2010)

None of the required Graduate Attributes mention sustainability but are related to skills and development. They focus on the synthesis of complex designs and critical appraisal as well as personal professional development. Notably, none of the four criteria require the integration of sustainable design into the design studio, using the terminology of "understanding" and "knowledge". This leaves open the possibility for the division of

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sustainable design from practice.

1.3 The design studio as context

1.3.1 The design studio internationally and in the UK

In architectural education, in the UK and internationally, the design studio is the dominant pedagogic model. In a detailed study of 59 international schools of architecture conducted by Altomonte, Attia, Herde, and Dartevelle (2010), the design studio, or versions of the design studio (such as design "laboratories"), were common in all countries and nearly all courses considered. It forms the central part of most courses, often carrying the majority of assessment credits.

Faced with contemporary challenges of environmental degradation, economic instability and social integration, it is imperative that architects are adequately equipped to meet these issues. Accordingly, the design studio, and its associated pedagogy, must enable meaningful learning for sustainable design. The design studio can increase critical engagement, encouraging acceptance that sustainability is a contestable and value led concept (Gürel, 2010). The design studio also has the potential to encourage transdisciplinary learning (Khan, Vandevyvere, & Allacker, 2013). However, these opportunities are rarely exploited by educators and student engagement in sustainable themes is often poor (Clune, 2014).

Current incarnations of the architectural design studio can be traced back to both the Ecole des Beaux Arts in Paris in the 19th Century as well as the Bauhaus (Schön, 1985). Yet its roots reside far deeper in the mediaeval guilds and the master and apprentice model of arts and crafts education (Broadbent, 1995; Lackney, 1999). The design studio is characterised by the absence of a single body knowledge which allows individuals to develop their own work in relation to a broad and eclectic professional community (McClean, 2009). This gives rise to a complex epistemology, in which the designer's personal ideas allow an infinite number of possible design options (Shaffer, 2003)

1.3.2 Teaching architecture at the University of Bath

The context of the research is the University of Bath Department of Architecture and Civil Engineering. Its curriculum has developed over the past fifty years, based on the

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work of a number of former prominent educators notably Smithies (1981) and Brawne (2003). The course in architecture at the University of Bath began in 1959, then housed in the Bristol technical college (Wilkinson, 2016). As Wilkinson notes:

> 'because the principal architectural staff were practicing architects, they believed that the structural and service elements of buildings needed to be taught by professionals in those disciplines' (Wilkinson, 2016, p.512).

This led to the course in building technology which acted as a vehicle for combined education for architects and engineers who began to share lectures and work together on design projects. Moreover, both degrees had considerable periods of industrial training and focused on a practical education through project work.

Collaborative design still forms a cornerstone of the educational model employed. Initially, architects are jointly educated with civil engineers and undergo a number of combined projects throughout their undergraduate education. Each BSc (RIBA part 1) year contains approximately 100 architecture and 100 civil engineering students from which project groups are formed. This collaboration encourages a design approach which is both practical and legible, requiring the need for communication of design ideas to those beyond the architectural community. This picture changes somewhat in the MArch (RIBA part 2) course. The course runs over a two-year period including the first six months which is an industrial placement each year consists of approximately 30 students and does not include interdisciplinary working.

Learning at the case study department was characterised by a *signature pedagogy*. The design project was the vehicle for learning; the design studio provides its context. While deep and experiential learning may underpin the epistemological motivations of the studio, these cognitive processes are framed through the process of design itself which has its own codes and conventions. At the University of Bath, the Critical Method (CM) is explicitly advocated as a model of design. CM is based on the critical rationalism of Popper (1963) and was applied to design initially by Darke (1979) and developed by Brawne (2003). It describes a process of conjecture followed by analysis or, in the terminology of Brawne (2003), *tentative theory* followed by *error elimination*. CM is an iterative process of informed guess work (Bamford, 2002) tested through the application of professional tools (drawing, modelling etc.). Darke (1979) proposed a further aspect to the cycle: the *primary generator*. A primary generator, also

termed the design concept, describes the initial starting point of the process based on the designer's preconceptions, experiences and personal motivations. It is most often an *article of faith*, a collection of conceptual ideas, rather than a rational list of constraints (Darke, 1979). Wright (2011) suggests appropriate criticism is the *'essential component'* in design development at the University of Bath and emphasizes the objective analysis of students' work as key to creating a productive and non-hostile studio environment.

1.4 Sustainability

1.4.1 Defining sustainability

The contemporary sustainability agenda has its roots in international environmental legislation and policy in the 1970s (Basiago, 1995). Successive UN conferences, sessions and summits have challenged the notion that civilization is essentially unsustainable, and that without action, protection and improvement of the human environment, global we risk doing *'incalculable harm to human beings'* (Stockholm, 1972). The United Nations Environment Programme (UNEP) was formed in 1972 and focussed on acid rain and pollution in northern Europe. Following a series of strategic directorates, the Brundtland report (Brundtland et al., 1987) recognised the need for a global approach to sustainable social, economic and environmental issues. Sustainable development has become a major issue for the UN leading to the formation of a number of groups and commissions including the Intergovernmental Panel on Climate Change (IPCC) (1988), the United Nations Conference on Environment and Development (UNCED) (1992) and UN Commission on Sustainable Development (1993), as well as a number of legal treatise and protocols including the Kyoto Protocol (1997), Bali Action Plan (2007) and the Paris Agreement (2016).

Perhaps the most commonly cited interpretation of sustainability in the literature is that provided by the UN's 1987 report *our common future*, which defines *sustainable development* (as opposed to sustainability) as 'development that meets the needs and aspirations of the present generation without destroying the resources needed for future generations to meet their needs.' (Brundtland et al., 1987, p.42). Two key concepts underline sustainability in the UN's framework, firstly the ability to meet needs and secondly the necessity for limitation. Added to this may also be the notions of

development and change, all of which are problematic in developing a coherent definition. The United Nations' 2005 world summit outcome identified three aspects the sustainability as being environmental, social and economic (U.N., 2005) embracing its complex, interdisciplinary nature.

In 2015, the UN general assembly adopted the resolution *Transforming our World: the 2030 Agenda for Sustainable Development* (U.N., 2015) Within this document, they identified seventeen sustainable development goals which capture the complex and multifaceted nature of sustainability. These include themes as diverse as ending poverty and hunger, building resilient infrastructure, combatting climate change and ensuring universal water sanitation. While these themes sit within the social, economic and environmental domains, they describe the expanding field of sustainable development which addresses a range of global issues.

(Daly, 1992) notes that the concept of sustainable development is an oxymoron. Any growth is limited by the finite bounds of the earth's ecosystem. In an increasingly globalised world this natural limit is being rapidly approached (Cullingford, 2004). Meeting the needs of the both present and future generations encompasses assumptions about what needs are now as well as a prediction on what future *needs* may be. This is inextricably linked to resources, which are defined in relationship to the needs in which they enable.

One possible source of confusion is the assumption that sustainability represents an ideological end state. The implication of the Brundtland report is that once certain conditions have been met, sustainability will have been achieved. Basiago (1995) provides multiple conflicting definitions of sustainability present in five competing domains; biology, economics, sociology, planning and ethics. In each domain sustainability represents differing and often competing concepts from bio-diversity to resource management to positive urbanism. Basiago concludes that sustainability is to be understood as a methodology and identifies four methodological principles that govern sustainable decision making; futurity, equity, global environmentalism and bio-diversity which principles may act as a framework for sustainable decision making in a wide range of fields.

Although the term sustainability is commonly used in architectural discourse, there is little consensus on its definition (Altomonte, 2009; Alvarez & Rogers, 2006; Gürel, 2010; Guy & Moore, 2007; Khan et al., 2013). Without clearly defined terminology, the concept is open to misuse, misinterpretation and simplification, while

reducing it to a keyword strips it of its value (Altomonte, 2009; Gürel, 2010). In the realm of architecture, various interpretations of sustainability range from the ethical stance it embodies to performance analysis to technological innovation (Khan et al., 2013). As Guy and Moore (2007) put it 'a search for some form of consensus around universal best environmental practice appear to have failed' (p. 15).

In the context of this research, sustainability is considered a pluralist concept which captures a range of environmental, social and economic discourses (Hajer & Versteeg, 2005). Sustainability and sustainable design, therefore, are contestable fields which are subject to change (Cook & Golton, 1994). In architectural design this manifests itself as a series of competing "logics" which offer different interpretations of sustainable concepts, as well as alternative built responses (Guy & Farmer, 2001). This research seeks to raise a critical awareness of the issues that may be considered (Cook & Golton, 1994) to form contextual and individual meanings of sustainability.

1.4.2 Architecture and sustainability

It is in the context of the global sustainability agenda that architecture must operate. Khan et al. (2013) note architectural responses generally focus on global-molecular issues such as climate change and technological fixes. Yet according to the UN, unsustainable urbanisation poses a bigger challenge (UN-Habitat, 2013) and perhaps one more readily approached by architects.

Competing notions of sustainability are often grouped under the title of *green* architecture and the inherent pluralism of sustainability is not embraced (Guy & Farmer, 2001). The role of technology is often seen as essential to architectural sustainability both through application (eco-technologies) and testing (Moe, 2007). Guy and Farmer (2001) suggest that any building may be seen as an amalgamation of technologies that can be objectively compared (techno-supremacy) while pluralist approaches are viewed negatively.

Lizarralde, Chmutina, Bosher, and Dainty (2015) argue that green architecture represents a focussing of the ambiguity of the sustainable agenda onto specific goals and outcomes thus provides a means of implementation. In developed countries, however, this has led to a narrow focus on the reduction of energy consumption and the reduction of carbon emissions (Kibert, 2007). It ignores the complex, contradictory and nuanced nature of sustainable development ignoring other social, economic and

environmental principles. This is reflected in green building certification (Ding, 2008) which may lead designers to ignore the inter-relationships of seemingly independent green criteria.

Berardi (2013) synthesises recent interpretations to define sustainable building as increasing: demand for safe building, flexibility, market and economic value; neutralisation of environmental impacts by including its context and its regeneration; human well-being, occupants' satisfaction and stakeholders' rights; social equity, aesthetics improvements, and preservation of cultural values. This agenda is a repackaging of the four points of analysis proposed by Basiago (1995) whereby the first point represents futurity, point 2 global environmentalism and biodiversity, and the third and fourth points equity.

Guy and Moore (2007) have noted the diversity of architectural responses and attitudes towards diminishing environmental conditions. Rather than attempting to simplify or homogenise this understanding, their approach is to embrace this pluralism as a means to developing a critical dialogue. They go further to suggest that through embracing this diversity, positivist and post-positivist epistemologies (notable scientific certainty and faith in technology) may be challenged. Proposing a pragmatist stance, they stress the link between society and environmentalism suggesting that sustainability is a product of concerted democratic action.

1.5 Aim and objectives

The complexity of the environmental sustainability agenda has led to a multiplicity of competing architectural strategies however it is unclear to what extent this variety is critically appraised in architectural education. This research aims to develop pedagogies and strategies for deep learning and enhancing the awareness, understanding and critical application of sustainability in the architectural design studio. It will describe the challenge of sustainability from the point of view of early career architects (those in their final year of study before completion of RIBA part 2) and develop methods for critical responses to the issues facing the future of the natural and built environment. Table 1.1 outlines the objectives of the research.

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Table 1.1: research objectives

	Objective	Intended outcome	Methodology	Value
1.	Assess deep learning for sustainability in the architectural design studio	The identification of issues and opportunities for the integration of sustainability in the design studio informing future action on pedagogy, culture and learning	Ethnographic research Semi-structured interviews with students, staff and stakeholders Observations of teaching and learning practices Ex post facto analysis of project work	Providing the context and direction for future research Addressing identified gaps in the literature
2.	Develop strategies for deep learning for sustainability in the architectural design studio	A framework for utilisation by learners and educators	Participatory action research and knowledge co-creation Group workshops with learners Individual interviews with learners Co-creation of framework with learners Interviews and feedback from industry experts Interviews and feedback from academic experts	The framework will structure further action A conceptual synthesis of sustainable approaches into a coherent and accessible framework
3.	Develop, test and assess pedagogies for deep learning for sustainability ion the design studio	A pedagogy for the application for the developed framework	Participatory action research Group workshops Tutorials Observations of teaching and learning practice Individual interviews with learners Ex post facto analysis of project work	Understanding how the framework may be implemented to test its transferability, dependability and credibility
4.	Position the proposed strategies in the context of UK architectural design	A review of architectural practice in the UK and evaluation of the appropriateness of the framework	Interviews with practitioners in the UK	Understanding the transferability of the research

1.6 Structure of the thesis

The thesis is structured into 9 chapters. Due to the phased nature of the research, it is divided into discrete sections of work that occurred sequentially. Throughout the thesis, relevant literature is discussed at each phase, rather than being "front-loaded" in a literature review. This introduction (chapter 1), introduces the general concepts of architectural education, sustainability and teaching for sustainability in the design studio.

Chapter 2 describes the overarching action research methodology which informed the nature of the subsequent research phases. At each phase, the specific methods and sampling used, as well as examples of the analytical approach are described.

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Chapter 3 describes phase 1 of the research which sought to identify the salient issues in the design studio for action. This is preceded by a review of deep learning in the design studio for sustainability and the chapter also presents the findings and discusses the results in the terms of this review. This chapter synthesises findings from across the research to provide a detailed picture of the case study design studio.

Chapter 4 describes the creation of a sustainable design framework through an action group of students (phase 2). The background to this chapter examines the literature of models and frameworks for sustainable development and then uses these as a basis for creating a new and specific architectural model. This forms the basis for action.

Phase 3 of the research is described in chapter 5. 26 UK architecture practices were interviewed and the results used to validate the theoretical robustness of the sustainability model.

Phase 4 of the research is presented in chapter 6. This involved the integration of the specific model into the MArch design studio at the University of Bath. This phase of the research explored my own teaching practice and how a structured learning tool might inform pedagogy. A literature review of similar interventions into the design studio is presented at the start of the chapter.

In chapter 7, the validity of the findings is examined by conducting two complimentary research processes. A Delphi study conducted with a new sample of practitioners provided external validity to the sustainable design framework. An examination of individual student case studies provided an internal validity to the application of the framework in chapter 6.

Chapter 8 is a discussion of the overall findings while chapter 9 presents conclusions and recommendations for further action.

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Chapter 2. Methodology

2.1 Introduction

The thesis adopts an action research (AR) paradigm. AR was chosen for its capacity to affect direct change within a professional context. AR has been practiced in various forms however at its core, it is a form of practitioner research which involves reflective action as an extension of the professional experience (Winter, 1996). It is important to note that AR is not a method but rather a paradigm which may incorporate a range of data collection and analysis techniques.

This practitioner focus distinguishes AR from alternative approaches that may have been employed. For an example, a purely ethnographic approach could have provided a rich understanding of the design studio and the social structures it enables. While this descriptive approach can be valuable in certain contexts, it only provides a platform for action whereas AR can examine and test potential change. Another alternative culd have included experimental and pseudo-experimental approaches which may have provided a more controlled context for testing, however would force a simplification of the richness and complexity of the design studio. They would also have limited the potential for understanding how interventions might have impacts the lived reality of the design studio. A further option could have considered the range of sustainable design teaching across the institutions in UK and abroad through large scale survey techniques. While this would have provided a wide range of data, it would not have provided the deep analysis necessary to understand the complex social constructions of the design studio that constitute its unique character.

2.1.1 Action research

In AR practice is considered as both action and research, and its improvement is a central theme acting as a vehicle to allow practitioners to take control and improve their actions (McNiff, 1997). It is intended to help the practitioner gain a deep understanding of their own practice and that practice in relation to others. It has a both a personal and social aim in order to improve learning and subsequent behaviours in both the researcher (practitioner) and those who interact with the research. This makes it distinct from alternative qualitative approaches, such as ethnography, in which the researcher

merely observes the process rather than taking action to implement change (Moore, 2005). AR is "self-reflective" and aims to enhance practice so they can "be more effective and act more intelligently" in social settings (McKernan, 1987) however there is also an emphasis on democratic change. Participants are not seen as passive subjects but actors who influence future decisions and evaluate strategies tried out in practice (Winter, 1996).

According to Bradbury-Huang (2010), AR can be characterised by its "orientation towards taking action, its reflexivity, the significance of its impacts and that it evolves from partnership and participation." (p.98). *Taking action* refers to the way research can guide new action as well as developing practitioners' own practice. *Reflexivity* is the acknowledgement of individuals as impacting and effecting change and understanding of their role in the process. *Partnership and participation* refers to developing relationships stakeholders and ensuring their *appropriate* involvement in developing the research.

Reason and Torbert (2001) present three dimensions of AR: first-, second- and third-person modes of enquiry. First-person AR focuses on the development of the individual and their capacity to act thoughtfully, critically and in social contexts. When the researcher undertakes direct, face-to-face consultation with others with a view to enhancing this reflection, this is described as second-person AR. Cooperative AR is an example of this which according to Reason and Torbert (2001):

> "…all those involved in the research endeavour are co-researchers, whose thinking and decision-making contributes to generating ideas…" (p.20)

Third-person AR aims to create a wider community of researchers who may be dispersed over a large geographical area and might empower members to conduct first- and second-person AR.

This typology is distinct yet related to the hierarchy of AR described by Carr and Kemmis (2003) of technical, practical and emancipatory practice reproduced in table 2.1. The technical approach is a form of problem solving in which a clearly defined issue can be "solved", typically conducted by a person or group with greater specific expertise than the participant group (Grundy, 1987). Practical AR also seeks to enhance technical processes, but involves a process of self-reflection and development aspiring toward "doing good" as well as the "correct" course of action (Kinsler, 2010).

Finally, emancipatory action not only seeks to build practitioner effectiveness and development, but also empower participants to implement change in a non-hierarchical system. Moreover, it aims for transformation of the system in which the research operates, removing impediments to effective collaborative action (Zuber-Skerritt, 1996b). Zuber-Skerritt (1996a) aligns these approaches with comparative paradigms in research: the technical approach aligning with a positivist stance; the practical with an interpretive position; and the emancipatory with a critical approach.

Table 2.1: Types of action research and their main characteristics (reproduced from Winter (1996))

Type of action research	Aims	Facilitator's role	Relationship between facilitator and participants
Technical	Effectiveness/efficiency of educational practice Professional development	Outside 'expert'	Co-option (of practitioners who depend on the facilitator)
Practical	As above Practitioners' understanding Transformation of their consciousness	Socratic role, encouraging participation and self-reflection	Cooperation (process consultancy)
Emancipatory	As above Participants emancipation from the dictates of tradition, self-deception, coercion Their critique of bureaucratic systemisation Transformation of the organisation and of the educational system	Process moderator (responsibility shared equally by participants)	Collaboration

Numerous authors have rejected non-emancipatory paradigms of AR (Carr & Kemmis, 2003; Grundy, 1987; Zuber-Skerritt, 1996b) especially in an educational context as it typically instrumentalises AR to achieve an externally imposed outcome undermining the transformative function and social reproductive nature of education (Carr & Kemmis, 2012).

Winter (1989) describes six principles of AR as reflexive critique (of the researcher undertaking the action), dialectical critique (of observed phenomena), collaborative resource, risk (or the potential transformation of a situation), plural structure (the existence of multiple, equally valid realities) and the processes of theory, practice and transformation. AR is political and emphasises values, rather than purporting to generate objective knowledge in the positivist paradigm (McNiff, 2016).

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The research draws into question the limitations of its context (in this case the design studio) and seeks to empower participants to challenge implicit value systems.

Unlike other forms of research, AR is conducted from those engaging in the practice, rather than an outsider perspective and does not seek to manipulate a situation by modifying and adjusting variables (McNiff, 2016). The creation of theory in AR, can be understood as living theory in which the researcher is "constantly creating, re-creating and living [their] own theories". (McNiff, 2016, p.253).

2.1.2 Participatory action research

The research sought to align itself to a participatory approach to AR. The participatory and social nature of AR make it highly applicable to an educational context, especially the design studio, and offers a means for effecting change at a local level (Cohen, Manion, & Morrison, 2000). In a participatory approach participants are not considered passive subjects but active engagers in the research process (Whyte, 1991, p.20). This has had considerable success instigating institutional change, through considering organisations as dynamic, fluid and contradictory consisting. Not only are they a combination of people, policies and activities but complex and conflicting interrelations between these components (Whyte, 1991). Through emancipatory action (Zuber-Skerritt, 1996a) opportunities arise for challenging assumptions in the studio system and eroding perceived hierarchies to provide new opportunities for change and adaptation. Knowledge acquired through collaboration with communities that have local insight that may be utilised to improve their situation (Flicker et al., 2008). Adopting a constructivist understanding of knowledge the issues surrounding the place of sustainability in design studio education are not be seen as problems to be solved but rather issues to be addressed.

In a participatory approach there is joint responsibility for planning, implementation and dissemination of research (McIntyre, Chatzopoulos, Politi, & Roz, 2007). McIntyre et al. (2007) identify four characteristics that distinguish participatory action research from other approaches.

(1) A collective commitment to investigate an issue or problem salient to a particular community.
(2) A desire by people themselves to engage in self- and collective reflection in order to gain clarity and awareness about the issue under investigation.

(3) A joint decision to engage in individual and or collective action that leads to a useful solution which benefits the people involved.

(4) A recognition that the term researcher applies to both local actors and those people who contribute specialized skills, knowledge, and/or resources process.

2.1.2 Practitioners, participants and practice

In AR practitioners adopt a primary role in the research process and the emancipatory type emphasises the shared responsibility of participants in this task. This is often confined to professionals (teachers, nurses, managers etc.) without adequately engaging the voice of those also involved in the practice (such as students, patients or clients) constituting an inadequate form of AR (Kemmis, 2006). In these cases, practice is understood to be that of the professionals (which might be teaching practice, nursing practice or managerial practice) and its impact. In the architectural design studio, the concept of practice takes on the potential to embody different meanings. As in traditional AR, it refers to the educational practice of tutors and educators, associated pedagogy and its capacity for emancipatory change. However, this ignores the practice of which the design studio enables; the process of design. Accordingly, the design studio is a hybrid environment in which two forms of professional practice operate in a complex and symbiotic relationship. In seeking emancipatory change, AR in the design studio has the opportunity to not only transform pedagogy but also the practice of design. Given the dual potential of the research, students are not only considered to have valuable contributions to professional action (Kemmis, 2006), but practitioners in their own right.

Schön (1985) makes an attempt to capture this duality by describing the process of mimetic learning through which reflection-in-action is transferred between master and student. In the context of AR, he describes a technical interpretation of professional action; a process designed to convey "expert" knowledge through demonstrative action.

2.1.3 Challenges to emancipatory action research

While the research aspired to develop a student led approach drawing from the epistemology outlined by Gibbons et al. (1994) of knowledge co-production, as it progressed the methods were modified to account for practical issues. These are outlined in each subsequent chapter, and accordingly the research process might be

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considered continually evolving in response to contextual conditions.

In the first instance, collaborative action, was challenged both by student and staff commitment. Working with final year master's students meant their availability for activities beyond the perceived scope of their degree and commitment to the research was limited. Accordingly the approach was made directly relevant to their studio projects. This bounded the research by the assumptions and expectations of studio pedagogy. Staff commitment was also limited; most were part time members of staff with little free time. In an ideal AR scenario, a community of interested practitioners would conduct the research in a non-hierarchical manner. This was not possible, given the conflicting needs of participants. The methodology was adjusted to meet these conflicting demands, described specifically in later chapters, with myself acting as a facilitator and structuring the research within the studio environment.

Many of the proposed actions required considerable pedagogic change that were beyond the scope of the research. My own role as a tutor and student meant the scale of action was typically limited to my own interventions and did not extend to curricular change. Moreover, as a successful architecture department with a "unique signature pedagogy" there was only limited appetite change. This was reflected in tutor practice, most of whom had refined their approach over years of experience.

2.1.4 Generating theory and impact

In traditional research, theory is expressed in terms of rules between sets of variables that allow prediction and verification. It involves describing causal relationships that can be applied to other situations that replicate the conditions of the original experiment (McNiff, 2016). When conducting AR, these traditional forms of theory are untenable; they rely on assumptions that knowledge can only be generated by a "correct way of thinking" (McNiff, 2016, p.252) and these produce fixed and "true" theories. Winter (1996) notes the symbiotic relationship in AR between theory and practice in which each constantly challenge and question the other. For McNiff (2016), this manifests itself as a "living form of theory" in which thinking about why action took place constitutes a personal theory that belongs to the individual. Theory takes the form of reflective dialogue based on "lived experience". In traditional theory, validity might be provided by replicability and generalisation however, in AR this is done through providing evidence of how theory and action have influenced learning. Operating

within a naturalistic paradigm inherently limits the generalisability of the research (Lincoln & Guba, 1985). Indeed, no attempt to *generalise* is desired as the research by its very nature is specific, contextual and unique. The alternative of *transferability* was sought (Lincoln & Guba, 1985), described later in the chapter.

2.2 Research Methods

2.2.1 A qualitative approach

The research used a qualitative approach viewing the study of design studio as a holistic system and acknowledging and critically reflecting on my own agency in the research (Marshall, 2016). Unlike quantitative research, a qualitative approach uses direct (rather than remote and inferential) methods to capture individual points of view. It is also concerned with the messiness of everyday life, its constraints and issues and the findings are embedded within this context. It provides "rich" descriptions through detailed accounts of the study (Denzin & Lincoln, 2011, p.12).

AR frequently draws from techniques in qualitative research however, as Bradbury-Huang (2010) notes, a key difference is that AR is not just *about* practice, but rather aims to transform practice *with* practitioners. Indeed, this focus may lead to the use of quantitative techniques specific and relevant to a particular AR project, often administered through questionnaires. Quantitative approaches have been used widely in broader assessment of deep learning in classroom based activities or experimental scenarios however, accurate measurement of learning is elusive. Reflective learning activities that typically lead to deep learning are not present in typical one-to-one tutoring sessions or classroom activities (McNamara, 2011). Moreover, deep learning may not be explicitly expressed; one student may verbalise their thinking process over a long period of time while another may internalise it and perform rapid reflection. The issue of measurement is compounded in an action research context where student learning cannot be attributed to specific causal relationships due to the milieu of the specific student experience. Standardized assessment procedures provide limited insight into deep learning. The association between high test scores and high standards may encourage superficial and surface learning (Kohn, 2000).

While some practitioners have developed specific instruments for assessing deep learning (Nelson Laird, Seifert, Pascarella, Mayhew, & Blaich, 2014), such approaches

require large sample sizes to provide generalizable data sets which tend to analyse what is taking place rather than the embedded meanings or structures that support these outcomes. For example, the study by Nelson Laird et al. (2014) refers to specific classroom studies and theoretical literature to provide reasoning for the outcomes of their research.

Formal assessment methods for deep learning have been developed including the Study Process Questionnaire (Biggs, 1987), the Multidimensional-Multiattributional Causality Scale (Lefcourt, von Baeyer, Ware, & Cox, 1979) and the Teacher Efficacy Scale (Dembo & Gibson, 1985). These were used in the quasi-experimental approach of Gordon and Debus (2002), who utilised longitudinal survey data to examine interventions made on specific modules on a teacher training course. A number of other studies have adopted alternative, pseudo–scientific approaches to the analysis of deep learning. Newman, Webb, and Cochrane (1995) used a content analysis method and develop a set of "paired indicators" to analyse transcripts for evidence of critical thinking. Despite quantifying these results, the authors found it was impossible to remove subjectivity in their analytical method. Other authors have used questionnaires to assess the effectiveness of teaching and learning strategies. Mantri, Dutt, Gupta, and Chitkara (2008) and Chung and Chow (2004) used questionnaires to assess the perceived improvements in learning of a redesigned problem based learning course however both concluded the small sample sizes limited the effectiveness of a quantitative approach. Douvlou (2006) used open ended questionnaires triangulated with data collected in observations to assess the effectiveness of a problem-based learning course which yielded deeper understanding than purely quantitative methods. A similar mixed methods approach was used by Allison and Pan (2011) who used interviews, observation and questionnaires to understand learning. Burns (2013) also uses a mixed methods approach when assessing the integration of sustainability in two university course compared to their own theoretical model, however noted that:

> "Because of the small number of participants and the descriptive nature of this research, the qualitative data has more potential to provide the thick description necessary to deeply understand the connections between the Burns Model of Sustainability Pedagogy and student learning." (p.169)

Purely qualitative approaches to assessing deep learning have also been used. In the broader field of education, Tal and Tsaushu (2017) use analysis of student and staff

interviews and class observations to identify themes which are compared with characteristics of deep learning. Howlett, Ferreira, and Blomfield (2016) used data from student essays and course feedback to provide a "thick" description of an action research project for teaching sustainable development reflecting on staff and student viewpoints.

In this research, its relatively small sample size, need for a "thick" description and the embedded, contextual nature of the project, meant alternative approaches could be used. As McNiff (2016) suggests, potential questionnaire data was collected through interviews and observations and precluded their use. Qualitative data is particularly appropriate in an AR methodology in which instigating emancipatory change through holistic restructuring of systems which are barriers to desired change (Zuber-Skerritt, 1996b).

The qualitative approach employed in the research used direct methods to capture individual points of view. The research sought both *richness* (high quality) and *thickness* (quantity) of data (Fusch & Ness, 2017) to provide a detailed accounts of the case-study . In the framework set out by Stake (1995), the case study was considered instrumental (rather than intrinsic or collective). The case study was chosen to provide insight into the integration of sustainability into the design studio, rather than offering specific, intrinsic interest. As Baxter and Jack (2008) suggest, it is used to accomplish something beyond an understanding of the specific situation and sought broader recommendations for practice.

2.2.2 Context of the research

The field of study was a final year MArch design studio at the University of Bath. This allowed participants to have a reflective view on their architectural education and were most likely to go into architectural practice, maximising potential impact of the research. The MArch course is organised through a single studio in which all students undertake a self-defined project in a European city of their choice. The first half of the year is organised into groups, each of which undertake a master-planning project. The second half is an individual project in the chosen city with a brief defined by the student. Studio tutors support the students and in the second half of the year each student is assigned a tutor to guide them through the project. The participants had a sophisticated level of design ability and could articulate values and understand issues.

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This is described in greater detail in chapter 3.

The design studio at the University of Bath was chosen for my specific and unique role in the department. Teaching in the architectural design studio for six years, gave me intimate knowledge of the unique pedagogy of the department and I had relationships with, and access to, other members of staff. However, having never taught in the sixth year studio and not being introduced to the students as a tutor, allowed me to bridge the perceived hierarchal void between teacher and learner and operate in an interstitial space. This allowed unique access to the course from both learner and educator perspectives.

2.2.3 Sampling strategy

A non-probability sampling strategy was employed, defined by the limitations of resources and time constraints. While a non-probability sample limits the research, it is nevertheless appropriate to a small scale action research inquiry (Cohen et al., 2000). Students on the MArch course (RIBA part 2) at the University of Bath were purposefully selected for the study as they represented those close to entering the profession and still engaged in personal design work. Having already undertaken a minimum of 3 years architectural training and at least 1 year of professional placement, they had a reasonable amount of experience on which to reflect and draw from. Moreover, they had completed their RIBA part 1 studies at a number of different institutions providing a range of experiences. Two consecutive cohorts of students were chosen for the study (2015 intake and 2016 intake) although the teaching staff remained consistent across this period.

2.2.4 Trustworthiness and Bias

Playing an active role in the research introduces significant levels of bias through unconscious prejudices and preconceptions. Participants may modify behaviours, misunderstand questions or miscommunicate ideas in the presence of the researcher. In addition, the nature of the convenience sampling strategy, although allowing deep access, is highly unrepresentative (Cohen et al., 2000, p. 129). In conventional research reducing bias enhances reliability and validity (Cohen et al., 2000) however in a naturalistic paradigm, complete impartiality is impossible. An alternative framework is defined by Lincoln and Guba (1985) who suggest that research of this type should seek

to be trustworthy. To achieve this, the research must be credible, confirmable, transferable and dependable (Cohen et al., 2000).

Credibility (the naturalistic researcher's equivalent of internal validity) was achieved through prolonged engagement with the environment in order to learn the culture (Lincoln & Guba, 1985). The researcher's position as a former student, PhD researcher and teacher enabled this. Credibility was enhanced through persistent observation which refers to the need for the researcher to be open to different elements of a situation which may contribute data which address issues surrounding learning for environmental sustainability. Triangulation of data through using various direct and indirect means of collection as well as member checks (validating data with participants) provided further credibility (Oliver-Hoyo & Allen, 2006). Tactics to ensure the honesty of participants were also employed; individual interviews were conducted outside of the design studio and it was made clear to participants that they were able to be frank and open (Shenton, 2004). This was helped by my position between student and staff that I occupied in the department, allowing me to gain a level of trust.

The data are made transferable (generalizable and externally valid) though providing a thick description of the research allowing another to reach a conclusion about whether a possible transfer, to another context, might be possible (Lincoln & Guba, 1985). The accumulation of similar studies across a range of contexts might enhance the transferability and the potential generation of theory (Shenton, 2004).

Dependability refers to what the traditional researcher might consider reliable and confirmability refers to the objectivity of the study. In a naturalistic paradigm, the findings are tied to the participants and specific context and so cannot be repeated. Instead, a detailed description of the research process was provided to allow readers to assess the dependability of the work (Shenton, 2004). Ideally, a weekly data and analysis audit of a reflective journal would establish dependability and confirmability however this was beyond the resources of the research (Lincoln & Guba, 1985). Triangulation can provide dependability through the careful cross referencing of results from a variety of sources and collection techniques (Lincoln & Guba, 1985).

Confirmability might be made comparable to objectivity in conventional research however, it is impossible in AR to remove the agency of the researcher. Miles and Huberman (1994) suggest one approach might be to acknowledge and record the influence of the researcher. Again, a detailed description of how the research was

conducted is presented in the findings allowing the reader to track the formation of theory (Shenton, 2004).

Further validity to the research is provided in chapter 7 which describes standalone validation exercises which utilise member checks, expansion of the sampling set and data triangulation through detailed consideration of individual case studies.

2.2.5 Reflexivity in the research

Reflexivity is an important aspect of AR. It refers to the need of the researcher to "recognise and work with the notion that the researcher is constitutive of both the data and the final research product" (Hall, 2003, p.31). Winter (1989) divides the concept into critical reflexivity and dialectical reflexivity. The former refers to the an understanding of an individual's thinking processes, while the latter refers to the broader cultural influences that effect these processes. Reflexivity is a concept that refers not only to the acknowledging the self in the writing of the report but also acting reflexively during the empirical stages of the research (Hall, 2003).

Hall (2003) provides four principles for acting reflexively:

(1) reflecting on the method and modifying practice accordingly;
(2) writing the myself into the case-study and assessing how my own values have influenced the capture and representation of data;
(3) recording changing relationships with participants;
(4) attempting to offset the hierarchy of researcher and researched.

(modified from Hall (2003))

Each of the points above was addressed throughout the study. The report of the research details how personal reflection modified the actions that were taken in the studio. Throughout the research, an awareness of my own values is described and subsequent impact on the nature of selection of data and analysis. To a large extent this was influenced by my own beliefs in the purpose of education, the nature of sustainability and a broader political stance. My relationship with the participants is described and how this changed throughout the research. Finally, the research method is marked by a continuous attempt to balance the power relationship between researcher and researched, between tutor and student. These reflexive procedures were

particularly important in phases 2 and 3 of the research in which deliberate action was taken in the design studio.

2.2.6 The action research cycle

AR is an iterative process in which cycles of action and reflection are constantly being undertaken to move towards enhanced practice (REF). (Zuber-Skerritt, 1996a) defines a model of emancipatory change which adopts a four stage process of planning, action, observation and reflection. This is a common approach in the literature and shares similarities with that proposed by McNiff (1997) who defines a five stage linear approach to action research which adds an initial problem statement into the cycle. This involves problem statement, imagination of a solution (planning), implementation of solution (action), evaluation of solution (observation/reflection), modification of practice (reflection/planning). The research is presented in three phases. Phase 1 considers McNiff's formation of the problem while phases 2 and 4 operate on the cycle process of planning, action, observation and reflection.

2.2.7 Data collection methods

Data collection techniques were specific to each phase of the project however there were numerous common methods that were used to assimilate data operating with a qualitative approach. Through collecting data through different methods, triangulation was used to ensure data was credible and confirmable (Oliver-Hoyo & Allen, 2006).

Interviews

In depth interviews were conducted using an interview guide (Patton, 1980). This consisted of a series of themes which ensured all interviewees addressed the same issues. This had the advantage of keeping the interviews focussed but also allowing for individual perspectives to emerge (Patton, 1980). I was then able to examine, probe and question salient issues that the interviewee had raised beyond the initial assumptions when generating the guide. This was particularly pertinent when conducting "elite" interviews, due to the tendency of respondents to elaborate on their experiences, discuss their own personal interests, restructure the question (Marshall, 2016) or avoid answering it completely (Harvey, 2011). The interview guide method meant I was able

to adjust the nature of the questions accordingly, while eliciting in depth responses from interviewees. In some cases, this meant the data collected was unexpected or seemingly "off-topic". This however, was valuable in building a more complete picture of the research from a range of perspectives, assessing values and questioning my own assumptions of practice. Interviews were audio-recorded and transcribed.

Observations (tutorials and crits)

Observations were conducted in-situ and recorded with field notes. Field notes focussed on the integration of sustainability, utterances of the topic and the nature of critical thinking from tutors and students around these topics. Notes were structured using a pro forma dependent on the nature of the observation drawing from the example provided by Kolb and Goldman (1973). For example, in crits, two columns were provided, one which detailed tutor questions and comments, and a parallel column which described student responses and associated values. These were supplemented by my own notes and analysis (figure 2.1).

Figure 2.1: Example of field notes made in a crit. (The column heading feelings refers to values that were exhibited by critics and students)

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Workshops

A large amount of data were collected through workshops. These took place either within the design studio as tutorial sessions or in extra-curricular sessions. Gathering of the data utilised the observational methods described above as well as drawing from focus group methods in the literature. The advantage of collecting data in a group scenario is that it encourages the formation of socially constructed knowledge, often in a more relaxed environment than individual interviews (Marshall, 2016). However, this method exposed clear power asymmetries in the group which was dominated by a number of more vocal students.

As well as specific focus-group style workshops, observations of my own practice also took place. These activities fell between focus-groups (which might be considered group interviews) and observations of teaching practice. This was done through recording and analysing my own interventions into the design studio. This was both a form of observation and personal reflection common in AR (McNiff, 2016, p.157).

Documents and artefacts

The data were supplemented with an analysis of documents relating to the design studio. Analysis focussed on documentation that was produced in the everyday course of the studio however a number of artefacts were produced specifically for the research (Marshall, 2016). These mostly took the form of student work submitted at the end of each semester. As part of the course, students were required to produce a "process document" that charted how they had arrived at their final design. They also produced a number of "final reports" that demonstrated their final design proposals. Within workshop sessions, artefacts were occasionally generated that took the form of maps and diagrams made collectively by the group. These were photographed by the researcher and provided a further source of data.

Reflective diary

I kept a reflective diary throughout the research process (McNiff, 2016). This was typically completed after each observation or event. Thoughts were recorded in the initial field notes and then transferred to a single document to assimilate them in one

place. After each session, further reflective thoughts were added. It was used both as a way to illustrate general points that were observed in the field but also keep track of personal thoughts and reflections.

2.2.8 Data analysis

In each phase of the research the data were analysed using the seven phase procedure defined by Marshall (2016): organisation of the data; immersion in the data; generating categories and themes; coding the data; interpreting the data; searching for negative cases and alternative understandings; and writing the report.

Data organisation took place through utilising NVivo (a qualitative analysis software). This allowed data to be organised into cases, and viewed in parallel with other data. This also provided a means for me to *immerse* myself in the data. In many cases, audio transcripts were manually transcribed or they were re-read when professionally transcribed. I was then able to understand and organise related data from participants.

While coding was specific to each phase of the research and is explained in greater detail in each subsequent chapter, the coding method remained consistent. Marshall (2016) note that codes may be either theory generated or created *in vivo* (emerging from the data itself). In the first instance, codes were created from the data and adopted its words and phrases (Miles & Huberman, 1994). Codes provided units of analysis which could then be formed into emergent categories (domains). At this stage, relationships between the data was searched for. For example, a particular category might contain coded data from a range of sources suggesting linkages. These categories were then further modified and structured using conceptual frameworks drawn from the literature (Marshall, 2016). For example, in the first phase of the research, one category was formed which looked at holistic thinking, a concept drawn from the literature on both deep learning (Marton & Säaljö, 1976b) and educating for sustainability (Buckingham-Hatfield & Evans, 1996). This process allowed speculative inferences which suggested possible explanations for relationships. The data were then summarised and interpreted revealing inferences and indicating avenues for further iterative action research cycles. Negative cases were sought which modified the hypotheses made in the data summary to accommodate that data. Theory was then generated which informed future action cycles. This was validated through member

checks in further data collection with participants and triangulation of various sources (Lincoln & Guba, 1985; Shenton, 2004).

2.2.9 Presenting the data

Transparency was an essential part of the presentation of the research. Qualitative research relies on transparency so readers might understand the reasoning and processes which have generated particular conclusions. Moravcsik (2014) identifies three "dimensions" of research transparency: data, analytic and production transparency. Data transparency is provided through allowing access to the data from which the research is drawn. This is provided in the appendices to the thesis. Example of the analysis process is given in each chapter in order to provide an understanding of how the data were examined. Finally, production transparency is provided through allowing the reader access to the full body of collected research, rather than a selected or curated selection of finding relevant to the research question. A "thick" description of the research is provided (Lincoln & Guba, 1985).

2.3 Professional interviews and the Delphi Method

2.3.1 Confirming the model

The action research was complemented by a parallel research strand. This examined prevailing approaches to sustainable design within the architectural profession. This phase of the research asked if the findings from the action research were relevant to the architectural profession and considered the representativeness of the model developed for sustainable architectural design. This phase of the research adopted a two-stage process; the first used interviews with professionals while the second adopted a Delphi Technique.

2.3.2 Professional interviews

The qualitative approach adopted in the AR phase was continued through a series of semi-structured interviews with professionals. These were considered "elite" interviews (Marshall, 2016), as participants were national and international leaders in sustainable architectural design. In-depth, standardised open-ended interviews (Patton, 1980) were

used. More detail on the methodology, sampling and analysis is provided in chapter 5.

2.3.3 The Delphi Method

Following the interviews, analysis and the formation of initial results, a validation stage was conducted using a Delphi Method. This phase of the research was designed to validate the findings developed from the AR phase and the interview data from professionals. It was carefully designed to identify key characteristics which differentiated alternative forms of sustainable practice, providing legitimacy to the model proposed in earlier phases.

A Delphi Method is a means of pooling expert opinion with the goal of achieving consensus about a certain issue or range of issues (Ziglio, 1996). Importantly it can be undertaken remotely and so did not require arranging a meeting among professionals. More detail on the methodology, sampling and analysis is provided in chapter 8 and Appendix A.

2.4 Ethical considerations

2.4.1 Working with participants

Addressing ethical concerns forms a key part of the research methodology. As Davies and Dodd (2002) note, ethics is embedded in the way we do research. It informs actions and concerns relationships between the researcher, participants, stakeholders and the wider community. Ethical approval was obtained from the University of Bath for all three parts of the research (the design studio, practitioner interviews and the Delphi study) taking into account the mitigation measures described below. In the context of an AR paradigm, the transformational approach implies a focus on ethics through the commitment to instigating social change and the potential *trustworthiness* (Lincoln & Guba, 1985) of the research is contingent on ethical rigour (Marshall, 2016, p.51).

Ethical challenges were encountered at all stages of the research, from its inception through planning, data collection, analysis and representation. The context of the research is one I am personally very familiar. As stated, this gave me unique access however raised issues of exploiting pre-existing relationships with participants. In the case of students, none of the participants were currently being taught by me, and with the exception of one student, I had never taught any of them in the past. By contrast, I

had strong relationships with a number of tutors and educators on the course as a tutor and academic. To some extent, this was leveraged to allow access to areas of the research context that may have been off limits to an outside researcher. I was careful, however, not to betray the trust of these participants. To mitigate this, interviews were conducted in formal settings utilising a semi-structured approach which was clearly in the domain of the research. Personal conversations were considered beyond the scope of the data collection.

All participants provided informed consent. In the case of students, this was done through signed consent forms for those participating directly in the research. I also made myself known to the cohort through an introductory lecture which described the aims of my research and the activities I would be undertaking. Marshall (2016) outline four demands of participants which were described on the forms. The research parameters were described and their role in the research. Participants were able to withdraw from the study or remove their data at any time. Potential risks were outlined and, all data were anonymised and identifying features removed. Interviews with tutors, staff and architects in practice were considered "elite" interviews (Marshall, 2016). In the context of the research, these individuals were particularly well-informed and held positions of power and were selected for interview particularly because of their specific position at the University of Bath or in the UK architectural community. Parameters and rights of participants were described through written form and reiterated verbally. Consent was provided in written response, accepting interview and verbally confirming this at the interview. In some cases, signed forms were impossible as interviews were conducted remotely, so an online consent form was completed instead.

Observations can be problematic as the researcher is placed between an experimental model in which a hypothesis is tested through experimental action, and the non-intrusive model of many ethnographers (Angrosino, 2005). While informed consent is practical for individual interviews and structured sessions, this is more challenging in observational settings in which any number of external actors might influence the context. Winter (1996) suggests gaining permission before undertaking observations. This was done through consultation with the year coordinator, presenting my intentions to the year, asking permission at specific observational sessions and making my presence known. Marshall (2016) notes that the practice of informed consent is complex and ongoing. No observations were taken covertly and data

collection was limited to field notes rather than audio recordings which were used in more controlled environments.

Participation in the research was voluntary for students. I was fortunate that the pool of participants were particularly highly motivated and compliant with the research aims. Nevertheless, Tyldum (2012) notes the ethical issues associated with participation, especially if the research has no perceived benefit and can lead to skewed understandings of social situations. Tyldum (2012) suggests this may justify a level of coercion, however, to mitigate this effect, while interviews and participation in extra-curricular workshops were voluntary, this was triangulated with data collected in naturalistic observations of the context.

AR seeks to empower and emancipate participants (Zuber-Skerritt, 1996b) rejecting the role of external observer which may be is assumed in forms of ethnographic research (Angrosino, 2005). This is embedded in an ethical stance which respects and values the standpoints of all participants however also takes into consideration the wider context in which the research operates. The research had the potential to favour those participating, possibly at the expense of those who had chosen not to participate. While all students enrolled in each cohort were given the opportunity to contribute, this does not avoid favouring those with significant "social capital" (Tyldum, 2012). This was mitigated through developing much of the research in the naturalistic settings of the design studio. This allowed all students the benefits of the research and its potential impact on their practice, without having attended extra-curricular workshops.

I was acutely aware of the potential for impact on participant time. Indeed, the conducting of interviews, additional teaching sessions and workshops all have the potential to disrupt student and staff working. For the students, they were in their final year of a MArch course and were often occupied with heavy workload and impending deadlines. For staff, all the tutors (with the exception of the head of year and director of studies) were on part time teaching contracts and so their time at the university was limited. Days were often fully occupied; some would work through their lunch break in order to spend more time with students. As Pendlebury and Enslin (2001) note, research might be considered unethical when it betrays the values of the potential beneficiaries of the research. This is particularly true in AR which aims to transform practice in the pursuit of "social justice". Various measures were taken to mitigate this impact. Teaching interventions were fully timetabled in agreement with the year

coordinator, and placed on the year timetable and formed part of the course delivery. Groups were able to opt out of these interviews (one group of 8 students chose to do so) In other cases, students were made aware of the time commitments volunteering for participation would take and these were carefully scheduled away from course deadlines. Interviews were limited to 20 minutes in length and conducted at a time of the student's choosing. Observations were conducted in situ. Tutor interviews were also conducted at a time of the tutor's choosing. For some this meant at a convenient date in the working day, for one it was conducted over the phone while for a third, it was done outside of term time when time pressures were reduced.

2.4.2 Data management and GDPR

Presenting the research also provides a series of ethical dilemmas. While anonymity was at the heart of the presentation of the data there are clear limits on modification to remove all identifying contextual factors from the research without undermining its validity (Tyldum, 2012). The lack of sensitive and personal data meant once anonymised identification was almost impossible. While some authors have described the tendency of full anonymization to mask personal stories and supress individual voices (Marshall, 2016), I decided this process was necessary to protect the views of participants. A data management plan was created and data were stored on the institution's managed storage and protected with passwords where necessary to protect confidentiality.

All external services used were GDPR compliant. Questionnaires and consent forms were administered by Google in Europe and written confirmation was provided by their support team that data would be stored in the EU and their practices were GDPR compliant. Participants were also given the right to remove themselves from the study and have their data erased at any point.

2.5 Planning the research

2.5.1 Structure of the research

The research consisted of three distinct phases, which form the overarching AR methodology. Numerous authors have defined the structure of AR and this research draws from the five stage process defined by McNiff (1997) and the classical spiral

model of action research described by Zuber-Skerritt (1996a). The research involved an initial stage of issue identification followed by numerous cycles of planning (or revising the plan), acting, observing and reflecting. The phases of data collection are outlined in table 2.2 and figure 2.2.

Table 2.2: Outline of the research

Research Phase	Chapter	Timing	Description
Phase 1	3	09/2016-02/2017	Sustainability in the design studio
Phase 2	4	02/2017 – 06/2017	Co-producing a critical framework
Phase 3	5	06/2017-09/2017	Strategic approaches in UK architectural practice
Phase 4	6	10/2017-06/2018	Applying the critical framework
Phase 5	7	08/2018-02/2019	Validation (Delphi technique and case studies)
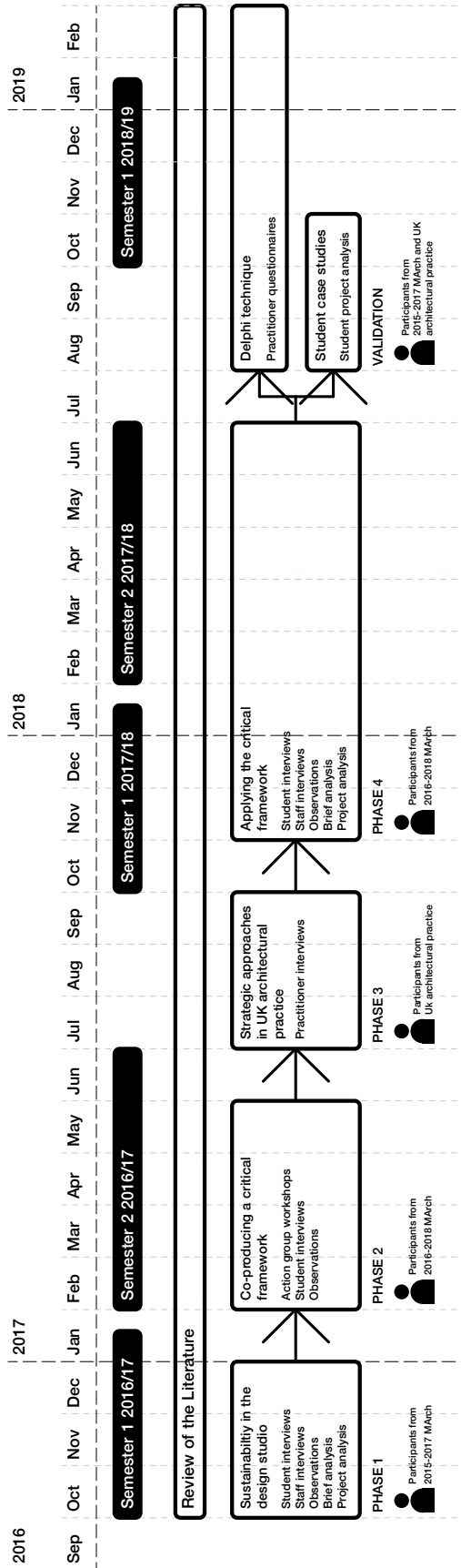
Figure 2.2: Phases of the research

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Phase 1 (Chapter 4)

The first phase of the research aligns with the issue identification phase of McNiff (1997). This phase drew from ethnographic techniques to provide an understanding of the design studio, opportunities and barriers for integrating deep learning for sustainability in the design studio.

Phase 2 (Chapter 5)

The second phase of the research involved the creation of a community of students through which action was planned and developed. Findings from the first phase of the research were presented and this was used to inform the actions of the group. This group operated outside of the design studio and did not seek to directly implement design practice.

Phase 3 (Chapter 6)

Phase 3 of the research used interviews with architectural practitioners in the UK to complement the model of sustainable design proposed in phases 2 and 3 of the research.

Phase 4 (Chapter 7)

The fourth phase of the research explored how the findings of the action group might be implemented in the design studio and be used to inform design practice. Action took the form of changes in teaching and pedagogy, and observations of this impact on learning was made directly in the design studio.

Phase 5 (Chapter 8)

The fifth phase of the research was designed to add further validation to the research. Firstly, a series of student case studies were undertaken, considering how the framework had effected their learning. Secondly, a remote Delphi Technique was used to confirm and validate previous findings from the AR phases and interviews with practitioners.
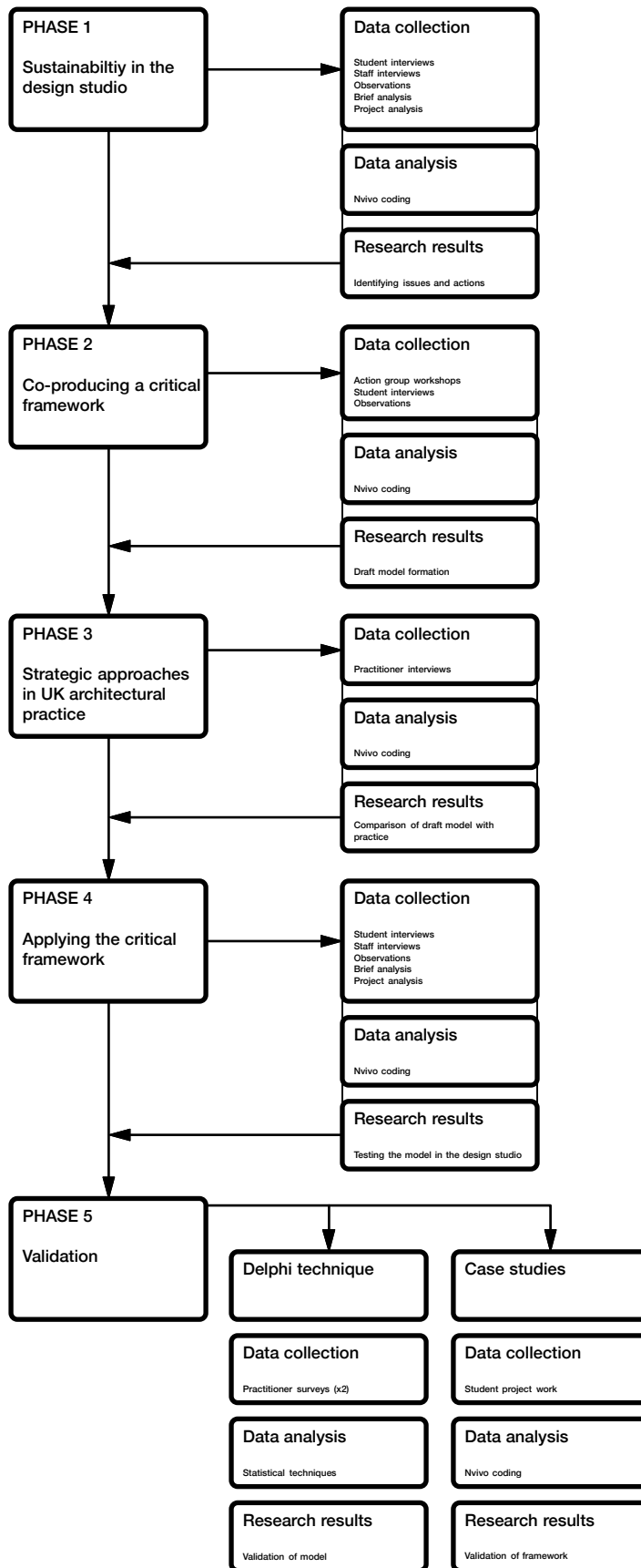
Figure 2.3: Research flow diagram

Chapter 2. Methodology

2.5.2 Data collection timetable

A full timetable of data collection is provided in table 2.3 for the design studio.

Table 2.3: Full data collection schedule in the design studio

Date	Event	Data type
7 October 2016	Head of year interview	Audio recording
27 October 2016	Student interviews	Audio recording
10 November 2016	Student interviews	Audio recording
17 November 2016	Crit observation	Field notes
24 November 2016	Sustainability tutor interview	Audio recording
6 December 2016	Crit Observation	Field notes
25 January 2017	Sustainability lecturer interview	Audio recording
6 February 2017	Action group introduction	Lecture
15 February 2017	Action group meeting 1	Audio recording
27 February 2017	Action group meeting 2	Audio recording
13 March 2017	Action group meeting 3	Audio recording
3 May 2017	Action group meeting 4	Audio recording
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
8 November 2017	Action group reflection	Audio recording and observations
10 November 2017	Tutorial observations	Field notes
17 November 2017	Crit observations	Field notes
30 November 2017	Tutorial observations	Field notes
5 December 2017	Student interviews	Audio recording
17 December 2017	Crit observation	Field notes
16 January 2018	Student interviews	Audio recording
20 January 2018	Final masterplanning design report	Notes
30 January 2018	Framework introduction	Field notes
8 March 2018	Sustainability tutorial observation	Field notes
20 March 2018	Sustainability tutorial observation	Field notes
12 April 2018	Student feedback interviews	Field notes
18 April 2018	Crit observation	Field notes
14 May 2018	Student feedback interviews	Field notes
25 May 2018	Final individual design report	Notes

Chapter 3. Phase 1: Sustainability in the design studio

3.1 Introduction

Phase 1 of the research sought to reveal opportunities and challenges for deep learning for sustainability in the design studio. Firstly, relevant literature regarding deep learning for sustainability in the design studio is presented. The case study design studio at the University of Bath is then analysed and the findings discussed. This chapter presents the findings from this initial phase of data collection which went onto inform subsequent action research. However, data collection continued throughout the two year research period and informed the findings of this chapter. These findings are also presented to enhance the portrayal of the design studio and its relationship to sustainable design.

3.1.1 Aim of phase 1

The first phase of the research examines the case study university and describes the existing pedagogy and integration of deep learning for sustainability. It aims to identify the barriers for effective teaching and learning as well as revealing opportunities for further action. This chapter seeks to provide a detailed understanding of sustainability in the design studio by synthesising data from across the research.

3.2 Background

3.2.1 Sustainability and the architecture curriculum

Making sustainability an integral and 'mainstream' part of an architecture curriculum is a primary challenge for educators (O'Rafferty, Curtis, & O'Connor, 2014). Dochy, De Rijdt, and Dyck (2002) have noted that despite significant levels of prior understanding, aiming the curriculum at learners with low prior knowledge is an effective way to instil and modify values, suggesting the need for fundamental restructuring of curricula. On the one hand, an approach which emphasises the implicit nature of the subject risks a lack of engagement and cause a lack of uniformity which could discourage engagement (Cotgrave & Alkhaddar, 2006). On the other, an overtly explicit approach may undermine the holistic nature of sustainability across all aspects of design however may

encourage a deeper understanding of sustainability (Fenner, Ainger, Cruickshank, & Guthrie, 2005; Parkin, Johnson, Buckland, & White, 2004). Murray and Cotgrave (2007) looked at accreditation in the built environment education in the UK and the impact on higher education. The findings suggest integration is achievable in UK construction courses and institutions should adopt incremental changes towards teaching for sustainability.

The nature of sustainability integration is contingent on course structure and type. In the white paper produced by EDUCATE (2012), five curriculum structures for integrating sustainability were identified by the authors.

- A linear or parallel approach where individual modules have little overlap and deal with discrete themes.
- A partially integrated approach where taught modules link the studio and other core knowledge, sometimes through assessment or delivery.
- A fully integrated approach where the curriculum is delivered around the central design studio and project.
- An iterative approach where interlinked phases broaden and deepen knowledge.
- An elective approach, where students can choose units in their study programme possibly from other departments.

Despite this plurality, the white paper suggests universal course strategies which may enhance deep learning including: developing the connection between lectures and studio; promoting a research based, holistic and analytic approach to design; increasing sustainability competence throughout the curriculum; promoting the design studio as central to architectural education; and encouraging student centred learning (including e-learning) (EDUCATE, 2012). Brady (1996) presented a hypothetical framework for allowing continuity and change into architectural curricula to adapt to a changing world. This included shorter modules which allow flexibility and was supported by examples of student work. Wright (2003) calls for sustainability to be at the core of the curriculum and identifies three models of integration in US architectural education: fully ingrained implicit approach (embedded in all modules); a greater emphasis on modules that deal explicitly with sustainability; and sustainability as an explicit outcome of all modules. This was based on the work of Boyer and Mitgang (1996) who reviewed architectural education in the US and provided a framework for

transformation. This is echoed by Iulo, Gorby, Poerschke, Kalisperis, and Woollen (2013) who used the perspectives of course leaders in the US and six case studies to demonstrate four dominant approaches to integration: a core value to the curriculum; emphasised as a technological addition; considered an elective module; or a specialist skill learnt at graduate level. Springett (2005) warns against the sustainable agenda becoming dominated by technical expertise and the rationality of this approach should be challenged to truly educate for sustainability. For example, work by Allen (1997) found that skills were more readily and efficiently acquired when learnt on an as-needed basis. Rieh et al. (2017) reviewed Korean universities and assessed three possible sequential curriculum structures for sustainable design suggesting the prior and parallel learning is preferable to teaching sustainable design after other aspects of the course.

Cotgrave and Alkhaddar (2006) have pointed out that there is a need for learning outcomes and module design to reflect issues in sustainability however current courses are often designed around course inputs such as resources and staff expertise. Moreover, integration must be holistic and coherent as fragmentation, ad-hoc additions and non-uniformity my prevent meaningful integration (Cotgrave & Alkhaddar, 2006).

Courses could be framed by sustainability however they must embrace its holism as well as not making assumptions about the future (Cole, 1980). Gürel (2010) describes a sustainable design studio that is themed around sustainability in both the curriculum and the environment created. The research concludes that this changed the way students understood design however should not be limited to just one module but pervade the curriculum. Alternatively, Cole (1980) suggests theming of the curriculum around indirect topics which necessitate engagement with sustainability. For instance, energy consumption could be approached indirectly and abstractly through topics such as '*consumer society*'. A development of this may be blended approaches which mix implicit and explicit integration have been tested in architectural education.

More recent global studies include Khan et al. (2013) who developed a complex hybrid framework for introducing sustainability in the design studio and Iyer-Raniga and Andamon (2015) who proposed a discipline based framework for educating for sustainable design in Asia-Pacific universities.

3.2.2 Pedagogic implications

Pedagogy is inextricably linked to deep learning, where developing values and

encouraging independent critical thought focussing on underlying meaning are central (Warburton, 2003). Student engagement with a topic is essential to deep learning (Ramsden, 1997) and appropriate pedagogies must reflect this. The unique and holistic challenges posed by sustainability require an integrated approach that goes beyond the addition of content (Warburton, 2003). Sherman and Burns (2015) create a framework for constructing sustainable curricula tested in an action research framework. Not only is sustainable content necessary but students must be exposed to diverse perspectives, apply ideas in context and engage in emancipatory processes. Similarly, Howlett et al. (2016) advocate a constructivist approach to education and sustainability can lead to changes in students thinking processes rather than merely the application of knowledge or understanding.

Iulo et al. (2013) suggests sustainability should be a core value that pervades the curriculum emphasising the relationship between discrete modules however Cotgrave and Alkhaddar (2006) suggest that even an approach that emphasises connectivity across modules does not necessarily encourage engagement. Moreover, Cole (1980) suggests that focussing curricula on sustainable topics discourages deep learning as it undermines holistic nature of the subject. Perceptions and attitudes towards sustainability must change in learners before effective teaching can take place (Villecco, 1977).

Schools of architecture are typically split between transmissive teaching (e.g. lectures) which provide abstract conceptual knowledge, and active modes of education (e.g. the design studio) in which this knowledge is practiced (Altomonte, 2009). Dividing the curriculum in this manner relies on the assumption that knowledge can be acquired then applied (Gelernter, 1988). Such an approach has been advocated in engineering education as it provides students with the skills to deal with both *hard* and *soft* problems (Fenner et al., 2005). This pedagogic dichotomy, where knowledge is 'front loaded', has been criticised for being ineffective (Gelernter, 1988) due to the non-sequential nature of skill acquisition. Drawing from the cognitive theory of Piaget (1971), Gelernter suggests that practice and acquisition operate in an actively recurring and cyclical relationship. The conclusion is that integrated packages of learning where students construct knowledge through small design projects which deal with technical aspects of learning may be an effective pedagogic approach.

A further trend in the overreliance on didactic pedagogies is the transformation of knowledge from social production to *'information and skills'* which embed

assumptions and beliefs (Crysler, 1995). This has led to the development of project based approaches in which students assemble a portfolio of data which is then questioned by the educator (Douvlou, 2006).

3.2.3 The design studio

Promoting the design studio as central to architectural education has been identified as essential to developing deep learning for environmental sustainability (Clune, 2014; EDUCATE, 2012). The design studio is the "core environment, learning medium and event in architectural education" (McClean, 2009, p. 40). As an environment, it describes the physical space, or often a series of spaces that provide permanent workplaces for students and encourage collaboration and community. As a learning medium it refers to a form of project based learning which encourage personal exploration through open ended assignments. As an event it refers to the specific pedagogies that define student teacher interaction, notably the tutorial and the review (or crit).

Contemporary incarnations of the architectural design studio can be traced back to the Ecole des Beaux Arts in Paris in the 19th Century as well as drawing significant influence from the Bauhaus (Schön, 1985) yet its roots reside far deeper in the mediaeval guilds and the master and apprentice model of arts and crafts education (Broadbent, 1995; Lackney, 1999). According to McClean (2009) the studio is underpinned by constructivist theory (Kelly, 1955) whereby the student is considered an active participant through engaging in explorative learning, simultaneously assuming greater personal responsibility (p.48). One of the primary characteristics of the design studio is the absence of a single body knowledge which allows individuals to develop their own work in relation to a broad and eclectic professional community (McClean, 2009). This gives rise to a complex epistemology, in which the designer's personal ideas give rise to one of an infinite number of possible design options (Shaffer, 2003).

In an ethnographic study of the Oxford Design studio at MIT, Shaffer (2003) identifies a hierarchical structure of the architectural design studio linking in various concepts in complex relationships that enable functioning. Structural elements including the nature of the physical space of the studio and the flexibility of timings allowed a unique pedagogy which in turn engendered particular epistemological beliefs.

Chapter 3. Phase 1: Sustainability in the design studio

This framework is developed by Brandt et al. (2013) who interprets the studio as a bridge between academic and professional domains.

Despite its ubiquity, there are few examples where architecture courses have dispended entirely with didactic methods or more formal learning environments. Levy (1980) describes a *total studio* in which all learning takes place through this medium however falls short of its implementation suggesting that such an approach may not be appropriate to instilling adequate technical competencies. Newcastle University (Australia) in 1984 and Delft University in 1990 introduced full problem based learning course whereby all technical subjects were taught through the design studio (Banerjee & Graaff, 1996). In both cases, it was observed that some students did not devote enough attention to technical aspects of design while staff exhibited the tendency to view these aspects as peripheral. Banerjee and Graaff (1996) conclude that *preparatory blocks* of technical knowledge are required to allow the design studio to adequately provide a sufficient educational experience.

The nature of independent learner development in the design studio offers possibilities for student project definition. Non-prescriptive briefing describes a strategy whereby students define their own learning ensuring personal experience becomes the basis of further learning (Kolb & Goldman, 1973). Despite these noble aims, without intrinsic motivation, non-prescriptive briefing may sideline sustainability themes (Oliveira & Sexton, 2016). Moreover, little work has been done on student attitudes towards non-prescriptive briefs (Oliveira & Sexton, 2016)

As the primary means of educating architects, it is imperative that the design studio addresses environmental sustainability if the architects of the future are to meaningfully engage with its issues in practice. It can increase critical engagement and awareness, encouraging acceptance that sustainability is a contestable and value led concept (Gürel, 2010). The design studio also has the potential to encourage transdisciplinary learning (Khan et al., 2013). However, these opportunities are rarely exploited by educators and student engagement in sustainable themes is often poor (Clune, 2014).

3.2.4 Learning through design at the University of Bath

Learning in the design studio at the University of Bath is design centred, focussed around design projects, developed both for and by students. The design project is the

vehicle for learning; the design studio provides its context. While deep and experiential learning may underpin the epistemological motivations of the studio these cognitive processes are framed through the process of design itself which has its own codes and conventions.

At the University Bath, the critical method (CM) is explicitly advocated as a model of design. CM is passed on the critical rationalism of Popper (1963) and was applied to design initially by Darke (1979) and developed by Brawne (2003). To Popper, the nature of scientific discovery was one of making informed guesses followed by testing their validity, underpinned by the principle of falsifiability. Any theory was only considered valid if it had the potential to be proved incorrect and was only as strong as the number of attempts at disproof it had resisted.

While the Popperian method is an attractive and plausible theory of design, it does not fully explain the process of dealing with the complex problems designers face. It is not clear how an initial conjecture may arise. Furthermore, when faced with no tangible set of criteria for analysing success or determining falsifiability, it is unclear how one assesses the validity of any particular solution. Darke (1979) approaches the former issue through the concept of *primary generators*, the concept, group of ideas or objectives that spawn a project. These are not necessarily rational but often an "article of faith" a collection of conceptual ideas, rather than a rational list of constraints (Darke, 1979).

Brawne (2003), describes the CM process as one of generating tentative theory followed by error elimination. CM is an iterative process of informed guess work (Bamford, 2002) tested through the application of professional tools (drawing, modelling etc.). CM contrasts with the problem solving model of design proposed by Simon (1969) who suggests that design is a process of problem analysis followed by synthesis of a solution. According to Simon, through a process of reduction, any complex problem could be reduced to constituent parts.

The principles of CM share many of the characteristics of *design thinking*; an approach to tackling issues not solvable through conventional problem solving techniques. Design thinking describes a transferable concept for dealing with complex problems across a range of fields. The term was first used by Rowe (1987) in his book of the same name and has since evolved into various models drawn from theories of design methods and external disciplines (Dorst, 2011). Design thinking is necessitated

by the often poor definition of architectural problems highlighted by Cross (1982) and Fang (1993).

The production of a generalizable theory of design practice has led to a range of descriptions of 'design' (Kimbell, 2011). Considering design thinking as a cognitive style has enabled the concept to be applied to a variety of problems across different disciplines (Dorst, 2011; Rowe, 1987; Schön, 1984b) emphasising the distinction between the designer and the world in which they operate. (Kimbell, 2011). By contrast, the account provided by Buchanan (1992) considers how designers use design thinking to generate a *subject matter* for design in order to tame complex design situations. Design thinking has also been used to as a tool for organisational strategy; a methodology to engender innovation (Brown, 2008).

Design thinking stands in contrast to problem solving theories of design advocated by Simon (1969) who asserted that design problems could be approached by reduction to a series of well-defined problems*.* Rowe (1987), however, asserts that the nature of design problems can be categorised into *well-defined*, *ill-defined* and, often, *wicked problems.* A wicked problem is one in which the definition of the problem is unclear and the desired outcome unknowable. Moreover, they are value judged, have no stopping rule and any number of possible solutions (Rittel & Webber, 1973). Solving design problems requires moving beyond linear understanding of the design process which typically describes a process of problem definition (analysis) to solution creation (synthesis) (Buchanan, 1992). When dealing with wicked problems, however, this approach is clearly inadequate. By its very nature, a wicked problem cannot be defined and when there are almost infinite number of possible solutions, its synthesis is often a messy, non-linear process.

Alternatives to the analysis-synthesis approach typically describe a process of trial and error, beginning with an initial conjecture followed by an analysis of the possible solution. Dorst (2011) provides a framework which uses the language of formal logic, building on the work of Roozenburg and Eekels (1995). To Dorst, human reasoning methods can be understood in terms of the equation:

WHAT (the thing) + HOW (its working principle) = RESULT (observation)
(Dorst, 2011, p. 523)

Settings of the equation, where different variables are known at the outset, can be used

to describe rational processes. In deduction, for example, the WHAT and the HOW are known at the outset allowing the prediction of a particular result. In induction, the thing itself is observed however its working method is unknown and must be conjectured. Attempts are then made to falsify this hypothesis.

Tomiyama, Takeda, Yoshioka, and Shimomura (2003), represent this equation in the language of formal logic where 'WHAT' can be understood as a set of facts (F), 'HOW' is a set of general axioms (A) and 'RESULT' is a specific theorem (Th). σ is the reasoning rule that allows derivation of the theorem. Accordingly:

$$A \cup F \mid\text{-}\sigma Th$$

A specific theorem is the domain created in the union between general principles and set of facts or observations. In deduction, specific theorems are derived from general rules and observable facts (Th is unknown). Dorst (2011) uses the example of astronomy in which observable facts are represented by the stars and the science astronomy and physics provides a set of general rules which govern their movement. Using these general principles, a deductive process can be used to predict their observed movement. In induction, specific instances and observable facts are used to infer general rules or axioms (A is unknown). In the case of astronomy, specific observations take the place of predicted theorems to derive general principles (A). The scientific process is thus both inductive and deductive; the former used to establish axioms and the latter used to test these axioms through observation.

Dorst (2011) asserts that this equation can be applied to design and used to describe the nature of problems through a process of *abduction*. In abduction, specific theorems and general axioms are known at the outset generating a set of possible facts. As the factual domain is larger than that of specific theorems, there are potentially multiple possible outcomes that may satisfy the requirements of the result. In Dorst's model, specific theories (Th) are understood as a values or aspirations (V), axioms as general design principles (A) and facts as the object of design (F). The equation is then re-written as:

$$A \cup F \mid\text{-}\sigma V$$

Important to Dorst's work is the notion of framing. A frame is often a rich and complex metaphor which embodies an aspirational value coupled with a possible principle to

achieve used to shape the end product. The frame restructures the design situation allowing the designer to work towards a possible end product. To Dorst, the core of design thinking is the parallel formation of an end product and its operational design that allow a desired value set to be achieved and it is the designer's application of a frame that enables this.

3.2.5 Sustainability and design thinking

In the taxonomy of problem types defined by Rowe (1987), designing for sustainability is very much a wicked problem. Design output and working method are often unknown and there are any number of possible solutions. To combat this a raft of quantifiable sustainable methodologies, assessment regulations and measures have been created to help designers construct aspirational targets and provide certainty (including BREEAM, PassivHaus, Code for Sustainable Homes in the UK).

Design thinking is possible approach for addressing the wickedness of sustainable design. Its various conceptions as a cognitive strategy, a situated methodology and a means for organisational innovation (Kimbell, 2011) are all strategies for framing problematic situations. The unique challenge posed by sustainable design, however, draws into question the potential efficacy of design thinking as a strategic approach for designers. Sustainable design is holistic in nature, operates at multiple scales, over different time periods, effects multiple stakeholders and embodies a variety of competing values. Moreover, in the logical construct of design thinking advocated by Dorst (2011), the aspirational value that helps construct the designer's "frame" is often contestable, contradictory and unstable. Not only does this apply to the concept of sustainable design but nature itself is a contestable concept (Hajer & Versteeg, 2005). Environmental problems are the result of social and political conflict over interpretations and its results must be understood as socially constructed (Oluf, 2007). For example, Dryzek (2013) identifies *Ecological Modernisation* as the dominant discourse surrounding climate change, prioritising economic and technological innovation at the expanse of democratic action, emancipatory change or radical resistance.

Considering this complexity, design thinking as a cognitive or design strategy may be severely limiting. As Kimbell (2011) notes, not only does it ignore the place of specific, historically situated practice, design thinking also assumes the hegemony of

the designer as the principle agent of design. Considering sustainability through the lens of a constructivist epistemology composed as a series of contradictory discourses (Dryzek, 2013), the dominance of design thinking risks leaving the assignment of meaning in the hands of the individual.

The inherent ambiguity of sustainability means a critical approach must be taken, to analyse and appraise competing approaches (Gürel, 2010). Guy and Moore (2007) call for design approaches that embraces the pluralism of sustainability, rejecting the primacy of technical certainty, utilising reflective engagement. Interdisciplinary working has been identified as a possible approach requiring collaboration beyond subject boundaries to tackle issues (Jones, Selby, & Sterling, 2010; O'Rafferty et al., 2014).

3.2.6 Deep learning in the design studio

Critical to the design studio education is the assumption that the design process is analogous to learning. At the case study university this is an assumption that practice of CM constitutes the development of professional competencies. The relationship between design and learning is something that has been highlighted throughout the literature on design. As Renzo Piano puts it:

> "Designing is a journey, in a way. You set off to find out, to learn. You accept the unexpected. If you get scared and immediately seek refuge in the warm and welcoming lair of the already seen, the already done, it is no journey. But if you have a taste for adventure, you don't hide, you go on. Each project is a new start, and you are in unexplored territory. You are a Robinson Crusoe of modern times." (Piano, 1997, p.10)

The development independent of critical thought is at the heart of both studio education (McClean, 2009) and engagement with sustainability in design education (EDUCATE, 2012). *Deep learning* describes a level of information processing that emphasises a holistic approach which focussing on underlying meaning (Marton & Säaljö, 1976b). This stands in contrast to surface learning and strategic learning which emphasise descriptions and competitiveness respectively (Warburton, 2003). Various scholars have highlighted the need for deep learning in sustainable education (Buckingham-Hatfield & Evans, 1996; Warburton, 2003) as well as specifically in architectural

sustainable design (Clune, 2014; EDUCATE, 2012). The holistic and interdisciplinary nature of sustainable requires a critical approach consistent with the self-motivated and reflective process associated with deep learning (Buckingham-Hatfield & Evans, 1996). Deep learning implies a critical approach to understanding whereby assumed beliefs are challenged and reconsidered. It is a meta-reflective process, where the deliberate act of questioning action provides a deeper understanding. This requires student centred pedagogies to take prominence and reflective educators to enable this (Clune, 2014). Beattie, Collins, and McInnes (1997) describe three primary characteristics of deep learning.

> "(1) Seek to understand the issues and interact critically with the contents of particular teaching materials;
> (2) relate ideas to previous knowledge and experience and;
> (3) examine the logic of the arguments and relate the evidence presented to the conclusions." (p.3)

In the wider literature on learning, this process is variously described as *reflection-on-action* (Schön, 1984b), *double loop learning* (Argyris & Schön, 1974) and *experiential learning* (Kolb & Goldman, 1973). It is an act of critical thinking which requires the processes of "identifying assumptions, researching them, and generating multiple perspectives" Brookfield (1997).

The nature of learning that takes place in the design studio was largely undeveloped until the work of Donald Schön in the 1980s. His book *The Design Studio* (1985) built on work in *The Reflective Practitioner* (1984b) and describes a number of key concepts at play in the design studio. *Reflection-in-action* describes how professionals conduct the process of design through a constant reflective dialogue during the act of creation. In contrast, *reflection-on-action* occurs after the event and allows space for the practitioner to consider their output. Through experience of the iterative process of design, students, absorb knowledge unconsciously which becomes tacit. *Knowing-in-action* describes this understanding and the ability to apply it obtained through previous experiences of *reflection-in* and *reflection-on* action.

Schön's reflective practice evolved from work done by Chris Argyris and himself in the 1970s on double and single loop learning (Argyris & Schön, 1974). They are distinct strategies that share commonalities with reflection in and on action. Single loop learning describes a problem solving approach in which individuals attempt to

understand the internal systems in which they operate. Double loop learning, by contrast, involves questioning assumptions and why action is undertaken in order to improve their inner values (Gribbin, Aftab, Young, & Park, 2016). Single loop learning is concerned with improving actions to reach desired outcomes while double loop learning questions both how something is done but also why it is done in that way (figure 3.1)
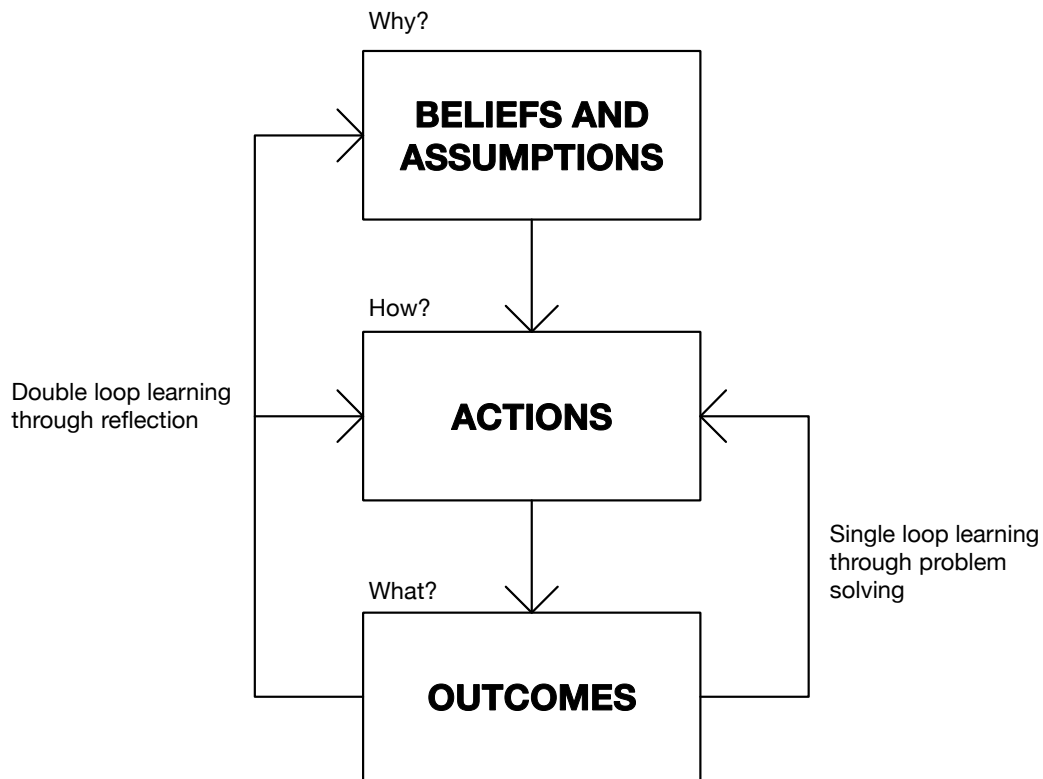
Fig 3.1 Single and double loop learning cycles (redrafted from Gribbin et al. (2016))

Critics of Schön point to a number of failings of his description of the design studio. Eraut (1994) notes he fails to clearly define what he means by *reflection-in-action*. Three possibilities emerge; that all thinking is reflection, reflection only occurs when action is stopped or that reflection is a *metacognitive process* and effectively constitutes thinking about what course of action to explore next. Furthermore, Schön's description could be considered a demonstration of reflective designing to the student, a master/apprentice model. Eraut suggests the designer is himself accepting the wide range of perspectives and possibilities as he tacitly explores the design process yet the transmission of this knowledge is purely didactic. The suggestion to the student is that architectural education is purely about the transmission of skills, abilities and professional competence rather than accepting it is a contested and dynamic field

(Webster, 2008).

Schön also fails to note the importance of immersion in architecture and limits his description of learning to formal encounters between master and student. Webster (2008) suggests informal learning is essential to architectural education and that high performing students engaged in "reading expansively, visiting cities, buildings and exhibitions, attending lectures, spending long hours in studio, and living in houses with other architectural students." (p. 67). While Schön's work provides a description of the cognitive action of design, it does not present an accurate portrayal of learning in the design studio.

McClean (2009) has noted the link between Schön's reflective description of design studio pedagogy and Kolb's Experiential Learning Theory (ELT) (1984; 2001; 1973). ELT can accommodate the holistic nature of learning framing it as a four stage cyclical process whereby the learner moves between opposing notions of perception (grasping knowledge) and process. Knowledge is *grasped* through either *concrete experience* (specific encounters founded in the real world) or through *abstract conceptualisation* (knowledge in the theoretical domain). It is processed through the opposing actions of *reflective observation* (conscious evaluation) or *active experimentation* (hands-on activity) (figure 2.2). Kolb suggests learning should begin with individual experience as the foundation of acquiring knowledge, then reflected upon, related to general theories, and finally experimented to generate new experiences (2005). This reflective cycle has parallels in both deep learning and critical pedagogy, both of which emphasise recognising the need to base learning on a critical understanding of individual experience (Pettit, 2010).

Kolb identifies four learning styles that are defined by how learners prefer to perceive and process information (Kolb & Kolb, 2005; Kolb, 1976). Subsequent development of the model has suggested nine learning styles, that include the intermediate preferences between styles and a central balanced learner (Abbey, Hunt, & Weiser, 1985; Kolb et al., 2001). Kolb describes the four primary styles as assimilators, convergers accommodators and divergers. Assimilating learners are able to organise a wide range of ideas into abstract concepts. They prefer lectures, readings and personal research. Converging learners like to engage with tools and activities and develop abstract ideas through technical application. In architecture this may include drawing, model making and engaging with technologies. Accommodating learners prefer to learn from direct engagement with real world experiences, such as placements, trips,

and collaborative work. Divergent learners like to learn through reflection on their own experiences and prefer social interaction such as crits, tutorials and peer discussion to enable this.
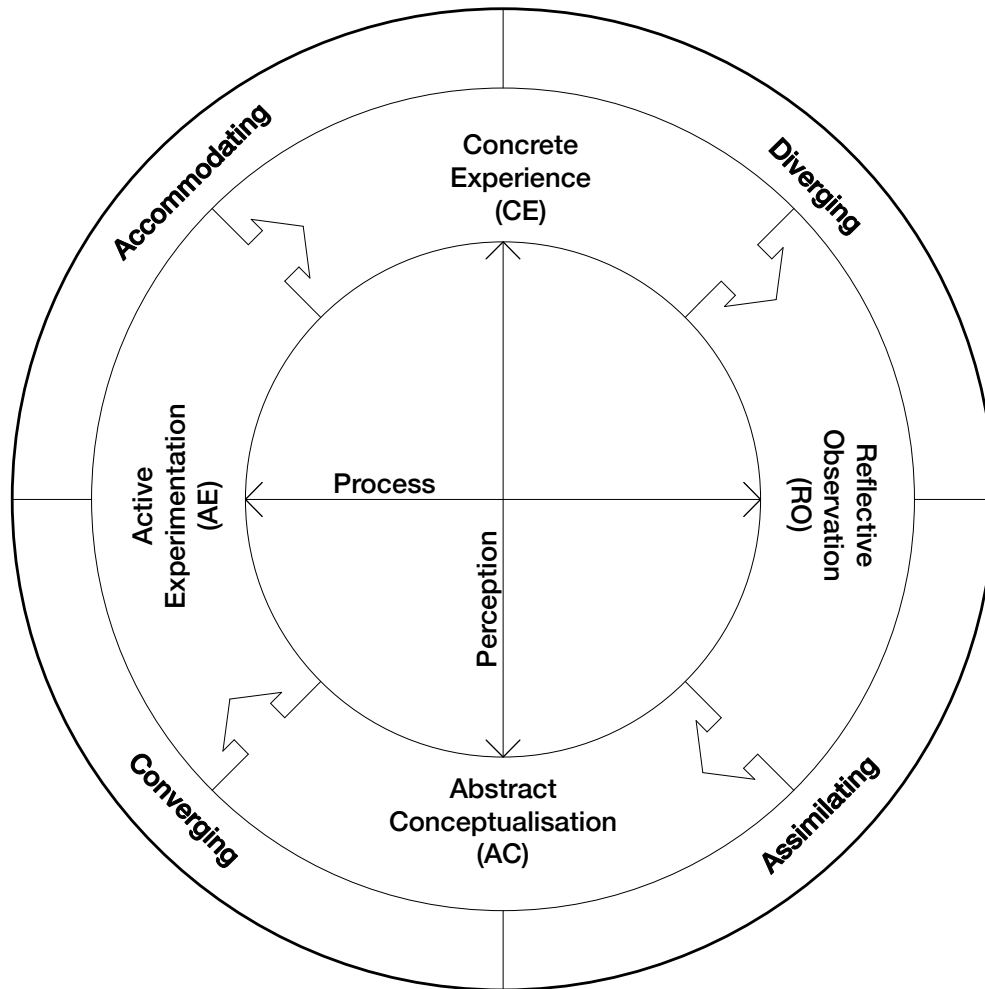
Figure 3.2 The experiential learning cycle (redrafted from Kolb et al. (2001))

Kolb's model provides an understanding of reflective education that accepts the broader range of influential, environmental factors that affect learning while still accepting the critical role of reflection advocated by Schön. Informal experiences, self-directed learning, peer interaction, environmental factors may all play their part in Kolb's holistic model.

3.2.7 A model of deep learning in the design studio

The reflective cycles of Kolb, Argyris and Schön have clear parallels to CM: initial assumptions constitute primary generators; action generates conjectures; and design solutions provide concrete experiences. Accordingly, in order for effective deep

learning to take place, it is not enough for the design cycle to consist of only conjecture and analysis generating new conjecture, as suggested by (Brawne, 2003). Instead, the designer must constantly return to their primary generators, questioning their initial underlying assumptions in light of newly created design knowledge.

Although the application of Kolb's learning cycle to the design studio has been suggested (McClean, 2009) to date, the author is unaware of a coherent model of the design studio that incorporates multi-layered reflective practice. Drawing from ELT, reflective practice, CM and double and single loop learning, a coherent structure can be formed which synthesises these different processes. A hierarchy of decision making processes may generate a set of interrelated learning cycles which operate at different cognitive speeds as described by Eraut (1994).
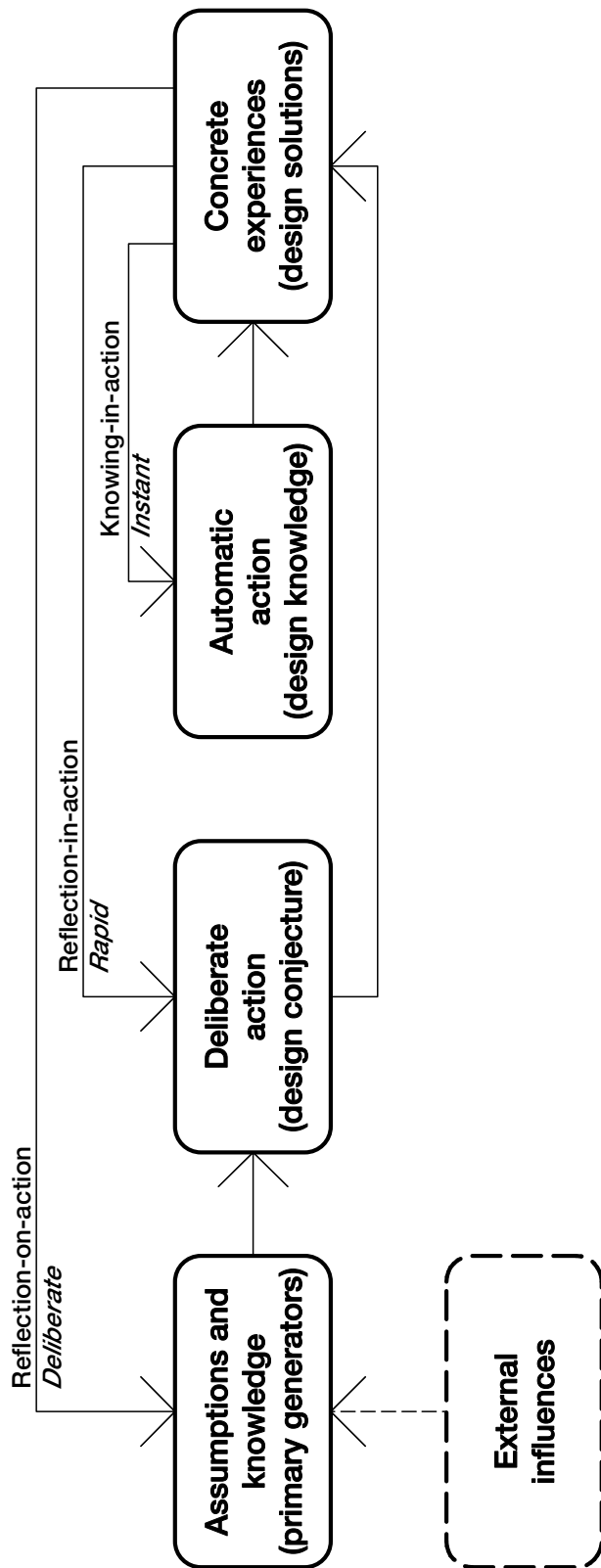
Figure 3.3 Reflective processes in the design studio (by the author)

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Each reflective loop in figure 3.3 represents a single learning cycle. Assumptions and knowledge form the inputs to this model of learning, often effected by external factors such as personal experiences or taught modules. These assumptions create *primary generators* (Darke, 1979)

Knowing-in-action

Knowing-in-action describes an analytical process of instant recognition, an immediate decision making process and routine unreflective action (Eraut, 1994). This process takes place internally and without conscious reflection constructed from accumulated experiences and accepted practice. It is an efficient decision making process and relies on assumptions that are translated to new scenarios. This process is necessary and essential and in part defines professional competence (Schön, 1984b).

Automatic, unreflective process can be dangerous, however, when addressing *ill-defined* or *wicked-problems* (Rittel & Webber, 1973) in which accepted processes may not be equipped to deal with the formation of new design situations. Moreover, in the context of sustainability, where rapidly changing issues are both contextual and effected by value systems, the blind repetition of process and solution may be inadequate. The *knowing-in-action* cycle must become the subject of meta-reflective processes to constantly assess one's own practice and assumptions.

Reflection-in-action

Reflection-in-action is a rapid decision making process in which the action itself constitutes an act of reflection (Schön, 1985). It represents professional competencies which allow rapid analysis of design ideas, akin to single loop learning (Argyris & Schön, 1974). This cycle emphasises the process of learning and designing rather the product of design; in this case, conjecture is also reflection.

Considered from an ELT perspective, in the *reflection-in-action* cycle, the processes of active experimentation, concrete experience and reflective observation occur almost simultaneously while new abstract concepts are generated through this internalised single loop process. Through repetitions of this cycle, the learner forms professional competence (Schön, 1985) which in itself constitutes a form of assumptive knowledge.

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Reflection-on-action

Reflection-on-action is a meta cycle of learning and involves both the creation of new knowledge, questioning initial assumptions (primary generators) and reflecting on the design process. This can be understood as double loop learning whereby assumptions are identified and challenged leading to the creation of new knowledge. Adopting the experiential learning model, learners must develop the appropriate conceptual knowledge, equipped with the skills and resources to test ideas, exposed to direct experience of specific example and allowed space to express opinions and enter dialogue. This experience develops professional competencies that allow action in the studio. It is the *reflection-on-action* cycle at which true deep learning takes place. It is here where the learner makes space to step back and critically assess the processes and assumptions that are underpinning action and subsequent experience.

3.2.8 Enabling deep learning for sustainability

To encourage deep learning for sustainability, the design studio must support a full range of learning experiences that motivate learners to consider underlying meaning. Kolb highlights the necessity of creating space for thinking in the experiential learning environment (2005). In order to develop deep learning, sustainability knowledge must be related to personal motivations and as such the studio must support the acquisition of abstract ideas defined by the student. Examples may include allowing personal interests to be developed as well as providing the physical resources such as permanent personal working space that allow learners to take ownership of their environment.

Kolb describes the transfer of conceptual ideas to a wide variety of different contexts (convergence) through encouraging the enhancement of technical skill (2005). The studio must provide the space and the resources to enable specialist techniques to model and assess sustainability be learnt and applied. The studio must allow for the testing of innovative techniques and new technologies. The assignments that define the workload of the studio must accommodate and encourage the acquisition of these skills. Examples may include sketching, sketch model-making, digital simulation and theoretical writings.

Accommodating learning activities emphasise the resolution of practical problems through hands-on experience (Kolb & Kolb, 2005). As well as supporting a broad range of practical activities, the design studio must provide space for creativity

and unconventional approaches to knowledge production. The generation of new experiences is essential which may include physical construction with sustainable building techniques, trips to exemplar sustainable precedents, live projects and group working towards specific goals.

Divergent learners prefer acting and reflecting (Kolb & Kolb, 2005). The studio must provide space for social interaction between peers and teachers that enables reflection on specific realities, whether they be design product, or wider personal and collective experiences. Feedback mechanisms must support reflection from a wide variety of perspectives to encourage a broad range of opinions to enhance critical consideration of learning situations. To encourage critical sustainability, feedback should not be just from those within the profession of studio but seek to provide a range of perspectives from multi-disciplinary experts as well as those from outside the fields of architecture and sustainability.

Facilitating deep learning not only relies on providing space for multiple learning styles but also providing meaningful interactions between educators and students. The individual tutorial (sometimes referred to as the desk crit or desk review) forms the backbone of design studio education and is the primary means in which students interact with teaching staff (Webster, 2004). Schön's account of the tutorial (1985) positions it as a site of *reflection-in-action* whereby the student's problem is criticised, reframed and the consequences determined by the master (p. 50). The tutorial is a place for both feedback and an opportunity for the tutor to communicate the accepted practices of the profession (McClean, 2009).

The tutor's role in the Schön tutorial is one of demonstrating rapid modes of metacognition that constitute a professional way of thinking. Schön presents an idealised role of the tutor where the student learns through observation, assimilation and imitation (Webster, 2004) rather than constructive discussion. This exacerbates the *power asymmetry* between master and apprentice (Dutton, 1991) and to some extent undermines the student's individual quest for meaning and in turn, possibilities of deep learning.

Goldschmidt, Hochman, and Dafni (2010) analyses of tutorials identified three common tutor roles. In the three case studies they considered, it was found that the tutor acting as a '*coach*' was the most effective. This approach struck a balance between contribution to problem resolutions and a feeling of mutual equity however the authoritative role of a tutor as an '*expert advisor*' was also beneficial. Interrogating

students in an attempt to prompt them to produce a solution was found to lead to feelings of inferiority and frustration in students. Consequently, for deep learning for sustainability to be successful employed in the design studio, the tutor must take on a role which facilitates yet does not limit learning.

The phenomenon of the crit has had a great deal of attention in the architectural education (Anthony, 1991; Doidge, Sara, & Parnell, 2007; Sara, 2004; Wilkin, 2005). It is considered a necessary but controversial and often unpopular aspect of architectural education (McClean, 2009). From its origin in the Beaux Arts teaching tradition, it has developed a status in which it is seen as a rite of passage from many practitioners. The crit can be a rich learning experience; it allows diverse feedback and challenging feedback which can develop independent thematic interests and can significantly broaden student learning (McClean, 2009). It can be understood as a form of professional induction in which knowledge and behaviours are passed on and the student is taught to "think like an architect" (Weaver, 1997).

Crits may be a valuable mechanism for encouraging deep learning for sustainability. As Sara (2004) has identified, they may help develop critical awareness and expose students to a wide range of viewpoints. However Wilkin (2005) observed crits encouraged negative and confrontational atmospheres. Students, not knowing the rules of the crit, could only discover them through breaking them and being subsequently criticised (Doidge et al., 2007), developing hierarchical relationships which undermine the ideology of the studio and prevents effective dialogue (Willenbrock, 1991). This *mystery-mastery* approach to teaching often led to frustration echoing the findings of Goldschmidt et al. (2010) in design tutorials.

Stevens (1995) has noted the tendency of the crit to favour both certain types of learners and those from particular class backgrounds (especially those who are particularly culturally literate). Thus its effectiveness may be limited to those who are *favoured* by the system while those who are from particular social classes, less confident or lack the specific personality traits that the crit demands, struggle in this environment. This is pertinent in the context of deep learning where personal motivation is a key factor to uncover underlying meaning.

Despite appearing an ideal environment for developing deep learning (Clune, 2014), relying on the design studio to develop a particular set of values and skills may be unreliable (Banerjee & Graaff, 1996). Furthermore, self-directed learning may negatively impact student time and direct it away from other aspects of the curriculum

(Datta, 2007). The contestable nature of environmental sustainable design which necessitates a critical and deep approach poses a major barrier to successful application. Misconceptions regarding sustainability can lead to barriers to implementation (Filho, 2000) and presenting sustainability as a vague and pluralist concept confounds this (Gürel, 2010).

The development of the design studio from its origins leaves one questioning the alignment between its pedagogy and intended outcomes. The master-apprentice model, on which the studio was founded, poses particular problems for developing deep learning for sustainability. The challenges of sustainability require innovative approaches, picking apart widely held assumptions, and considering alternative ways of acting. Dutton (1987) points towards a powerful hidden agenda of the studio that both intentionally and subconsciously acts to legitimise certain types of knowledge and practice. Underpinned by hierarchical social structures and unchallenged assumptions, each design studio or school of architecture delivers a particular form of architectural and professional agenda (Dutton, 1991). This professional validation, generated by institutionalised power asymmetries, necessarily excludes alternative forms of practice and in turn, validates the profession and promotes "a series of self-referential and autonomous values" (Till, 2003). In the search for innovative processes, underlying meaning and challenging assumptions, '*thinking like an architect*' (Weaver, 1997) may prove problematic.

The autonomous nature of architectural education reaches beyond the confines of the design studio. Stevens (1995) notes the tendency of architectural education to preserve the status quo of the profession limiting its social diversity. Placed in the context deep learning, this limits the exposure of students to multiple points of view, reinforcing professional assumptions and behaviours undermining critical understanding (Brookfield, 1997).

Perhaps the biggest barrier to significant change in the education of architects comes from the professional and institutional culture it operates within. Murray and Cotgrave (2007) suggest that despite the minimal requirements of sustainability in the curriculum laid down by professional bodies, the major hurdle to overcome is a professional one. This is particularly prevalent in architecture and at the University of Bath where a majority of studio practitioners come from industry. Moreover, Alabaster and Blair (1996) notes that academics in Higher Education are often resistant to values

imposed from outside their subject areas. This poses a particular problem to the interdisciplinary nature of environmental sustainability.

3.3 Research method

3.3.1 Research approach

Phase 1 of the research drew from ethnographic methodologies to observe and identify issues for the integration of deep learning for sustainability in the architectural design studio. The aim was not to generate concrete theory or instigate change through purposive action, but rather to create a *working hypotheses*. (Lincoln & Guba, 1985). Phase 1 sought to identify issues and possible domains for change.

The research utilised a qualitative approach using direct methods to capture individual points of view. The research sought both *richness* (high quality) and *thickness* (quantity) of data (Fusch & Ness, 2017) to provide a detailed accounts of the case-study . In the framework set out by Stake (1995), the case study is considered instrumental (rather than intrinsic or collective). The case study of the University of Bath was chosen to provide insight into the integration of sustainability into the design studio, rather than offering specific, intrinsic interest. As Baxter and Jack (2008) suggest, it is used to accomplish something beyond an understanding of the specific situation and sought broader recommendations for practice.

3.3.2 Context of phase 1

Phase 1 of the research was conducted over a two-year period at the University of Bath, Department of Architecture and Civil Engineering enrolled on the MArch course. This provided an opportunity to observe and interview two consecutive cohorts of students in their final year of architectural study and their sixth year of formal education. Observations were conducted in the learning environment; in the design studio, in crit rooms and in lecture theatres or seminar rooms. The research was conducted in-situ so the results must be read as contextual, value-bound and consist of various overlapping realities.

3.3.3 Sampling and data collection in phase 1

The research used a voluntary and purposive sample in which participants were selected based on their knowledge and experiences as well as their willingness to participate (Tongco, 2007). In this case, the relatively small population meant willing student and educators could be targeted for their perspectives on the course. Data collection took place over a two-year period. Final year MArch (RIBA 2) students at the case study university and educators on the course were participants. Students were typically in their sixth year of formal architectural education allowing them a reflective view on their architectural education. They were also most likely to go into architectural practice.

The researcher was a member of staff in the case study department but not directly involved in teaching on the MArch course in order to avoid possible bias. The role of the researcher was predominantly one of *observer-as-participant* (Gold, 1958). In this role most data were gathered through relatively formal settings, (scheduled interviews and planned observations) in which the researcher was considered *acceptable incompetent* (Lofland, 1971). In all cases the participants were aware of the presence and role of the observer. The researcher's role allowed a passive approach that limited impact on the students. The openness of the study and knowledge of participants negated the potential ethical implications of a more immersive researcher role. It allowed a broader data set to be gathered, maintained a suitable distance from the subjects and avoided possible ethical issues. Consideration was also given to discretion in interviews, responsibilities to student welfare, preferential treatment and respecting the attitudes of student to remain anonymous.

This chapter describes the findings of data collected throughout a two year period in the course of the research. Initial results informed the action in later chapters. However it continued in parallel with the action research phases and contributes to the findings presented min this chapter. Data collection involved a cyclical process of collection, analysis and validation which informed further cycles (Cohen et al., 2000). A voluntary sample of 20 participants within the population (n=70) were interviewed using semi-structured interviews (Patton, 1980). This provided a baseline understanding and informed further data collection and analysis. Six educators on the course provided supplementary interviews. Participants and interviews are described in table 3.1.

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Table 3.1: Participants contributing to chapter 3 research.

Pseudonym	Intake	Interview date	Mini feedback interview	Masterplanning Group
Students				
Laura	2015	27/10/2016		
Georgina	2015	27/10/2016		
Jane	2015	27/10/2016		
Gregory	2015	27/10/2016		
Yvonne	2015	31/10/2016		
Martha	2015	01/11/2016		
Fred	2015	03/11/2016		
Jack	2015	03/11/2016		
Gemma	2015	07/11/2016		
Gordon	2015	10/11/2016		
Simon	2015	10/11/2016		
Anne	2016	04/12/2017	12/04/2018	E
David	2016	05/12/2017	12/04/2018	B
Phil	2016	05/12/2017	12/04/2018	F
Chris	2016	16/01/2018	12/04/2018	B
Emma	2016	16/01/2018	12/04/2018	B
Sylvia	2016	16/01/2018	12/04/2018	F
James	2016	24/01/2018	12/04/2018	B
Karl	2016	24/01/2018	12/04/2018	F
Harry	2016		12/04/2018	D
Brian	2016		12/04/2018	A
Martha	2016		12/04/2018	B
Kathy	2016		12/04/2018	E
Pierre	2016		12/04/2018	E
Katie	2016		12/04/2018	G
Sarah	2016		12/04/2018	B
Frank	2016		12/04/2018	A
Xing	2016		12/04/2018	D
Michelle	2016		12/04/2018	C
Grace	2016		12/04/2018	D
Joshua	2016		12/04/2018	F
Katherine	2016		12/04/2018	F
Paul	2016		12/04/2018	E
Jeffrey	2016		12/04/2018	F
Tutors				
Alan		24/11/2016		
Alison		10/06/2018		
Adam		07/10/2016		
Richard		01/05/2018		
Arlene		14/06/2018		
Michael		25/01/2018		

Observations of crits and tutorials were undertaken by the researcher in a naturalistic manner (Lincoln & Guba, 1985). These provided a formal educational encounter which gave data on the students and educators. Observations were noted and categorised in-situ paying particular attention to the theming of discussions taking place as well as the nature of this dialogue. Data were collected over a 2 year period involving two consecutive cohorts of students. Table 3.1 outlines the data collected.

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Table 3.2: Data collection schedule for phase 1

Date	Event	Data type
7 October 2016	Head of year interview	Audio recording
27 October 2016	Student interviews	Audio recording
10 November 2016	Student interviews	Audio recording
17 November 2016	Crit observation	Field notes
24 November 2016	Sustainability tutor interview	Audio recording
25 January 2017	Sustainability lecturer interview	Audio recording
10 November 2017	Tutorial observations	Field notes
17 November 2017	Crit observations	Field notes
30 November 2017	Tutorial observations	Field notes
5 December 2017	Student interviews	Audio recording
17 December 2017	Crit observation	Field notes
16 January 2018	Student interviews	Audio recording
24 January 2018	Tutor interview	Audio recording
8 March 2018	Sustainability tutorial observation	Field notes
18 March 2018	Tutor interview	Audio recording
20 March 2018	Sustainability tutorial observation	Field notes
18 April 2018	Crit observation	Field notes
12 June 2018	Tutor interview	Audio recording
14 June 2018	Tutor interview	Audio recording
-	Course materials (design studio brief, Learning Outcomes, professional compliance criteria)	Notes
-	Final masterplanning design report	Notes
-	Final individual design reports	Notes

3.3.6 Data analysis of phase 1

Analysis of the data occurred in tandem with the collection. This allowed a constant process of verification and theory generation (Cohen et al., 2000). On a practical level, it allowed large quantities of data to be dealt with and sufficiently narrow the field of inquiry in later study. The process of coding is described in chapter 2 (methodology). The data were analysed using the seven phase procedure defined by Marshall (2016): organisation of the data; immersion in the data; generating categories and themes; coding the data; interpreting the data; searching for negative cases and alternative understandings; and writing the report. This was a continuous and iterative process

which allowed processing of the data over a long time period and enabled a narrowing of the field of inquiry in later study based on initial findings. Initial immersion in the data gave rise to an early set of themes or *domains*. Domains were formed through a synthesis of the relevant theory with the *in vivo* generation of codes from the raw data. The creation of codes and domains was influenced by my own sensitisation to the relevant literature. This was an iterative process in which codes and domains were reassessed as the data increased. An example of the coding structure is provided in table 3.3.

Table 3.3: Example of coding and domain creation

Domain	Category	Code	Raw data
Teaching interactions	Tutor influence	Combined tutorials valued	"We had a few tutorials with two tutors but not too many where they had different opinions but I think instead of having two tutorials it was better to merge it into one." (Chris, student)
		Exposure to different specialist tutors	"One thing is I would prefer is tutorials with people who have more specialities in that and the same ideas wouldn't just keep happening over again. You look at other projects, they this must plan projects eight years, as the same sort of principles that come up every time. I'm not saying that they should be different but that's to do with the way that you see other years and the way the tutors are the same." (James, student)
		Parallel tutorials valued	"…we always had an environmental report that would go alongside our design and it wouldn't be a last minute thing but we would have environmental tutorials that would go alongside your tutorials so it would usually be quite integrated with that." (Jane, student)

This process was facilitated by a software package (NVivo) which allowed data to be coded and categorised. Interview transcripts, field notes, reflections and photographic evidence was imported into the program and coded. Notes and writing took place simultaneously which was then cross referenced with the analysis informing re-coding and categorisation.

The researcher's role of *observer-as-participant* allowed for easy exiting of the field due to the relatively undeveloped relationships and clear understanding of the researcher's place in the study by participants. The openness of the study and knowledge of participants negated the potential ethical implications of a more immersive researcher role. Choosing when to leave the field, however, was less straight forward and was limited by the time scale of the university semesters and time spent in the studio. This was chosen to be May 2018 as this coincided with the completion of the design projects and provided adequate data for the completion of the pilot study.

Writing of the report is an important aspect of the naturalistic research process, and accurate representation of the research situation is essential to achieving trustworthiness (Lincoln & Guba, 1985). It is essential that the report *catches and portrays* to the reader what it is like to be embedded in the specific case study (Cohen et al., 2000). In line with the guidelines set out by Lincoln and Guba (1985) the report writing focussed on the presentation of facts linked to the collected data, anonymised participants and began by over-including data which was then edited (p.365-6). The report writing process occurred in a cycle with the data analysis, allowing categorisation of data, and informed recoding and restructuring of the data.

3.4 Results

Four overarching domains emerged from the research which impacted learning for sustainable design in the studio: course and curriculum, the design process, learner independence and teaching values. Within each of these domains, further sub-themes were identified. These are shown in table 3. The themes are then expanded.

Table 3: Representative quotations and key results

Domain	Themes
Course and curriculum	Assignment theming, disconnect between studio and lectures
The design process	Integrating sustainability into the design process, avoiding sustainable design, the studio environment
Learner independence	Freedom in the studio, student values
Teaching interactions	Tutor influence, student led design

3.4.1 Course and curriculum

Table 4 describes the key themes related to the course and curriculum with representative quotes.

Table 4: Representative quotations and key themes on course and curriculum

Theme	Representative quotes
Assignment theming	"We are creating a sustainable city. It's in the name so you're almost forced to do it." (Georgina, student) "the project we're doing is completely different because it's a masterplan and the project we're doing is a bit different because it's all about sustainability." (Fred, student)
Disconnect between studio and lectures	"There is a disconnect between what you learn in lectures and what you actually do in the studio. I don't think I used anything that I learnt in lectures to what I do in my design studios." (Simon, student). "It sorts of feels it's taught at [university] like that [adding technologies]. For example if you put a wind turbine on then it works. It doesn't feel like they teach it very well in the respect." (Laura, student)

Explicit sustainable theming of the assignment signified its importance. At an urban

scale, students used observations of unsustainability as design generators, proposing sustainable agendas which were then addressed through design proposals. For example, one group aimed to make their chosen city carbon neutral by 2030 which informed a range of design decisions and infrastructural choices including enhancing cycle networks, reimagining a car free city and exploring alternative means of food production. In the individual building project, students were also able to integrate sustainable concerns, from initial ideas to detailed designed. For example, one student described how a desire to create sustainable housing on flooded land had led him to develop prototypical floating structures, guiding his design process. He then drew from his own technical knowledge of building physics to inform the design of these structures.

Design studio teaching was supplemented by lectures on sustainable design. However, there was little evidence of the taught content from lectures manifesting itself in design projects. Lectures were considered valuable by students as providing "core" knowledge to adequately integrate sustainable design holistically into design projects. In the studio, however, sustainable strategies were specific to projects and individually researched. One student highlighted the abstraction of lectures and its seeming irrelevance to design studio work while another described the "disconnect" between learning in lectures and the studio.

Despite a strong sustainable research agenda in the department, little of this filtered into the design with most researchers having no connection to the course. Tutors were all part-time, non-academic staff who spent most of their time in practice.

3.4.2 The design process

Table 5 describes the key themes related to the design process with representative quotes.

Table 5: Representative quotations and key themes on the design process

Theme	Representative quotes
Integrating sustainability into the design process	"...for example, on the site, where we put the building on that site and that is one of the first considerations of the environmental strategy…then later on you can consider the environmental strategy again as to what sort of technology you can put in your building to make it more sustainable." (Simon, student) "In the design studio it's hard. For me sustainability comes out in the Excel spreadsheet really. You can sort of convince in the design studio but really it' s hard to quantify." (Phil, student)
Avoiding sustainable design	"I'm not sure whether it's realistic that you do consider the environmental aspect of every project." (Simon, student) "if you want to avoid [sustainable design] you can avoid it easily" (Anne, student)
Studio environment	"[Design studios] tend not to look like the sort of places where people are concerned with materials. The material is visibly wasted and treated quite badly and not valued and by extension time and resources are squandered in a way in which it doesn't treat those things as valuable." (Michael, tutor) "I guess having the materials and things like that are the ones that are readily available, can easily be cut or manipulated and, yeah, no-one really thinks too much about [sustainability] do they?" (Alison, tutor)

In the case study design studio, the design process was utilised as an educational learning experience. This placed emphasis on tools such as drawing and model making as instruments for reflective practice. Students were required to record their design development in "process documents". Their design process typically involved defining an issue, developing a design "concept" or idea, testing through modelling or sketching, and then accepting, modifying or rejecting these ideas. For example, one group in the masterplanning project identified the issue of disconnected communities, proposed a concept to "stitch" them together and developed a weaving path through sketches that provided a "platform for social interaction" (figure 3.4).
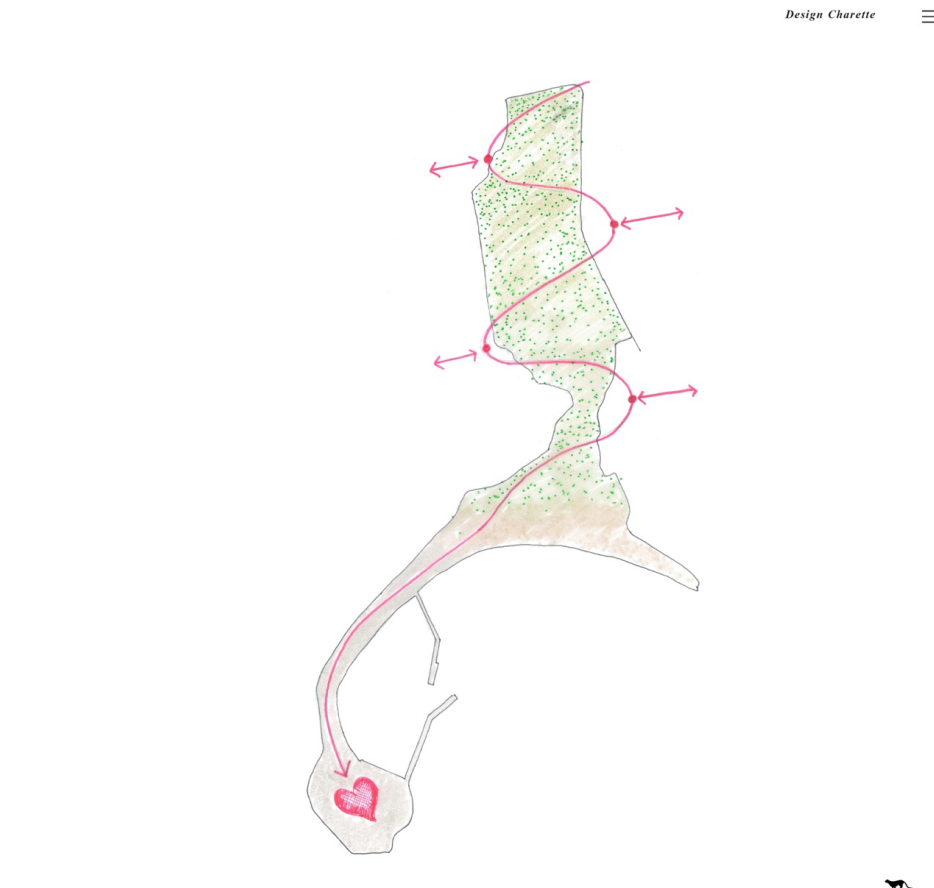
Figure 3.4 Concept sketch of a "weaving path"

At an individual project level, design generators were more abstracted. For example, one student used sketches to develop a route which carried the users of the building from light to dark (figure 3.5). Sustainable design was conceptualised as a problem-solving activity in order to address issues arisen during the design process. This tended to manifest itself in the application of specific strategies to solve isolated issues that arose during the design process. Often, this involved additive measures that could be overlaid onto completed designs. Learning was often restricted to technical knowledge about particular systems and did not act as a design generator as seen in the masterplanning project. Students spoke of sustainable design being "put on at the end [of a project]" (Laura), "applied" to the project (Chris) or in some cases in viewed as optional or impossible. Tutors described how they rarely saw sustainability as the underlying generator of design narratives.

Figure 3.5 Example student work developing a route from "light to dark" through sketches.

Quantitative performance analysis was rare, in part due to the limitations of the representational techniques employed in the studio. This was despite a desire by some students to engage in more quantitative techniques. Others felt the lack of genuine analysis could mask basic or ill-conceived approaches.

The influence of this design process had an impact on the studio environment (figure 3.6). There was value placed on design as an iterative process, involving trial and error. This involved the disposal of physical artefacts which were rarely recycled.

Figure 3.6 The design studio

3.4.3 Learner independence

Table 6 describes the key themes related to learner independence with representative quotes.

Table 6: Representative quotations and key themes on learner independence

Theme	Representative quotes
Freedom in the design studio	"This is seen as your opportunity to be free in design and be as creative as you can and if you perceive that as something that hinders creativity or is it another thing that gives you constraints that may help you design something better." (Jane, student) "I find students who really have impressive environmental strategies do that in a modest way that isn't necessarily celebrated through the projects and students who do crazy processes of their building type which is far more interesting." (Martha, student).
Student values	"[I have sustainable concerns] more outside of architecture…so things like in my household we're quite keen on measuring energy usage and involved in community projects, that kind of stuff." (Martha, student)" I know it's very important but when I come to designing something at [university] I don't think about it as much as should because it's not the thing I find the most interesting." (Laura, student)

A number of students demonstrated strong personal motivation for sustainable design. For example, three of the students had undertaken Passivhaus courses in their own time while another had been to a sustainability conference. The freedom of the design studio

enabled some students to propose overtly environmental agendas (such as a research centre for climate adaption) and develop knowledge beyond that of their tutors. For others, this freedom allowed them to all but avoid environmental concerns. There was a misalignment between values and action; students would describe how they were concerned about sustainability but this did not impact their studio work. This was noted by tutors who spoke of student's varying levels of engagement with sustainability in their design projects however noted a lack of a fundamental integration.

In many cases the complexity of a design project was seen as a barrier to examining sustainable design themes. One tutor described it a "complex Venn diagram" with sustainability occupying one small section. This open-ended complexity required students to construct their approach based on prior interests, values and assumptions yet not necessarily related to sustainable design. Students and tutors, both described a set of underlying "agendas" for design which were perceived as conflicting with, or undermining, sustainability. One student expressed this tension as the difference between something being "design led" and sustainable (Martha) while another described it as the balance between aesthetics and sustainability (Jane). This dichotomy was echoed by tutors; one spoke of the students who designed with an "architectural aesthetic and visual approach" in which sustainable concerns were secondary (Alan, tutor). Another described other more practical design concerns (such as the location of the front door or the sizes of the rooms) taking precedence (Michael, tutor). Some students perceived a lack of appreciation by both peers and staff for sustainable design.

An exception to this was observed in one student who developed his own sustainable agenda and then structured his individual project around dealing with this issue. This was founded on his own personal experiences of the project site, as well as his existing design knowledge and expertise (he was a Passivhaus designer). This enabled him to develop an architectural response at a building scale that was driven by overtly sustainable concerns.

3.4.4 Teaching interactions

Table 7 describes the key themes related to teaching interactions with representative quotes.

Table 7: Representative quotations and key themes on teaching interactions

Theme	Representative quotes
Tutor influence	"If a tutor has a sustainable agenda then I think that definitely influences the way you work." (Georgina, student)" "I had a very good tutor and he said you have this brief, the brief to design a sustainability centre. He said if there is a topic that you really want to tackle you can move away from the brief in order to address the problem if you can justify it." (David, student)
Student led design	"I've never been led by a student into discussing their design thinking, in what I would describe in the broadest definition of sustainable ideas." (Michael, tutor)"I can't actually think of many students who've actually used [sustainability] as a generating thing at the beginning of their project" (Richard, tutor) "I think it kind of comes from the students really if it's going to be something that's high on their agenda." (Arlene, tutor) "It's a balance; [it is not just] advising but it needs to be within what they're interested in. Not just like 'Well that's a load of rubbish, do it like this." (Alison, tutor)

Students described how Input from tutors had been highly influential on design projects. They spoke of how specific design ideas had originated from their tutor, or how a particular tutor had directed them to explore a particular theme. For example, one student described how his tutor had encouraged him to depart from the written brief to tackle an issue of local flooding (David). In some cases, however, students felt their tutor was not interested in sustainable design or "didn't real necessarily talk about it" (Yvonne).

Conversely, tutors described how their teaching was predominantly student led. One tutor spoke of their "psychoanalytical" open ended discussion technique which drove students to make their own decisions (Michael, tutor). Another described how student values governed their approach.

This was reflected in observations of crits (figures 3.7, 3.8 and 3.9) in which students chose what work to present which directed the nature of the conversation. For example, in one crit, one of fifteen discussion topics were focussed on sustainability, and in another, only three of twenty. By contrast, in one scheme where the students had developed a particular strong sustainable agenda, eight of the twelve discussion points centred around sustainability concerns. As well as the content of the crit, its format (45 minutes long analysing work pinned up on a wall) led to graphical and verbal presentations which favoured clarity and brevity. Students felt the need to produce "flashy" images (Martha), while others noted the inadequacy of the crit to showcase technical design.

Figure 3.7: A typical group crit

Figure 3.8: An interactive group crit

Figure 3.9: Typical crit presentation

Tutorials typically involved students describing their design ideas followed by idea proposals from tutors. The sustainable design tutor (Alan) often identified problems and offered "solutions", continuously drawing and working through the design. By contrast, architectural tutors relied almost entirely on verbal communication however were still observed to raise issues and describe potential solutions. They described their process as one of understanding the student's project and then suggesting ideas that were consistent with their working method. Tailoring approaches in this manner was consistent among all the tutors. One spoke of how she would bring resources specific to the student (Arlene) while another spoke how it took her time to understand the project in order to offer specific advice (Alison). This specificity was valued by students who described how more generalised learning lacked application to their studio projects.

In the individual project, some group tutorials were conducted, however students exhibited little engagement with the projects of their peers. Indeed, these group "workshops" were abandoned later in the semester in favour of one-to-one interactions due to both student pressure and tutor preference.

3.5 Discussion

Sustainability integration was most successful when it was made an explicit theme of the design studio through overt description in assignments, supporting the work of Cotgrave and Alkhaddar (2006). However, the scale of design projects also had a major impact on sustainable engagement. Design at the urban scale involved directly addressing an unsustainability challenges. Students were unencumbered by expectations of design and were largely freed from programmatic constraints. This caused them to develop personal agendas which sought to resolve perceived problems. By contrast, the individual building project was governed by underlying values of good design which drove output. This supports the "hidden agenda" described by Dutton (1987), in which students, staff and practitioners defined primary architectural concerns through the development of a tacit, internalised language. "Sustainable design" was often seen to be at odds with "design" and students spoke of the need to balance these two competing concerns. Exceptions to this dichotomy were observed when students formed their own understanding of sustainability and used this to form a personal design narrative which dealt with specific sustainable agendas. In these cases, students were able to redefine the design expectations and generate alternative realities by placing their own experiences at the centre of their learning in line with a critical pedagogic approach (Crysler, 1995).

The literature on sustainable design advocates interdisciplinary and collaborative working that draws from a range of different backgrounds (Howlett et al., 2016; Jones et al., 2010; Walker & Seymour, 2008). This was evident in the group masterplanning project which enabled peer reflection and discussion of sustainable themes. Despite the social environment of the studio, interaction between peers was far more limited. There was little evidence of informal creative interactions (Welsh & Murray, 2003) and students lacked engagements with the projects of their peers in tutorials.

In the case-study, tutorials tended to be discursive rather than the purely transmissive approach described by Schön (1985) corroborating the critique by Webster (2008). In the case-study studio, an interdependent relationship between students and tutors was observed. Tutors responded to student design ideas by proposing improvements which were then adopted by students. This reinforced the embedded values of the design studio and left limited space for holistic, interdisciplinary and critical approaches required for deep learning for sustainability (Buckingham-Hatfield & Evans, 1996). Yet the shadow of Schön, and the power asymmetry of the master and

apprentice was apparent in the tendency for tutors to propose solutions technical or architectural solutions. This was particularly true in specific sustainability tutorials in which specialist knowledge was transferred to students in order to solve specific problems. While enhancing technical knowledge, it undermined critical and holistic approaches to sustainable design by emphasising mastery over the shared knowledge creation advocated by Welsh and Murray (2003). Tutors spoke of how they tailored their approach to different student projects, to offer specific design advice, in some cases, rejecting wider learning that was deemed irrelevant to project work. Tutors were positioned as experts to help enable product creation, rather than facilitate learning. The case-study design studio was taught by practitioners of architecture who themselves were educated in the same system. This embedded an internalised validation system with its own autonomous values (Till, 1996).

In crits there was an emphasis on presentation to aid communicative clarity. For some students, this removed the need for procedural rigour. The visual tools of design, predominantly drawing and model making reflected in crit presentations, were inadequate for quantifying sustainable measures. The emphasis on "discovery" learning through these techniques, did not guarantee the acquisition of specific skills pertaining to sustainable design in accordance with Banerjee and Graaff (1996). This is consistent with the professional practice described by Schön (1985) in which the architect uses design tools, such as drawing and making, to engage in reflection-in-action. While these allowed a critique of design conjectures, they were limited in their capacity to encourage deliberate, reflection-on-action, a critical skill for deep learning for sustainability (Warburton, 2003).

Crits and tutorials were student-led and discussions surrounding sustainability relied on the nature of the work presented. Although placing students at the centre of the learning process sharing similarities with critical pedagogy (Darder & Baltodano, 2003) and experiential learning (Kolb, 1984). However, this provided no guarantee on the content of crits which often avoided sustainable design. This corroborates the work of Datta (2007) and Oliveira and Sexton (2016) who suggest self-directed learning can exclude sustainability concerns. This lack of engagement in sustainability was partly blamed on the perceived attitudes of critics and tutors, whom many students considered not to value it.

While the need for compliance at a national level (with the RIBA and ARB) ensured the curriculum addressed sustainability concerns, the possibility to extricate

these ILOs into satellite units, unrelated to the design studio avoided the need for integration. This supports the assertion by Warburton (2003) who suggests that merely adding content is inadequate for deep learning for sustainability. Dividing lectures and studio is common practice in architecture schools (Altomonte, 2009). This research supports the assertions of Gelernter (1988) who suggests this approach is ineffective due to the non-sequential nature of learning.

The design studio displayed many of the characteristics consistent with deep learning and critical pedagogy. Students demonstrated a high level of internal motivation for design and were able to reach logical conclusions drawing from their experience as described by Beattie et al. (1997). The formation of a design proposal demonstrated consistent logical inferences of sustainable knowledge.

Where the studio was less successful was in critically interacting with teaching materials, questioning assumptions and challenging accepted notions of sustainable design (Beattie et al., 1997). The pedagogy of the MArch studio served to develop reflection-in-action (Schön, 1985) and professional competence. However, this limited the ability to address sustainable issues, challenge assumptions and create a wide variety of innovative proposals. Nevertheless, the studio provided space for individual engagement with the four stages of Kolb's learning cycle through individual project led learning (Kolb, 1984), however concrete experiences and abstract conceptualisation was restricted to a narrow sphere of knowledge, rarely based on broader prior experiences.

The MArch studio provided the illusion of independence but student process and learning were both consciously bound (through the requirements of assignments) and subliminally influenced (through exposure to a limited range of experiences and perspectives) by the context of study (Ward, 1990). Clune (2014) suggests that deep learning mirrors the pedagogy of the studio through its student centred approach to learning. However, this research suggests that student independence is affected by the narrow scope and the professional focus of the studio, inconsistent with double loop learning processes. The design studio was seen to be a single loop learning environment (Argyris & Schön, 1974) in which basic assumptions were rarely challenged. This system is represented in figure 3.10 in which reflection-on-action, the meta cognitive process required for deep and critical learning for sustainability, is broken.
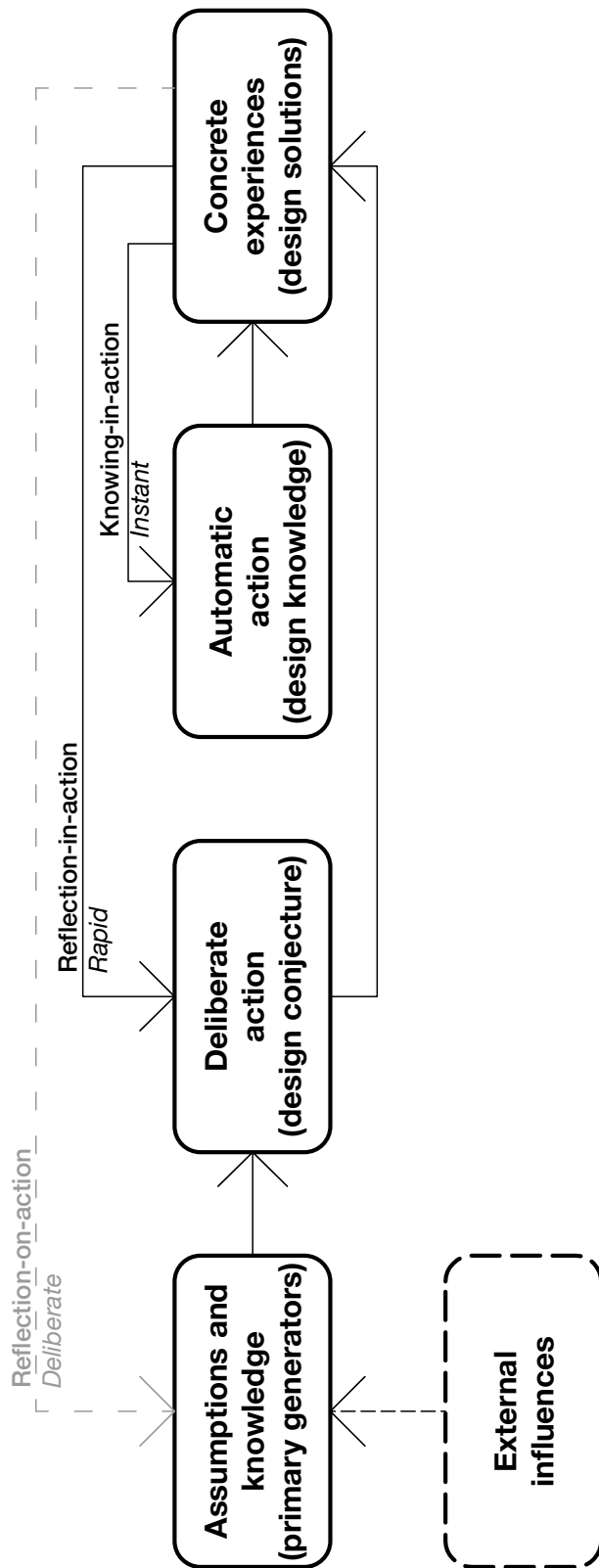
Figure 3.10 learning in the design studio without reflection-on-action (by author)

The department described itself as having a "signature pedagogy"; an advocacy of the *critical method* (see chapter 1). This describes a process of idea generation (conjecture) followed by analysis (error elimination). This was evident in student descriptions of their process which typically involved forming an idea and evaluating it through sketches and making. This is consistent with the professional practice described by Schön (1985) in which the architect uses "tools", such as drawing and making, to engage in *reflection-in-action*. While these tools allow a critique of design conjectures, they are limited in their capacity to encourage deliberate, *reflection-on-action*, a critical skill for deep learning for sustainability (Warburton, 2003). Even in explicit critical environments (the crit and tutorial) *reflection-on-action* is prevented by the assumed sphere of professional action of the architect.

Considered through the lens of the experiential learning cycle (Kolb & Goldman, 1973) the design studio favours the procedural over perceptive activities. Active experimentation and reflective observation are continually present in the design creation and error-elimination phases of the critical method, evident in the design studio through the constant drafting and sketching to both test and analyse ideas. By contrast, perceptive activities of abstract conceptualisation and concrete experience are relatively limited. Although students visited their case study cities and would often engage in their own research, this was often used as a point of departure for design. This was especially true in individual building projects in which alternative design generators were often abstract and removed from experience.

3.6 Conclusion and recommendations

3.6.1 Conclusions

In the case-study, the structure, agenda and pedagogy acted as the primary barriers to successful sustainable integration. The results show that in order for the design studio to successfully engage with the challenges of sustainable design, it is not enough to merely add content or demand compliance. Formal learning outcomes, defined either by professional bodies or the course leaders, did not materially influence the output of the design studio. The need for compliance meant it was often easier to "outsource" learning outcomes to satellite modules rather than attempt studio integration. Theming

design studios around sustainable design had some success at encouraging early integration and the creation of sustainable narratives however fall short of questioning assumptions. The perceived emphasis on design product, however, limited student's capacity to explore alternative forms of sustainable design processes with rigour and embracing risk and holistic sustainability.

The teaching events in which students interacted with tutors prevented the questioning of assumed sustainable design principles. Both tutorials and crits were predominantly student led which in some cases led to sustainable design being completely neglected. Where tutorials were themed as sustainable, they tended to focus on technical solutions to isolated problems, rather than challenging underlying issues or creating "upstream" solutions. Furthermore, in the case study, educators were all practising architects with a similar background and outlook which embedded assumptions and expectations in the studio. Ultimately, the specific pedagogy of the studio is drawn into question. Developing independent learners in an *apprentice-style* environment limits the holistic and critical thinking required for sustainable design and generates a sophisticated, yet insular, single loop learning environment.

3.6.2 Recommendations and further work

Deep learning may be facilitated through the creation of an environment which constantly questions underlying assumptions and values a plurality of design approaches. Parallel learning environments may have the potential to do this however they must be made relevant to the design studio to enhance integration in design projects. By stepping outside of the traditional limitations of the design these wider assumptions might be challenged which may in turn alter the epistemological basis of the studio.

Exposing students to a variety of external experiences may also raise critical awareness and engender intrinsic motivation for sustainable design. Drawing staff from a variety of fields with a diverse range of backgrounds may help to break the introverted cycle of design validation.

Finally, reflection-on-action was seen to be inhibited by the range of possible tools for analysis available to students. Warburton (2003) describes how using a critical learning tool such as concept mapping may encourage students to see relationships between ideas in a visual two dimensional format. This form of evaluation and analysis

may be used in the design studio to expand the range of critical tools available to students to enhance reflection-on-action.

Chapter 4. Phase 2: Coproducing a critical model of sustainable design

4.1 Introduction

The first phase of the research concluded that the current design studio limits deep learning for sustainability and genuine reflection-on-action. Despite engagement with issues of sustainability, there lacked variation and coherence in approaches. The nature of teaching interactions in the design studio were characterised by either student led informal conversations or formal supplementary lectures. Results from the initial ethnographic study suggested that while the design studio offered an environment conducive to the development of professional competencies, especially rapid and instantaneous decision making (*knowing-in-action* and *reflection-in-action*), there was little space provided for meta-reflective processes that question assumptions and challenge accepted ways of operating.

The second phase of the research draws from the recommendations of Warburton (2003) and seeks to develop an analytical tool for enhancing reflection-on-action. Through the establishment of a sustainable design action group (SDAG) strategies were generated for students of architecture to engage critically in architectural sustainability.

4.1.1 Aim of chapter 4

This chapter aims to develop an alternative educational approach, and associated learning environment, to encourage deep learning. This involved creating a voluntary action group through which a practical model for sustainable design was developed. This acted as vehicle for critical reflection beyond the current scope of the design studio.

4.2 Background

4.2.1 Beyond the design studio

The traditional architectural design studio offers a variety of spaces for both reflection-in-action (through undertaking design work) and reflection-on-action (the crit or design review). At the University of Bath, these activities formed the backbone of teaching

interactions. However, there was a failure to adequately critique its own practices and embrace ideas beyond accepted conventions of the profession (Banham, 1991; Till, 2003). The medium of the design project and the focus on its production often distracted from the examining underlying values (Bashier, 2014; McAllister, 2010; Till, 2003). The application of sustainable principles to the design studio through overlapping taught modules, may enhance its product however the capacity for critical analysis and the questioning of inherent assumptions is compromised.

Learning about sustainable design through parallel modules is common throughout architectural education in the UK. The report produced by Altomonte et al. (2010) describes how schools of architecture in the UK use a combination of taught modules and integrated design studio projects to examine sustainable design. Despite this, none explain the link between pedagogy and sustainable design integration. When described, parallel modules are almost exclusively taught in lectures and seminars, while the design studio is delivered through tutorials and reviews. Integration is achieved through overlapping assessments which use studio work as the basis for sustainable design. In some cases lectures and seminars are designed to "support" the studio however their relationship to specific design project work is unclear. From the descriptions provided by Altomonte et al. (2010), there appears a clear gap in the teaching of the design studio which uses a seminar or workshop format directly relating to the specific activities and projects of students.

4.2.2 Mapping for critical learning

Warburton (2003) recommends the use of conceptual mapping as a means of enhancing deep learning for sustainability. As Warburton notes:

> "Conceptual frameworks should be developed in a clear and graphic fashion. Through enquiry learning and problem-based learning, students can make connections between key concepts and visualise these relationships in two-dimensional space as strings, networks or mind-maps." (Warburton, 2003, p.49)

In the context of the design studio, such an approach may enhance deep learning for sustainability through providing alternative evaluative methods beyond the methods of drawing and making. In their White Paper, EDUCATE (2012) advocate frameworks which "promote an evolutionary path to learning" (p.9) rather than providing students

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with a body of knowledge.

A variety of formal tools have been developed to encourage critically reflective learning. These include critical incident analysis (Flanagan, 1954), reflective journals (Bolton, 2010), repertory grids (Kelly, 1955), reflective and reflexive conversations (Palmer & Dunford, 1996), storytelling (Gold & Holman, 2001), reflective metaphors (Marshak, 1993), concept mapping (Novak & Cañas, 2006), mind mapping (Biktimirov & Nilson, 2006) and argument mapping (Twardy, 2004). Of these concept mapping, mind mapping and argument mapping utilise a graphical form to organise information, reveal relationship and encourage understanding, in turn, promoting deep learning (Davies, 2011; Entwistle, 2013). Maps can contain large quantities of information expressed in the physical relation of ideas (Winn, 1991) and have been shown to improve critical thinking (Twardy, 2004). Furthermore, active map construction can enhance engagement in learners and deepen understanding (Twardy, 2004). The argument for using mapping methodologies extends into the cognitive sciences where studies have shown that visual representation can improve learning (Larkin & Simon, 1987). The categorisation of information and its graphical display facilitates organisation and comprehension as well as highlighting "discrimination" between clusters (Winn, 1991).

It is important to differentiate between different mapping methodologies. Davies (2011) outlines the difference between mind mapping, concept mapping and argument mapping. Mind mapping describes a free-form generation of networks of ideas and concepts, often embellished with colours and graphics, first formally described by Buzan (1974). Concept mapping is a more structured, hierarchical approach to mapping which uses a *tree* structure to show relationships between concepts (Davies, 2011). Argument mapping adopts a similar tree structure however is concerned with visually representing the logical structure of arguments, demonstrating the relationships between particular propositions (Davies, 2011).

Structured models are used widely in market research to position perceptions about products and services. One approach is known as perceptual mapping (or multi-dimensional scaling), which scale two or more independent factors (Hauser & Koppelman, 1979). This allows consumers to assess products to provide an understanding of the field. They maybe compositional or decompositional. Compositional methods rely on predefined sets of criteria to shape the analytical space while decompositional approaches are based on individual judgements (Steenkamp,

Van Trijp, & Berge, 1994). Compositional perceptual mapping has an advantage over more decompositional techniques as it allows a utility of use for the researcher, providing predictive validity and clear interpretation of dimensions (Hauser & Koppelman, 1979). However, these rely on the completeness and validity of the pre-defined dimensions (Steenkamp et al., 1994).

4.2.3 Model categorisation

Modelling sustainable development provides clarity to the complex conceptual debate as well as guiding strategy and design through structuring and organising knowledge (Choucri, 2007). According to Dusch, Crilly, and Moultrie (2010), models can be considered in two broad categories: nominative models (either principle or domain based) and evaluative models (which place conceptual ideas within a wider framework). Nominative models attempt to fully describe a concept or phenomenon through a comprehensive set of ideas or characteristics. An example may be the *three pillars* model of sustainable development (Brundtland et al., 1987) which describes the field through three conceptual categories. Evaluative models, however, map a conceptual field which allow a single idea to be contextualised. For example, O'Riordan (1989) describes the field of sustainable development through the spectrum of *eco-centrism* and *techno-centrism* which provide a spectrum of possible sustainable development paradigms.

Bell (1988) provides a taxonomy of models of decision making described as descriptive, normative and prescriptive. This categorisation is comparable with the classification of *normative* and *descriptive* models from decision theory (MacCrimmon, 1968). Normative models are based on ideal outcomes of behaviour; they prescribe what ought to happen based on the decision maker's values (Slovic, Fischhoff, & Lichtenstein, 1977). They share characteristics with nominative models in that they present principles to guide actors in making better decisions. Descriptive models however, represent actual observed behaviours. They are evaluative in the sense that they seek to describe values and beliefs and make sense of them within a broader context (Slovic et al., 1977).

This distinction is important as the difference between prescription and evaluation imply different learning processes. If nominative models guide decision making, their prescription undermines critical and analytical thought. While they may

provide a path to more robust choices, this is with the limited bounds that a normative construct implies. Evaluative and descriptive models offer an alternative to this prescription by encouraging reflection and analysis. Rather than guiding choices, they provide a framework for existing values which allow the decision maker to critique existing motivations. Not only is this important in encouraging deep and reflective learning but it also mirrors the plurality and contestability of sustainable design itself.

4.2.4 Nominative models of sustainable development

Principle based nominative models describe a particular concept through generalised ideas. Jabareen (2008) introduces a cycle of seven distinct concepts each of which are related to provide a framework for sustainable development. Equity, global agenda, eco-form, utopia, integrative management and natural stock capital surround an ethical paradox, which for the author, lies at the heart of sustainable development. Indeed the tension between *sustainability* and *development* allows the coexistence of diverse and often contradictory sustainable practices.
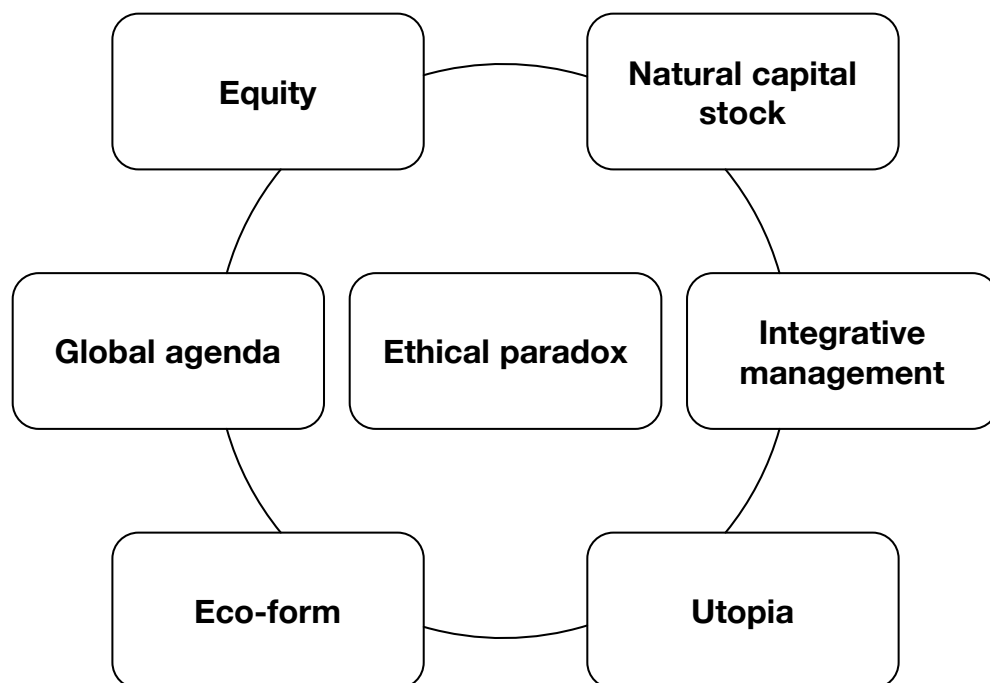
Figure 4.1: A conceptual model for sustainable development redrafted from Jabareen (2008)

Haughton (1999) defines five equity principles that might govern the formation of sustainable urban environments. These *equity concerns* are inter-generational, social, geographical, procedural and inter-species and each sustainable city type (externally

dependent, self-reliant, redesigning cities and fair shares) priorities these differently (table 4.1).

Table 4.1: Environmental justice and models of sustainable urban development redrafted from Haughton (1999)

Equity concern	City type			
	Externally dependent	**Self-reliant**	**Redesigning cities**	**Fair shares**
Intergenerational	+	+	+	+
Social	?	+	√	+
Geographical	?	?	=	+
Procedural	?	+	=	+
Inter-species	=	+	?	√

Positive (+), neutral/unclear (=), implicit (√), potentially perverse (?)

Domain based nominative models describe different areas of focus for sustainable action such as the well documented three pillars of sustainability (Brundtland et al., 1987). Connelly (2007) develops the three pillars concept and considers the contested nature of sustainability an inevitability. A model is developed that maps three competing factors that define the breadth of the field: economic growth, social justice and environmental protection (figure 4.2). He contends that any value or approach may prioritise one aspect over any other and contests the notion of an ideal solution. This maps closely to the UN's definition of three pillars of sustainability (the social, the environmental and the economic) (Brundtland et al., 1987).
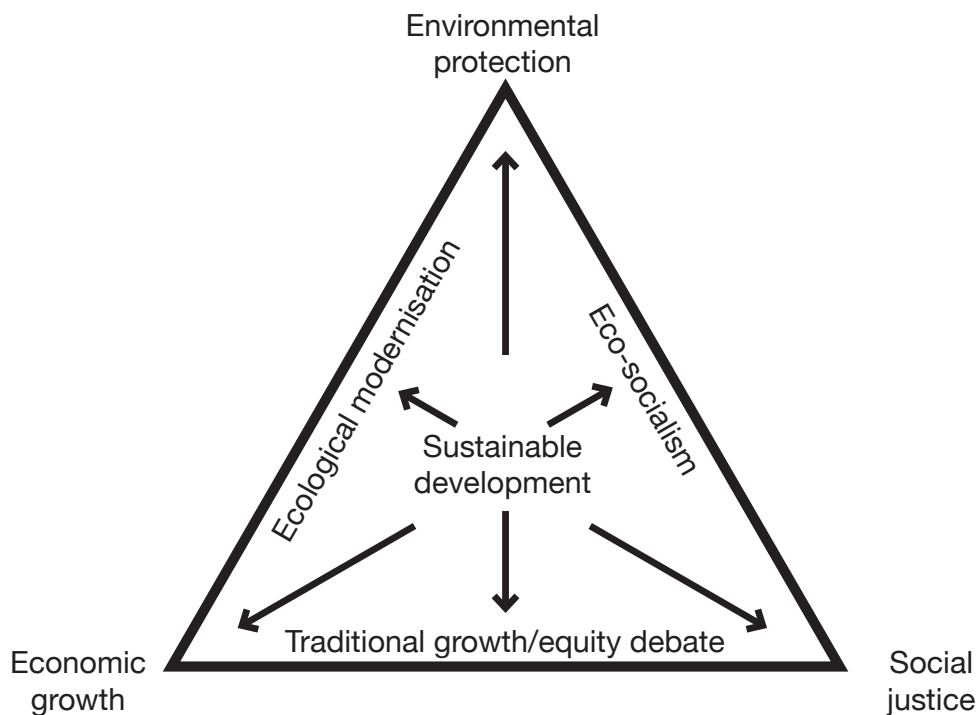
Figure 4.2: Mapping the three pillars of sustainable development from Connelly (2007)

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Choucri (2007) describes a more comprehensive domain based model which begins by defining a series of themes; the *core-concepts* of sustainable development (table 4.2).

Table 4.2: Domains of sustainable development from Choucri (2007)

Demographic domain	Population Dynamics
	Urbanization
	Migration and Dislocation
	Consumption patterns
	Unmet basic needs
Energy and natural resource domain	Energy use and source
	Forests and land uses
	Water uses and sources
	Agricultural and rural activities
Technology-centred domain	Trade and Finance
	Industry and Manufacturing
	Mobility and Transport
Domains of decisions and choice	Conflict and War
	Governance and Institutions

Through mapping these domains as a series of "slices" of an overall circular domain space is created. Concentric circles then represent the dimensions that constitute each domain: activities, problems, technical solutions, social solutions, international responses (figure 4.3). As domains intersect dimensions, a complex model of sustainable is created that provides a menu of possible practice to enable sustainable development.
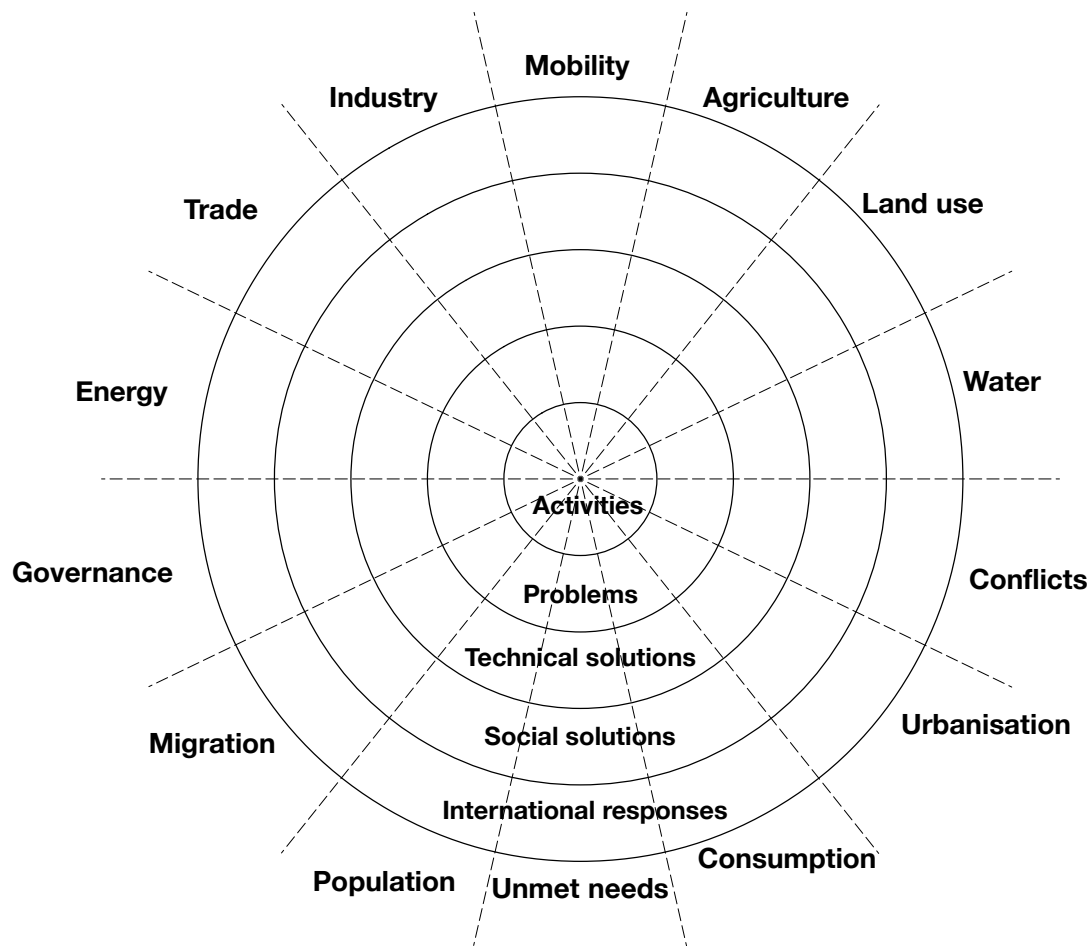
Figure 4.3: Domains and dimensions of sustainable development redrafted from Choucri (2007)

4.2.5 Evaluative models of sustainable development

Evaluative models organise conceptual ideas within an analytical framework. They do not provide a complete overview of all possible scenarios but "apply defined criteria to discuss a concept under certain conditions" (Dusch et al., 2010).

The evaluative model of O'Riordan (1989) frames sustainable development through the contrasting paradigms of *eco-centrism* and *techno-centrism* noting an alignment of these approaches with political viewpoints (table 4.3).

Table 4.3: European perspectives on enviornmental politics and resource management (redrafted and edited from O'Riordan (1989) p.85).

Eco-centrism		Techno-centrism	
Gaianism	Communalism	Accommodation	Intervention
Faith in the rights of nature and of the essential need for co-evolution of human and natural ethics	Faith in the co-operative capabilities of societies to establish self-reliant communities based on renewable resource use and appropriate technologies	Faith in the adaptability of institutions and approaches to assessment and evaluation to accommodate to enviornmental demands	Faith in the application of science, market forces and managerial ingenuity

Eco-centrism is based in a nurturing view of the environment, that is based on a faith in natural ethics and the self-reliance of communities based on "renewable and appropriate resources" (p.85). This captures *Gaianist* and *Communalist* paradigms which tend to be aligned with social and economic equity. By contrast*, techno-centrism* adopts a manipulative world view which often coincides with either "faith in the adaptability of institutions" (p.85) (accommodation) or the application of technology, innovation and market forces (intervention).

Hopwood, Mellor, and O'Brien (2005) remap this linearity, separating social and environmental concerns. Indeed, as the authors note, social justice and environmental sustainability are not necessarily directly related but rather linked through consistent moral codes. Through representing environmental concerns on one axis, and socio-economic concerns on another, they visually compare different dominant discourses of the sustainable development debate (figure 4.4). Overlaid is a hierarchy of three development scenarios: the status quo; reform; and transformation.
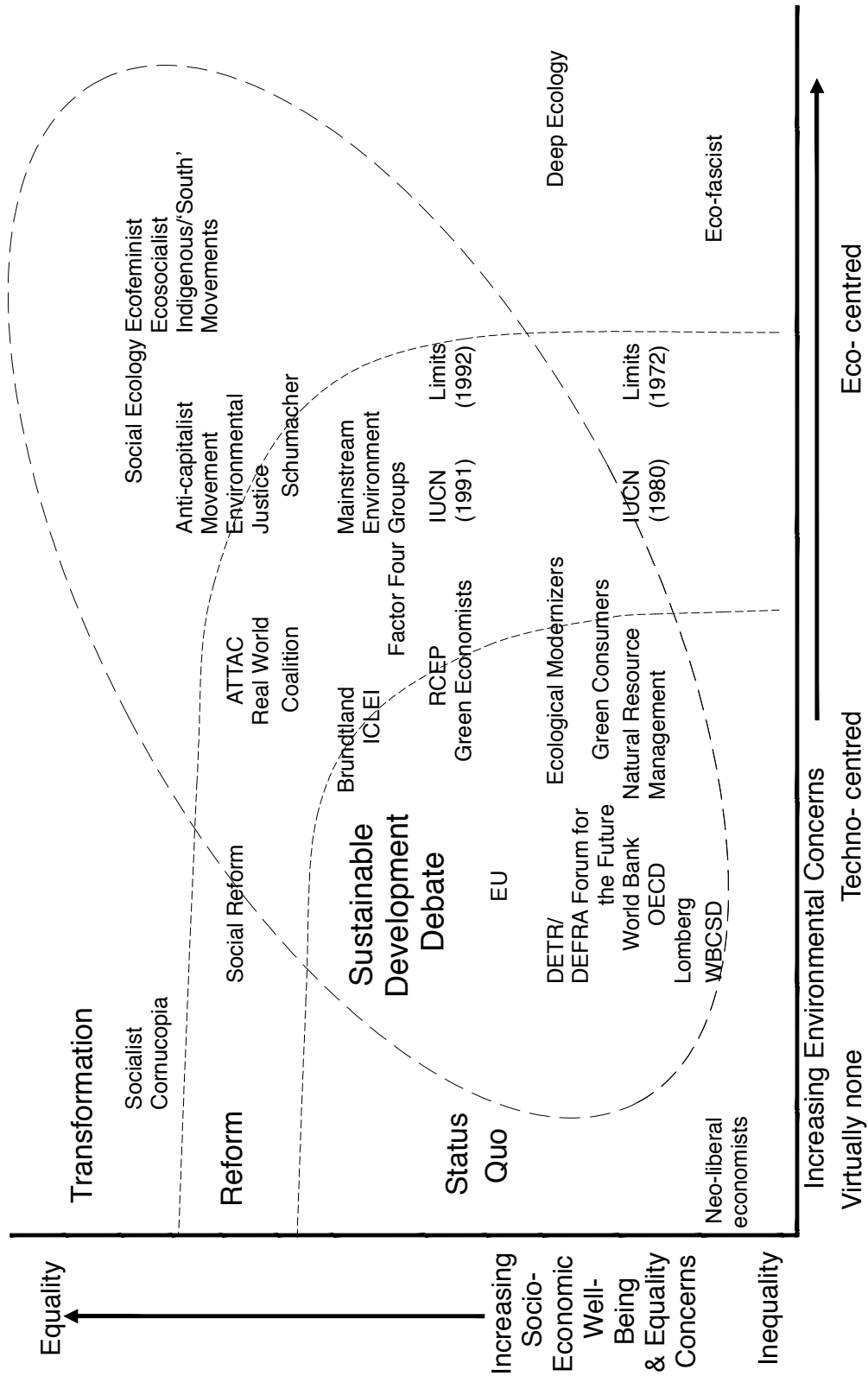
Figure 4.4: Mapping views on sustainable development (redrafted from Hopwood et al. (2005) p.41)

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Hopwood's model fails to avoid the dichotomy of eco-centrism and techno-centrism. Interventionist paradigms are considered synonymous with technical innovation, while eco-centric approaches describe a *deep ecological* attitude to the environment within which humanity's place in natural systems is emphasised.

4.2.6 Models of sustainable design

Within the field of sustainable design exist a range of normative models, both domain based (Fuad-Luke, 2009; McDonough & Braungart, 1998) and principle based (McLennan, 2004; Sev, 2009). While these models provided robust frameworks for decision making in design, their prescriptive nature undermines critical understanding. Alternatives to this standardisation reside in evaluative frameworks that take a contextualise conflicting design strategies to provide holistic understanding of the field and possible directions for future action.

Vezzoli and Manzini (2008) look at the creation of sustainable products and develop an evaluative model based on innovation models of product design (Dusch et al., 2010; Tischner & Verkuijl, 2006). Four levels of intervention represent increasingly *upstream* interventions from the redesign of existing systems to the re-imagination of entirely new life-styles.

(1) The environmental redesign of existing systems;
(2) Designing new products and services;
(3) Designing new production-consumption systems;
(4) Creating new scenarios for sustainable life-styles. (p.xi)

At the first level, the redesign of existing systems deals with a neutralisation of accepted patterns of behaviour; at the second, the processes that generate the need for action are redesigned; at the third, the underlying behaviours that create need for these processes are questioned; while at the fourth, entirely new life-styles are reimagined. At each level, the role of technology becomes diminished, contingent on social action.

Ceschin and Gaziulusoy (2016) develop Vezzoli's approach to present an evaluative model which compares the movement of from technical approaches to human centred ones with insular to systematic innovation. They suggest optimal sustainable design addresses a systemic and social approach comparable with Vezzoli's creation of new scenarios (figure 4.5).
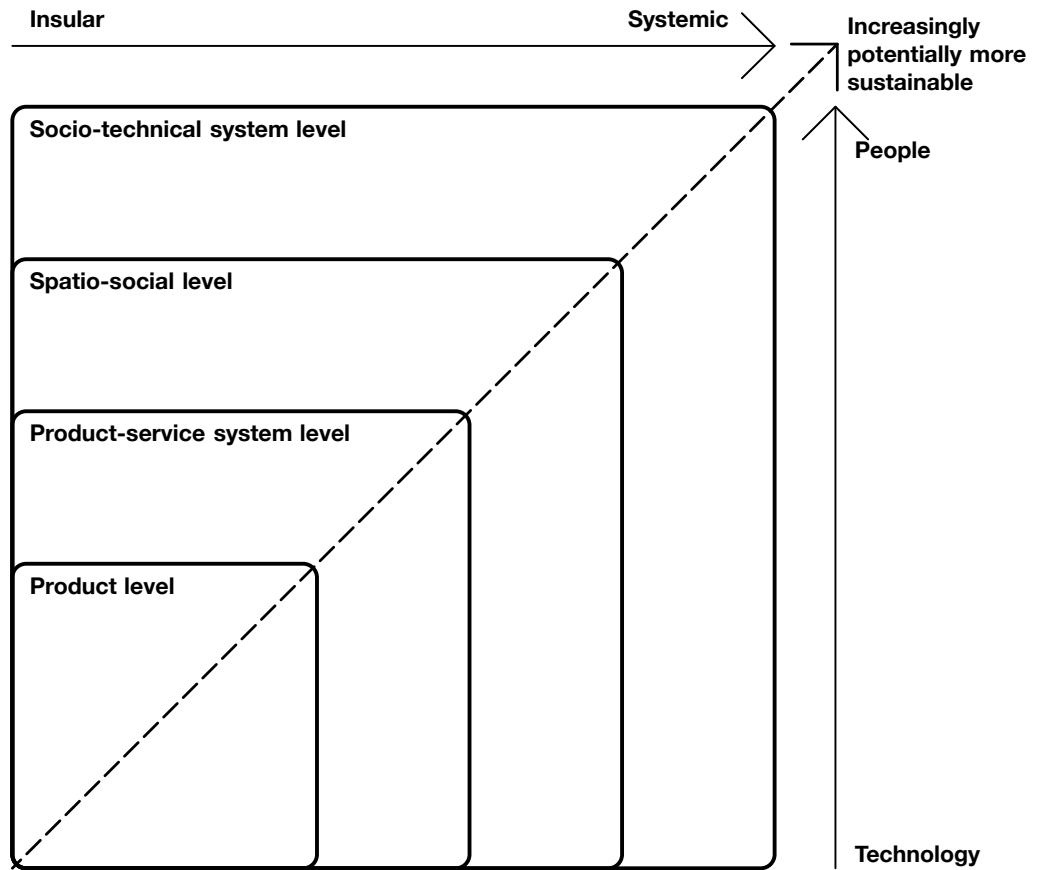
Figure 4.5: The DFS evolutionary framework (redrafted from Ceschin and Gaziulusoy (2016))

Abernathy and Clark (1985) represent this approach on a multidirectional, two by two grid which sets technological innovation against potential market linkages. This allows both the physical characteristics of a product as well as its human application (figure 4.6).
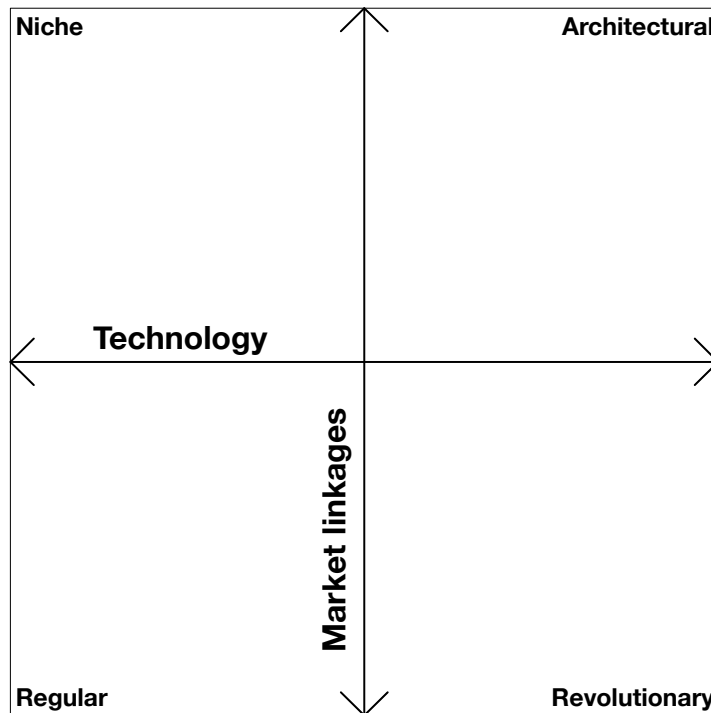
Figure 4.6: "Transilience map" redrafted from Abernathy and Clark (1985)

Using a similar approach, Dusch et al. (2010) generate a matrix, drawing from the hierarchy of Vezzoli, to create a model of sustainable innovation (figure 4.7). They combine models of sustainable development with those in the field of design to create a "compound" framework. The framework is structured through the competing eco-centric and techno-centric domains to develop a matrix of approaches which compare changes in consumption behaviour with technological innovation. Not only does this allow design activities to be classified and compared but also provides opportunities to reveal the sustainable potential of a particular activity. Unlike Abernathy's framework, the model suggests a desire for an optimal sustainability response. This is seen as one of "*creating new scenarios*" and assumes this is only possible through major behavioural shifts and implied technological innovation.
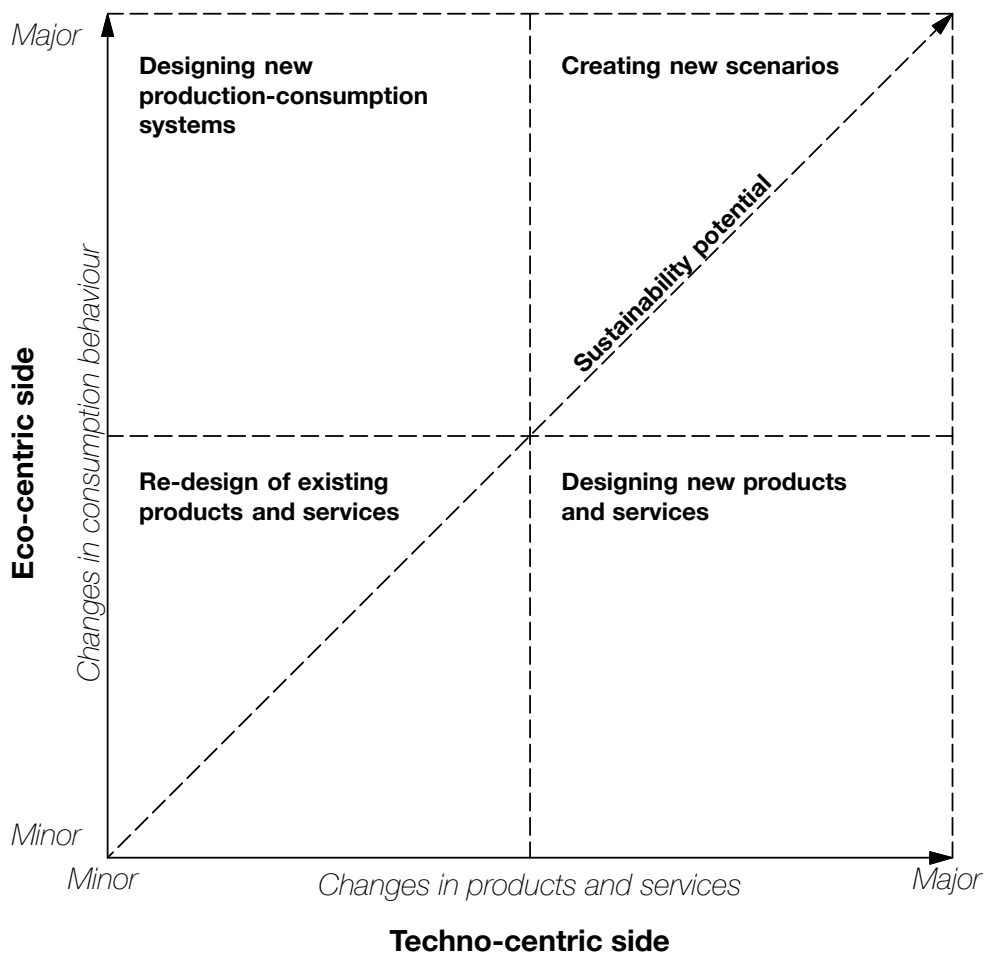
Figure 4.7: Sustainable design approaches in the context of sustainable development (redrafted from Dusch et al. (2010))

In the domain of architecture, Cook and Golton (1994) describe a green spectrum that categorises the "contestable" concept of sustainable design. At one end of this spectrum they describe *transpersonal ecology* which is aligned with anti-capitalist politics and rejects technological solutions. By contrast, *cornucopian environmentalists* believe environmental issues may be dealt with through innovation and interventionist strategies, underpinned by a faith that free-markets and continued growth can be inherently sustainable.

This model is founded on a distinction between competing paradigms of eco-centrism and anthropocentrism (Wilkinson, 2013). Eco-centrism sees equal value in humans and the natural environment while anthropocentrism sees humankind as the sole motivation for sustainable change. The authors suggest strong sustainability is associated with the former while weak sustainability is associated with the later. This

division, however is a blurred one. As Wilkinson (2013) points out, eco-centrists paradoxically see humans as taking on a form of environmental stewardship. Furthermore, the distinction between fair use and exploitation of the natural environment is unclear from either perspective.

4.3 Methodology

4.3.1 Context of the research

The participants in the second phase of the research were drawn from the 2016 intake of students described in phase 1. This allowed these students to be followed through their course from the first to the second year of Masters study. They were in their first year of study when phase 2 was conducted. The research was conducted between February and June 2017. 43 enrolled students were eligible to take part, all of whom had undertaken RIBA part 1 validated courses in the UK as well as spending at least one year in practice.

The design studio was structured around an individual project in which students were given a site however had considerable freedom to develop their own briefs, similar to the second year of study. Design studio tutoring and frequent 'crits' (design reviews) were supplemented by workshops, presentations and a stand-alone lecture course in sustainable design. Workshops within the design studio were designed by the course coordinator to encourage a wide range of experiences into different aspects of the design process. This curriculum in the first year of study was characterised by a shorter, more experimental project than the second year of study. The project took place over a 15-week semester.

4.3.2 Research approach

Phase 2 of the research adopted a participatory action research (PAR) framework. The participatory and social nature of action research make it highly applicable to an educational context, especially the design studio, and offers a means for effecting change at a local level (Cohen et al., 2000). PAR is distinct from more traditional forms of action research in that its participants are not considered passive subjects but active engagers in the research process (Whyte, 1991, p.20). Placing learners at the centre of the environment is essential for experiential learning (Kolb & Kolb, 2005) and provides

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opportunities for change from a bottom-up, learner perspective. The method draws from theories of knowledge co-production (Gibbons et al., 1994) to develop social and collaborative change.

4.3.3 Communities of Practice

This phase of the research drew from theories of Communities of Practice (Wenger, 2000), operating under a paradigm of knowledge co-production (Gibbons et al., 1994). Students were engaged to implement change aligning with the emancipatory paradigm of Zuber-Skerritt (1996a). A Community of Practice (CoP) is formed when a group of people with a common agenda engage in a collaborative learning effort, both for individual and group benefit (Wenger-Trayner & Wenger-Trayner, 2011). According to Wenger-Trayner and Wenger-Trayner (2011), a CoP is defined by three primary characteristics:

The domain

The domain defines the common interests of the group. To become a member of the community requires commitment to the domain, although does not require particular expertise in the domain. It is the purpose of the community that define the activities and practices that it undertakes.(Cambridge, Kaplan, & Suter, 2005).

The community

A CoP relies on development of a community. Members must come together, share ideas and exchange knowledge. This exchange maybe irregular, not situated at the site of work or in the digital realm, however relationships between members must be created to enable learning.

The practice

The members of a CoP must have a shared practice. Together, they develop the tools, the ways of working and methodologies to address the issues within their particular domain.

Arguably, the MArch design studio could be interpreted as a CoP. The community is

formed through interrelations that are developed by working in a shared environment (the design studio). Practice emerges through this interaction and knowledge shared through direct and indirect interaction with peers. Yet the domain of the design studio is loose and often ill-defined. Although assignments form a rough guideline, students are encouraged to develop their own project briefs and explore their own design agendas. This individualism and lack of common goals undermines the formation of a CoP. CoPs may provide a platform for deep and experiential learning by allowing learners to define their own learning, generate shared knowledge, engage in collaborative processes and providing an environment for critical dialogue (Cambridge et al., 2005).

4.3.4 Scale and appropriateness

The scale of the intervention at this stage was governed by practical and ethical concerns. It was important that the intervention was made in the context of the first phase of the research. Firstly it provided continuity which built on the specific understanding of the University of Bath MArch studio. Secondly, it directly related to my own practice which was embedded within this structure. Accordingly, it took place within the same department, and on the same MArch course. This is appropriate to the nature of an Action Research paradigm which concentrates on making impactful change directly relating to practice (McNiff, 2016). As a naturalistic study, this continuity was essential as the initial results, although possibly *transferable*, may not be assumed *generalisable* across multiple contexts (Lincoln & Guba, 1985).

The commitment of the participants limited the scale of the intervention. An action group of students was formed as an extra-curricular activity which had the potential to disrupt from formal learning. This raised an ethical question which was dealt with by limiting the quantity, and length of group meetings. This was restricted to five workshops, which met on a bi-weekly basis at a lunchtime. It was stressed that membership of the group was voluntary and participants were able to join or leave at any time.

4.3.5 Planning the sustainable design action group

A sustainable design action group (SDAG) was created and aimed to meet on a bi-weekly basis, for one hour in an informal workshop. The workshops were the primary means of formal interaction of members however it was anticipated informal

interactions would take place within the design studio.

Members of the SDAG were drawn from the MArch cohort on a voluntary basis with a flexible membership, whereby no-one was excluded from the community and were free to join at any point in its existence. This drew from the literature of creating CoPs (Wenger-Trayner & Wenger-Trayner, 2011). Students were made aware of the action group at their initial design studio meeting (week 1) and asked to volunteer. This voluntary sample is consistent with the development of similar learning communities (Wenger, 2000) and its actions are defined by what the members consider important. Its scope extended beyond benefits for its members and the rest of the design studio was considered its audience. Table 4.4 shows the participants and their attendance across the workshops.

Table 4.4: Participants and attendance across the workshops.

Student	Workshop1	Workshop2	Workshop 3	Workshop 4	Feedback interview
Anne	Y	Y	Y		
Sylvia	Y	Y	Y		
James	Y	Y	Y	Y	Y
Sam	Y	Y	Y		
Karl	Y	Y	Y	Y	Y
Eve	Y	Y	Y		
Harry	Y	Y	Y	Y	Y
Kathy	Y	Y	Y		
Michelle	Y	Y	Y		
Katherine	Y	Y	Y		
Rachel	Y	Y	Y	Y	Y
Jeffrey	Y	Y	Y		

The SDAG was introduced to students in the first month of their course (week 1) and had its first meeting the following week (week 2). The group had five meetings in total each lasting for an hour. The nature of the meetings was defined by the researcher taking the format of facilitated workshops, however, content was primarily student led. Collaborative and independent learning was supported by the open nature of the workshops. Facilitating the creation of both a practical model and teaching method, each workshop had a specific structured aim (table 4.4). Initial workshops introduced the students to the previous research and sustainable models in the literature. A specific model was then developed before being tested through participant led mapping exercise in the final workshop.

Table 4.5: Workshop schedule and intended outcomes

Week	Date	Workshop	Intended outcomes
1	15 Feb 2017	-	• Introduction of SDAG to students
2	27 Feb 2017	Workshop 1	• Introduction to previous research • Determine specialist skills and knowledge • Propose possible ideas for action
4	13 March 2017	Workshop 2	• Validate the findings of the first workshop • Discuss approaches to critically assessing sustainable design • Introduce the group to sustainable models in the literature • Introduce the group to different sustainable design paradigms
6	27 March 2017	Workshop 3	• Refine the sustainable design model by identifying strengths, weaknesses and opportunities for its use as a critical thinking tool in the design studio
13	15 May 2017	Workshop 4	• Develop the critical model through a participant led mapping exercise • Encourage student engagement • Examine possible critically reflective techniques for its application in the design studio

At each workshop the researcher was an '*observer-as-participant*' (Cohen et al., 2000).
In participatory action research, researchers and participants are jointly responsible for
the creation of knowledge (McIntyre et al., 2007). In this study, the researcher was
responsible for guiding each workshop and facilitated any actions taken. I also defined
the initial content and developed this content between sessions. The agency of the
researcher was necessary to avoid ethical considerations of overburdening the
participant who were already under considerable stresses from their compulsory studies.
The participants were responsible for defining the path of further actions and critically
evaluating previous actions.

4.3.5 Data collection

Each workshop was audio recorded and transcribed and photographic evidence of key
outcomes was taken. Ongoing field notes were also made and categorised *in-situ*
(Lincoln & Guba, 1985). These were supplemented by reflective notes which allowed
continuous post-analysis of observations. Standardised, open–ended interviews (Patton,
1980) were also conducted after the final workshop. These were audio recorded and
transcribed and were structured around five subheadings: reflections on the content
workshops; reflections on the pedagogy workshops; changes in personal motivation;
learning and relevance of the workshops; and possible modifications for the future.
Adopting a constructivist epistemology, knowledge was co-produced by participants

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(Gibbons et al., 1994) who became both the subjects and generators of the research. Students formed an independent learning group which was used as a medium to implement change through an emancipatory paradigm (Zuber-Skerritt, 1996a).

4.3.6 Data analysis

Data were analysed using the coding system described in chapter 2 (methodology). Analysis of each workshop took place immediately after completion, being coded and analysed in NVivo (a computer programme for qualitative data analysis). As new data were added following each workshop, this was assimilated into the data set which was then recoded. Writing up occurred throughout the process. This was written in as a narrative recording reflections and observations from each workshop and subsequent outcomes. The writing acted as a form of analysis which was cross-checked against the collected and coded data. An example of the coded data is provided in table 4.6.

Table 4.6: Example of coding from phase 2

Domain	Category	Code	Raw data
Use of the model	Mapping process	Plotting activity changes sustainable approach	When you were talking about plotting yourself on the grid and then plotting precedents, architects and technologies and then you look around and find something you're interested in and it starts pulling you over in certain ways and it's a driver to consider you're approach to sustainability. (feedback from workshop 2)
		Mapping precedents aiding design process	Plot precedents could be helpful but wouldn't want to type cast myself and it might not be about me as architect. Might be more successful just as a project by project base. The mapping of precedents would also be really helpful. And not just precedents picked for their sustainable merits but a wider spectrum of ideas. (feedback from workshop 3)
		Practice at centre of map	So there is a gradient of how different technologies may sit on this matrix. It's good to think of it as a matrix or a scale. Everyone operates in centre (group agree). (Researcher in workshop 2)

4.4 Results

4.4.1 Workshop 1: introduction and ideas for action, week 2

Workshop 1 involved an was an introductory session to introduce the group to each other, to determine specialist skills and knowledge and to propose possible ideas for action. The researcher outlined research and its motivation. The group's objectives and aims were also presented and discussed. The first workshop was attended by 12 volunteers and the researcher. It involved active engagement from participants who all

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engaged in discursive activities facilitated by me. The structure of the first workshop is outlined in table 4.7.

Table 4.7: Structure of workshop 1

Topic	Time	Notes
1. Introduction to the research	10 mins	The background to the project was presented by the researcher and the motivation for conducting the research was explained.
2. Introduction and experiences of members	15 mins	Members introduced themselves and discussed their experiences, interest in sustainability and particular expertise.
3. Introduction to the sustainable mapping models	10 mins	The researcher introduced the participants to the literature surrounding sustainable models.
4. Brainstorming possible issues and initial ideas for action	10 mins	Participants generated possible ideas for action and change to improve sustainable teaching in the design studio. They wrote these on post-it notes which were then displayed and organized by the group.
5. Mapping and discussion of possible actions	10 mins	The group discussed the possible actions generated in terms of what aspect of the experiential learning cycle they would enable, their likely impact and practical consequences.

The group spent time brainstorming conceptual ideas for change in the studio and compared them against the literature of experiential learning. This exercise allowed concepts to be clearly structured and students to see their ideas for change in context. There was a clear desire for exposure to radical and alternative ways of thinking beyond the accepted and conventional content of their sustainable education to date. The group highlighted the need for knowledgeable experts and consultants to be involved in studio teaching. There was a perceived lack of personal skills and access to tools for analysis and assessment of sustainability in the design process.

Participants described how examples of sustainable architecture used by educators lacked wider architectural merit beyond their environmental credentials and implicit sustainable construction was often neglected in favour of overtly 'green' buildings. There was a desire to be exposed to precedents that integrated sustainability within schemes of high architectural merit. As one student put it:

> "I can think of quite a few [examples of sustainable buildings] but they're all ugly!" (Eve, participant in workshop 1)

The group stated the need for a forum for debate and analysis of larger scale environmental issues. Suggestions included a sustainably focussed crit or *conference style* teaching environments that might provide reflective spaces beyond the design

studio. Some participants felt that the traditional architectural crit did not provide space for wider conceptual thinking on sustainability:

> "In the crit situation it's very difficult to have a back and forth interrogation with the critics. Someone might just say that doesn't work…or there will be a design tutor who will almost take your word for it". (Sam, participant in workshop 1)

4.4.2 Workshop 2: developing a critical model, week 4

The intended outcomes of the second workshop were to validate the findings of the first workshop, develop a means of critically assessing approaches to sustainable design, introduce the group to sustainable models in the literature as a possible means to do this and introduce the group to different sustainable design paradigms.

A sustainable development model (figure 4.8) was presented, based on the axes defined by Dusch et al. (2010) with the sustainable typologies and their characteristics drawn from Guy and Farmer (2001) mapped to it. The researcher plotted these paradigms and presented them as to stimulate discussion surrounding each type. The researcher also presented a number of 'typical' projects that characterise each paradigm, drawn from the exemplars provided by Guy and Farmer (2001). The intention was to allow any architectural example to be considered for its sustainable credentials.
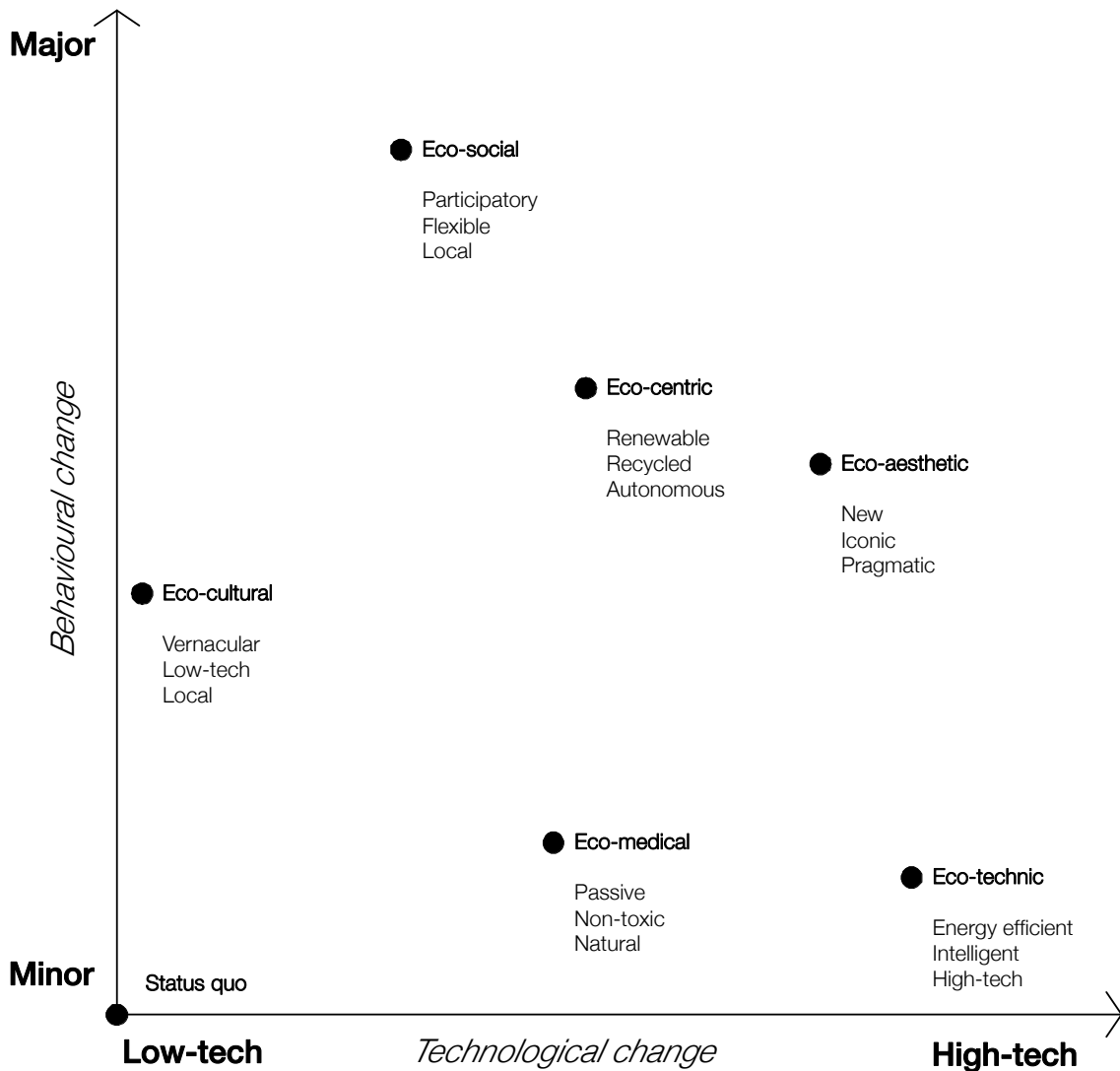
Figure 4.8: A model of sustainable design as discussed in Workshop 2.

The second workshop was attended by 14 participants and the researcher. It involved active engagement by participants but operated as a reflective focus group whereby students critically assessed sustainable paradigms in the literature. The second workshop took the format outlined in table 4.8.

Table 4.8: Structure of workshop 2

Topic	Time	Notes
1. Reflections from previous workshop	10 mins	Reflections and conclusions from the previous week were validated by the group.
2. Introduction to mapping sustainable paradigms	15 mins	The researcher introduced a critical model to map sustainable paradigms derived from the literature. This was based on the need for meta-analysis which emerged from the first workshop.
3. Examples of sustainable paradigms presented	10 mins	The researcher presented concrete examples of sustainable paradigms through case studies identified in the literature.
4. Discussion based on incorporation of ideas into the studio	10 mins	The researcher facilitated an open discussion based on the critical model and examples presented.
5. Possible actions and next steps	10 mins	Based on discussion

The group pointed out that the axis to the model suggested a hierarchy which may be detrimental to the understanding of sustainable approaches. It emerged that a hierarchical approach may undermine sustainability as a contested concept. The group expressed a desire to make sustainable concepts relevant to personal design projects. This highlighted the fact that the studio is structured around independent project development, thus relevancy to specific scenarios is particularly important when attempting to encourage uptake of concepts.

The group spoke about their limited exposure to alternative or contradictory approaches to sustainability in their education. An applied technical approach was considered the dominant paradigm in the design studio aligning with the eco-technical typology on the model. As one participant put it:

> "At undergrad only eco-technic was really ever explored and talked about. We were not taught about the others and it's only really through working in practice or doing my own thing that I realised there are other approaches [to sustainability] than just bling." (Rachel, participant in workshop 2)

Participants stated that a critical model that balances different sustainable concepts could provide confidence when developing alternative ideas in individual work:

> "It [the model] gives confidence in a particular strategy without having to feel like you need to cover other aspects unnecessarily." (James, participant in workshop 2)

However, participants expressed concerns that they might "type cast" themselves and as

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such a model would have to be specific to projects, not individuals.

4.4.3 Workshop 3: refining the critical model, week 6

Responding to the outcomes and reflections of the second workshop, the mapping tool was populated with predefined precedents which represented contestable sustainable concepts. It utilised a non-hierarchical axis understanding that there may are multiple conflicting views of sustainability. Each example represented an idealised archetype. The model provided an initial conceptual synthesis between the unstructured typological approach of Guy and Farmer (2001) and the uncategorised continuum of Hopwood et al. (2005).

The intended outcomes of the third workshop were to refine the sustainable design model by identifying strengths, weaknesses and opportunities for its use as a critical thinking tool in the design studio.

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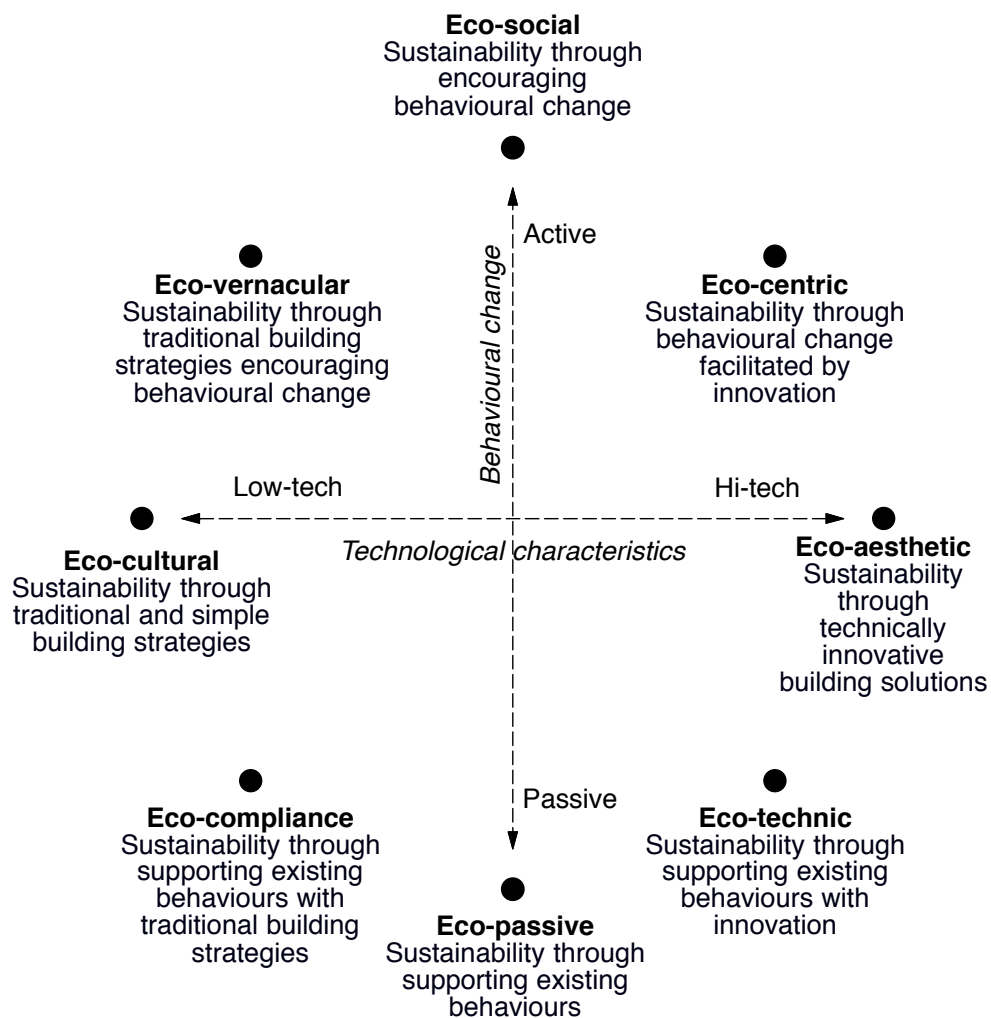
Figure 4.9: Sustainable typological model with exemplar typologies modified from Guy and Farmer (2001).

The model was structured by the tension between technological innovation and behavioural change as approaches to sustainability. It was intentionally non-hierarchical and provided a 'compass' as opposed to a directional graph. Categories were derived from the eco-logics of Guy and Farmer (2001) and adapted and plotted to represent ideal paradigms. This offered a restructuring of the eco-logics discussed in the second workshop. By mapping strategies, learners could relate them to particular "ideal" approaches. Each paradigm was supported by a specific precedent presented by the researcher. These precedents were drawn from the work of Guy and Farmer (2001).

The third workshop was attended by 12 participants. It began by validating the previous workshop's findings and confirming them with the group. The typological model was presented with exemplar projects used to support the typologies. A semi-structured group discussion then followed, facilitated by the researcher, offering feedback on the model. The group were firstly asked if they could identify the assumptions embedded in each particular paradigm. Secondly the structure of the model and possible means of implementation in the design studio were discussed. Finally, possible actions and next steps were considered. Table 4.9 describes the structure of the workshop.

Table 4.9: Structure of workshop 3

Topic	Time	Notes
1. Reflections from previous workshop and on model implementation	10 mins	Reflections and conclusions from the previous week were validated by the group. The testing of the initial model was discussed.
2. Further development of model	15 mins	The facilitator introduced a developed model and provided further examples to support the identified typologies.
3. Identifying assumptions of model	10 mins	The group were asked to identify assumptions associated with each typology in an open model.
4. Application of precedents to model	10 mins	The researcher facilitated an open discussion based on the presentation and means to incorporate it into the design studio.
5. Possible actions and next steps	10 mins	Possible actions were discussed based on the outcomes of the workshop.

The group discussed various competing notions of sustainable design accepting that there may be multiple solutions to problems. A number of members expressed critical attitudes to specific strategies (including vertical farming and nuclear power stations). Some of the group did not consider sustainability as value driven. One participant

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considered sustainability as contextual and not linked to any particular set of political values:

> "I don't think it depends on what we think – we may think it's all of those but it's got to be relevant to the project." (Michelle, participant in workshop 3)

There was a clear issue relating broader precedents to sustainable strategies. The group felt the model could only be successfully applied to 'eco' exemplars and other precedents fell outside of this approach. As one participant put it:

> "I thought about my precedent but generally it's not a good environmental building at all so where would you put it? This model is just about environmental types." (Chris, participant in workshop 3)

Engagement in the workshop was noticeably lower than the previous workshops. The model used, developed by the researcher, required detailed explanation and justification which dominated the workshop. Participants were unable to articulate assumptions made by each of the positions on the model however demonstrated the ability to critically assess real world case studies including ones drawn from personal experience:

> "We designed a pool for a rich person using so much stone that it has to be quarried over 2 years. They claim to be sustainable!" (Eve, participant in workshop 3)

4.4.4 Workshop 4: interaction and engagement, week 13

The purpose of the fourth workshop was to develop the critical model through a participant led mapping exercise with the aim of encouraging student engagement. The intended outcomes were not only to test the model but also to examine possible critically reflective techniques for its application in the design studio.

In this workshop, an adapted version of concept mapping was selected. Concept mapping is a technique that allows relationships between ideas to be displayed via a hierarchical tree structure (Davies, 2011). The advantage of this method over other critical reflective techniques was that it allowed the generation of a wide variety of possible concepts which could then be plotted to the critical model and clustered as well as offering a structured approach. The technique allowed dynamic restructuring of

information, appropriate for mapping concepts to the grid. It drew from the literature on compositional perceptual mapping (Steenkamp et al., 1994) in which pre-defined dimensions provide clear interpretation of ideas adding structure to the conceptual field.

Davies (2011) and Trochim (1989) provide a stage based processes of concept mapping. Drawing from this literature, the workshop was structured around this process (table 4.10).

Table 4.10: Structure of workshop 4

Topic	Time	Notes
1. Reflections from previous workshops and the teaching in sustainability to date.	15 minutes	The group reflected on their current teaching of sustainability over the previous three months and provided insight into how they were utilising the content of the workshops in the design studio.
2. Brainstorming exercise	10 mins	The question of how architecture can be sustainable was posed and a post it-note brainstorming exercise of statements was undertaken.
3. Idea mapping	20 mins	Each statement was mapped to the model depending on how 'high-tech' it was or how 'social' it was. This was facilitated by the instructor. Miscellaneous statements were pooled to one side.
4. Reflections from the exercise	10 mins	The group reflected on the workshop and were asked whether this approach could be applied to projects, how useful the approach was and how it may be made more valuable.

The participants began by discussing their reflections from the first year of their part two course regarding sustainability. An emergent theme was the lack of integration between the design studio and taught sustainable parts of the course leading to conceptual confusion. This disjointed approach led to a misuse of terminology and lack of conceptual clarity. Of particular confusion was the relationship between the environmental control of buildings and environmental sustainability, the two often being considered interchangeably:

> "The confusing thing for me was my project was more about sustainability but then there was the environment thing which I hadn't really thought about a specific strategy." (James, participant in workshop 4)

Participants were all able to contribute to the exercise and were able to both map conceptual ideas to the model as well as critically position their own design projects (figure 4.10). The ambiguity of defining what constitutes high-tech, low-tech, active engagement or passive engagement provided stimulus for the group to critique their

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strategies.

> James: I could definitely place my project. It's low tech and highly [socially]
> active.
> Rachel: I would say yours is high tech and socially active. It's underground!
> James: I suppose in terms of its construction. So in use its one side and operation
> it's the other side…more long-term its low-tech.

Through simply attempting to position their project on the model, James was able to
enter into a dialogue with Rachel and question his own work revealing the potential
impact of previously unconsidered aspects of his scheme (the fact it was underground).

The group highlighted a trend in the model that conceptual ideas tended either to
occupy the low-tech, active quadrant or the high-tech passive quadrant. Moreover, they
questioned how cost might affect the mapping exercise, considering it to be the driving
force behind sustainability in commercial situations and asked whether it might be
incorporated into a redesign of the model.

> "I think it would be replotted against cost. Not necessarily different positions but
> they might take priority for example blinds over more expensive shading
> techniques." James

The group identified categories of comparable ideas and gave them name (tick-box
environmental add-ons, easily criticised holistic, large scale, small scale, true
sustainability) which allowed them to identify assumption embedded within each
strategy as well as critique their value (see figures 4.10 and 4.11).
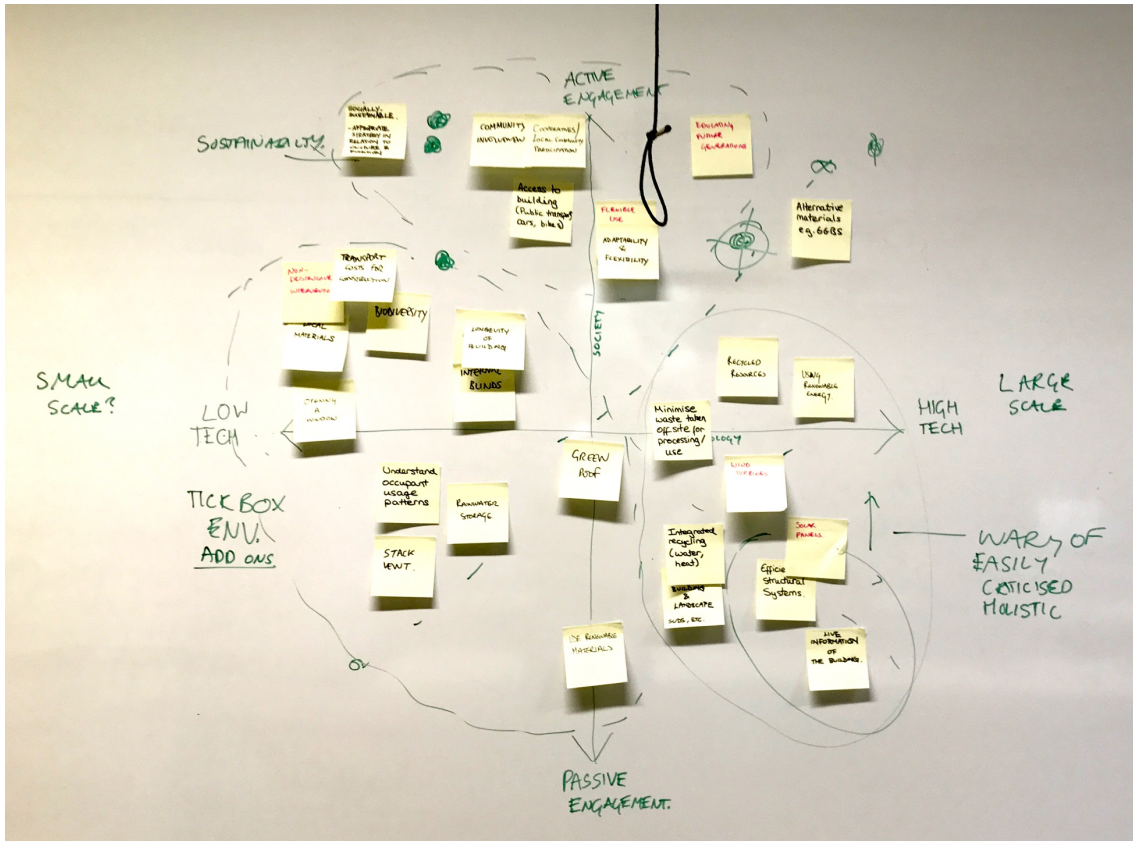
Figure 4.10 Workshop 4 mapping exercise.
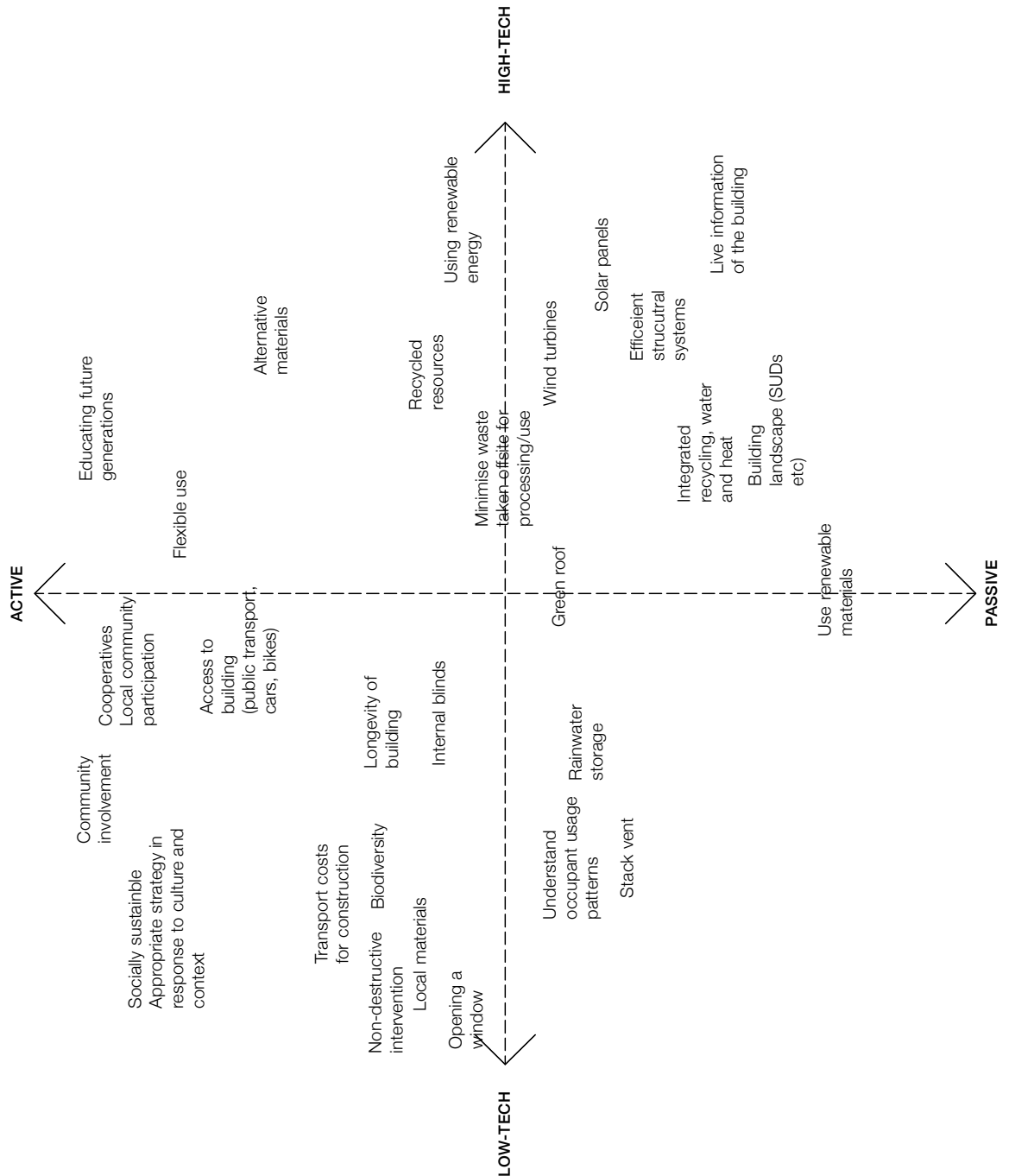
Figure 4.11 Workshop 4 mapping exercise redrafted.

4.4.5 End interviews and feedback

Feedback was gathered through individual and group interviews with members of the group that had completed all the workshops. Interviews were conducted 4 months after the end of the workshops to understand how the students might apply the model in their design work.

The final workshop, where participants actively engaged with the matrix was deemed most successful. As participant A suggested, it was helpful to see that's "how you use it". Some participants said they were internally relating back to the model to categorise and structure their own thinking (Harry). It was considered helpful to clarify internal narratives and approaches to sustainability, combatting, as one participant put it *"the cloud of different ideas"* (James) that constitute sustainable design. The participants preferred using the matrix as a structure as it allowed ideas to *overlap* while predefined typologies presented in earlier workshops were considered limiting. Participants also found it helpful to reveal where knowledge was lacking through contextualising their ideas in this manner.

While set typological categories were rejected, some participants suggested the addition of tangible case studies, plotted on the matrix, might be helpful. Through comparison they could relate their projects to a wider architectural context as well as providing a model for knowledge extraction from exemplar schemes. Many suggested a workshop approach, similar to that undertaken in workshop 4 might be beneficial instead of traditional, student led tutorials.

4.5 Discussion

There was a clear link between the use of the model and the format and structure of the workshops. Workshops which encouraged active participation and knowledge co-creation engendered a greater sense of ownership of the model and participants were able to demonstrate critical analysis of ideas. The reliance on the active participation of members of the SDAG became problematic in the later stages of the project where deadlines and external pressures limited enthusiasm and participation.

The final workshop was deemed most successful by participants and confirmed the potential of the model as a tool for positioning and critiquing conceptual approaches to sustainability. Reflecting on the outcome of the fourth workshop suggests that the model was effective even without formal definition of the axes or associated typologies. Drawing from concept mapping methodologies (Novak & Cañas, 2006) created a valuable reflective tool for critically comparing sustainable strategies.

The design of the model was initially based on diagrammatic representations of sustainable innovation, notably that defined by Dusch et al. (2010) however it was developed by continuous feedback over the course of the SDAG. This development led

to a re-construction of the model as multi-directional; a compass in which all approaches may be considered equally valid. This was particularly beneficial when adopting a pluralist understanding of sustainability.

Mapping the *eco-logics* of Guy and Farmer (2001) made the model specific to architecture however without significant explanation it remained too abstract to be of use. Providing precedent examples allowed a way into the model for the learners however of most value was actively creating and engaging with the model. This process of co-creation encouraged participants to analyse strategies and reveal underlying assumptions and meaning, prompting critical conversation aligning with the aims of deep learning (Marton & Säaljö, 1976b).

There was an ambiguity of application of the model. It was used to understand precedents (workshops 2 and 3), to compare political paradigms (workshop 3) and to map specific strategies (workshop 4). This reveals the strength of the model as a tool for promoting critical and reflective conversation rather than a quantitative comparative method.

The findings highlight the importance of creating space beyond the design studio in which students can reflect upon their own practice. Through extending the bounds of architectural education, as well as enabling environments in which professional and academic practice can be challenged, innovative thinking and deep learning can flourish. The success of a formal workshop style workshop questions the hegemony of the traditional desktop crit or tutorial which are unstructured and student led (Goldschmidt et al., 2010). The alternative presented here allowed students to generate new and diverse knowledge, beyond the scope of the traditional tutorials, which could both enhance studio work and foster deep learning. The action group provided a space for *reflection-on-action* (Schön, 1984b) encouraging deep learning.

In end interviews participants stated a workshop-like environment would be beneficial in addition to the traditional studio in which sustainable issues could be discussed and challenged. This supports the provision of alternative complimentary environments to the design studio, such as the *second studio* concept (Allen, 1997), which serve to encourage a more complete experiential learning cycle (Kolb & Goldman, 1973).

4.6 Conclusion and recommendations

4.6.1 Conclusion

An original reflective mapping tool designed as a means to structure conceptual sustainable design emerged from the need for deep learning and meta-reflective practices in the design studio. Its evolution began by synthesising existing conceptual models notably those by Dusch et al. (2010) and Guy and Farmer (2001), however developed based on continuous learner feedback. As the workshops proceeded, the importance of knowledge co-creation as a means for emancipatory action became clear (Gibbons et al., 1994; Zuber-Skerritt, 1996a). Top down definition of sustainable typologies required detailed explanation and didactic methods. Using a simple structural device through which participants could map their own knowledge, combined with researcher facilitation, provided greater engagement and understanding as well as student satisfaction. The combination of the model and its means of implementation were critical to success.

When dealing with sustainable issues, a critical approach is necessary to deal with conflicting paradigms (Gürel, 2010). The proposed model for sustainable design allowed a conceptual structure to encourage critical engagement while still encouraging freedom to explore multiple ideas. The research describes a complimentary learning environment to traditional teaching in the design studio which is often based on tutor intuition (Webster, 2004). It draws into question the effectiveness of the design studio, and the addition of satellite sustainability modules, as the favoured method to prepare students for contemporary global challenges (Altomonte, 2009). It creates an intermediary environment that contributes directly to, yet operates outside the norms of the design studio.

Beyond architectural education, the model provides a tool for contextualising sustainable approaches in all disciplines which adopt a design studio pedagogy. Through mapping designs strategies by comparing their technological characteristics with their social implementation, critical discussions can be facilitated which ultimately encourage deep and reflective learning.

In the wider context of UK architectural education, similar approaches to learning for sustainable design offers opportunities to go beyond the requirements of professional accreditation (provided by the Royal Institute of British Architects). At

both undergraduate and post-graduate level, requirements emphasise "knowledge" and "understanding" (Royal Institute of British Architects, 2010). From this criterion, the common curriculum of semi-integrated satellite modules has developed which may limit deep learning. Updating this wording to suggest a critical approach may encourage the creation of alternative learning environments beyond the traditional studio.

4.6.2 Recommendations and further work

Phase 2 of the research highlighted the need to address the division between sustainability in theory and in practice. The abstracted context of the sessions, removed from the pressure of the design studio, allowed the creation of a reflective critical environment yet its impact on individual design processes is less clear. Further iterations of the study may examine whether the workshops alter actual practice in the design studio. How the proposed model and learning environment operate in a range of architectural education institutions and pedagogies could also be looked at. This would provide data that would enhance transferability.

Phase 2 of the research fails to address the impact of an evaluative model on actual design practice in the studio. Further work must address the potential for a critical thinking tools to enhance and modify design practice, by providing a tool for encouraging reflection on action. This must be integrated into the design studio. Furthermore, the model formed through the SDAG must be examined for its relevancy to architectural practice. This is explored in Phase 3 of the research.

Chapter 5. Phase 3: Strategic approaches in UK architectural practice

5.1 Introduction

5.1.1 Confirming the model

Phases 1 and 2 described an action research approach to enhancing deep learning for sustainability in the architectural design studio. At its centre, was the creation of a critical model which allowed the mapping of sustainable design information to organise concepts, reveal relationships and evaluate proposals. This chapter places this model in a professional context and considers its relevance to UK architectural practice.

5.1.2 Aim of phase 3

The aim of the 3rd phase of the research was to place the model developed in phase 2 of the research in the context of UK architectural practice. It sought to determine whether the proposed model captures the range of architectural practice as well as using the model as an evaluative lens to assess current trends. It aims provide a picture of UK architectural practice, identify opportunities, strengths and possible sustainable futures.

5.2 Background

There is little consensus on an optimal course of action to meet the needs of today without compromising those of future generations. This heterogeneity is captured within the field of architecture in which issues as diverse as human health to carbon emissions to biodiversity all form the basis of design action. Strategies range from technological innovation to participatory action to low-impact design. Rather than reducing over time, the conceptual field of sustainable design is expanding (Guy & Moore, 2007). In the UK, there has been little work attempting to capture this plurality and there lacks means to critically assess competing approaches. Phase 3 analyses and interprets the range of sustainable architectural practice in the UK. It does not search for a consensus in which sustainable design might be objectively defined (Brennan, 1997), but seeks to examine its various interpretations.

The model developed in chapter 4 synthesises two competing strategies to sustainable design; a technical approach to sustainability and an environmentalist one

(Brand & Fischer, 2013; Jackson & Ravetz, 2000; Jepson Jr, 2004; Symons & Karlsson, 2015). The technical approach represents a positivist view of human mastery of the natural environment compared to the participatory approach which adopts a constructivist view understanding environmental problems as social constructions. This debate might be most clearly understood as the tension between technological fix or value change (Robinson, 2004).

Qualitative studies into sustainable architectural practice in the UK have focussed on the integration of specific themes. For example, Hay, Samuel, Watson, and Bradbury (2018) interviewed ten practices, operating in the UK and overseas, to ascertain their engagement with post occupancy evaluations (POEs) and the barriers for implementation in practice. Their findings revealed confusion over the requirements for POEs as well as a desire by the professions for a more holistic assessment methodology beyond the emphasis on carbon reduction and occupational comfort. Their study shows a range of interpretations of what constitutes sustainable practice, as well as varying implementations dependent on practice type and size.

Akotia and Opoku (2017) interviewed 21 key practitioners regarding their engagement in sustainable regeneration. They found that there was significant variation in the design stages at which practices became involved in sustainable regeneration due to project type and its requirements. Practitioners who had sustainability assigned to their role were typically the least engaged, seemingly due to the fact that stakeholders and clients of the projects in which they were involved placed little value on sustainable regeneration.

Oliveira, Marco, Gething, and Robertson (2017) interviewed 26 practitioners across four firms of architecture regarding specific attitudes towards using energy modelling tools in design practice. They found that while most participants saw value in their use, integrating energy modelling tools into practice was constrained by existing workflows and was associated with increased levels of risk. Institutionalised practices were found to be a stumbling block for successful adoption.

Owen and Lorrimar-Shanks (2015) provide an insight into the broader "field" of sustainable design in Australia through interviews with 42 architects. Using a sociological model, they uncover the paradoxical nature of sustainable design which attempts to satisfy requirements in the domains of both arts and sciences. This causes a tension between integration (with the profession) and separation (the realm of green

architecture) that, for the authors, is best satisfied by a social approach to sustainable practice.

Other studies Baba, Mahdjoubi, Olomolaiye, and Booth (2012) examined architects' knowledge of Code for Sustainable Homes (CSH) using a mixed methods approach involving interviews and questionnaires. They found that most architects had only limited knowledge of CSH exposing limitations in information transfer from professional bodies to architects. Grierson and Moultrie (2011) used interviews and case studies of Scottish architects to identify common principles and processes in their design work. The findings suggest passive design, energy reduction and integrated approaches are shared by all practitioners. The authors argue for the creation of a set of "guiding principles" within a typology of building design to be created. Higham and Thomson examines the sustainable literacy of construction professionals. They conclude, there is a lack of literacy in the industry which is governed by a "business-as-usual" attitude. A negative view of sustainability is compounded by "profit-led decision making", the risk of instigating change and inadequate regulatory responses.

Guy and Farmer (2001) identify six "eco-logics" (table 2), based on an analysis of completed "green" buildings, describing the relationship between "diverse technical design strategies and competing conceptions of ecological place making" (p.140). They identify a series of "emblematic issues" (Guy & Farmer, 2000) that give rise to discourses; collections of "ideas, concepts and categorisations that are produced, reproduced and transformed in a particular set of practices" (Hajer, 1995, p.44). It is through critical dialogue and a participatory approach that a wide range of contextual responses to sustainable design may be generated (Guy, 2010) (table 5.1).

Table 5.1: Eco-logics in architecture (redrafted and edited from Guy and Farmer (2001))

Logic	Image of Space	Source of Knowledge	Building Image	Technologies	Idealised Concept of Space
Eco-technic	global context macrophysical	technorational scientific	commercial modern future oriented	integrated energy efficient high-tech intelligent	Integration of global environmental concerns into conventional building design strategies. Urban vision of the compact and dense city.
Eco-centric	fragile microbiotic	systemic ecology metaphysical holism	polluter parasitic consumer	autonomous renewable recycled intermediate	Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and "flourishing" of local and global biodiversity.
Eco-aesthetic	alienating anthropocentric	sensual postmodern science	iconic architectural New Age	pragmatic new nonlinear organic	Universally reconstructed in the light of new ecological knowledge and transforming our consciousness of nature.
Eco-cultural	cultural context regional	phenomenology cultural ecology	authentic harmonious typological	local low-tech commonplace vernacular	Learning to "dwell" through buildings adapted to local and bioregional physical and cultural characteristics.
Eco-medical	polluted hazardous	medical clinical ecology	healthy living caring	passive nontoxic natural tactile	A natural and tactile environment which ensures the health, well-being, and quality of life for individuals.
Eco-social	social context hierarchical	sociology social ecology	democratic home individual	flexible participatory appropriate locally managed	Reconciliation of individual and community in socially cohesive manner through decentralized "organic," non-hierarchical, and participatory communities.

The typology of Guy and Farmer (2001) suggests that within the architectural domain, sustainable design is multidirectional. Innovative, performance driven technologies may be as equally valid as low-tech vernacular solutions. This pluralism implies simultaneous paradigms that are conflicting and contestable. Williamson (2003) suggests that a particular building might adopt one or several of these *logics* but not many. Williamson presents three "caricatured images" of sustainable building, placing emphasis on the *horizon* (the scale of concern) of the architect: the *natural* embraces local ecological systems and sensitivity to place; the *cultural* focuses on local building and expertise; and the *technical* adopts a global approach emphasising the role of science and technology. While this conception appears ostensibly to reframe the techno-centric/eco-centric dichotomy of O'Riordan (1989) a clear distinction is drawn between ecological preservation which may reject vernacular traditions, and a respect for shared cultural knowledge and meaning. Williamson (2003) goes on to suggest that built form may reflect a combination of these images. Examples merge vernacular

traditions, the influence of nature and contemporary technology. The model implied is a triangle where cultural, natural and technological paradigms occupy each corner which any building may sit somewhere between these poles as a combination of these concerns.

5.3 Research methods

This research analyses the state of contemporary sustainable architectural practice in the UK and seeks to categorise the range of practices. Practices are analysed through the model developed in chapter 4 and based on earlier work by Dusch et al. (2010) which contrasts the opposing domains of eco-centrism and techno-centrism. Eco-centrism is understood as the *nurturing mode* of sustainable development (O'Riordan, 1989), concerned with the reduction of human impact through behavioural changes (Sylvan & Bennett, 1994). By contrast, techno-centrism represents the *manipulative mode* of action (O'Riordan, 1989) which advocates technical solutions to unsustainability. Through considering eco-centrism and techno-centrism as complementary domains, the analysis raises the possibility of hybrid practice which seeks to both reduce human impact while embracing technological innovation. This phase of the research also adopts a qualitative approach utilising "elite" interviews to examine exemplar sustainable practitioners in the UK.

5.3.1 Sampling and data collection

In-depth, standardised open-ended interviews (Patton, 1980) were conducted with 24 architects in the UK. This ensured a degree of structure between participants however also allowed them to expand on their topics that were of interest to them. This was of particular concern when considering trying to capture the plural nature of sustainability. Interviews lasted between 20 and 60 minutes and sought to uncover the breadth of sustainable practice in the UK. As well as revealing the specific sustainable design approaches of practitioners, the interviews sought to interrogate how this impacted design processes and the underlying motivations. This was put in the context of the nature of practice and type of work each practice undertook. Participants were selected for their prominence in sustainable design in the UK using a purposeful sample appropriate to expert interviews (Tiuwright, 2009). The purposeful sample allowed a specific group of practitioners that were national and international leaders in sustainable

design. This allowed a picture of the current state of exemplar sustainable design, necessary when considering the application of sustainability in education. Interviewees were considered "elite" (Marshall, 2016) for their prominence in the organisations they represented as well as their specific knowledge and experience in sustainable design. Firstly, members of the RIBA Sustainable Futures Group were approached for interview. Secondly, practices that had won national or regional awards for sustainability were approached. Finally, a *snowball* technique was used to expand the range and diversity of correspondents. Table 5.2 describes the sample selected. All participants have been anonymised in the results.

Chapter 5. Phase 3: Strategic approaches in UK architectural practice

Table 5.2: Sample UK architectural practices

Practice	Pseudonym	Size	Position of interviewee	Nature of projects	Link to sustainability
A	Kristian	180-200	Sustainability partner	Large scale commercial	Award winning
B	Elizabeth	n/a	Architect liaison	Professional organisation	RIBA Sustainable Futures Panel
C	Christian	20	Principal	Medium scale community and housing	Award winning
D	Isabelle	65-70	Sustainability team leader	Medium scale arts and residential	Award winning
E	Ray	1	Principal	Small scale self-build, charity	AECB
F	Fred	14	Senior partner	Medium scale education, arts, culture	Award winning/green branding
G	Gavin	180-200	Project architect	Medium-large scale mixed	Award winning
H	Patrick	170	Senior partner	Medium-large scale mixed	Award winning
I	Roberta	10	Architect	Small scale residential, commercial and community	Self-identifying
J	Simon	10	Partner	Small scale education and community	Self-identifying
K	Rowan	20	Partner	Medium scale residential, urban and mixed use	Self-identifying
L	Charles	4	Partner	Small scale Community and charity	Self-identifying
M	Luke	13	Partner	Medium scale Scientific and cultural	Award winning
N	Dave	65-70	Architect	Medium-large scale Residential, education and healthcare	Award winning
O	Neil	40	Partners	Medium scale Mixed use	Award winning
P	Fiona	1	Partner	Small scale Residential	Self-identifying
Q	Martin	60-70	Architect	Medium-large scale Research, science and healthcare	Award winning
R	Robert	3	Partner	Small scale Residential	RIBA Sustainable Futures Panel
S	Richard	3	Partner	Small scale Residential	Self-identifying
T	Peter	1	Principal	Small scale Residential and community	Award winning
U	Jonathan	3-6	Principal	Small scale Residential	Award winning
V	Jane	40-55	Sustainability partner	Medium scale Sports, healthcare and education	Award winning
W	Samuel	200	Head of sustainability	Medium-large scale Mixed use	RIBA Sustainable Futures Panel
X	Phillip	75	Director	Medium scale Mixed	RIBA Sustainable Futures Panel
Y	Arnold	200	Partner	Services Engineers	RIBA Sustainable Futures Panel
Z	Jonah	4	Principal	Small scale Residential and community	Self-identifying

The method contrasts with that used by Guy and Farmer (2001) which is based on an analysis of buildings taken from published literature, and Dusch et al. (2010) which is theoretical. This allowed the research to uncover individual motivations for sustainable design as well as assess value sets held by practitioners. Data were collected throughout each interview and each was audio recorded (either in person or by telephone) and then professionally transcribed. Interviewees from each practice were asked about their approach to sustainable design, in terms of both use of technology and stakeholder engagement.

5.3.2 Data analysis

The findings were analysed through the contrasting domains of techno-centrism (technological engagement and the physical attributes of building) and eco-centrism (attitude to behavioural change and social engagement) (Dusch et al., 2010; Hopwood et al., 2005; O'Riordan, 1989). Interview data were initially coded and these codes were then sorted into categories depending on how the interviewees spoke about the physical nature of their architecture, including its construction and performance, and descriptions of the relationship of their work to clients, stakeholders and the wider community. Sub-domains were then identified representing groups of categories that comprised similar themes. An example of coding and sub-domain creation is shown in table 5.3.

Table 5.3: Example of coding and sub-domain formation

Sub-domain	Category	Code	Raw data
Codes and regulations	Disengaged from standards	Rejection of sustainability badges	"So, I suppose, one of the things in the agenda has always been to slightly steer away from all the badges that one looks for in sustainability, whether it be the original Code for Sustainable Homes or BREEAM whatever it is, it's never been an interest." (Simon, practice J)
		Standards irrelevant	"I don't do BREEAM and things like that because I think they're generally not particularly relevant to what I do, you know, I think it's a good system for people who…well the aim of it is to bring up the general standard of construction in the country and that's fine but isn't really relevant to what I do." (Peter, practice E)
		Liberated from standards	"So it's a bit of an irony, really, but the fact that some of those standards have fallen away a little bit has actually been, in our work, a bit more liberating, cause we're now working for people who are doing things for the right reasons." (Rowan, Practice K)
Technology	Low-tech strategies	Traditional design technologies	"…very much drawing from traditional buildings so you've got the right kind of principles of thermal mass, depth of plan and Lux levels and things but then give people the opportunity to use I don't know, external shutters or something to then change their environment." (Fred, practice F)
		Vernacular design influence	"I think we are very much sensitive to and respondent to any local vernacular. It's quite often there for a reason, albeit possibly an historic reason, but I think those are still interesting and valid and good things to respond to and deal within terms of the local characteristics. But also it does quite often give you a material approach to a project." (Richard, practice F)
		Low-tech operation	"…the very theoretical approach that's used in Passivhaus is not particularly relevant in a maritime climate where you've got far fewer, far smaller fluctuations in temperature, you've got more humidity to deal with and you can actually get away with much lower tech systems." (Robert, Practice R)

Each practice was considered for its coded relationships and the sub-domains it occupied identifying themes that dominated that participant's discourse. Codes and sub-domains were analysed in relation to the primary domains of eco-centrism and techno-centrism providing a tentative classification of practices. An example two practices' categorised subdomains are presented in table 5.4. These were then sorted into the wider overarching domains of eco-centrism and techno-centrism. This was then summarised into a tentative structure of practices into consistent categories.

Table 5.4: Example of classified sub-domains in practices A and C

Practice	Eco-centric sub-domains	Techno-centric sub-domains
A	• Building promoting social interaction • Top-down approach • Pro-standards and benchmarking	• Building performance optimisation • Technical monitoring • Operational data • Innovation as value
C	• Human-centric • Two-way educational process • Wealth generation • Collaborative process • Community engagement • Rethinking role of architect	• Renewables • Carbon

Negative cases were sought to find exceptions to the data. This was based on the method set out by Glaser and Strauss (2009) and adapted by Cohen et al. (2000). Categories were not considered discrete and like the *logics* of Guy and Farmer (2001), they *"are not meant to be in any way exclusive, or frozen in time or space"* (p.141). Rather, each category is dominated by a particular set of concerns, emblems and characteristics (Hajer, 1995). Data analysis was facilitated through NVivo (a computer programme for qualitative data analysis).

5.4 Results

Practice ranged between simple, low-tech design and a more technological approach. Practices adopting high-tech approaches tended to develop responsive buildings delivered through smart technologies and big data, which sought to optimise internal environments. Buildings were technical in nature, often requiring specific environmental qualities delivered through highly engineered solutions (such as artificial lighting linked to Ethernet cables to monitor and adapt to room conditions or buildings that could operate in extreme and hostile environments). Mid-tech practice was characterised by the use of "appropriate" and established technologies. *Fabric first* approaches were often favoured which sought to minimise energy consumption through passive design (such as natural ventilation and lighting) and engineered building envelopes. Low-tech practice focussed on embodied energy and natural materials, often utilising vernacular expertise. Solutions tended to use simple building systems that could be easily implemented economically at a small scale. These included using found materials on-site, recycling, local crafts people and moderating internal environments through passive strategies such as cross ventilation.

Practices also fell on a spectrum between active engagement with stakeholders throughout design and occupation or top down strategies that enhanced sustainable inhabitation. Participatory practices were characterised by strong stakeholder involvement at the design, construction and operation phases and targeted emancipatory processes. For example, one practice delivered workshops on how to design and construct self-build homes while another worked with local communities to develop both economic and architectural action plans. Intermediate practices adopted a hybrid approach in which the architect tended to retain a sense of authority and specialist knowledge yet engaged in client education and post occupancy analysis. Authoritative practices considered stakeholders as passive users, and assumed a role of design experts, often aiming to manipulate client expectations.

The results are presented in terms of attitudes to technology and cooperation expressed by interviewees. Where participants spoke of adopting mixed approaches, they were categorised through the dominant approach that shaped their practice. Six groups emerged from the data from a possible 9 combinations of social and technological approaches. These were not discrete but on a spectrum of possible practice. The matrix provides a general model for structuring contemporary architectural design approaches in the UK.

Table 5.5: Practices categorised by technological strategy and social strategy (number of staff in parenthesis)

	Attitude to technology	Low-tech	Mid-tech	High-tech
Attitude to cooperation				
Participatory		Practice E (1) Practice P (1) Practice T (1)	Practice C (20) Practice O (40) Practice L (4) Practice F (14)	
Intermediate		Practice S (3) Practice R (3) Practice K (20) Practice J (10) Practice I (10)	Practice D (65-70) Practice W (200) Practice N (65-70) Practice G (180-200) Practice X (75)	
Authoritative			Practice V (40-55) Practice H (170) Practice U (2-6)	Practice A (180-200) Practice M (13) Practice Q (60-70)

5.4.1 Low-tech/participatory

Three practices exhibited a low-tech/participatory approach to sustainable design. They tended to favour simple building technologies combined with a design approach that sought to educate and engage clients and users. The practices were small (all were single practitioners) with relatively low turnovers. Projects tended to be specialist small scale residential, community buildings or educational. Waste reduction through design that advocated an efficient and simpler way of thinking about building and a connection to place and the natural environment were reoccurring themes.

> "I'm also interested in the architecture of frugality which is, this building we're in is a very crude little shed in many ways. But it was designed around the eight trees that grew here on this site. Those are the only materials we used to make the structure of this thing." Peter (sole practitioner, practice E)

Design strategies tended to emphasise the use of local materials that did not require significant processing such as timber and rammed earth. Practice E decided to use only found materials on site to minimise transport and building impact. There was an emphasis on engaging clients in the building process; for example, practice P ran workshops that allowed clients to learn about building with earthen materials. They sought to empower clients to engage in their own self build projects with minimal

professional input.

Passive and simple operational strategies such as thermal mass and openable windows were favoured, combined with encouraging behavioural changes that allowed occupants to adapt to environmental conditions. This included simple acts such as wearing more clothes in winter (practice P) or manually warming internal environments through stoves running on firewood (practice E). There was a clear desire for simpler modes of inhabitation which formed part of a wider narrative that embraced nature and ecology.

> "…if we are building new we should be trying as much as possible to build using locally sourced material and then very much within that building as well harnessing the environment too." Fiona (sole practitioner, practice P).

While this group did not overtly express the *Gaianist* ideology described by Lovelock (2000), they placed strong emphasis on the natural homeostatic principles of which humans are an integral part. Ecological harmony was sought after through an active and equal participation in the natural order, sharing the eco-centric reformulation of sustainable development (Imran, Alam, & Beaumont, 2014).

5.4.2 Low-tech/intermediate

A low-tech/intermediate approach was adopted by five of the interviewed practices. Practices were small (between 3 and 20) in size. Projects tended to be small in scale, predominantly residential but also some small public buildings. They described a sustainable design agenda that valued translations of vernacular building technologies in a traditional, architect-led, building process often using natural building materials.

> "I'm really interested in the materiality of things …not full of evil chemicals and things like that. I really like the idea of using natural products for everything."
> Simon (principal, practice J)

Locality remained an important theme, but this was linked to a cultural idea of place rather than a connection to the natural environment. Frampton (1983) describes this as *Critical Regionalism*: an attempt to "mediate the impact of universal civilisation with elements derived indirectly from the peculiarities of a particular place" (p. 21) and buildings were considered to symbolically represent local values:

> "…it's [the design] driven in part by a material response. But in part conceptually from the use of locally contextual and appropriate materials. The history of brickmaking in that area drives the aesthetic in that locality" Ryan (principal practice S)

For these practices, using local crafts people and understanding vernacular building techniques emerged as important aspects of design that respected materials and site with the end goal of efficient building processes:

> "we…try to specify things like wood fibre or hemp or straw, and I think that's really come from a background of understanding breathability and things like that and historic buildings." Roberta (architect, practice I)

In a number of cases, there was an explicit rejection of quantitative measures or sustainability benchmarking procedures:

> "…one of the things in the agenda has always been to slightly steer away from all the badges that one looks for in sustainability, whether it be the original Code for Sustainable Homes or BREEAM whatever it is, it's never been an interest." Simon (principal, practice J)

5.4.3 Mid-tech/participatory

Four practices focussed on participatory action with a moderate engagement with techno-centric solutions. Practices were typically medium sized with one smaller practice (4 staff, 14 staff, 20 staff and 40 staff). They tended to adopt alternative models of working such as one interviewee who spoke of their "cooperative" business structure (practice O) in which all staff had a stake in the business and design process sharing similarities with the *communalist* paradigm described by O'Riordan (1989). Practice C had worked with a local community to develop a cooperative housing trust (Petrescu & Trogal, 2017, p.216). A common theme was an expansion of the architect's role, beyond the design of buildings to economic to social structures or enabling groups to take control of the building process themselves.

> "…we're working on community led housing where the financial modelling is as much a design task for us as the design of the building, as the design of the

> governance, working with communities – so I think we're going to have to
> completely rethink the role of the architect." Christian (principal, practice C)

Engaging in two-way processes where clients had a stake in the design and operation of the building was important. Sustainability was framed as a social concept, sharing similarities with a constructivist perspective (Hannigan, 2014). Design strategies emerged from dialogue with communities. often transforming client expectations through collaboration at briefing stages.:

> "...we managed to get them to do a workshop on healthy working, which was led
> by somebody from [an environmental consultancy], which was very good, we have
> big staff engagement." Charles (principal, practice L)

Participation was often combined with specialist knowledge and specific technologies. They emphasised *appropriate* sustainable technologies, often questioning the value of particular building upgrades. For example, one practice spoke about how when refurbishing a building for a client they encouraged the users to change how they controlled the heating and air-conditioning through educational workshops while integrating a greater number of opening windows (practice L). Another described how they explicitly rejected "eco-bling" in favour of material and fabric substitutions (practice L). Despite this, there was often an engagement with engineered solutions (such as Passivhaus) and innovative materials (for example developing practical, large scale straw bale systems), distinguishing them from the low-tech family of practices. The mid-tech/participatory practices tended to examine sustainability through a social lens, rather than the a cultural or material approach characterising the low-tech groups.

5.4.4 Mid-tech/intermediate

A mid-tech/intermediate approach was described by four of the practices interviewed. This represented the most diverse range of practices in terms of size (3 to 200 employees) yet all were involved in medium to large scale projects, with a range of uses, well in excess of £1 million. Unlike the mid-tech/participatory group who emphasised empowerment of stakeholders, communication tended to focus on education as a one-way process which involved seeking to change client aspirations.

> "The clients will vary enormously and so we will, at the earlier stages, have that conversation, try and make sure as much [sustainability] is incorporated as possible. There have been times where it's not necessarily possible to push much further and you've had to accept that you do what you can." Isabelle (head of sustainability, practice D)
>
> "Basically, it's just about talking to people, ensuring that you've understood what they're actually after, and then trying to make sure that the design delivers that and then the building delivers that…It's just about trying to communicate all the way through the chain" Philip (partner, practice X)

A common approach was benchmarking design against sustainable standards. All the practices engaged in BREEAM (BRE, 2018),as a tool for ensuring a balanced approach, the Soft Landings Framework (BSRIA, 2009) was used by two practices and two practices were actively engaged in creating Passivhaus buildings (Passive House Institute, 2017).

> "..we're a commercially led, client led practice we tend to take our lead from the initial brief from the client, so the client says and generally because we do a lot of higher education and publicly funded stuff; BREEAM is the stick that's generally used." Martin (head of sustainability, practice Q)

Design strategies were underpinned by a knowledge of building physics and included thermal mass, natural lighting and natural ventilation as means of creating low operational energy buildings. In two of the large practices, sustainability was managed by in house teams who audited projects and had developed their own frameworks (practice D built a sustainability toolkit and practice W used a traffic light system covering 12 aspects of sustainable design). Many of the architects in this category, spoke of an inherent alignment between sustainability and good design:

> "…sustainability has been a pretty good Trojan horse just for better architectures. Thinner floorplates, higher ceilings, heavier structure, they're all good things. Well-proportioned windows. They make buildings that are nicer really." Philip (partner, practice X)

This centrist approach is aligned with the notion of *accommodation* as described by O'Riordan (1989). This position relies on institutional adaptation and assessment

methods to meet changing environmental demands. O'Riordan suggests it "is the arena of modest reform, tinkering at the margins" and "designed to maintain the status quo" (p.87).

5.4.5 Mid-tech/authoritative

Three practices exhibited a mid-tech/authoritative approach each having between 50 and 200 staff. They worked on a variety of projects from large scale developer led housing, to public projects (including cultural and educational buildings) to commercial ones. They typically adopted a *fabric first* approach in which the performance of the building was considered primary for the creation of sustainable architecture. Reduction of operational energy was a major aim often through passive design strategies, engineered materials or high performance building methods (such as Passivhaus). Carbon reduction was a major motivating factor. Practice U, for example, spoke of an experimental design upgrade to existing housing stock to dramatically reduce emissions. As a senior partner in practice H put it:

> "…the word 'sustainability' has come to mean a wide range of – taking in a wide range of issues that's a lot broader than the key one, which, to me, is still minimising carbon emission." Patrick (senior partner practice H).

There was a focus on sustainable measures being both holistic and integrated into the building design:

> "I think ultimately the things that really work actually they're where those sustainable designs function or are serving the end of the building. It's not something that you can then strip away, it's something that becomes integral to the building and I think that's really our aim." Jane (head of sustainability, practice V)

Meeting client aspirations was often at the heart of their working. Design was looked upon as facilitating sustainability through discrete strategies rather than educating for change or emancipatory action. Like other mid-tech approaches, benchmarking and standards played a major part in driving sustainable design. However, an autonomous approach which pursued a sustainable agenda despite perceived client apathy distinguished these practices from others in the mid-tech group.

> "Client pressure is quite often just we want to be seen to be doing well…[the projects] where we were pushing the boundaries were where we were setting the agenda for ourselves, so we were doing our own development work." Patrick (senior partner, practice H)

This might broadly be described as a form of "ecological modernism"; an approach that accepts the challenges of sustainability yet can be "accommodated by changes in production processes and institutional adaptation" (Blowers, 1997, p. 846). These practices did not emphasise the innovation which characterised the high-tech/authoritative group, but rather focussed on the scientific application of accepted principles to enhance performance.

5.4.6 High-tech/authoritative

Three practices focussed on implementing high-tech, performance buildings. There was a range of practice sizes (13 staff, 60 staff and 200 staff) and projects tended to be highly technical buildings with large budgets. One practice, for example, specialised in research buildings in extreme climates, while another conducted significant work in laboratory and research sectors. The high-tech group were distinct from the mid-tech group in their focus on building performance through innovative, quantifiable and often digital solutions. Design tended to focus on a top-down approach to technical problem solving and used strategies such as energy recovery and highly integrated services design. Interviewees exhibited a techno-centric attitude placing faith in the potential for technological innovation to tackle environmental problems through maximising building efficiency (Guy & Farmer, 2001), applying technological innovation and human ingenuity (O'Riordan, 1989). While there was a focus on building performance, and tended to portray building inhabitants as passive users:

> "…the big data's used at present…as a basis for understanding how buildings really do work and then how people inside the buildings use the building and then be able to advise clients on how to design and manage their people better." Kristian (partner, practice A)

There was significant value placed on the role of innovation in and technology in design. Practices were engaging in smart technologies (one practice spoke of using sensors in bathrooms to optimise building performance) as well as holistic building

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systems. This involved detailed technical analysis and two of the practices collected operational data in order to optimise building performance.

> "If we can figure out that no one's using the washrooms on that floor on that day, then we just don't send anyone to clean them so it means 20% less work and then potentially a cost saving of some sort, so there's that kind of practical thinking but there's also the idea that we can hot-desk, we can close down several floors."
> Kristian (partner, practice A)

Design processes tended to be heavily abstracted and consider buildings as solvable systems.

> "we mapped out with arrows and blocks and squares everything that needs to happen to make one of these buildings…into graphic diagrams and then we were able to take that and simplify them…benchmarking the developing design against the [project] diagram" Luke (partner, practice M)

Two of the three practices (practice M and practice Q) discussed wellbeing a driver for sustainable design which was framed as a technical issue to be solved using building systems and intelligent design or directly linked to the efficiency of the building comfort strategies.

5.5 Discussion

To capture the pluralism of sustainable architectural design, a conceptual model was constructed which accounted for possible shifts towards competing architectural paradigms (figure 5.1) drawing from the model developed in phase 2. The *x* axis represents attitudes to building technologies while the *y* axis displays captures attitude to cooperation with stakeholders. High-tech building performance strategies are contrasted with low-tech ones while participatory intervention approaches oppose authoritative ones. The range of sustainable architecture practice in the UK can be overlaid, highlighting the potential for enhancing practice. The findings suggest the combination of high-tech and participatory approaches or low-tech and authoritative approaches may offer opportunities for enhancing practice.
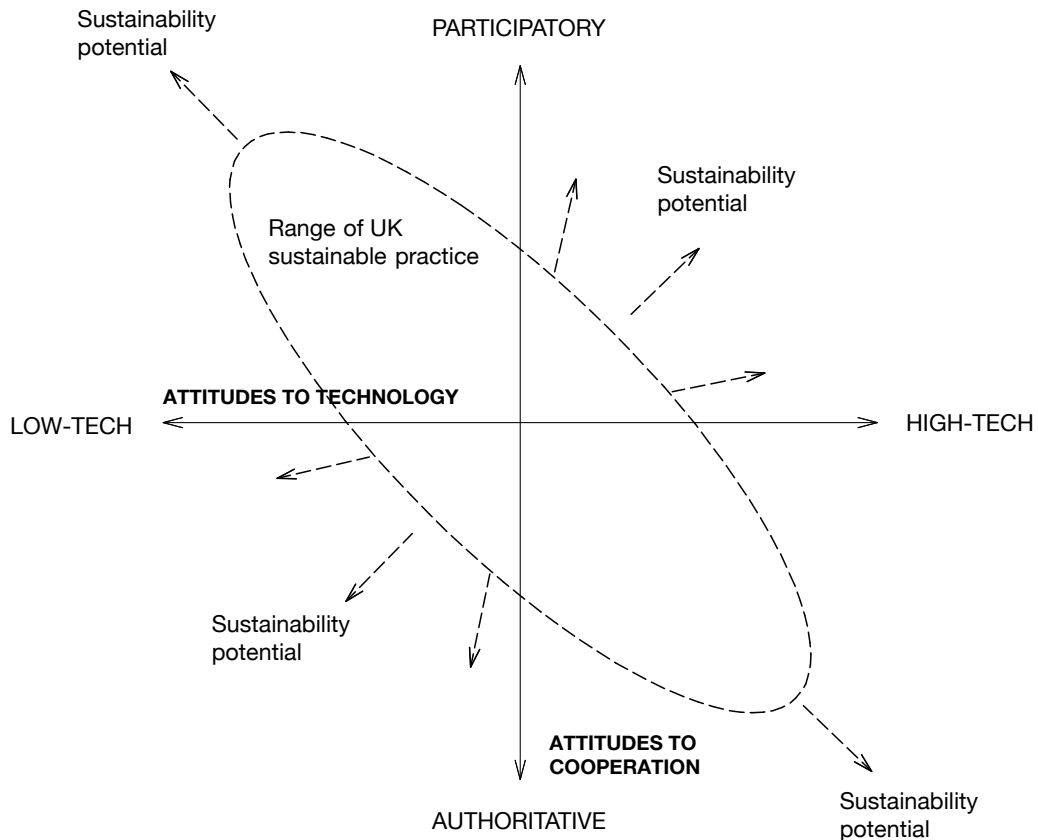
Figure 5.1: A model capturing competing aspects of sustainable architectural design

In this model, the naming of the axes has been simplified in which eco-technic becomes attitudes to technology while eco-centric is described as attitudes to cooperation. This avoids confusion with the terminology in the literature in which eco-centric and techno-centric are occasionally used to represent distinct sustainable development paradigms.

While there was a polarisation of participatory approaches and technical ones, the range of practice suggests that the two may coincide, rejecting straightforward linearity (O'Riordan, 1989). This corroborates the model of Dusch et al. (2010) who argue they are not mutually exclusive approaches. This was most apparent in the categories of low-tech/intermediate, mid-tech/participatory and mid-tech/authoritative, all three of which sit outside the expected range of eco-centric/techno-centric spectrum. Arguably, those practices which embraced low-tech solutions with limited participatory approaches still adopted the nurturing mode of action exhibiting a weak communalist paradigm (O'Riordan, 1989). Similarly, mid-tech/authoritative approaches expressed

weakly interventionist attitudes which focussed on the technical enhancement of building fabric.

While the findings challenge the duality of the eco- and techno-centric divide, their distinct lack of practice in the top right and bottom left corners of the model pose questions about the nature of this unrealised potential. However, redefining of the role of the architect to enable sustainable design strategies that both mobilises communities and engages in innovative technical solutions is a distinct possibility evidenced by the four practices that exhibited a mid-tech/participatory approach. These paradigms may currently be too challenging to achieve within the current structure of UK professional practice and may suffer from a lack of recognition by the profession, subsequently avoiding the sampling method used.

Unlike the assertion by Dusch et al. (2010) that potential for sustainable development only exists in the domain of major technological and behavioural changes, those practices who were weakly techno-centric were not characterised by a rejection of technology but an engagement in traditional and vernacular craft. Likewise, those practices operating with in an authoritative manner, still expressed concern for social issues, albeit by taking full control of the design process to optimise building performance with holistic oversight.

The findings suggest the six logics proposed by Guy and Farmer (2001) may map coherently onto a structured evaluative model for sustainable design. The *eco-technic* and *eco-centric* paradigms clearly align with the high-tech/authoritative and low-tech/participatory categories respectively. Similarly, their description of the *eco-social* logic parallels the mid-tech/participatory group and the *eco-cultural* logic aligns with the low tech approach. Notably, only three practices mentioned wellbeing as a factor in sustainable design and this was largely confined to the high-tech/authoritative group. Despite practice X identifying it as an emerging trend, it did not constitute a significant factor in current UK sustainable design. The *eco-aesthetic* logic of Guy and Farmer (2001) considers sustainable architecture an "iconic expression of societal values" (p.143), yet participants tended to accuse explicit displays of sustainability of being "green bling". Any educational activities were largely confined to direct pre-construction consultation with stakeholders.

Smaller practices tended to favour low-tech, socially orientated approaches while larger ones focussed on performance based technological ones. This was partly due to practice organisation wherein small practices tended to be defined by the views

of a single individual while larger ones relied on quantitative performance measurements to provide coherence across the design process. This was especially true when dealing with complex projects which involved multiple stakeholders and consultant groups. Invariably, at the low tech end, practices dealt with simpler projects, often for private individuals which allowed for more straightforward approaches.

Practices that sat centrally on the axis most heavily relied on standards and benchmarking procedures. This allowed them to develop a balanced approach that ensured wide coverage of a diverse range of sustainable issues. Sustainable aspirations were often defined by aiming to achieve a BREEAM rating or Passivhaus standard. By contrast, smaller practices engaged in eco-centric strategies tended to ignore or overtly reject standards or benchmarks. For many this was framed as a personal moral stance rejecting "*checklist*" exercises for a "*more involved*" approach (Practice K) often informed by personal anecdotal experience.

The plurality of approaches to sustainable building highlights the challenges of defining sustainability at a building level. Berardi (2013) asserts that the contextual dependencies of a single building make such categorisation impossible and instead categorisation must take into account multiple scales. The findings may be interpreted as representing different scales of concern (Williamson, 2003). The local scale considers immediate ecological systems and cultural forces (low-tech and participatory approaches). The global scale, by contrast, is concerned with a large scale issues such as carbon emissions often through technical application (high-tech and authoritative approaches).

5.6 Conclusions and recommendations

5.6.1 Conclusions

There is a range of sustainable architectural practice in the UK which is characterised by the contrasting approaches of participatory/low-tech design, and technical/performance orientated design. The absence of simultaneous technical and participatory working reveals opportunities for new forms of practice. In part, this absence may be due to the sampling method (which was based around national and regional professional recognition) possibly indicating an inherent bias of the architectural profession towards more conservative sustainability measures and a

rejection of more radical forms of practice. Furthermore, the relative complexity of high-tech solutions, which require specialist design engineering, may alienate users from the design process. Traditional building techniques and low-impact solutions may foster non-architect engagement, through tangible and simple methods. Yet, by allowing for alternative theoretical possibilities, this research suggests there may be approaches beyond mainstream architectural validation. Greater engagement with innovative technologies for smaller firms and stronger participatory approaches for those that are involved in high performance and technical design, could enhance practice.

The correlation between practice size and design approach suggests, individual sustainable strategy is as much contingent on circumstance, context and project type as by political or moral outlooks. Many practices defined their sustainable agenda by external requirements to meet particular standardised benchmarks (often client led) while others explicitly rejected these measures. In both cases, however, these standards acted as comparative benchmarks for sustainable practice.

5.6.2 Recommendations and further work

The profession must recognise the potential for alternative approaches to sustainable design in an arena that is characterised by a narrow conception of sustainability. Architecture students must be exposed to a wide range of outlooks in order to recognise appropriateness to context and integrate both technical and participatory solutions. Certification schemes (such as BREEAM, LEED, Passivhaus etc.) must continue to push the boundary of what is considered best practice while government policy must steer towards a more holistic understanding of sustainable building design. Further work may expand the sampling method to seek out radical practice beyond the scope of mainstream architectural recognition. This may include a consideration of communities who simultaneously embrace innovative technologies combined with low impact lifestyles.

Phase 3 of the research confirmed the applicability of the model to UK professional practice and highlighted possible missed opportunities. Phase 4 will examine integrating the model into the design studio as a tool to enhance critical understanding of sustainable design.

Chapter 6. Phase 4: Applying the critical model

6.1 Introduction

The previous chapters described the creation of a critical model for architectural education. This was developed through a participatory process in phase 2 with the aim of generating a means to critically assess sustainable design solutions. Phase 3 looked at professional practice and confirmed the model developed. This chapter takes that model and aims to develop an associated pedagogy for integration into the design studio. Using the same cohort that formed the action group described in chapter 4, a series of interventions into the design studio were made to explore the potential impact of the model on student learning and design practice. This phase of the research again adopted an action research methodology.

6.1.1 Revising action

Phase 2 of the research offered limited success in terms of encouraging learning and critical thinking about sustainable design. The aims of action research are to transform practice and while phase 2 influenced my own understanding of my teaching practice and offered opportunities for alternative pedagogy, the impact of this alternative approach was unclear on the practice of design in the studio. Indeed, the development of an alternative environment without significant impact on studio practice falls short of the initial aims of the research. Phase 3 develops the findings of phase 2 and seeks to apply the model for critical sustainable thinking in a live design studio environment. This was initially administered through a series of tutorial workshops in which the model formed the basis of intervention.

Phase 3 is structured through three iterative cycles, each of which represents an individual action research cycle of problem identification, planning, action and reflection (Zuber-Skerritt, 1996a). Cycles 1 and 2 describe individual workshops administered by me in the design studio while in cycle students were provided with the model for independent use in the studio.

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6.1.2 Aim of phase 4

Phase 4 aims to apply the model to the design studio as a critical thinking tool. It aimed not only to encourage critical thinking, but to effect changes in student design practice. It sought to develop a specific teaching method for integrating the model, appropriate to the demands of learning for sustainability. It aimed to develop an innovative pedagogy that sought to empower participants with the capabilities to question and challenge assumed sustainable knowledge and the limitations of its creation with the architectural design studio.

6.2 Background

6.2.1 Intervention in the design studio

The design studio has been widely used use as a context for study. Its unique pedagogy and various modes of implementation have led to a range of research which varies from reflections on teaching practice to integrating specific themes to pseudo-experimental projects. Much of it reflects on personal experiences in the design studio or describes individual approaches to curriculum design or course delivery. In some cases, researchers test particular ideas or explore specific themes within the studio context. As well as this, a range of scholars have looked at theory generation based on analyses of the studio.

Case studies of the design studio provide a picture of its variety and range of implementations and are prevalent in the literature. Case studies include descriptions of whole curriculum models. For example, Levy (1980) describes the concept of the "total studio" in which all teaching was delivered through the design studio. He found it devalued technical subjects and developed a void between these and the focus on spatial and formal design. More recently, the review by Altomonte et al. (2010) looked at over fifty international architecture courses and considered their curriculum and the integration of satellite units. This was done through analysis of course outlines, often provided by practitioners at those institutions.

More commonly, research into studio practice has examined the incorporation of specific themes into studio teaching through descriptions of specific practices. These include subjects as diverse as designing for people (Yilan & John, 1981), collaborative working (Dunster, 1990; Lessard & Torres, 2007), techniques for encouraging personal

reflection (Quayle & Paterson, 1989), designing with the community (Cameron et al., 2001; Ward, 1991), incorporating building technology (Reno, 1992), designing with typologies (Tice, 1993) and digital technologies (Bender & Vredevoogd, 2006; Guzdial, Rick, & Kehoe, 2001). Typically, these studies reflect on personal or institutional practice through the use of specific case studies.

On occasions, researchers have not acted as participants but rather passive observers to develop ethnographic accounts of the design studio. Examples include Shaffer (2003), who created a comprehensive analysis of the *Oxford Design Studio* through collecting data in a range of methods and contexts, and Frederickson (1990) who considered communication in design juries and critiques through the analysis of multiple video recordings.

A number of academics have concerned themselves with generating theory within the studio, often overlaying conceptual model to provide pedagogic insights. The seminal work by Schön (1984a), in which he describes the architectural design studio as an exemplar model for *reflection-in-action,* was based on recordings of student and tutor interactions. Oxman (1986) uses a theoretical approach applying a linguistic analogy to the teaching of architecture to generate an alternative pedagogy illustrated through a series of design exercises. Stamps (1994) overlays a Jungian viewport to the design studio and supports it through a study of architectural education literature. Ledewitz (1985) provides an account of alternative pedagogic models in the design studio and Crysler (1995) examines the role of critical pedagogy through examples from a university course and second hand literature.

6.2.2 Integrating sustainability in the studio

Attempts to integrate sustainable design into studio education have tended to adopted similar research methodologies. Much research has taken place since the early 1990s following the publication of the Brundtland Report (Brundtland et al., 1987) and subsequent UN and UNESCO initiatives however earlier studies looked at energy conscious design (Villecco, 1977) and designing for thermal comfort (Cole, 1980).

Case studies of sustainably themed studios are a common aspect of sustainable design education research. It is often practitioner led and based on personal reflections or descriptions of "alternative" teaching practice, usually introducing unconventional activities into the studio environment. Alvarez and Rogers (2006) describe their own

teaching approach of taking students into the field to speak directly with local residents. They found this provided a more valuable experience than remaining in the "classroom" to understand the "messy" nature of sustainable issues. Sieffert, Huygen, and Daudon (2014) describe a studio in which architecture and civil engineering students work together to use recycled materials. Other authors have described using formal structures in the design studio. Bala (2010) describes a studio system in which highly structured design activities are used, including mood boards, matrices of criteria and structured evaluations. A structured model is used by Lee (2014) to generate a designed studio curriculum, while Sherman and Burns (2015) create a principle based model for integration and apply it to a single case study.

A number of researchers have conducted more formal research, either through pseudo experimental approaches or using action research methodologies. Walker and Seymour (2008) experiment with using a design charrette to enhance sustainable design and concludes its success through using questionnaires before and after the event. Gulwadi (2009) uses reflective journals to analyse enhancing critical sustainability in the design studio. Hatton and Smiths's reflection model is applied to assess the content of the journals and conclude this approach can be the start point for encouraging students to think more critically about complex problems such as sustainable design. Gürel (2010) explores using a team of educators with a range of sustainable design expertise and assess this through observation and end of course questionnaires. The findings suggest that putting sustainability at the core of the studio raised awareness of sustainability as a complex subject that requires critical thought. A more explicit action research approach was used by Clune (2014) who introduced a range of design exercises such as thinking about their design in the future, considering a "day in the life" of a client and developing a human centred design brief. These were intended to enhance deep learning for sustainability, outlined in Lopes, Clune, and Andrews (2007). The findings highlight the possibilities of the studio to engender change through the teacher acting as a researcher as there is the possibility to continuously reflect and amend both pedagogy and content. However, they suggest there are still issues when the educator lacks sufficient design knowledge.

Chapter 6. Phase 4: Applying the critical model

6.3 Methodology

6.3.1 Research approach

Phase 4 of the research attempted to instigate change within design studio practice. It went beyond the aims of phase 2 which operated in an environment external to the design and sought to explore the integration of the critical model into the design studio. Using the cyclical process defined by Zuber-Skerritt (1996a) and Cohen et al. (2000), a description of each stage is provided below.

(1) Problem identification: Initial problem identification was drawn from the work done in previous chapters which identified barriers and opportunities to deep learning for sustainability in the design studio. From this initial start point, the research was then divided into smaller *cycles* within which action was planned, undertaken and reflected upon before redefining the problem to be addressed by the subsequent cycle.

(2) Action planning: At the start of each cycle, action was planned. This took the form of deciding how the intervention was to be made in consultation with the year convenor. Action was designed to occur at a time beneficial to student timetables and deadlines. The nature of emancipatory action research is that the actions not only seek to make the educational process more practical but also to empower participants to alter their context. Accordingly, action was designed not to *instrumentalise* the participants but rather to collaboratively develop approaches for developing sustainable learning.

(3) Taking action: Each cycle began with an intervention in the form of workshops delivered to all students. These were typically 45 minutes in length conducted in the design studio. Each intervention was audio recorded and transcribed for analysis and photographs were taken.

(4) Observation and reflection: Observational data were collected through a number of methods. Observations of the studio were made, both of tutorials and crits. Notes were taken in each using a structured pro forma. Tutorials and crits typically lasted about an hour for which the researcher remained presented throughout the whole session (details of the observations are set out within tables 1, 3 and 5). Supplementary lectures on the course were also attended and field notes taken to provide a grasp of the wider learning context. Interviews

with students were conducted at the end of the workshops to provide feedback on the model and its administration.

6.3.2 Context and sampling in phase 4

Phase 4 took place in the architectural design studio at the University of Bath. In contrast to phase 2, it was delivered directly in the design studio through a series of workshops administered *in situ*. The design studio was structured around two projects: the first a masterplan of a foreign city of the students' choice, working in groups (September – January); the second, a single building designed individually within the masterplan (February – May).

The sample for phase 4 consisted of final year RIBA 2 MArch architecture students at the University of Bath (n=43) of the 2016 intake. Workshops were conducted in 7 groups of between 5 and 7 students. All participants had similar levels of architectural education, all having completed an RIBA Part 1 course and the first year of an RIBA Part 2 course and all had at least one year's experience working in industry. Participants were aged between 21 and 30 with 21 male and 22 female students. 14 students were members of the action group described in the second phase of the research.

6.3.3 Analysis

At the end of each cycle, the data were analysed using NVivo. Following the analysis process defined by Hinchey (2008) the data were unitised (coded), categorised, and findings formulated. The process took a modified form of the protocol set out by Cohen et al. (2000). This process is outlined in chapter 2 (methodology) in which the shared use of in vivo and theory generated codes is defined. In this analysis, codes were initially defined from the raw data. Categories were then drawn from these codes while domains were generated from the theoretical model of the literature. Categories were then assigned to these domains. Domains included themes such as "tutorials", "student agenda" and "design process". Examples of the codes, category and domain formation is provided in table 6.1.

Table 6.1: Example of coding and domain creation

Domain	Category	Code	Raw data
Use of the model	Providing clarity and recognition	Clarifying core concepts	I felt you knew our project when he sat down with a speech stripped away everything that you heard before and really just lay down the core principles and how users within our work and I thought I was really useful. (David)
		Articulating a mixed strategy	Exactly, we've set up community events and fairs. The top down gives the infrastructure for the bottom to use. You need the top down to set the line for that park so the community spaces can come in and go in that park. It's such a big scale, you need both. If you don't have the backing from the top. (Group A, group workshop)
		Strategic clarity	But it did certainly give us a broad image of where our site or locale could fit in and where our master plan could go. (Sylvia)

6.4 Cycle 1

6.4.1 Identifying the problem

The first cycle drew from my own reflections and experiences as well as that recorded by students in phases 1 and 2 of the research. Notably, it was unclear how design practice might be informed by the model of sustainable design developed in phases 2 and 3. Furthermore, its impact on actual practice in the design studio was unclear. The aim of the first workshop was to provide an introduction to the critical sustainability model and apply it as a means to frame project strategies addressing sustainability, specifically in the design studio. The first workshop had three primary objectives.

(1) Identify issues of unsustainability in the context of each group's chosen city.

(2) Map proposed design strategies for sustainability using the sustainability model.

(3) Critically reflect on the proposed design strategies.

6.4.2 Planning action

Cycle 1 of phase 4 consisted of a workshop designed by myself and administered in the design studio. The structure and nature of this workshop emerged from the findings of phase 2. Firstly it utilised the sustainability model as a critical thinking tool through which students could map their own sustainability strategies. Secondly, it emphasised an active learning process through which students could actively "construct knowledge". This was born from my own experiences in phase 2 in which engagement and understanding were noticeably enhanced in student led sessions.

Chapter 6. Phase 4: Applying the critical model

It was intended that each workshop follow a similar structure as outlined in table 6.2. This involved a process of identifying the issues they were dealing with followed by clustering these and identifying assumptions. Students were then asked what the solutions to these issues they were proposing and asked to plot these on the model. This was then intended as a tool to critique possible strategies, identify opportunities and reveal linkages. Cycle 1 took the form of a 45 minute workshop delivered in seven groups of 5-7 participants taking place in the design studio. The workshop of cycle 1 took place on 18 and 20 October 2017.

Table 6.2: Structure of Workshop 1

Topic	Time	Notes
1. Identifying issues	10 mins	Describe the city and extract the unsustainable issues associated with it.
2. Cluster issues and identify assumptions	10 mins	Similar issues were clustered by categories chosen by students. It was then asked why are these unsustainable issues? Do they act on a global, regional or local level? How do they relate to social equity, economy and the environment?
3. Proposing solutions	10 mins	Strategies to address these issues are proposed. What issues are they addressing?
4. Mapping solutions	10 mins	Strategies are mapped in terms of their technological and social criteria against the axis.
6. Summary	5 mins	Discuss possibilities of possible strategies: High tech and low tech ways of dealing with sustainability Activity levels of the users in the formation of sustainable strategies

Data were collected through audio recording and transcribing the. Field notes of observations of tutorials and the interim project crit were also taken. The researcher also observed two of the group's lectures. The data collection is outlined in table 6.3.

Table 6.3: Data collection in cycle 2

Date	Activity type	Time	Data type	Description
Continuous	Reflection	-	Reflective diary	Researcher's running reflective diary
4 October	Observation	2 hours	Structured field notes	Master-planning lecture given by external tutor
18-20 October	Intervention	7x45mins	Transcriptions	First workshop administered by researcher
25 October	Observation	2 hours	Structured field notes	Economics lecture given by course convener
27 October	Observation	3 hours	Structured field notes	Student presentations of initial findings
10 November	Observation	3 hours	Structured field notes	Tutorials given by two tutors
17 November	Observation	4 hours	Structured field notes	First interim crit

6.4.3 Findings from cycle 1

Application of the model was dependent on students having preformed ideas, strategies or approaches to sustainability. In two cases the students had returned from field trips and had not formulated a set of initial ideas and were unable to apply ideas to the model. As a tool, the model was simple for students to understand, even those that had not been involved in its development. I was able to draw the axes and explain its use simultaneously on a sheet of A1 paper. I was then able to rapidly write on and describe where the strategies of each project might sit.

In the sessions, the model was used to structure ideas and reveal possible competing approaches. For example, in one case it exposed the contrast between embracing high-tech and low-tech, bottom-up approaches to development.

> "A lot of the home-grown [businesses] there could be considered low-tech. There are plans for development in the area which are focusing more on smart tech and its relation to the harbour area and industrial stuff." (Student from group R)

Students were then able to synthesise the two approaches through citing an example they had come encountered where an app was enabling community engagement in local services. Despite this not directly relating to sustainable development, the model acted as a vehicle to prompt the student to consider combining ideas about community engagement and hi-technology.

The model was introduced through a tutorial format. This had the immediate advantage of engaging students and made it specific to their project. There was an

association with the traditional means of teaching in the design studio which allowed participants to feel at ease with the workshop. Through doing so, the workshop conformed to the rules of the traditional tutorial and it was predominantly student led, often involving a lengthy description of the project. Participants would often have set questions which they required "answered" or in some cases were looking for specific guidance on how to proceed. I found sticking to the structured format of the session was challenging and in most cases the identification and explanation of issues dominated the tutorial. Observations of other tutors in action corroborated that this was typicality of this process.

The structure of the tutorial limited the amount of time with which the model could be discussed. It was not integral to the tutorial but rather an addition which garnered a limited amount of conversation in the last five minutes of each session. Rather than eliciting deep student learning, the functioning of the model required the tutor to populate and act as a facilitator. Participants generally wanted clarity on where aspects of their scheme should sit on the model.

> "When you draw the graph, is it appropriate for this sort of criteria? How about if we include a clean energy plant? Does this fall in the high tech area?" (Student from group H)

In all cases the model stimulated discussion however this was generally limited in scope and length. Through placing disparate ideas on the axis, one group were able to synthesise them into coherent spatial strategy using a piece of infrastructure which connected social and technological themes.

> "Maybe that's where the water comes in...I think the water could be a way to socially engage people…maybe we could think about when it rains it floods and uses water for small farming along the river. Linked to how the city works and flood relief." (Student from group M)

6.4.4 Reflections from cycle 1

The tutorial emerged as a challenging format to administer the model. Participants were often beholden to the "rules" of the tutorial and discussed almost exclusively their own projects with little reference to wider concepts. This supported the observed insular cycle of the design studio where the culture is defined by expected behaviours and

reinforced by tutors.

The model was only of use when students were dealing with concrete proposals or had a set of strategies in mind. This was because of the need to populate the axis in order to compare approaches. Consequently, there was no opportunity for me to introduce the axis when working with two of the groups that had very few strategic proposals. Before the workshops I had assumed the model might be a valuable ideation tool but this was not the case. In part this may be due to the student led nature of workshops which began with a description of their own work.

Despite the tutorials being predominantly student led, I was required to complete the model. I restructured the concepts raised by the participants. While this restructuring of information in most cases added clarity to student concepts, there was limited student engagement. There was no evidence that what was a valuable teaching tool encouraged deep learning for sustainability or indeed altered ways of thinking about sustainable concepts.

In terms of my own practice, I found myself doing much of the analytical work. While students were adept and articulate in explaining their ideas, I found myself taking a dominant role. Indeed, my desire to "shoe-horn" the model into a tutorial session was often uncomfortable and awkward. While some students engaged directly with this alternative teaching method, others clearly viewed it with scepticism or bewilderment. While this was not directly vocalised, it was often met by silence and raised eyebrows. Changing the path of a tutorial, and shifting my own accepted practice proved to be a challenge to both students and me.

Despite these challenges, the model provided a vehicle for *reflection-on-action* by adjusting the typical tutorial format and providing a scaffold to frame ideas. It allowed an objective format with which to critically assess strategies and encouraged me as a teacher to engage in lines of critical questioning that may not have otherwise been revealed. Within the workshops there was a clear restructuring of ideas to synthesise new possibilities, characteristics of deep learning (Warburton, 2003). For example, one group linked a range of disparate strategies through a single piece of architectural infrastructure by identifying them on the model. Nevertheless, it was unclear if this reflection led to sustained deep learning or critical thinking. There was no explicit description of the model in either crits or tutorials while it was impossible to isolate the impact of the model through observations of wider teaching experiences alone.

As a teacher, it encouraged me to challenge my own prejudices, particularly a favouring of social led solutions to sustainable design. This was also apparent in students who were able to legitimise solutions beyond previous expectations.

6.5 Cycle 2

6.5.1 Identifying the problem

Cycle 2 was informed by the findings of the first cycle and aimed to develop a critique of sustainability strategies using the critical model to structure thinking. At this stage in the project, students had far more developed design schemes and associated sustainability strategies. I also sought to develop my own practice based on my reflections from the previous cycle, particularly challenging the nature of the tutorial format. The aim of the second workshop was to critique proposals for design strategies using the critical model. The second workshop had four primary objectives:

(1) Reflect on experiences using the model since the first cycle.
(2) Identify specific sustainable design strategies.
(3) Map proposed design strategies for sustainability using the sustainability model.
(4) Critically reflect on the proposed design strategies.

6.5.2 Planning action

The second cycle was instigated in the same manner of the first cycle, that is through a 45 minute tutorial session delivered directly in the design studio in six groups of 5-7 students. One group opted out of the session as they felt they had "tutorial saturation" and preferred to focus on their work. It took place on the 22 and 24 November 2017. By this stage in the project, students had well developed projects for critique.

In terms of my own practice, I sought to enforce a stronger structure onto tutorials. I was initially concerned that this might undermine the participatory nature of the research, however, I deemed it necessary to challenge existing expectations of studio teaching. Indeed, my experience suggested it was the expectation of a student led tutorial that limited the integration of critical, double-loop learning processes.

Data were collected in a number of ways. Firstly the interventions (workshop 2) were audio recorded and transcribed. This was supplemented by observations of

tutorials and the final project crit in which structured field notes were taken. Interviews were also undertaken at the end of the cycle offering feedback on cycles 1 and 2. Finally, completed project work was analysed. The structure of workshop 2 is set out in table 6.4 and data collection in table 6.5.

Table 6.4: Structure of Workshop 2

Topic	Time	Notes
1. Feedback regarding previous model	5 mins	Did you find the model helpful for structuring your ideas? Did you think about it beyond the session?
2. Discuss effectiveness of crit and tutorials	10 mins	How helpful has the your teaching in tutorials and the crit to develop your sustainable strategies?
3. State aim of masterplan strategy and list design strategies employed	5 mins	What are you trying to achieve? These are written on post-it notes either by students or facilitated by researcher
4. Analyses strategies	20 mins	Break down each strategy into technological and behavioural characteristics and plot on matrix
5. Reflect on findings with possible future solutions/clarifications	5 mins	Strategies are mapped in terms of their technological and social criteria against the axis.

Table 6.5: Data collection in cycle 2

Date	Activity type	Time	Data type	Description
Continuous	Reflection	-	Reflective diary	Researcher's running reflective diary
22-24 November	Intervention	6x45 mins	Transcriptions	Second workshop administered by researcher
30 November	Observation	3 hours	Structured field notes	Tutorials given by two tutors
5 December	Observation	4 hours	Structured field notes	Second interim crit
12 December	Interviews	8x20mins	Transcriptions	Feedback interviews on model conducted by me
26 January	Project work	-	Notes Analysis of work	Analysis of final project work

6.5.3 Findings from cycle 2

The model was used in all six of the workshops undertaken. I began each workshop by asking some clarifying points about the scheme followed by a listing of the strategies they were employing for sustainable action in their masterplan. On occasions I was required to clarify and reveal emergent strategies. This often took the majority of the tutorial. This dialogue offered the students an opportunity to discuss and question their own approaches and also revealed issues they were encountering.

Once the emergent strategies had been listed on post-it notes, the researcher then plotted these on the model which was drawn in front of the group. In all cases, although the listing of strategies emerged from student conversation, I was required to apply these to the axis, often with the students nodding in agreement. It was notable that the students did not construct the model themselves in any instance, nor did they query the position of strategies on the model.

Figure 6.1: Constructing the model in a workshop (group C)

In only half of the workshops did students refer directly to the constructed model. In these instances, the model provided a clear visual representation of design strategies:

> "For a presentation can we use the diagram like that but you've made? We could just pick that up! It's quite good because you can see we have more of the majority in lower tech. It is quite top down. But that's needed." (Student from group B)

In all of the workshops, the model revealed a lack of connectivity between strategic approaches across the scheme. By plotting individual strategies on the model, both participants and the researcher were able to visual identify strategic holes. One student suggested "bridging the gap" was required to link disparate strategies and that

"something more in the short term and more traditional bottom up stuff" might help the group implement their long term goals. A second group used the model to realise that to "list loads of technologies" was inadequate and their design approach needed to "permeate" the scheme. In one case students realised there was a disconnect between what their aspirational approach and the strategies they had actually proposed:

> "We thought we were talking about it is a really active community but I didn't realise how much stuff that doesn't really need people to engage with its necessarily." (Student from group R)
> "The whole point of [the city] is that is really easy for you to do things yourself. We need to get into the scheme more." (Student from group F)

Another group recognised that their strategies had to tackle contradictory issues of drinking water shortages and flooding:

> "I'm worried if we tie it to water there is going to be a shortage of drinking water when we really want to speak about the river. And city and land won't be an issue but water and flooding will be an issue." (Student from group C)

This was supported in the end of semester interviews in which students were able to cite examples of how the workshops had revealed omissions in their thinking:

> "I think looking at our project you could see there were massive gaps. So we put it [the model] up on the wall and we could really see those. I think we were really top-down so we are starting to bring some of the more bottom-up things into the masterplan." (Chris, student, group B)

In four of the six cases, students explicitly identified how the model had clarified proposals and linked disparate strategies. One group identified a river that ran through the centre of their city was the "catalyst" for development and provided clarity to their work:

> "So it keeps coming back to how this [the river] is forming everything." (student, group G)

A second group recognised a tram network they were forming through their city was the common element across a number of sustainable strategies (figure 6.2).
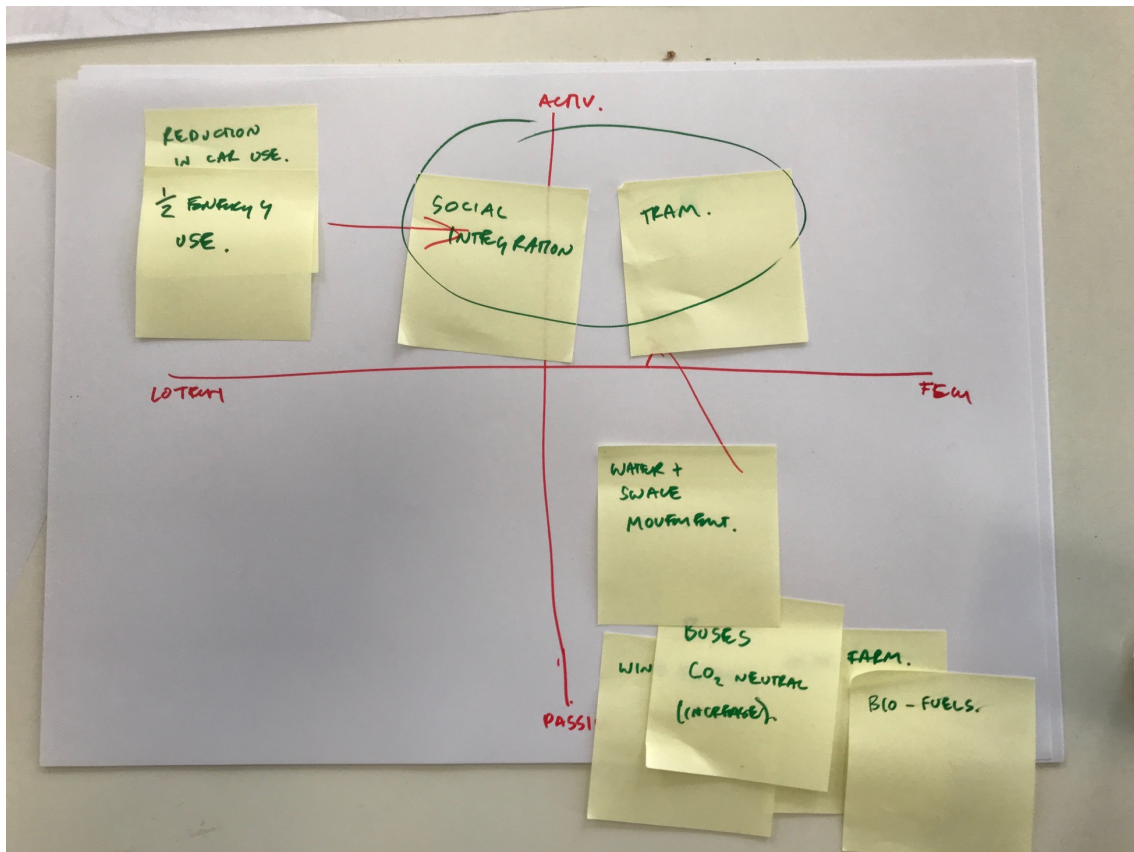
Figure 6.2: Example of mapping using post-its and the model (group B). Ideas are plotted and linked through the introduction of an overarching infrastructural strategy (tram network).

A third group used the discussion prompted by the model to connect sustainable farming to an economic strategy that already existed in their chosen city.

> "You could work out how economically the hydroponics would work and get different companies to invest in it. It's a different example but the walkway/yellow concourse, each company that invested has their name along it so it lets you know who bought it." (Student, group A)

Figure 6.3: Model constructed from group A

In interviews at the end of the semester, students revealed how the sessions prompted a change in narrative approach of their group. On student described how the workshop had prompted their group to recompose their ideas into a single coherent strategy:

> "…after we had that meeting with you we could link all those things together and they could be solved through one system. The swales came in and we stopped seeing them as different problems and realised we could do them together."
> (Emma, student, group B)

Another group described how the workshop had made them realise what the primary driving force of their design was:

> "We did [use the model] for a couple of days. We pushed aspects of it such as we wanted it to be really futuristic and more technical and that was lost along the way as more things came through. But now the biodiversity and the wetland we're creating is the driving force and that can be flooded so elements that we didn't think before with the axis [the model] have come in." (Sylvia, student, group E)

In two of the workshops, groups used the discussion from the model to generate new

ideas, realising where new strategies might enhance existing proposals. One group decided that burning waste was an incongruous approach and that actively engagement residents to reduce waste might be more effective:

> "Other cities don't have this waste burning infrastructure. So they can't burn this much waste. So maybe we can't do that. It's already there [waste incineration in the city]. So if we push the active approach through our tram stops then that's a strategy in itself." (Student, group B)

Another group recognised opportunities for combining large scale infrastructure with education and linked this to personal experiences:

> "You're talking about them engaging with the community. I can remember my secondary school going to power stations and you walked round a huge power station. It is impressive." (Student, group C)

When describing the influence of the model, no students claimed however, that it had encouraged them to generate new ideas. In almost all cases, the students saw the sessions as providing greater clarity to their overall sustainability approach. Where students were asked about the influence of the model on learning, there was mixed reaction to its impact beyond the workshops. One student was almost ambivalent to its efficacy:

> "I wouldn't say we've built in it that much but I do think it's an interesting way of thinking about it." (Phil, student, group F)

Another considered it valuable and effective but was unable to articulate their learning directly:

> "It's quite difficult to pin down what because it was early-stage" (Anne, student, group E)

By contrast, some were able to describe directly the impact of the model on their learning:

> "I remember from that day. I don't think I was in the meeting but [another member of the group] redrew [the model] and they sat down and re-explained what you'd

said and it made sense what had been done. I suddenly realised all these things
came together so it was definitely a catalyst for the thing." (Emma, student, group
B)

6.5.4 Reflections from cycle 2

I made a deliberate effort to structure workshops; to make them run according to my
predefined schedule. However, sessions tended to lose their focus, consisting of long
periods of students describing and clarifying approaches. Ideas were presented in an *ad
hoc* manner, often skipping at random between points. The introduction of props (post-
it notes and drawing of the model) to some extent alleviated this but this was often late
into the tutorial.

I was required to construct the model and although the students described their
ideas, I synthesised and applied them to the model. While this provided a useful tool
for further discussion, it limited student engagement with the model. The traditional
tutorial format led to student expectations which undermined critical dialogue. I found
challenging these expectations and engaging the students actively through the model
problematic.

The learning processes that emerged from the tutorials were often not directly
related to the model but rather the emergent discussion. There were two cases where
students referred directly to the model and in one of these, clear visual representation
allowed succinct and focussed recognition of issues and opportunities.

The students exhibited learning characteristics consistent with deep learning
directly as a result of the introduction of the model. The model encouraged students to
observe relationships between different elements, analysis of ideas, imaginatively
reconstructing information and formulating new hypotheses (Smith & Colby, 2007;
Warburton, 2003). Yet there was little evidence that the model or tutorial helped
enhance intrinsic learner motivation. The facilitation of the model by the researcher
undermined the student centred approach essential to a deep learning strategy (Clune,
2014) and there was no evidence of the model having a meaningful effect beyond the
workshops in either observed tutorials or crit scenarios. Observations of subsequent
tutorials and crits (one week, three weeks and four weeks later) provided insight into the
direction of projects and the types of strategies being employed however there was no
explicit evidence of the model in use.

The session again drew into question the nature of my own practice. It was challenging not to be drawn into conversations about spatial and formal issues. I became acutely aware of my own lack of specific knowledge. For example, this was clear when students asked for precedents of particularly successful smart cities and I was unable to provide answers. While I sought to enhance critical thinking in the context of sustainability, this was no substitution for addressing the desire from specific knowledge from students. Observations of tutorials revealed how tutors were quick to suggest ideas which the students might "test" in their design work. On occasions this left my own practice exposed and I felt myself retreating into the comfortable realm of spatial and formal analysis.

6.6 Cycle 3

6.6.1 Identifying the problem

Cycles 1 and 2 introduced the model to the participants and succeeded as a teaching aid to structure and tutorials. Despite this, there was little evidence of students utilising the model outside of tutorials or that it was empowering participants to take control of their learning. Emancipatory action research calls for a change to the nature of the practice but also the context of the practice. While the model provided some effectiveness in improving the nature of practice (notably the structure of the tutorial and student understanding) it did not served to significantly affect the context in which sustainable knowledge is produced (the nature of the design studio process).

The aim of the third cycle of action research was to empower participants to alter their own practice through questioning the implicit values of the architectural design studio. Independent application of the model as a tool for structuring sustainable design information was promoted. Cycle 3 had the following objectives.

(1) Facilitate independent use of the critical model.
(2) Examine the impact of the model on design practice in the studio.
(3) Assess the impact of the model on learning for deep sustainability.

6.6.2 Action planning

This cycle took place in the second semester when students had moved to individual

building designs. The participants were formally introduced to the model and asked to use it in their design work. Examples of the extremes of the model were offered as well as an indication of how it may be used in practice. The model was also introduced to the sustainability tutor and year coordinator before the beginning of the semester with the explicit aim of making them aware of the model and suggesting how it might affect their own practice. These members of staff also acted as informants as to whether the model is causing an alteration in design approaches. The data collection schedule for cycle 3 is outlined in table 6.6.

Table 6.6: Data collection in cycle 3

Date	Activity type	Time	Data type	Description
Continuous	Reflection	-	Reflective diary	Researcher's running reflective diary
8 January	Staff introduction	45 mins	Notes	Introduced the model to the year convener
24 January	Staff introduction	2 hours	Notes	Introduced the model to the sustainability tutor
5 February	Student introduction	30 mins	Notes	30 minute introduction to the use of the model and the design process
6 March	Sustainability tutorials	3 hours	Field notes	Observations of tutorials
8 March	Sustainability tutorials	2 hours	Field notes	Observations of tutorials
16 March	Interim review	4 hours	Structured field notes	Observations of crit
20 March	Sustainability tutorials	3 hours	Field notes	Observations of tutorials
18 April	Interim detail review	4 hours	Structured field notes	Analysis of interim project review
May	Feedback interviews with students	20x5-10 mins	Field notes	Feedback interviews on model conducted by researcher
24 May	Project work	-	Notes Analysis of work	Analysis of final project work

6.6.3 Findings from cycle 3

The model was initially introduced to the sustainability tutor and the head of the year. The sustainability tutor described how many tutors started with sustainable aspirations which got "watered down" throughout the project. There was a desire to push student schemes to explore specific agendas in detail however it was accepted that this may leave the student exposed to easy criticisms. For example, the head of year felt tutors often ask the "easy question" (such as exposing omissions in extreme projects) which

inadvertently may lead to an avoidance of risk. The sustainability tutor suggested students could plot where they are in the first session on the model and where they are aiming to be or expect to get to. He also suggested it would be good to get different disciplines views on sustainability.

The model was presented to students in a lecture given by me at the start of the semester. They were given a hand out to which outlined the model for use in their individual design projects. During the semester, tutorials were observed on three separate occasions. These were led by the sustainability tutor who had been briefed on the model. The sustainability tutor structured tutorials firstly by asking the students to identify five key elements of sustainability that they were focussing on. Students explored a range of themes including waste, ecology, water conservation, electrical generation, ventilation, passive cooling, materiality and heating. These themes were driven by the programmatic requirements of the building and the geographical context of the project. Students did not place these concepts within a wider critical understanding of sustainability, nor were they connected to political or ethical beliefs. Tutorials tended to focus on technical problem solving aspects of each of these issues, avoiding wider conceptual approaches. This was driven by the background of the sustainability tutor who was from an engineering background. While this was valuable to provide specialist knowledge, in some cases, environmental issues could have been addressed through simple architectural moves, rather than the addition of technical systems. For example, one student was struggling to cross ventilate rooms which it was suggested a mechanical ventilation system could be used. I suggested a simple rearrangement of the plan could, allow the rooms to become dual aspect, allowing natural ventilation to occur. In all the tutorials observed, the model was not used as a learning device by either the students or the sustainability tutor.

Students were interviewed for feedback on their use of the model one month before the final project hand in and end of the semester. Of the 42 students in the year, 21 were available for interview. When questioned, students described the use of the model in three different ways: full engagement, partial engagement, non-engagement.

Three students described full engagement with the model. These students described how the model had influenced their design decisions directly. One student (Pierre, student, group E) had the model pinned on the wall in front of him and identified his design as being high-tech and socially passive. In his words this is because he considered "people as being lazy" and so had felt the building had to

actively enable sustainability. Another student (Harry, student, group D) had used the model in his final design report to justify a passive and socially engaged approach. These students spoke of how the model had influenced them at the start of their design work and provided a goal to "work towards". In one case, after these initial strategies were decided, there was a gap in which the student dealt with other design considerations before returning to the model to provide structure in the detail design stage (Pierre, student, group E). In these cases, their sustainability strategy tended to be strongly linked to the "narrative" of the architecture. One student with a high-tech sustainable design approach linked this to intensive food production (Pierre, student, group E) while another who identified as operating on the participatory side of the spectrum spoke of a building that engaged local people by creating a "community exchange" (Harry, student, group D). A third student positioned himself as developing a "high-tech" sustainable systems had constructed an architectural narrative around water and ice research in the arctic (Brian, student, group A).

The majority of students (14 of the 21) described how they used the model indirectly. A common phrase used was "it was in the back of my mind". These students spoke of an "awareness" of sustainable potential that the model had given them. The model was utilised at a variety of stages throughout individual design processes. Most commonly, they engaged with it at the start of the design process where students described a process of positioning on the model then "thinking about it" throughout the design process. Reviewing their work, others described how this may have helped give focus to their project. Two of the students described how tutorial input throughout the project would have encouraged greater use of the model. One student (Chris, student, group B) described how it was easy to get lost in "architectural concepts" and input themed around the model might have kept the sustainable strategy more focussed. The model was occasionally used to post-rationalise sustainable strategies. One student (Kristen, student, group G) described the model as "useful to react against" possible tricky questions and to "push" particular arguments.

Four of the students interviewed, did not describe explicitly interacting with the model. For two of these students (Martha, group B and Phil, group F), their projects were characterised by strong sustainable agendas. Philip described how the model had been more useful at master-planning level and when designing the building it was too easy to get "tied up with small things". His experience of sustainability tutorials led by the sustainability tutor was one of technical input and he felt it undermined the strategic

aspects of sustainable design. Michelle described how as the model had not been "pushed" throughout the term, its use had fallen away. Despite this, she was able to easily place her project on the model and described a low-tech, participatory sustainability strategy that responded to the specific local context (group C).

A common theme was the feeling that the model had been more useful at masterplanning stage. In the individual projects on specific buildings, students spoke of how they often got side-tracked with other design concerns. For many, the active workshops delivered in the first and second cycles of the research were far more effective than being given the model as an independent tool. Structured tutorials which objectively analysed potential strategies, using the model as scaffolding tool generated much greater engagement with the model.

6.6.4 Reflections from cycle 3

In the third cycle I had limited contact with students. This was intentionally designed to examine their own independent use of the model. To some extent, I was disappointed to see the critical thinking *tool* that had been carefully crafted in collaboration with students was limited in its use. Both as a researcher and teacher, I found myself wanting to impose the model onto student design practices. Standing back from direct teaching and observing a reversion to more standard design practices I questioned the effectiveness of the model.

I found the nature of the formal sustainable tutorials delivered by a specialist tutor challenged holistic and critical sustainable design. The emphasis on solution finding, usually using technical approaches, perpetuated the notion that sustainable design is an additive process, external to the main task of building design. This was particularly true in building scale projects as advice tended to be more specific relating to particular solutions to isolated sustainable issues.

When the model was introduced as a tool for independent use, engagement was mixed. While a number of students actively used it to shape the primary generators for sustainable design, for others, the model was either subconsciously engaged with, fell out of use or not engaged with at all. For some, this was because it was not being "pushed" as a tool to be used while for others, they deemed it unnecessary in their project. This latter group tended to include those who had developed particularly strong

sustainability agendas in their projects but also those who had pushed sustainable design to the back of their agenda.

I also found collecting data more challenging towards the end of the project. In the first two cycles students were willing to give up time for brief interviews and the active workshops acted as a rich data source. In cycle 3, students were under significant pressure and were far less willing to commit time to thinking beyond the direct output of their design work. In observations of sustainability tutorials, these became progressively more focussed until the sustainability tutor abandoned group discussion altogether under student pressure. I was occasionally met with hostile looks or lack of engagement when I approached students to discuss the model. In the context of an action research project, this represented a reversal from the participatory approach which characterised the initial phases of the project. By removing myself from the environment of the studio and its associated design practice, I inadvertently generated a hierarchy of researcher and participant.

6.7 Tutor interviews

At the end of the 3 cycles, the model was presented to the tutors on the course through individual interviews. Four of the five tutors on the course were available for interview, as well as the sustainability tutor.

It was initially discussed with the sustainability tutor before the start of the third cycle with a view to integrating the model into his teaching. It received an initial positive response from both him and the head of the year, which included suggestions of alternative models and ways in which students might map their own expectations onto the model and strive to meet them. Despite attempts to instigate a workshop format, in which a small group of students discussed each other's issues in a seminar format, tutorials quickly reverted to a procedure of individual problems being raised then being technically "solved" by tutor. Despite the researcher's presence in the tutorials, opportunities to use the model to structure critical thinking were few. Student expectations governed the nature of these "sustainability" sessions in which they were expecting resolutions or technical input into their design proposals.

At the end of the cycle, four of the five studio tutors were interviewed and the model was presented to them. The tutors expressed interest in the model which was met with positive feedback. One tutor suggested structuring tutorials through such a tool might encourage student focus while another suggested the model might provide

inspiration of innovative design solutions. However, there was both clear concerns about how it might be incorporated into teaching practice. When asked about using the model in teaching practice on tutor put it:

> "I'm not averse to it, but I always try and administer in a background subtle way"
> (Michael, tutor)

Indeed, the same tutor expressed concerns about how such an approach might restrict tutorials, limiting the open ended discussion technique which they used in the sessions. For another tutor, the model acted as a point of departure for discussing alternative global approaches to sustainable design. Tutors also expressed concerns about the oversaturation of tools in the design studio.

When tutors described their own teaching methods, they all spoke about how they delivered unstructured, one-to-one sessions. Working with individuals and modifying tutorials to meet their needs was a key part of their philosophy.

> "I'll bring in stuff - books, references, my own work. It really depends on what
> their project is and what they're doing. So it's quite tailored really." (Arlene, tutor)

The importance of listening to students, responding to their work and allowing time and space to tackle unique and particular issues were all important. None of the tutors, for example, engaged in group sessions or structured workshops as part of their teaching practice.

> "I think time for me is really important and if you try and do it too quickly I feel
> like I haven't quite resolved or know [how to help]" (Alison, tutor)

While the model was viewed as a valuable and intriguing contribution, there was clear misalignment between its implementation and current tutor practices.

6.9 Discussion

6.9.1 Delivering the model and impact on practice

It became clear throughout the cycles that teaching method and the use of a critical thinking "tool" (the model) were inherently linked. In cycles 1 and 2 interaction and

engagement with the model was high due to my own agency. Introducing the model myself, asking probing questions, revealing strategies then mapping them onto the model elicited the clearest examples of deep learning observed throughout phase 4. In the second cycle, there was clear evidence of restructuring of information to generate new design possibilities (Warburton, 2003), forming relationships between different parts (Smith & Colby, 2007) and enabling a more holistic understanding of sustainable design (Marton & Säaljö) that was explicitly linked to individual design strategies. In cycle 2, designs were more developed and the model could be operationalised as an evaluative tool.

The group seminar formats of cycles 1 and 2 also aided implementation. Having six or seven students engaging in active discussion allowed greater potential for co-producing knowledge and sharing experiences (Gibbons et al., 1994). In cycle 3, individuals tended to work alone, and interact with tutors individually. Without the influence of a group or structured discussion, they relied on heuristic processes to develop and evaluate their design proposals.

By contrast, proffering the model in cycle 3 and expecting independent use and alterations to design practice was unfeasible. Uptake and use of the model was relatively limited. Most commonly, students described their use of the model as being "in the back of their mind" and "raising awareness" of sustainable issues. With the exception of three students, it had little significant impact on the practice of design and without it constantly being "pushed" students found it "fell away" from use. While in workshops the model had been used as an evaluative tool subsequent to design attempts, when used independently, students reversed this process and understood it as a potential "target" to work towards. They were then able to evaluate their proposals against this initial objective.

The model was most valuable as a teaching resource to challenge the traditional format of tutorials and offer alternative routes to enable deep learning for sustainability. The structured nature of the workshops produced an illusion of "objectivity" which allowed students to critically evaluate design decisions. For some students, it was the simple act of listing strategic approaches that they found the most valuable.

> "We joked that the tutorial we had with you was the only useful one, our whole
> thing was about sustainability but yours is the only tutorial that was super focused
> on what the project was actually about." (James, student, group B)

Warburton (2003) contends that providing critical thinking tools to enable deep learning is an essential aspect of sustainable teaching however the findings suggest that provision of the tool alone is inadequate. In the education of architecture, where learning is made analogous to a pseudo-design process, the provision of resources alone is not enough to change practice and subsequent learning.

6.9.2 The sustainable design model, deep learning and the design process

Feedback on the model showed that it influenced learning more substantially in the masterplanning section of the project. While this was in part due to the nature of the delivery (see 6.9.1) it was also observed that the abstraction of a masterplan and its large scale and diagrammatic nature limited the influence of alternative design concerns. Sustainability was a prominent theme for design in a process that tended to *instrumentalise* the city. Students were liberated from issues of form, style and appearance (and to some extent programme and organisation) and were able to focus on wider strategic goals. In some cases this allowed rich sustainable strategies that dealt with numerous environmental and social issues through both technical solutions and participatory action. The model clearly facilitated a number of the characteristics associated with deep learning including the creative restructuring of information as well as its analysis (Warburton, 2003). In the framework set out by Beattie et al. (1997) there was clear evidence of examining the logic of arguments and following through to conclusions.

However, there was less evidence of *double loop* learning (Argyris & Schön, 1974) and questioning assumptions of the system in which the learning take place (Beattie et al., 1997). While some students appreciated the more structured and objective tutorial format to question and analyse particular issues, there was limited evidence of questioning the place of architecture in the broader context of sustainability.

By contrast, in building design projects, alternative design concerns took precedence. Both tutors and students described a lack of focus on sustainable design in favour of more conceptual, practical or "architectural" design generators. This points towards a "hidden curriculum" (Dutton, 1987), a collection of values, assumptions and norms that governs design practice in the studio. This undermines a genuine deep learning approach in which knowledge must be related to previous experiences (Beattie

et al., 1997). It is this socially constructed conception of architectural design that in many cases limited foci on sustainable or alternative design processes.

6.9.3 Teaching practice

Tutors were reluctant to adopt a structured tool in their teaching practice. For architectural tutors, there was a perception that it undermined the philosophy of personal and tailored tutorials, specific to individual students. Tutors spoke of their desire to "understand" students or rely on probing questions so they could seek their own answers. When introduced to the model it was viewed with caution; possibly as a threat to conventional practice. For tutors in specific "technical" subjects from disciplines beyond architecture, they tended to adopt a problem solving approach to tutorials focussed on practical resolution.

In my own teaching practice, having been educated in an identical design studio system, I was found modifying my approach challenging. Not only did I find adopting a structured approach uncomfortable to implement but I sensed this ran against student expectations of a design studio tutorial. Developing a rapport with students, understanding their own motivations and altering practice accordingly is a key aspect of my own practice (Webster, 2004). Adopting formal processes with perceived inflexibility processes challenged my own assumptions on the nature of architectural education and my ability to develop personal relationships with students.

This points towards the need to encourage genuine critical pedagogies in the design studio in which teaching staff base tutorials on dialogic questioning (Darder & Baltodano, 2003). With the exception of one tutor (Michael), other tutors were observed to weight their tutorials towards more transmissive and mastery learning approaches Goldschmidt et al. (2010). The hierarchical relationships described by (Willenbrock, 1991) were still a feature (albeit more subtle than Schön's description) of the studio pedagogy. Scholars have noted the need the apply a blended learning approach which combines mastery and discovery learning (Warburton, 2003). The structured workshops described in this chapter offer one method of moving the formal interactions of the design studio, especially in the realm of sustainable design, away from an applied technical approach and towards a more discovery based methodology. This would enhance deep learning through encouraging ownership of knowledge creation in which the experiences of the student form the basis of effective learning

(Clune, 2014). It can also aid the transformation from intuitive tutor practices to deliberate, reflective and structured teaching (Webster, 2004).

6.9.4 Practical implications

Throughout the course of phase 3, I encountered a range of practical issues. At the fore were the ethical concerns I had about student participation. Despite workshops being structured around their design work with a specific view to enhancing practice, for some students, they felt the general number of tutorials was far too high. Some described it as reaching "tutorial saturation" in which their week was so dominated by teaching events that it disrupted their ability to progress in their coursework. This was a particular concern when asking students to be interviewed. Despite relying on a volunteer sample of willing participants, I limited the length of these exchanges to minimise disruption.

There was a similar story with design tutors most of whom worked on a part time basis. Securing interviews with busy tutors, who were on campus for only one day a week and often worked through their lunch hours was challenging. While they were willing participants, the impact on their time was evident.

As McNamara (2011) has noted, deep learning is challenging to observe as its characteristics may not be vocalised, articulated or explicitly displayed in an observational setting. My approach involved a triangulation of data from observations, workshops, interviews and coursework and relied on students being able to point to evidence for learning in their work. For some students this was relatively straightforward, however, many found it challenging to articulate or describe. I was often faced with vague comments about how the model had a "general" influence or "raised awareness" without specific examples.

I found I underestimated the inertia present in the design studio. I had assumed that introducing a tool for critical thinking and applying it in practice would be a relatively simple task. This was founded on the positive reception I had received in phase 2 of the research. Introducing new and alternative practice, as a part time tutor with limited student contact time and course impact was immensely challenging. Over the course of their architectural education students had constructed their own processes influenced by successive teachers, practical experiences and institutions. Even those students who had played key roles in constructing the model did not demonstrate major changes to their design processes.

6.10 Conclusions and recommendations

6.10.1 Conclusions

The conceptual model was shown to be a robust tool for critiquing and evaluating design solutions. When it was used most successfully, it was used to clarify ideas, restructure them and synthesise new proposals from the linkages that emerged, traits commonly associated with deep learning (Warburton, 2003). It was not observed to act as a standalone tool for ideation or informing "primary generators" (Darke, 1979).

Success of the model was linked directly to its teaching. When specific models were mapped with my own facilitation, students were most engaged and gained the most from sessions. Conversely, when given to students to allow them to introduce it into their own practice, utilisation was far more limited. Without continuous advocacy by tutors and educators, the use of the model as an evaluative design tool was surpassed by accepted practice. There was little evidence for the impact of the model on individual design practice. This was dominated by existing heuristic methods developed over participants' design education. This draws into question both the synergy of the model to the critical method, but also of current design practices as a vehicle to encourage deep learning for sustainability.

Using an action research approach can be a valuable method for enhancing professional practice for educators. My experience made me question my own assumptions of what I considered "good" teaching in the studio. This process however has to be a personal and self-motivated one. Imposing action, or asking other educators to change theirs in light of practice undermines the very nature of AR. Ultimately, the embedded assumptions, culture and expectations of the design studio limit the effectiveness of introducing new ways of working.

6.10.2 Recommendations for further action

Further research should focus on building shared knowledge among tutors and students. To effect change in either teaching practice or design practice the introduction of methods alone is inadequate. Rather, collaborative action in which all parties have a shared stake in building and developing knowledge, must be encouraged. This could be through the creation of participatory groups who work together to change and alter practice. The outcomes of the fourth phase of the research require validation which is

examined in the fifth phase of the research. Developing the findings into a coherent framework is necessary to make the results transferable to wider practice which is addressed in chapter 8.

Chapter 7. Validating the findings: model and application

7.1 Introduction

7.1.1 Aim of the chapter

This chapter describes further research undertaken to confirm the results of previous chapters. Although validation procedures have been embedded throughout the research (these are described in detail in chapter 2 and subsequent chapters) this chapter seeks to enhance understanding of their conclusions. This validation procedure looked at two distinct outcomes of the research:

- The model of sustainable architectural design.
- The application of the model of sustainable design in the architectural design studio.

This chapter provides a short summary of the findings of the validation processes. More detailed findings and data can be found in appendix A and appendix B.

7.1.2 Validity in naturalistic research

Validation in an Action Research paradigm varies significantly from traditional research. The contextual specificity of the research prevents repeatability or generalisation. The research instead sought trustworthiness (Lincoln & Guba, 1985), outlined in chapter 2. In traditional research, validity might be considered internal or external. Credibility refers to the equivalent of internal validity (how well can the research confirm the relationship between the variable considered) while transferability is the naturalistic equivalent of external validity (how well can the research transfer to other contexts). Mays and Pope (2000) propose a similar framework which emphasises *validity* (by which they refer to procedural principles during the research akin to internal validity) and *relevance* (their equivalent of external validity). For consistent terminology, I will refer to *internal validity* and *external validity* throughout (Hammersley, 1998).

 Internal validity

Chapter 7. Validating the findings: model and application

Internal validity (or credibility) typically refers to the accuracy of the measurement in quantitative research (Hammersley, 1998). In qualitative research, it might be understood as accurately describing the situation under observation (Hammersley, 1998) to draw logical and "valid" conclusions. Mays and Pope (2000) suggest six criteria for establishing internal validity, however, there is still judgement required on the behalf of the researcher (table 7.1).

Table 7.1: Procedures for internal validation modified from Mays and Pope (2000)

Criterion	Description
Triangulation	Using multiple data sources to identify convergence to corroborate interpretation.
Member checking	Comparing the researcher's account with respondents own interpretation.
Clear exposition of methods of data collection and analysis	Providing sufficient data and description of analysis to allow the reader to judge interpretation.
Reflexivity	Acknowledging biases and agency of the researcher.
Negative cases	Identifying and discuss contradictory data.
Fair dealing	Incorporating a wide range of perspectives

Internal validation procedures are embedded throughout the research as discussed in chapter 2, however, these procedures are expanded on in this chapter to provide additional validity to the research.

External validity

External validity (transferability) questions the value of the research as being applicable, or useful, to other contexts. Furthermore, *relevance* describes whether it adds to, or enhances existing knowledge (Mays & Pope, 2000). Typically this may be achieved through providing a *thick* description of the research (Lincoln & Guba, 1985) which is sufficient to allow the reader to form judgements about the research. Sampling techniques also improve external validity (Malterud, 2001). For example, probability sampling may ensure the results represent a broader population, or population samples might be expanded after initial findings (Mays & Pope, 2000).

7.1.3 Assessing validity in the research

In the research, validity procedures depended on the outcomes of the research. The model of sustainable design represents a process of theory generation, an inductive process formed from the testimonies of a limited sample. Accordingly, external validity was the primary concern; how much could the theory be considered universal. By

contrast, in the Action Research phase, this was specific to its context, attempting to apply a the general model to a unique circumstance. In this case, internal validity of the relationship between the model application and positive learning outcomes was of importance.

This chapter is divided into two sections. The first section looks at validating the model of sustainable design. Concerning external validity, this looks at expanding the sample size to validate the results against a more representative sample. The second section examines application of the model through the Action Research. This uses a series of case studies to triangulate longitudinal data, explores negative cases and uses member checking to enhance internal validity.

7.2 Validating the model

7.2.1 Introduction to the Delphi technique

In the preceding chapters, a model that captured sustainable architectural design approaches was developed through expert interviews and an action research process. In this chapter, the model was validated directly with professionals utilising the Delphi Technique. Despite focussing on the transferability (external validity) of the model, this validation phase also offered an opportunity for enhancing credibility.

The Delphi Technique is a tool to facilitate a group consensus remotely among experts (Ziglio, 1996). This allows the mobilisation of the expert participants from phase 4 of the research to validate the findings that emerged from the analysed interviews. The Delphi Technique provided a structured means to enable this confirmatory process.

Acting as a validation exercise, the Delphi technique was designed to confirm the attitudes and agendas of a range of sustainable practitioners. It was important to allow practitioners to provide meaningful input based on their own expertise (Ziglio, 1996). In this case, their own expertise consisted of their professional knowledge accumulated through their own individual practice. When validating the model, therefore, it was essential to allow them to reflect on their own specific knowledge rather than make assumed inferences about the conclusions of the research or the model that had been tested. Instead, the Delphi was designed to elicit the most important and least important issues in sustainable design to a wide range of sustainable practitioners. This was used to identify areas of concurrence-where there was expert agreement on the

importance of a particular issue as well as areas of divergence which characterised alternative approaches to sustainability. This was then referenced against the established model to confirm or deny the characteristics of alternative practices.

7.2.2 Aim of the Delphi technique

The aim of the Delphi study was to validate the model established in preceding chapters as a representative understanding of sustainable practice in the UK. This had the following key objectives

(4) To confirm the credibility (internal validity) of the sustainable model.
(5) To confirm the transferability (external validity) of the sustainable model.

7.2.3 Methods and analysis

A full methodology is outlined in detail in Appendix A. In the Delphi study, practices were clustered based on similar responses to form a series of distinct groups. Group responses were then assessed to identify the differentiating characteristics.

7.2.4 Achieving validity

Internal validity

Although the primary aim of the the Delphi technique was to confirm external validity of the model, the internal validity was also enhanced . This process draws from Mays and Pope (2000) methods five aspects of achieving internal validity in qualitative research. Although the Delphi technique itself draws from quantitative and statistical methodologies, the start point of this research was based on the interviews with practitioners.

Member checking was the primary means of validation (the presentation and confirmation of findings with participants) (Lincoln & Guba, 1985). Four practices participated in both the interviews and the Delphi study allowing their data to be compared. In each case their Delphi responses were then compared with their original interview data. This was done through comparison of the practice groupings formed at Delphi and interview stage. As each group was identified by a consistent set of characteristics, it was expected that similar characteristic types would be observed.

Chapter 7. Validating the findings: model and application

This also helped identify negative cases that were not consistent across different phases. This process also represented not only a triangulation from multiple data sources (surveys and interviews) but also different research methodologies. The process highlighted negative cases, for example practices that did not fit the model proposed in previous chapters. It also provided "fair dealing" (Mays & Pope, 2000) through the equal treatment of different cases.

External validity

To assess whether the model was transferable to a broader context, the sample set for the Delphi method was expanded to a wider range of practitioners. This allowed the findings of the original interview, based on a selective sample of participants might be representative of other experts in sustainable architectural design. Rather than focussing on leading sustainable practitioners, the sample set was widened to include practices on registered on the Green Register of architects. The Green Register is a UK organisation which trains building professionals to enhance their sustainable building practices, covering "all aspects of sustainability" (The Green Register, 2019). This allowed a broader range of practitioners, specifically concerned with sustainable design to assess the model. This sampling is described in detail in Appendix A.

7.2.5 Checking for internal validity

The groupings of the four practices that completed both the interviews and the Delphi study were compared in table 7.2.

Table 7.2: Summary of results of member checks from Delphi study.

Practice	Group from interview phase	Grouping from Delphi Phase	Consistent characteristics
N	Mid-tech/intermediate	A1 - "Ecological modernism"	Yes
O	Mid-tech/participatory	A1 - "Ecological modernism"	Yes
I	Low-tech/participatory	A2 – "Eco-centrism"	Yes
M	High-tech/authoritative	A2 – "Eco-centrism"	No

Practices N, O and I confirmed the results of the interviews. That is their groupings were consistent across the Delphi study and the interviews phases. Practice N was categorised as mid-tech/intermediate at the interview stage and fell into cluster A1 (ecological modernism). Both these groups have common characteristics including the importance of standards (such as BREEAM), and a focus on high performance building

fabric. Practice O also fell into this same cluster at Delphi stage however were categorised as mid-tech/participatory at interview stage. However, this could be expected, in part due to the additional categories generated at interview stage. Similar attitudes to technology (a focus on building fabric, passive performance and adoption of standards) were observed in both phases. Educing clients and stakeholders was ranked higher than practice O for the other practices in the group which confirms the practice's commitment to human centric approaches. Practice I were categorised as low-tech/participatory at interview stage and group A2 (eco-centrism)at the Delphi phase. Both these groups exhibit consistent values of an interest in natural building materials and a concern for local, cultural contexts, confirming these findings.

Practice M, represents a negative case in which the categorisations across each phase did not align as expected. The high-tech authoritative categorisation at interview stage exhibited a top-down approach which focuses on technological innovation. However, at the Delphi phase, the responses clustered in group A2 (eco-centrism) expecting a focus on natural building materials and local context. This may be due to the particular work of the practice involved who had two parallel strands to the their office: one which focussed on highly specialist and technical buildings in extreme climates; the other focussed on conventional buildings in the UK. The interview concentrated on the technical buildings which may not be representative of the majority of the practice's work. It is also worth noting that integrating innovative technologies, construction techniques and materials in building design ranked more highly (scoring +1.3 higher than the mean) than the other practices in this cluster. Collaborating with clients and health and well-being were also ranked more important the other practices in the same group (+2.6 and +2.0 repsecitvely).

7.2.6 Checking for external validity

The expanded sample set was then analysed across the two Delphi rounds to identify whether the conclusions drawn in phase 2 and 3 of the research applied. The research identified five differentiating themes which defined each individual cluster through relative importance: respect for nature; cultural context; non-polluting processes; technical measurability; and social transformation. However, clusters of individual practices did not oppose each other in their responses but rather placed different weightings on the value of certain sustainable themes. These themes and the correlation

between them indicates the presence of three broad paradigms that characterised individual practice. These may be termed the natural (eco-centrism), measurable (techno-centrism) and educational (human-centrism).

Natural

There was a clear correlation between non-polluting natural building and a concern for local and cultural context. Indeed, these themes were only differentiated at the five cluster level (see appendix A). This maps closely to the wider concept of *eco-centrism*; defined by O'Riordan (1989) as a broad, all-encompassing paradigm, however more precisely considered by Guy and Farmer (2001):

> "Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and "flourishing" of local and global biodiversity." (Guy & Farmer, 2001)(p.141).

It is this shared concern for locality and nature that encompasses the eco-centric approach.

Measurable

The research shows that *measurable* practices were not concerned with innovative technologies (a subject that ranked universally low) but rather this might be considered as measurable building performance. Measurability might involve technical analysis but it could also be considered a conformance to national and international standards. In the language of O'Riordan (1989), this is a weak form of techno-centrism termed *accommodation* which places faith in overarching institutional values. In the context of UK architectural practice, techno-centrism is not so much a faith in technological application but a reliance on measurability and precision.

Educational

A third paradigm emerged which might be considered educational. This was captured by a concern for client and stakeholder education, a differentiating factor in some clusters. Education as a means for achieving sustainable design falls outside the eco-centric/techno-centric spectrum (O'Riordan, 1989). It most closely maps to the notion of

eco-socialsim (Guy & Farmer, 2001): the "reconciliation of individual and community in socially cohesive manner" through the implication of user empowerment. However, the responses fell short of indicating the importance of genuine "participatory" processes which were not mentioned in any of the open text comments.

The findings suggest a tripartite model may more accurately reflect sustainable building design in the UK, rather than the "axes" of eco-centrism and techno-centrism previously suggested. The spectrum of alternative approaches is characterised by attitudes towards quantifiable performance, human engagement and natural ethics. The common goals of performance and human comfort occupies the centre space (figure 7.1). The three clusters can then be placed onto this depending on their individual weightings.
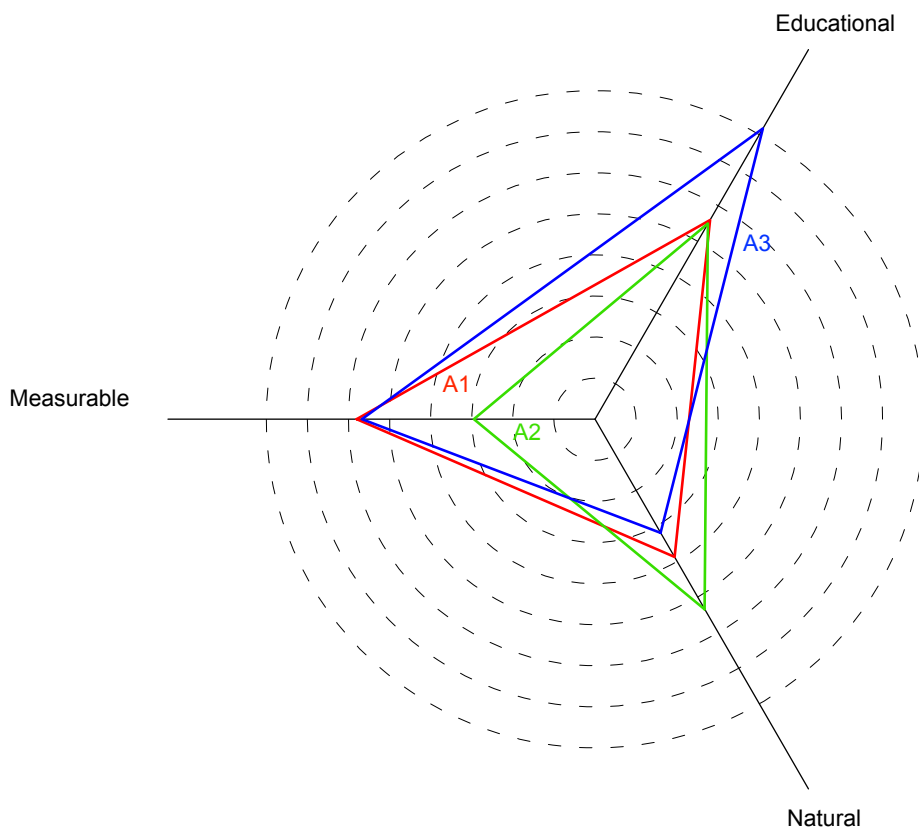
Figure 7.1: A radar diagram of sustainable practice based on the mean rankings for associated statements.

7.2.7 Discussion

Detailed discussion of the results of the Delphi study is provided in appendix A. In comparison the model of sustainable design proposed in chapters 4 and 5 and applied to the studio in chapter 6, the results of the Delphi technique provide an alternative

interpretation of these results. The model proposed in chapters 4 and 5 has four "polar" responses organised along the themes of technology and participation, which differentiated responses. The Delphi technique, however suggested there was strong consensus among practices in terms of important factors. High performance building fabrics seeking to minimise the carbon footprint of buildings was universally the primary concern. This may be due to the focus of building standards and certification schemes (Awadh, 2017) which have tended to shape this discourse (Murtagh, Roberts, & Hind, 2016). Design which valued health and well-being and enabling sustainable lifestyles were also prominent, however client engagement through education emerged as a differentiating factor between groups.

There was also an almost universal rejection of innovative technology as an important factor in developing sustainable design. This may be interpreted as a rejection of piecemeal, additions to architecture that was not sufficiently integrated, supported by a strong desire for holistic approaches.

Considering the differentiating statements, three key themes emerged which focussed on education (human-centrism), nature (eco-centrism) and measurability (techno-centrism). Human -centrism refers to the engagement of clients and stakeholders, eco-centrism to a concern with naturalism and localism and techno-centrism as a focus on performance. These findings share similarities with the principles of sustainable decision making defined by Basiago (1995) of futurity equity, global environmentalism and bio-diversity. Equity might be understood as a focus on education, global environmentalism with a concern for measurability (through a focus on meeting specific carbon reduction targets), and bio-diversity as a concern for nature. The concept of futurity was not specifically defined in the outcome of the Delphi study and was not found to be a differentiating factor. This may be because it was implicit and was not considered a stand-alone principle.

The findings tally with those of Grierson and Moultrie (2011) who identify passive design, energy reduction and integrated approaches as common themes across practitioners. This was reflected in the universal agreement on the passive design and high performance envelopes as important issues as well as the concept of holistic design being very important among almost all participants. Similarly, *caricatured images* of sustainability (Williamson, 2003) of the *natural*, the *cultural* and the *technical*, is corroborated.

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These may be broadly comparable with the placement of practices on the original, idealised model. Most practices fell on a spectrum which ranged between low-tech/participatory approaches to high-tech authoritative ones. Figure 7.2, maps the results of the Delphi technique to this idealised model.
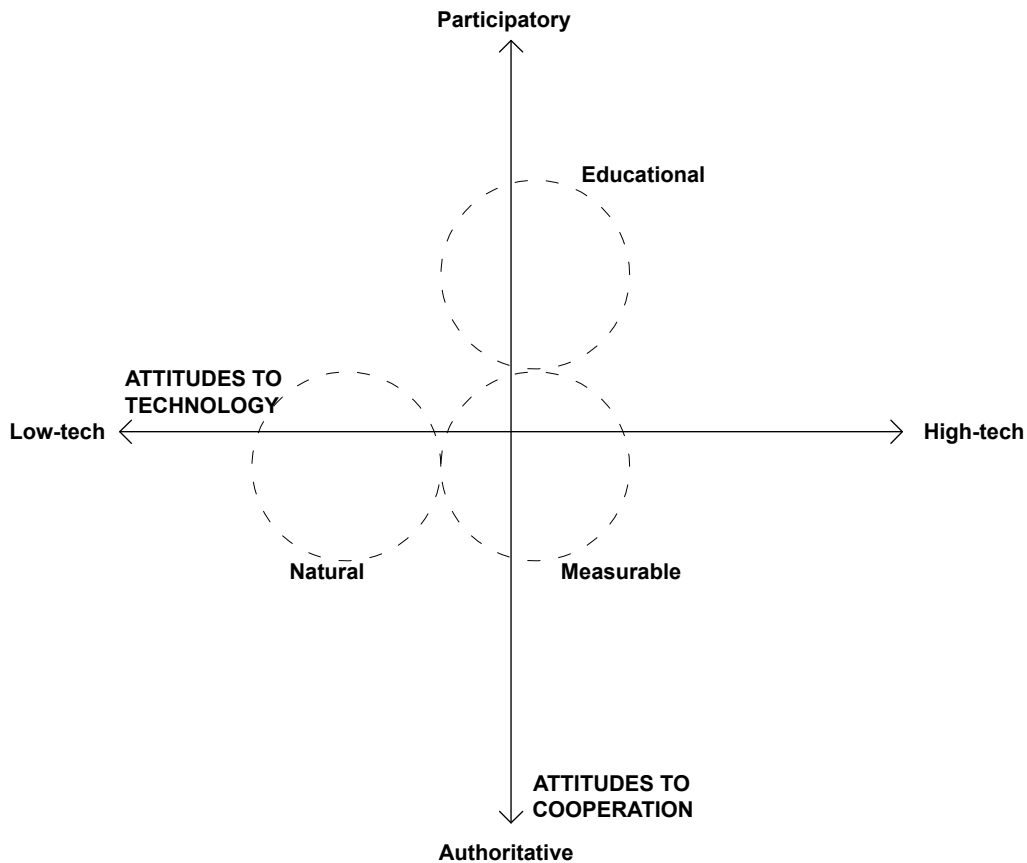
Figure 7.2: Natural, measurable and educational paradigms identified in the Delphi mapped to the idealised model of earlier chapters.

7.2.8 Conclusion

The findings of the Delphi confirm phase 3 of the research, however present an alternative interpretation. The three competing concerns of measurability, nature and education can be mapped to model developed in phase 2. However, there is a lack of high-tech/authoritative approaches. This might reflect a shift in sampling technique which looked at the green register of architects rather than those awarded for or prominent in sustainable design. Alternatively, it may suggest despite descriptions of high-tech approaches to sustainable design, there is a lack of precedence when placed in a broader context of strategies. Arguably, this has been replaced by a desire for measurability in design, representing the positivism observed in practices categorised as

"high-tech".

The findings suggest a remarkable degree of concordance between practitioners on what constitutes good sustainable design. This suggests different outlooks revealed by the interviews are manifesting themselves as similar approaches to the built environment. In addition, building regulations and standards may be acting to define a singular understanding of sustainable building, undermining the potential advantages of pluralist, contextualised and critical approaches.

7.3 Validating the application of the model

7.3.1 Introduction to the case studies

Five student cases studies described their learning and engagement through the critical model. The students were sampled from phase 2 and 3 of the research. A purposeful sample was used and a sample selected that described a range of sustainable design practices and levels of engagement with the model. This illustrated a range of different approaches. Given the small sample and case study nature of the chapter, inferring general principles is not possible, consistent with a qualitative approach. Rather, it adds to the "thick" description of the research (Lincoln & Guba, 1985).

The case studies seeks to achieve both credibility and transferability. Credibility is enhanced by a triangulation of the data, using data collected around a single individual from a variety of sources. Additional data are provided from studies of individual coursework. Triangulation can provide credibility through a process of "qualitative cross-validation" (Oliver-Hoyo & Allen, 2006). While this approach has been used throughout the Action Research, through the collection of different data types, by focussing on individuals, the triangulation can construct individual images of learning processes that validate broader, aggregated claims of the research. This might be considered a deductive process, a testing of theory against individual cases and identifying exceptions and outliers. In each individual case, all data collection and interaction with the researcher was assembled to provide a story of learning for each participant.

While credibility was the primary aim of the case studies, transferability was also enhanced through enhancing the "thick" description of the research (Lincoln & Guba, 1985; Shenton, 2004).

7.3.2 Aim of the case studies

The aim of this section is to validate the findings of the Action Research phase of the research. It aims to confirm the relationship between the application of a general model of sustainable design and deep learning for sustainability in the architectural design studio. It had two key objectives.

(6) To confirm the credibility of the Action Research phase of the research.

(7) To confirm the transferability of the Action Research phase of the research.

7.3.3 Internal and external validity

The primary focus is internal validation of the application of the model. Based on the typology of Mays and Pope (2000), table 7.3 outlines the strategies for internal validation.

Table 7.3: Procedures for internal validation modified from Mays and Pope (2000)

Criterion	Method used
Triangulation	Data collected from interviews, observations and project work.
Member checking	Learning described by participants in interviews and initial results fed back.
Clear exposition of methods of data collection and analysis	Described in earlier chapters.
Reflexivity	Described in earlier chapters
Negative cases	Case studies allow different cases to be individually analysed
Fair dealing	Case studies present wide range of different perspectives

External validation through the provision of a thick description throughout the thesis (Lincoln & Guba, 1985), however, the case studies add to the depth of this description and provide additional narrative material.

7.3.4 Methodology

Five individual students were sampled and the range of data collected around them considered, triangulated in a series of individual case-studies (appendix B). Participants were chosen to represent the range of learning approaches and uses of the model described in chapter 6. The sample included students who both contributed to the SDAG and those that did not. It also included students who had a significant amount of longitudinal data for analysis. For each student, data were triangulated from three sources:

   (8)   Observations made in tutorials, crits and the SDAG (see chapters 4 and 6).

   (9)   Individual interviews conducted with the student.

  (10)   The student's final project work.

This triangulation of data is shown in figure 7.3. The outer triangle refers to the data collection method, while the inner triangle refers to the three characteristics of deep learning considered (Marton & Säaljö, 1976b). However, this is particularly complex as there lacked a consistent approach among students. Rather, in each of the case studies a different interaction with the model and influence of the model was observed.
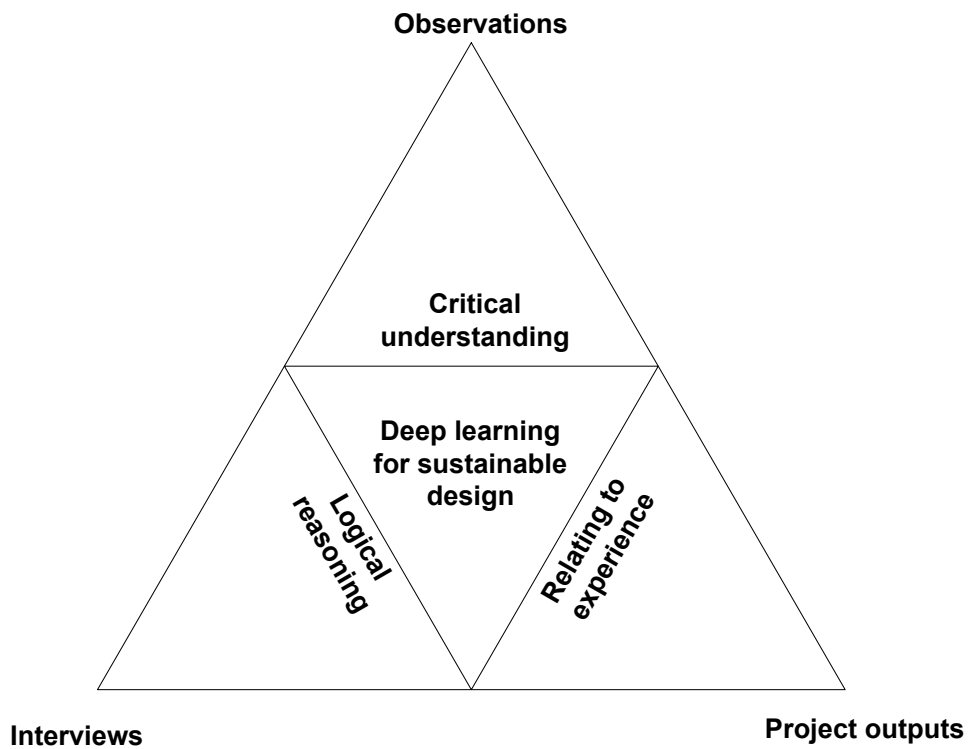
Figure 7.3: Data triangulation.

7.3.5 Findings

A detailed discussion of the findings is presented in Appendix B. Table 7.4 outlines each participant's exposure to the model and the evidence for deep learning.

Chapter 7. Validating the findings: model and application

Table 7.4: Summary of findings from case studies

Participant	Interaction with model	Evidence for deep learning for sustainability		
		Interviews	Observations	Project outputs
Harry	Prolonged (ESDAG, throughout individual project)	Reflected on different principles of sustainable design in different contexts using the model in interviews. Described the restructuring of sustainable design strategies using the model	Used the model to identify limitations of technical approach to sustainable design	Used model to evaluate alternative approaches and develop coherent strategies, explicitly in design report
Karl	Prolonged (ESDAG, throughout individual project)	Described how model structured conceptual information	Active mapping of strategies onto the model in ESDAG sessions	None
Anne	Prolonged (ESDAG, throughout individual project)	Identified alternative approaches to sustainable design, "Sub-conscious" use of model to guide design decisions	None	None
Phil	Limited (exposure in one tutorial and lecture)	Described clear existing motivation and agenda for sustainable design	Used model as basis of discussion on alternative sustainable agendas in group workshops.	Architectural narrative embedded approach to sustainable design
David	Medium (exposure in numerous tutorials and lecture)	Described the how the mapping exercise informed group decision making and enhanced clarity of sustainable design.	Used model to map ideas in workshops.	Holistic sustainable approach demonstrated in final design project

The five students described above all exhibited different levels of interaction with the model and sustainable design. This represented a range of different individual realities of alternative learning practices.

Harry used the model to structure his design thinking leading him to deeper engagement with sustainable design. In his individual project it acted as a tool for justifying particular strategies that he had developed through his own critical analysis and it allowed him to link these to his own personal architectural narrative. Harry's continuing engagement with the model could be linked to his involvement with the

action group. Of the five case-studies, he had the greatest input to the action group and committed the most of his extra-curricular time. His masterplanning group declined the second of their sustainability workshops due to "tutorial saturation" however, Harry's involvement in the initial stages of creating the model had a greater impact on its adoption in the design studio.

Karl and Anne had both interacted with model on numerous occasions, however, they did not use it as either a generative aid or to link conceptual ideas with design strategies. While the model raised their awareness of design possibilities, both viewed the sustainable aspects of their schemes as supplementary. Without constant interaction with the model it "fell away" from use for both these students. In this sense, it was intimately linked to pedagogy

Phil had very little engagement with the model. He exhibited confidence in sustainable design and had a strong personal interest. For Phil, the model was unnecessary as he was already deeply engaged in critical and analytical thought. His architecture was driven by a desire for sustainable action and accordingly, the model was unnecessary.

Although David had not been involved in the initial stages of the model creation, he found the structured and "objective" learning of the studio workshops highly beneficial. Despite this, he did not directly use the model in his design work, but found the reflective and critical nature of the design sessions had greater impact on his learning.

7.3.6 Discussion

The model clearly enabled a critical understanding of sustainability, directly embedded in their studio design projects. Harry demonstrated how the model may structure ideas and influence design decisions, consistent with the restructuring of information and logical inferences characteristic of deep learning (Beattie et al., 1997). This may have been attributable to a prior level of motivation for sustainable design into which the model could provide a degree of structuring, demonstrating personal experience as the foundation of this knowledge creation (Beattie et al., 1997) and self-motivation (Warburton, 2003).

Karl and Anne had similar levels of engagement with the model however its application as a learning aid was applied inconsistently. In workshops and discussion

they could use the model to examine the "intentional content" (Marton & Säaljö, 1976b) of the learning through the restructuring of information (Karl) or engagement with alternative perspectives (Anne). However, a lack of a consistently *deep* approach was evident in their project outputs which did not embed sustainable design into coherent design narratives. This limited engagement suggests a surface approach in which sustainable themes were overlaid rather than logically argued through project work (Beattie et al., 1997).

Phil and David exhibited high levels of personal motivation for sustainability. Despite very limited engagement with the model, Phil used his personal values to inform a sustainable agenda which drove his design decision making. Similarly, David spoke of his previous concerns for sustainable design and this was reflected in the holistic approach to sustainability in his project. Both these cases demonstrate the need to empower students to use their own experiences on sustainable design to act as the foundation for learning (Kolb & Kolb, 2008), In each case, the students exhibited low-levels of anxiety which allowed them to confidently explore these narratives.

The case studies highlight the variability among learners and learning types. Confident learners with strong sustainable values were able to integrate sustainable concerns into a wider design approach demonstrating a critical and *deep* approach to sustainable learning (Warburton, 2003). By contrast, students lacking a strong ethical agenda were limited in their ability to consistently critique and holistically apply sustainable themes. The case of Harry represents a transformation in which consistent application and prolonged engagement with the model enhanced his critical understanding of sustainable design. Using workshops based on participatory methodologies (chapter 4) and critical pedagogies (chapter 5) he was able develop an agenda which structured and evaluated sustainable design information, making logical inferences throughout his design process (Beattie et al., 1997).

7.3.7 Conclusion

These case studies point towards the co-creation of learning tools as essential in the studio environment. As the cases of Anne and Karl, suggest, the provision of a tool does not directly encourage deep learning but rather enhances surface learning approaches. For those already engaged in deep learning for sustainability (such as Phil), such tools are seen as superfluous to their own innate action and critical approach.

Finally, the importance of teaching method, as opposed to specifically content, was highlighted by the case of David. His learning was linked not only to the tool itself but the critical and evaluative nature of the workshop in which it was used. This suggests the necessity of critical pedagogic approaches in the design studio for enhancing deep learning for sustainability.

Chapter 8. Discussion

8.1 Introduction

This chapter brings together the findings from the 3 phases of the action research as well as the interviews with practitioners. It discusses these findings in terms of the literature and lays out the arguments for the conclusions in chapter 9.

8.2 A framework for integration

8.2.1 Learning through the design process

A framework for integration of deep sustainability into the design studio can be developed from the design activities observed in throughout the research. The model was utilised in a variety of ways throughout all stages of the design project, as well as in external settings such as the sustainability action group. The recommendations by EDUCATE (2012) explicitly link pedagogy with critical awareness and deep learning in architectural education, an observation corroborated in this study. The studio outwardly conforms to the suggestions of Warburton (2003) to adopt a "revelatory process" which "build individual awareness", substantiated by the work of Clune (2014). Despite this, the pedagogy of the studio was defined by the specific culture of professionalism which limits its efficacy as an environment for sustainable design. While the introduction of a "tool" for evaluation may provide a mechanism for encouraging the characteristics of deep learning, without pedagogic change, its ability to transform design practice was limited. While some participants used the model to construct a critical map of their design projects, they were very much an exception among students who relied on accepted heuristics to generate and evaluate their work. Practice was defined by the use of tools for *reflection-in-action* (Schön, 1985), such as drawing, sketching and model making, which favour automatic analysis rather than considered and deliberate questioning of assumptions. Design processes were perpetuated by a limited range of teachers familiar with this particular form of professional action. Success of introducing methods from critically evaluating sustainable design relied on a simultaneous shift in pedagogy.

Four stages were identified that define a framework for integration. These describe a cyclical process of awareness, framing, conjecturing and evaluating (table 8.1). At each stage a series of actions are defined based on the findings of research. These are then examined later in the chapter.

Table 8.1: Stages of the sustainable design framework

Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Awareness	Conjecture	Framing	Evaluation
1) Identify alternative approaches and attitudes to sustainable design. 2) Plot precedents and strategies onto model. 3) Raise awareness of alternative forms of sustainable practice.	1) Conjecture new design proposals. 2) Identify sustainable opportunities and strategies. 3) Map strategies to model.	1) Identify common strategic approaches. 2) Eliminate erroneous or inconsistent strategies. 3) Refine aspirational understanding of sustainable design.	1) Compare to alternative sustainability scenarios. 2) Reflect on position of proposals within wider context of sustainable design.

The phases of this process draw directly from the model of design studio learning described in chapter 3. This describes a process of primary generators (Darke, 1979) followed by deliberate action or automatic action and concrete experiences. The cycle is completed by differing levels of reflection, akin to automatic action, single loop learning and double loop learning (Argyris & Schön, 1974) (figure 8.1).
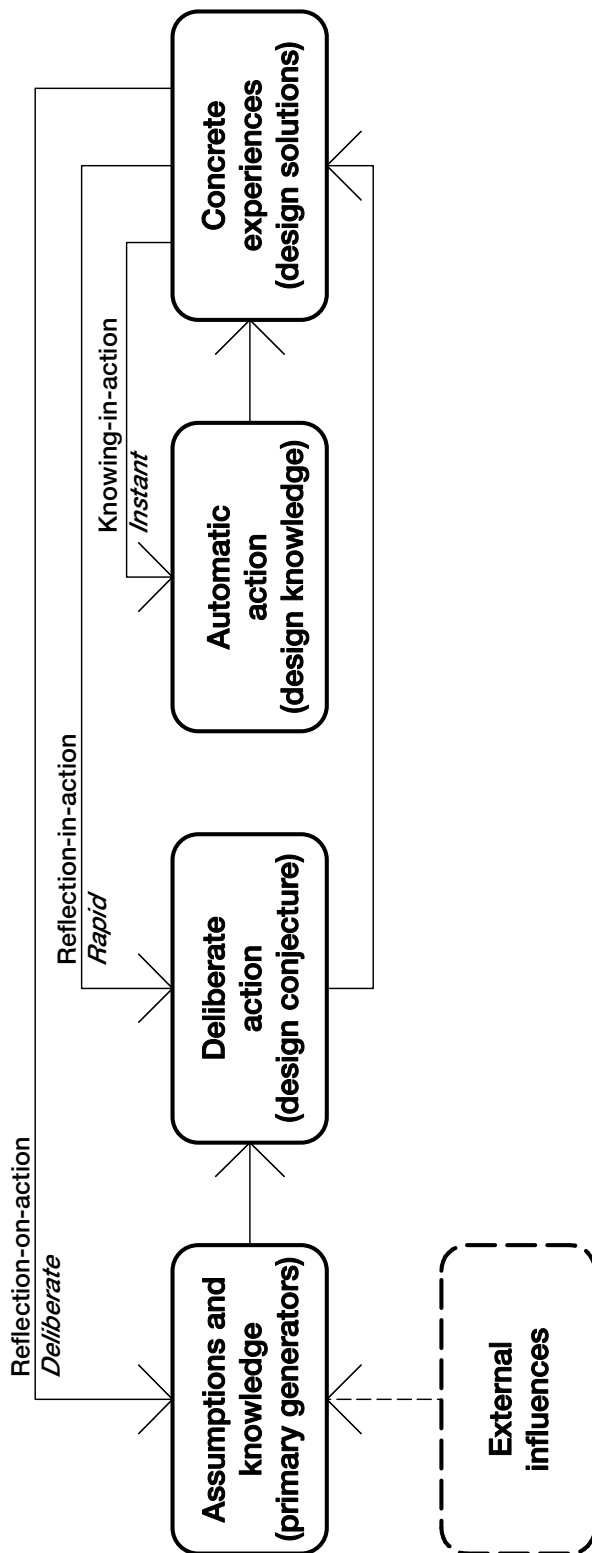
Figure 8.1: Reflective processes in the design studio
A comparison can be made of learning and design frameworks with the proposed

framework for sustainable design (table 8.2). The sustainable design framework is

Chapter 8. Discussion

compared with the Critical Method, Kolb's learning cycle, the phases of sustainable education defined by EDUCATE, Schön's reflective practice and Argyris's double loop learning model.

Table 8.2: Comparison of learning and design frameworks

Model	Stage 1	Stage 2	Stage 3	Stage 4
Sustainable design framework	Awareness	Conjecture	Framing	Evaluation
The critical method	Problem. Primary generator	Tentative theories	Error Elimination	
Kolb's learning cycle	Abstract conceptualisation	Active Experimentation	Concrete Experience	Reflective observation
EDUCATE	Sensitisation	Validation	Reflection	
Schon's Reflective practice	Reflection-on-action			
Argyris Single and double loop learning	Double loop learning			

8.2.2 Stage 1: Awareness

The first stage of this process is the consolidation of knowledge that form primary generators. The model directly fed into this stage through allowing students to develop an awareness of possible issues. For many, this involved a raising of awareness, akin to the first sensitisation of sustainable integration described by EDUCATE (2012). At this stage, students were exploring the possibility of alternative ideas and establishing the context of sustainable design. To draw comparison with Kolb's learning cycle, this might be understood as reflective observation (Kolb, 1984).

Awareness was widely exhibited by the majority of students in phase 4 of the research. They described how the framework was held at the "*back of their mind*" throughout the project. In phase 5, Karl and Anne exhibited this behaviour, using it to raise awareness of possible solutions however without actively contextualising their own design concepts. In the language of Kolb, this might be understood as a process of abstract conceptualisation, a provision of decontextualized knowledge unrelated to actions or experiences (Kolb, 1984). In an idealised framework, this process would mimic the activities of the SDAG in Phase 2 of the research, in workshops 2 and 3. In these workshops, students discussed populating the framework with archetypal approaches to sustainable design, and precedents form architecture. Three steps were observed at this stage.

(11) Identify alternative approaches and attitudes to sustainable design.

(12) Plot precedents and strategies onto model.

(13) Raise awareness of alternative forms of sustainable practice.

Figure 8.2 demonstrates this process in relationship to the sustainable architecture model; the grey circles represent categories of sustainable approaches identified from precedent examples.
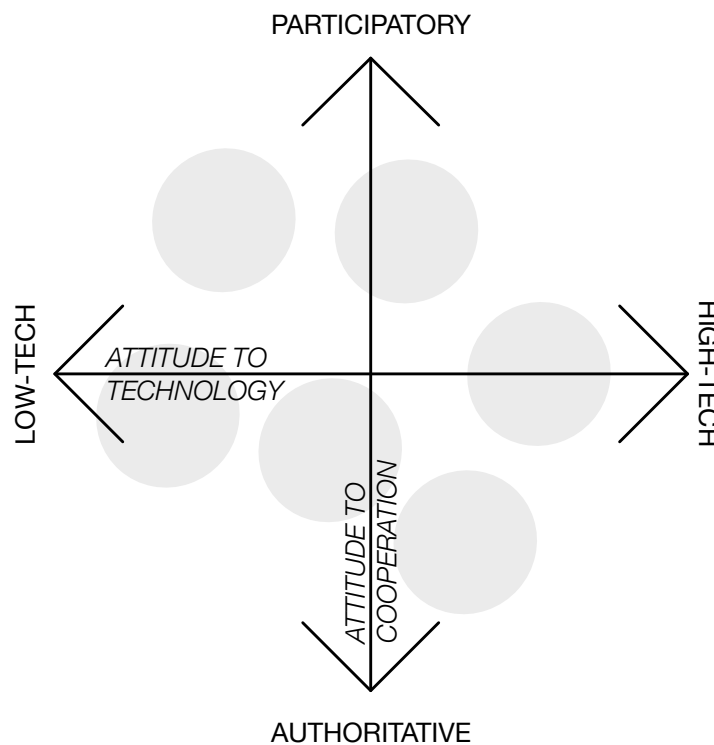
Figure 8.2: Using the model to create awareness of alternative design strategies.

8.2.3 Stage 2: Conjecture

The second stage of the framework describes the proposal of possible design solutions. Through initial interaction with the framework and a raising of awareness, possible design proposals are postulated. This shares similarities with the validation stage of sustainable integration described by EDUCATE (2012) in which students analysed and applied knowledge through the creation of design proposals. It also reflects the proposal of *tentative theories* as described by (Brawne, 2003). It closely maps to the *active*

experimentation stage of the experiential learning cycle (Kolb, 1984) in which abstract knowledge is tested and applied to real world situations.

For some students, the second phase of the process was producing this knowledge in coherent design proposals. For many the model increased awareness however this did not translate directly to specific design decisions. For some however (Harry in chapter 7 for example), this process involved structuring his design narrative around a desired sustainable outcome. He identified a low-tech, socially engaged approach that reflected his attitudes towards the context in which he was working and informed his design narrative. This process took place in a more formal context in the workshops conducted in the first part of phase 4 of the research (chapter 6). In these sessions, students mapped existing design ideas to the model to reveal commonalities and discrepancies in their thinking. This mapping process initially involved identifying and articulating possible strategies that had arisen through the design conjecture.

Observing the actual process of design creation was challenging however the impact of the heightened awareness provided by the model was described by students. Most described the model as being in the "back of their minds" allowing them to continually contextualise possible design approaches. It is also important to note that the process of conjecture and design formation was not changed by the model. Students still engaged in the use of tacit tools to explore new ideas (Schön, 1985). Stage two can be summarised in the three steps described below and in figure 8.3 where the black dots represent individual design strategies. Three methodological steps define stage 2.

(14) Conjecture new design proposals.
(15) Identify sustainable opportunities and strategies.
(16) Map strategies to model.
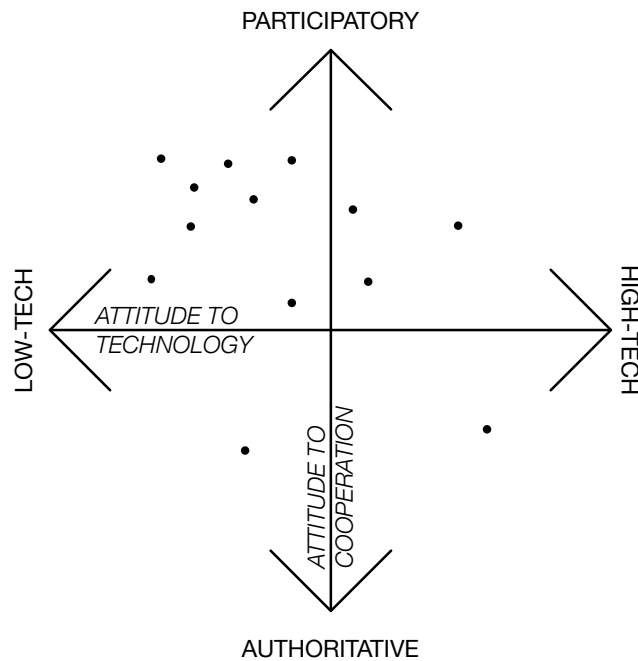
Figure 8.3: Using the model to create plot sustainable design strategies conjectured by students.

8.2.4 Stage 3: Framing

The third stage relates individual proposals to broader attitudes to sustainable design to individual experiences. Individual design scenarios are analysed to clarify the overall and strengthen overarching sustainable design agendas. This stage represents the initial part of the analysis phase of the Popperian design process often referred to as *conjecture/analysis* (Bamford, 2002). Perhaps it most closely represents the error elimination described by Brawne (2003) in which erroneous design decisions are removed. This creates a gradual honing of the design space in which sustainable design strategies take on greater coherence moving towards a holistic understanding of sustainable design.

This process took place in the workshops in the first part of phase 4 of the research (cycles 1 and 2). Students were able to identify common trends in their own design narratives through the model as well as realise conflicting ideas. This gave them insights into their own aspirational goals and clarified and structured their thinking. In some cases this enabled a definition of the design space in which key design moves

were identified as typifying or linking disparate design approaches (figure 8.4). The three steps of stage 3 of the framework are below.

(17) Identify common strategic approaches.

(18) Eliminate erroneous or inconsistent strategies.

(19) Refine aspirational understanding of sustainable design.
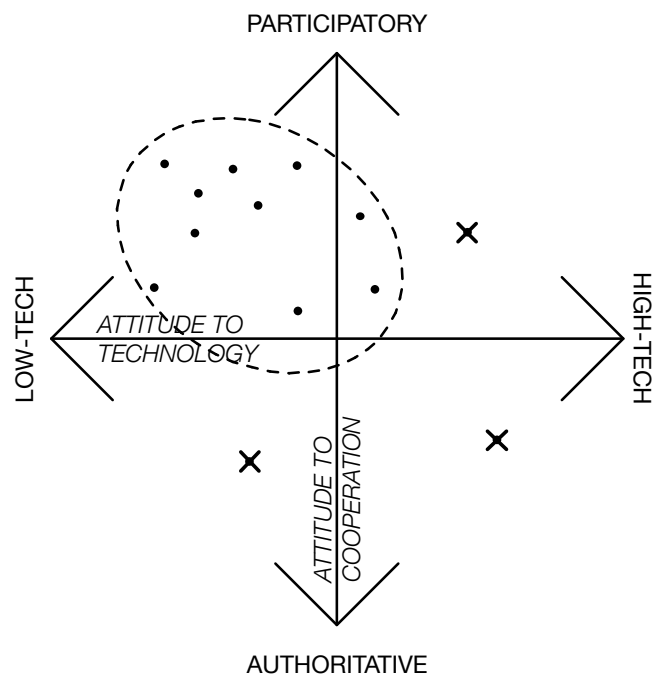
Figure 8.4: Using the model to compare sustainable design strategies with general concepts.

8.2.5 Stage 4: Evaluation

The final stage represents a process of reflection in which the model can be used to compare design solutions to intended outcomes (figure 8.5). This process contextualises *concrete experiences* (Kolb, 1984) generated by design proposals within a framework of competing and conflicting sustainable agendas identified in the first phase. It is this phase which constitutes the *reflective observation* phase of the learning cycle (Kolb, 1984) and parallels the *reflection* phase described by EDUCATE (2012). Further, it provides insights into the directions for the acquisition of new sustainable knowledge when re-entering the first phase of the process.

Students demonstrated the ability to contextualise their work using the model and were able to synthesis holistic proposals. Students implicitly located their ideas into a wider sustainable context often describing how their schemes belonged to a high-tech agenda or a social one (for example two groups who identified their schemes as being potential high-tech masterplan schemes). However, there was limited critical analysis of these particular positions, without input from the researcher. This may have been due to the disconnected nature of the workshops where the initial *awareness* stage was divorced from the other sessions. With a stronger overall structure and clearer framework for learning, critical reflection may have been enhanced. The two steps of the framework may be described below in figure 8.5.

(20) Compare to alternative sustainability scenarios.
(21) Reflect on position of proposals within wider context of sustainable design.
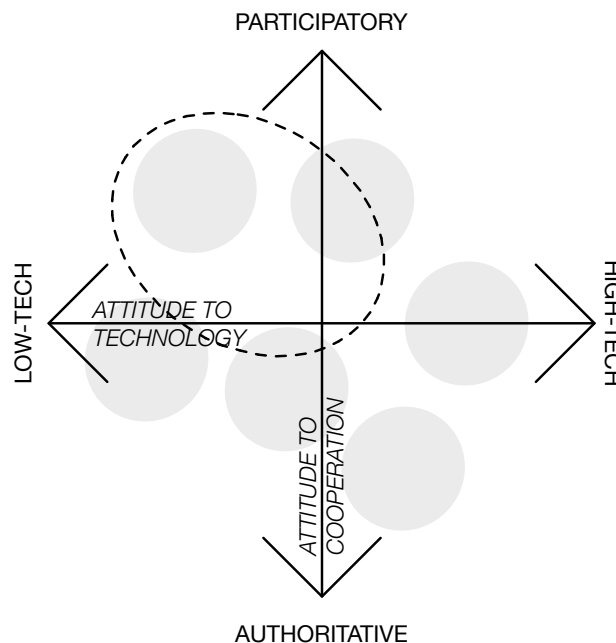
Figure 8.5: Using the model to evaluate proposals, eliminate inconsistent strategies and clarify design space.

Chapter 8. Discussion

8.3 Transformation in the design studio

8.3.1 Transforming pedagogy

The design studio pedagogy is successful at encouraging learner independence, motivation, passion and enthusiasm (Clune, 2014). Significant commitment throughout the course from both students and tutors was observed. Harnessing and directing this energy towards the challenges of sustainability may provide significant opportunities for implementing educational change.

The design studio must open itself up to a wider range of perspectives and viewpoints. These may be drawn from interested parties and the public but also those with expertise beyond the construction industries. Critique should extend beyond the accepted and agreed norms of the design studio and expose the assumptions of professionalism and architectural *connoisseurship* (Orr, 2010).

Greater emphasis should be placed on the process of design rather than purely the product. A solution focussed environment has the tendency to emphasise the "solvability" of problems. This especially true in sustainable design which was often viewed in a techno-rational manner, corroborating wider trends in sustainable development (Dryzek, 2013). Design problems should be framed as research projects, through which master and discovery learning can take place (Entwistle, 2013; Warburton, 2003). This would have the advantage of critiquing alternative professional competencies.

The design studio could allow space for significant reflection-on-action (Schön, 1985). This involves not only analysing the product of the studio but also the means and motivations that have imbued its creation. Current reflective practices focus on product and are predominantly student led so perpetuate the self-referential cycle of the studio. There is an absence of genuine space within and beyond the studio for meta-reflection that celebrate a diverse range of perspectives and draw from a range of personal experiences (Brookfield, 1997; Kolb, 1984).

The studio is characterised by practitioner teaching however this method of the transferal of professional competencies can lack sufficient reflective action to adequately address deep learning for sustainability (Webster, 2004). One approach may be to train educators and encourage reflection to enhance their own teaching practice. This aligns with the findings of the RIBA Sustainability and Ethics Committee report

(RIBA, 2018) which recommends "all teaching staff in validated schools of architecture have appropriate knowledge of ethics and sustainable development". While an approach and a direct link to the profession is one valued by staff and students, the current model of employing part time staff allows limited opportunities for the necessary training.

The research questions whether the design process is an adequate proxy for the learning process. While this may have provided a relevant education to architects in the past, the changing scope of architecture and the issues that they are now facing suggested that alternative mechanisms might be more appropriate. An alternative might embrace a wider range of experiences and learning activities that challenge the hegemony of drawing and making as primary tools for developing professional competency. When considering sustainable design, architects must be communicators, evaluators, negotiators, scientists and managers, as well as designers in the traditional sense (Bos-de Vos et al., 2018). It is the job of design education, and the design studio, to prepare them for this task.

8.3.2 Transforming practice

The research set out to examine deep learning for sustainability in the design studio, however it soon became clear that this was inseparable from teaching practice. The impact of tutors and teaching on students was evident in phase 1. Tutors were often credited with advocating a particular agenda or suggesting design ideas. Moreover, in interviews and observations of crits and tutorials, it became clear specific teaching methods were influencing the nature of learning. Crits and tutorials tended to be student led, in which the student would spend long periods of time describing their works and setting the agenda for the session. Architectural tutors often adopted a course of questioning both to understand the scheme and to draw our salient issues. This was followed by suggestions of ideas which the student might chose to ignore or adopt. By contrast, the sustainability tutor on the course, took a more problem solving approach, identifying key issues and then proposing through descriptions, drawings and diagrams possible technical solutions.

Ostensibly, the teaching practices of the design studio were consistent with a deep learning approach; through questioning and proposing conflicting options they encourage independent thinking and challenge assumptions (Marton & Säaljö, 1976b). However, this approach had limitations when considering its effectiveness for

enhancing sustainable design. Notably, the student centred nature of the interactions often meant sustainable design issues were ignored or pushed to one side. This is an observation shared with Levy (1980) who noted that full studio based pedagogies neglected technical learning and Oliveira and Sexton (2016) who found that non-prescriptive briefs depended on personal experience and preference to detriment of environmental concerns.

The findings support the assertions of Warburton (2003) who suggests blended learning approach that combine "mastery" and "discovery" learning. Mastery learning refers to an environment in which the educator structures the learning however still encourages independent student responsibility. Discovery, learning, by contrast, relies on the teacher as a *facilitator* of self-directed study. Observations of the studio reveal a pedagogy that emphasises a discovery approach, in which tutors attempt to understand student motivation and respond accordingly. Phase 3 of the research explored a hybrid approach in which I took a more structured format to the teaching interactions. For some students, this provided a level of objectivity and rationality that they perceived as absent from the typical tutorial structure. Essential to these sessions was the emphasis on the co-creation of knowledge (Gibbons et al., 1994), rather than the straightforward delivery of knowledge or technical solutions. The response to these tutorials, suggests educators in the design studio might enhance their practice by incorporating a range of approaches in their practice. For example, tutorials might begin with a structured exercise that forms the basis for open-ended discussion. This has the advantage of ensuring sustainable themes are not neglected yet allows space for personal and critical reflection.

A blended approach also has the advantage of appealing to a range of learning styles. Entwistle (2013) has noted the tendency of discovery methods to favour low anxiety learners while high anxiety learners respond well to mastery techniques. As Kolb and Kolb (2008) note, the learning environment must accommodate a range of learning styles and suggests:

> "The [educator] must respond to pragmatic demands for relevance and the
> application of knowledge, while encouraging the reflective examination of
> experience that is necessary to refine old theories and build new ones." (p.58)

To encourage deep learning for sustainability, educators must ensure interactions enable

space for experiential learning. This includes balancing the emphasis on perceptive aspects of the cycle (abstract conceptualisation and concrete experience) with the already dominant procedural ones (active experimentation and reflective observation).

8.3.3 Action research as a transformative process

Action research (AR) provides a methodology for transformative change in the design studio. The participatory and emancipatory values described by Zuber-Skerritt (1996b) could be considered complimentary to those of deep learning. Empowering individuals to take action, act as "personal scientists" (Kelly, 1955) and to tackle complex problems can contribute to the independence, self-motivation and desire for understanding necessary in deep learning. Engaging students in meaningful AR, through the medium of the design studio, might offer opportunities to transform practice in search of sustainable design.

This approach requires students to not be passive subjects in an experimental system, but rather to become active participants in engaged in "symmetrical communication" (Zuber-Skerritt, 1996b) with researchers. The design studio already provides an environment to develop such a practice through its emphasis on independent learning, open ended problem solving and the challenges of facing "wicked problems" (Rittel & Webber, 1973). Yet, I have observed how design studio culture, the insular reflective cycle and its particular expectations, limit the studio's capacity to develop truly innovative practice. This is confounded by a focus on professionalism and the limited pool of experience from which teachers and educators are drawn.

Collaboration and inter-disciplinary working are essential aspects of sustainable education (Jones et al., 2010; O'Rafferty et al., 2014). Similarly, emancipatory AR advocates the creation of research communities (Zuber-Skerritt, 1996b) through which knowledge is co-created in a non-hierarchical structure. While the design studio provides opportunities for collaboration, this is often restricted to explicit group projects. Interdisciplinary working, however, is far less prevalent. There were no examples observed in the research when critics or tutors were drawn from disciplines beyond architecture and the built environment. Building links between departments, subjects and researchers, may all provide opportunities to enhance deep learning.

Phase 2 of the research explored developing a parallel learning environment in which students could critically examine sustainable design approaches. In part, the success of this phase compared to phase 3 could be attributed to its separation from the

studio and liberation from its traditions and assumptions. Moreover, it encouraged discussion between peers, beyond the scope of individual project work. Embracing an explicitly research led agenda, in which students construct design projects as explorations of practice, as well as bringing perspectives from beyond the profession, may all help to encourage deeper and more meaningful learning and transformation of practice.

8.3.4 Transforming graduate criteria and validation

In the introduction, the RIBA and ARB criteria for validation (Architects' Registration Board, 2010; Royal Institute of British Architects, 2010) were introduced. The four graduate criteria that specifically mentioned sustainable design were mapped against a satellite unit that sat outside the design studio. This precluded the necessity to address sustainable design in the studio. The specific criteria does not focus on the potential for deep learning for sustainability. As noted in the introduction, the terms "knowledge of" and "understanding of" are used, which do not necessarily refer to the deep-level processing task of searching for underlying principles and reconstructing this knowledge. In addition, the attributes present a relatively narrow definition of sustainable design, limiting understanding to environmental impacts of specific design decisions. This undermines intrinsic holism and interconnected nature of the sustainability challenge.

By extricating these criteria from the studio, integrating sustainable design into design projects could be limited to a surface-level approach although some students did exhibit a deep engagement. Rewording these attributes to necessitate demonstration of sustainable design skills may be a first step at encouraging greater engagement in the design studio. A further move might reshape their concept of sustainability to encompass the broad range of issues associated with sustainable development. Finally, "mainstreaming" (O'Rafferty et al., 2014) this approach could require all attributes to be reconstructed in light of contemporary sustainable challenges, emphasising the need for architecture to address a range of issues in a critical and reflective manner. This implicit integration of sustainability might harness and redirect the inherent deep learning environment of the design studio.

Chapter 8. Discussion

8.4 A critical issue in the design studio

8.4.1 Barriers to change

Transforming the teaching practice of others was a challenging process and met little success. In interviews, tutors described highly personalised styles of teaching which they had developed throughout their own personal experience. When introduced to the framework it was met with curiosity however there was little enthusiasm for introducing into their own practice. This is despite an expressed desire to enhance sustainable design.

Conducting the research, I became aware of the limitations of an AR project conducted as a sole researcher. Zuber-Skerritt (1996b) emphasises the collaborative nature of emancipatory action in which participants share in the creation of the research. Perhaps it is little surprise that my suggestions were met with little enthusiasm from practitioners who had no stake in the research process. Integration was particularly challenging considering the nature of the teaching staff. With the exception of one tutor, all were part time staff who worked for one or two days a week, across different days and had little slack time in their schedules. To develop a working research group was not only logistically challenging but was also unrealistic in terms of the time commitment required.

While the limited pool of experience from which tutors were drawn impacted the transformational possibilities of design practices, it also influenced opportunities for effecting teaching. The *apprenticeship* model, on which the design studio was founded, is a form of professional education (Lackney, 1999) and often relies on the input of design tutors who are also practising professionals (Quinlan, Corkery, & Marshall, 2007). These tutors tend to have similar educational experiences and are transmitting their own professionalism to the student; a process described in detail by Schön (1985). Yet this containment of professional practice leaves little room for critical analysis. As Glasser (2000) asserts:

> "As is the case for many entering teachers, I found myself passing along notions gleaned from my own education, without having had the opportunity to test and evaluate these basic assumptions in the field." (p.250)

For the tutors interviewed, most found it challenging to describe their particular

approach. Most had no formal training, and considered their professionalism in the realm of design rather than in education. For example, they would speak of how they were required to understand and help students solve design problems, focussing on enhancing professional action as opposed to encouraging learning. Without self-critical analysis and reflexive processes, the understanding and transformation of practice is impossible. This corroborates the findings of Webster (2004) who recognised that tutors act intuitively, often at the detriment of the student experience. She found few tutors displayed the characteristics of the "liminal servant"; a mode of operating that promotes learning through addressing both the cognitive aspects (through scaffolding learning) and social aspects (through recognising values and belief systems) of learning.

The insular nature of design studio education points to a wider issue associated with professionalism. Orr (2010) describes the concept of connoisseurship in the fine arts and how assessors combine objective criteria with their own experiences and mutually agree on what constitutes value. It is a similar process that underpins professional education in architecture. Till (1996) describes how the privileged position of the architect as either the holder of specific knowledge or possessing implicit aesthetic judgement, exerts a level of control and exclusivity over the profession. For Till, architectural education has the role of both developing accepted tacit techniques of individuals and also validating this action through constructing theory. It is in this context that the challenges to accepted action must be considered. Introducing alternative means of teaching, diverse perspectives and challenging the structural foundations of the design studio are all possible threats to the mutual value of both the profession and its education. While deep learning for sustainability relies on collaboration, interdisciplinary working, experiential learning and critical meta-cognitive thought, current incarnations of professionalism may limit possible transformation.

8.4.2 The culture of the design studio

The dominance of the design studio in architectural education is founded on the assumption that it represents the optimal learning environment. I have already discussed how this assumption is based on the analogy between learning and the design process which poses problems for deep learning for sustainability. The origins of the design studio can be traced to the apprenticeship system of medieval guilds (Broadbent,

1995). This was then formalised in the Ecole des Beaux Arts which focussed around the solving of a "design-problem" with guidance from a "master" tutor. The system relied on expert teachers drawn from practice (Graham, 2003) and an assimilation of professional skills through mimicry of practice (Lackney, 1999). Lackney (1999) asserts that design solutions were critiqued on the criteria of "good taste"; a set of accepted and covert professional values. The design studio pedagogy was critical in establishing architecture as an autonomous discipline, in which design-problems could only be judged successful by practitioners who had acquired implicit intuitive knowledge (Till, 1996). In the Ecole des Beaux Arts, design-problems typically began as a sketch problem (esquisse) and , through drawing was developed into a set of beautifully presented images (Lackney, 1999). While various versions of the design studio have emphasised alternative techniques (the focus of the Bauhaus on production for example) the essence of the design-problem to be solved through techniques for reflection-in-action, remained consistent (Schön, 1985).

The challenges of the design studio to adequately adapt a sustainable future may be attributed to the nature of the design-problems that the studio has evolved to deal with. In the typology of problems define by Rittel and Webber (1973) design-problems may well be considered "wicked". Indeed, in the case-study in this research, problems lacked significant definition, were unique, open-ended and could not be judged unambiguously "good" (Seager, Selinger, & Wiek, 2012). Nevertheless, the focus of the design studio on generating well-formed "solutions", evidenced by the nature of work presented in crits and reports, emphasises production over process and learning. Deep learning, critical pedagogy and experiential learning share common goals of meta-reflective action grounded in personal experience (Pettit, 2010). It is through critical evaluation, questioning assumptions and reflection that transformative learning may be achieved.   Sustainable design and sustainable development are not "problems" to be solved. Not only is sustainability "wicked" in nature, but it also relies on holistic, collaborative, interdisciplinary and critical learning (Howlett et al., 2016). Sustainability cannot be considered a design-problem but rather a complex web of socially defined interconnected issues which provide a context for advocacy (Guy & Moore, 2007). The design studio, its autonomous problem-solving approach, disciplinary focus and dependence on professional competence is often at odds with develop of critical learning for sustainability.

Chapter 8. Discussion

8.4.3 Beyond design thinking

Despite the alignment with these design and learning models, the framework described below only captures the broad of an integration process into the studio. The findings of this research suggest that without adequate critical pedagogies and holistic design approaches, deep learning for sustainable design will remain a challenge.

In Chapter 3 I discussed the design thinking and the Critical Method, a version of design thinking employed at the University of Bath. At the core of design thinking rests the understanding the designer is the main agent in the creation of the built environment (Kimbell, 2011). Indeed, this is reflected in the prevalence of the master-apprentice educational model and subsequent transmission of tacit reflection (Schön, 1985). Moving towards double-loop learning practices (Argyris & Schön, 1974) through structured pedagogic interventions enhanced deliberate reflection but were ultimately bound by the context of the studio.

Personal agency in design stands at odds with the critical and dialogic ambitions of deep learning and critical pedagogy. As Kimbell (2011) notes, the design thinking model fails to acknowledge "known and unknown users and other stakeholders" (p. 301) as well as rejecting historical and culture alternatives to design. It becomes clear in the context of sustainability that the internalised methodology of design thinking limits the capacity for necessary engagement and contextualised thinking. Kimbell (2012) calls for an alternative design practice; one which decentralises the designer and understands design as "contingent" and "situated". These may include participatory approaches (Luck, 2018) or "design activism" (Julier, 2013) which engage with stakeholders and contexts in a move to design *with* rather than to design *for*. Promoting collaboration and accepting interdisciplinary cultures is also key to this process.

Moving beyond design thinking is necessary to achieve effective deep and transformative learning for sustainable design. Binding the design studio to a closed cycle of action and reflection limits the capacity to actively engage with the complex and socially situated challenges that face architects. This may be achieved through embracing critical pedagogies which examine alternative perspectives beyond the bounds of the design situated in contextual practice. The framework outlined at the start of this chapter may provide a first step to developing novel yet recognisable learning processes which embrace a holistic understanding of sustainable design.

Chapter 8. Discussion

8.5 Developing architectural design practice

8.5.1 Opportunities for architectural practice

The mapping of practices in chapters 5 and 7 (and appendix A) revealed opportunities for sustainable practice. It was noted that there was an absence of practices occupying high-tech/participatory approaches or low-tech/authoritative approaches possibly due to the potential problematic combination of these approaches. This suggests there might be potential to enhance sustainable practice, or develop alternative means of designing. Combining technological innovation with participatory action might pose problems practically. Arguably the complexity and expertise required for technical design exclude possibilities for participatory approaches. Alternatively, the existence of these practices adopting innovation and participation might fall beyond the recognition of the architectural community. At the opposing end of the spectrum, the authoritative and low-tech paradigm may not be an adequate model for producing high quality sustainable architecture. The absence of either technological innovation or participatory action may contribute to a maintenance of the status quo.

The mixed picture provided by UK practice supports, yet caveats the work by O'Riordan (1989). The range of practice indeed conform to the techno-centric/eco-centric split described however the reality is more complex. We have seen how practices adopt mixed methods and engage with clients and technologies to different degrees precluding a straightforward linear relationship. Moreover, there was little evidence that these approaches were directly linked to political or ethical standpoints. Rather, they were more contingent on project type, client motivation and practice size. Arguably, there may be a relationship between motivation and practice type, suggesting a self-sampling of projects and clients by practitioners as well as a desire to limit or expand practices according to personal ambition.

8.5.2 Developing the model

Following the interviews with professional practice, the developmental work done by the sustainable design action group and the supplementary Delphi Technique, a more comprehensive model can be created (figure 8.6). The model maintains the eco-centric and techno-centric domains as contrasting axes. The categories defined in chapter 6 of combinations of eco-centric and techno-centric approaches are then structured around

the matrix in a continuum. As a result, categories of *high-tech/participatory, high-tech* and *low-tech authoritative* are mapped onto the continuum, despite an absence of practice adopting these paradigms. At the ends of each axis, the categories describe opposing eco-centric and techno-centric paradigms (high-tech and low tech, authoritative and participatory). These categories represent he extremes of practice as in most cases (as suggested by the findings from chapter 7) practices will adopts a less extreme or centrist approach that exists somewhere in the centre of the axis. Each resulting quadrant is described based on its defined relationship between eco-centrism and techno-centrism.
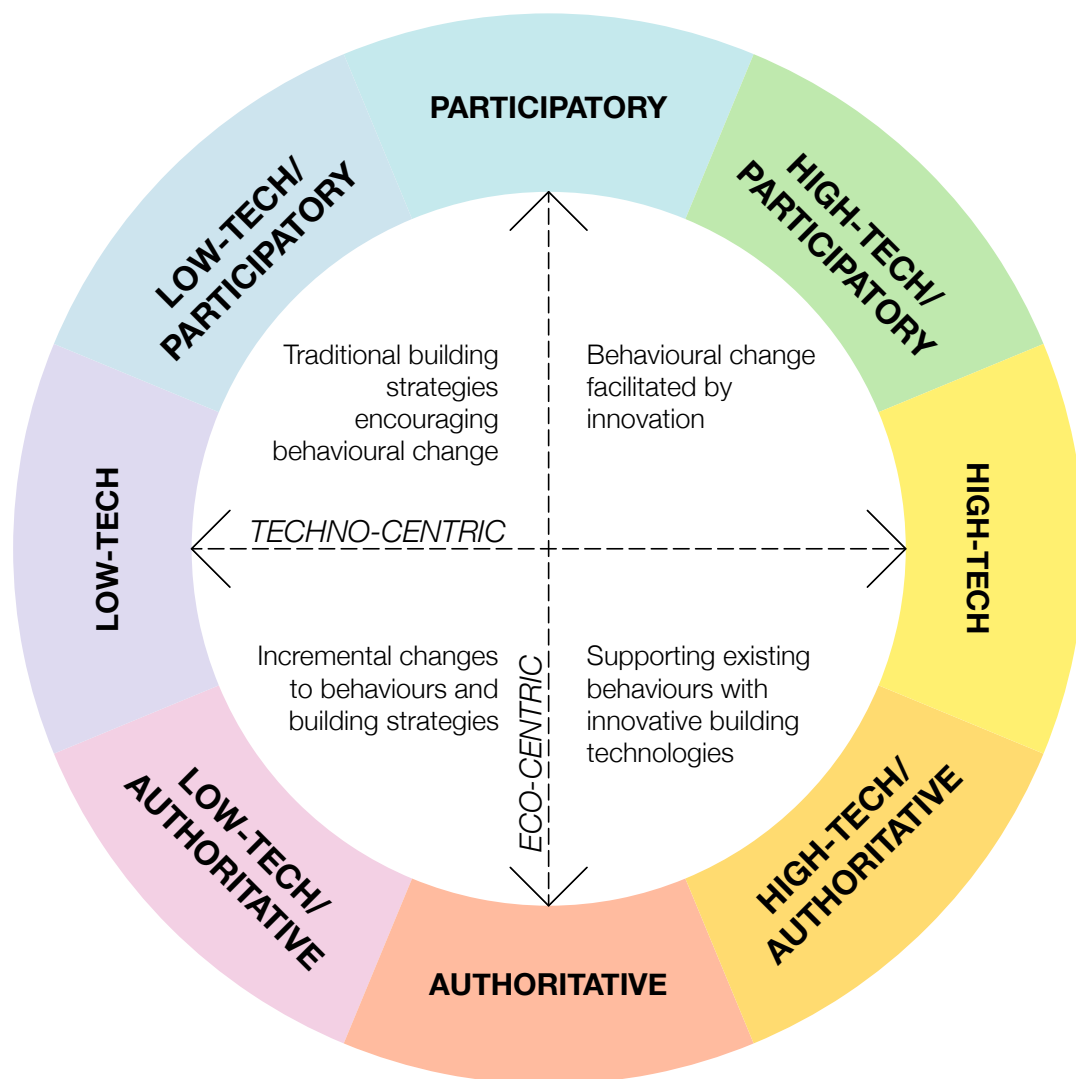
Figure 8.6: the developed model of sustainable design

The resulting model provides an evaluative model of actual and potential sustainable design strategies in UK architecture. The model does not assign value to different

strategies and is non-directional. Rather, it allows the range of practice to be mapped and organised to reveal the complexity of sustainable design. This has the potential to guide to future sustainable design strategy (Choucri, 2007) through realising potential alternative opportunities for strategy. It may also be seen as an aspirational tool where practitioners can identify their location on the axis and work towards a particular approach.

Chapter 9. Conclusion

9.1 Sustainability and the design studio

This research shed light on the integration of sustainable design into the architectural studio and proposes a framework for enhanced implementation. Through analysis of the design studio, participatory action and a survey of professional practice, the research makes a number of conclusions which reveal some of the barriers and opportunities for change. The research finds that embedded cultural behaviours pose the biggest threat to enhancing deep learning for sustainability in the design studio. These might be overcome by introducing new learning experiences including using structured tools such as the framework proposed.

9.1.1 Outcomes of the research

This research aimed to develop pedagogies and strategies for deep learning and enhancing the awareness, understanding and critical application of sustainability in the architectural design studio.

The first objective sought to assess deep learning for sustainability in the architectural design studio. This was achieved through an analysis of an MArch design studio in phase 1 of the research. This provided not only a unique insight into this specific context, but also provided a thick description which is applicable to other design studios sharing similar characteristics.

The second objective sought to develop strategies for deep learning for sustainability in the architectural design studio. This was done through the formation of an action group in phase 2 of the research. Strategies for implementation were developed collaboratively. This resulted in the creation of a model of sustainable design and a draft framework for implementation which could be tested in the design studio.

The third objective looked to position the proposed strategies in the context of UK architectural design. This was done through interviews with practitioners which verified the typological categories implied by the model. This resulted in a picture of the state of the art of UK architectural practice which revealed the prevailing discourse

in sustainable architectural design. This supported by the validation Delphi exercise described in chapter 7.

The fourth objective sought to develop, test and assess pedagogies for deep learning for sustainability in the design studio. This was done in phase 4 of the research in which the sustainable design model was used as a learning tool directly in the design studio. This gave rise to a framework for integration discussed in chapter 8 of the research.

9.1.2 Rethinking the sustainable studio

The design studio is a multi-faceted and complex learning environment. It actively encourages independent learning yet is simultaneously governed by tacit knowledge and embedded assumptions. Despite high levels of motivation, students rarely displayed the characteristics of deep learning towards sustainability.

Many of the studio's positive aspects were observed, including intrinsic student motivation, the development of a strong learning community and the nurturing of independent learning. However, when considering deep learning for sustainability the pedagogy of the design studio limited sufficient learning processes. The studio was very good at training students in a particular way of thinking and that recycled existing professional values, many of which were inconsistent with sustainable design. Rather than being viewed as holistic and intrinsic to good design, sustainability was often presented as a technical addition, perpetuated by a division of teaching for sustainability from project tutoring and typically focussing on environmental concerns or internal comfort.

Despite exhibiting environmental and social concerns in other aspects of their life, students rarely translated these experiences into the design studio. When students did explore their own interests this tended to influence learning content such as defining the subject matter of project assignments. These were then examined in a conventional approach. In only a small number of observed cases, were students able to project their own values onto procedural aspects of design to produce alternative sustainable ways of working that challenged prevailing methodologies.

The impact of individual tutors on student learning was a common theme across all participants. Tutor and student interactions were student led, and discussion revolved around the work presented. Design tutors would seek to understand the nature

of this work and feed in critical comments or propose alternative ideas, which would often shape student projects. By contrast, specialist subject tutors would adopt a problem solving, technical approach to tutorials. "Design" was advocated as a form of discovery learning driven by an iterative process in which students and tutors contributed. Sustainability, however, was taught in a transmissive manner in which knowledge was delivered by experts who made it specific to student projects. This dichotomy often caused a conceptual void between design as an autonomous discipline and sustainability as a technical requirement.

Developing the framework in a parallel learning environment in phase 2 of the research had the advantage of encouraging critical and reflective dialogue, however its impact on actual studio practice was limited. Liberating students from the confines of their project work allowed a wide range of themes to be discussed and a encouraged meta-critical reflection. High levels of attendance and commitment to the action group indicated an underlying student motivation for sustainable design issues, supported by comments made in individual interviews, which did not always filter through into project work.

In transforming design education, the introduction of tools alone was insufficient to modify practice and encourage deep learning in the design studio. While the framework developed was a valuable means to critically appraise design solutions, it required facilitation and structured learning from myself. It was most successful when students could construct their own knowledge; populate the framework themselves, identify links and recognise trends that was directly linked to their own project work. Using the framework in workshops in the design studio aided relevancy and impacted design thinking, it was limited by the student led nature of the traditional tutorial. The research suggests a blended learning approach which combines both mastery and discovery learning in a structured yet open ended tutorial can create a greater range of learning experiences which provide space for knowledge acquisition, action, experience and reflection. This encouraged an integration of sustainability with traditional design concerns.

9.1.3 Beyond the design studio

Interviews with practitioners revealed a range of sustainable design practice in the UK. This encompassed low-tech, participatory approaches to technological, designer-led

ones. Between these extremes, there were a variety of practices who adopted varying degrees of technological and social engagement. At the edges of the spectrum, approaches to sustainability tended to be motivated by critical attitudes and political standpoints. Towards the centre of the framework external factors played a larger role such as client aspirations and compliance. Analysis showed opportunities for enhanced practice, specifically in the realm of high-tech, socially engaged approaches, which were absent from the model. This points towards either the biases of the profession in validating particular types of practice (from which the sample was drawn) or indeed, that such practice does not exist or is irrelevant to contemporary sustainable design.

The Delphi study discussed in chapter 7 (and in appendix A in detail) supports these findings. It recognised three prevailing issues that defined alternative approaches to sustainable design in the UK. These could be described as competing concerns with nature, measurement and education, which could be mapped to the existing model of sustainable design.

9.1.4 Research, practice and education

The research raises questions regarding the relationship between architectural education, practice and research. The self-referential cycle of the design studio has already been alluded to however this indicates a wider trend across the profession. The *apprenticeship* model on which the design studio is founded relies on the input of practitioners who have been educated within this system. This relationship ensures relevance of education to the industry. The nature of the apprenticeship education is an artificial mirror of the profession. However, this risks the perpetuation of similar values and approaches, resisting alternative perspectives and change.

The research revealed the overwhelming attitude of the profession to value high performance building fabric and the reduction of carbon as primary concerns. This was reflected in the design studio as a tendency for students to view sustainable design as a technical application to buildings. There was also often a confusion between sustainable design, environmental design and the building environment itself, the former representing a broader, more holistic and contestable concept.

The practitioner led approach also divorced the design studio from its academic context. Rarely did the research taking place within the wider department actively impact the studio culture. While this may have been motivated by a concern to retain

the professional focus of the design studio, it served to limit the embedded range of knowledge and perspectives or students.

This research also highlights the capacity for action research to provide a methodology for continued professional development of teachers. Issues of time and resources notwithstanding, the rigorous and systematic reflection of personal approaches to pedagogy and sustainability may be leveraged to enhance critical understanding of teaching practice and the integration of sustainability.

Increasing the range of perspectives and alternative viewpoints in the design studio may provide a way to break the closed cycle of the design studio. This could involve enhanced engagement with academics making students, and educators, aware of the current state of the art of sustainability. However it may also involve increasing the range of learning experiences, moving beyond the studio and engaging with those who have specialist contextual or personal knowledge. Framing learning from the perspective of the learner can provide a mechanism to celebrate the diversity of lived experiences of students in the design studio. From a Kolbian perspective, this might be understood to enhance the nature of concrete experience to act as a platform for reflection, theory acquisition and active experimentation. Through enhancing the range of learning experiences in the design studio and broadening critical reflective approaches to sustainable design, the close link between the studio and its vocation could ensure actual change in practice through simultaneous education of future and current archtiects.

9.2 Research limitations and reflections

9.2.1 Researcher bias

The nature of an Action Research methodology risks introducing significant levels of bias through unconscious preconceptions. This is dealt with in section 2.2.4, however reflecting on the research process brought in fresh views on the bias embedded in the research. As a form of practitioner research, AR is reflexive, and concerned with learning of the individuals undertaking the research. Indeed, this personal involvement in the research is an essential component of an action research methodology (McNiff, 2016). Without my own personal involvement, I would not have been able to undertake the type of reflection on practice that is evidenced through this thesis.

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Notably, I am a member of the department in which the research was undertaken. It allowed *deep access* (Cohen et al., 2000, p. 129) to the participants as well as providing prolonged engagement which gave me rich understanding of the context. Moreover, my position allowed me to work with educators and participants in a manner which may have been impossible at another institution. Indeed, this can enhance the credibility and trustworthiness of qualitative research (Lincoln & Guba, 1985).

This approach also had a number of disadvantages. While I was not being paid for the interventions I made into the design studio, I was nevertheless bound by the expectations and prejudices prevalent in my workplace. I also undertook my undergraduate studies and was highly informative on both my architectural and teaching practice. This clearly embeds bias into the research, which I have attempted to mitigate through acknowledging possible bias and offering a thick description of the methods employed (Lincoln & Guba, 1985). While this does not eliminate the bias, it enables the reader to contextualise the research and consider my role as an actor in the creation of knowledge.

Reflecting on my own experience, there were a number of instances in which I experienced a conflict of interest between the research, my teaching role and my own personal agenda. For example, situations arose where I was conscious of not contradicting other staff members, a fear that was confounded by my personal involvement in the department. On other occasions, my familiarity with the teaching methods employed at the department led my to structure my tutorials in a manner which was familiar to both myself and students. Indeed, as a product of the very educational system I was studying, impartiality was clearly challenging. Despite these limitations, I have tried to map out the personal and academic journey the research has taken. Through this description, inherent biases are acknowledged and the results should be interpreted with this context in mind.

9.2.2 Representativeness

Conducting the research in a single department of architecture significantly limits the representativeness of the research. The findings cannot be said to represent the state of architectural education in the UK or abroad, partly due to the uniqueness of the department which is joint architecture and civil engineering. Arguably , the focus on

two individual cohorts further limits this representation. This has produced results which may be valid in themselves, have limited direct application to other contexts. A feature of AR is individual knowledge creation in specific contexts (McNiff, 2016) and may be both personally valid and socially valid. Personal validation, a form of internal validation, is dealt with in depth in chapter 7 which describes the process of validating findings against triangulated data.

Social validation, however, is when findings are discussed and judged by a range of practitioners and deemed to be valid. This happens in a continuing discourse with their own practice. This is an ongoing process however there is evidence to suggest the social validity of this work. Perhaps most simply, the literature review throughout this thesis provide a context into which these findings sit. While the research generated new knowledge, its relationship to exiting knowledge has been discussed in detail throughout. In addition, dissemination of the research has taken place at a number of academic conferences as well as a number of paper being peer reviewed. This provides an opportunity to *make the implicit explicit* (McNiff, 2016) by exposing the standards and processes through which the research should be judged. This is also captured in the *thick* description of the research throughout this thesis (Lincoln & Guba, 1985). The anonymous peer reviews that the published aspects of this thesis have undertaken provide further evidence of its representiveness in a wider context.

9.2.3 What did I learn?

A key component in AR is the agency of the self and developing personal living theory (McNiff, 2016). From the outset of the project, I was keen to develop tangible strategies for informing architectural education. The first phase of the research confirmed many of my own experiences of the design studio; its focus on space and form, the subsequent reliance on drawing and modelling as evaluative tools, and the limited space for genuine meta-reflective activities. To some extent, the analysis of this aspect drew from my own experiences of the studio. For example, I had direct experience of conducting crits and I had a familiarity with the format. I had seen the nature of the work students presented and was aware of the style of presentation. What surprised me was the extent to which it was led by students, a factor that perhaps is masked when I was immersed in critiquing a project.

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Observing the practice of others is not an opportunity that the studio typically allows. Interaction between tutors is typically reserved for crits rather than in the tutorial setting. I had assumed my practice was typical, and indeed, the format of tutorials reflected my own practice. Although have experimented with a range of structures in the past, I had often fallen back on the student led approach in which I would query decisions, identify issues and propose possible solutions. This was a common strategy among tutors (see chapter 3) with the exception of 'technical' tutorials which tended to focus on directly solving problems and imparting specialist knowledge. Conducting the research I designed workshops which took preparation time. I observed how part-time tutors would fill their day with student interaction, leaving no time for either preparation or reflection; something I had experienced myself. Given the pressures and expectations of tutors, it is little surprise that the intuitive approach described by Webster (2004) was popular. This was confounded when I made attempts to place learning at the centre of the tutorial, over the direct focus on a student project, this was sometimes met with bewilderment or hostility from students. Other tutors experienced this too. For example, when the sustainability tutor attempted to introduce short group workshops at the start of his sessions, student feedback prompted him to revert to a more traditional approach.

As I reflected on my practice, I became aware of my own political and ethical viewpoints on the nature of sustainable design, as well as the impact of this on student learning. Developing and utilising a critical framework exposed my own leanings towards participatory approaches that utilised simple building techniques. This was apparent not only in tutorials and workshops, in which I tended to respond more positively to student schemes which adopted these strategies, but also in professional interviews. On review of the interviews, I found myself subconsciously limiting my responsiveness to interviewees who expressed counter views. The advantage of using a structured evaluative framework was that it allowed me to look beyond these subconscious biases and recognise alternative views as equally valid. I became excited when students proposed ideas that challenged the status quo of sustainable practice.

Tutors spoke how they struggled with generating "new ideas" for students in tutorials, especially regarding sustainable design, and would fall back on their accepted and perceived knowledge. This was observed in tutorials in which tutors would typically attempt to solve issues or propose designs. Through enhancing my own critical awareness, I became aware of the limitations of this knowledge. Opening the

possibility for multiple contrasting design approaches provided a framework for ideation in tutorials to beyond what I was comfortable with. Rather than suggesting ideas, I used the framework to reveal possible linages or inconsistent approaches, avoiding steering the design towards my own preferences or expertise.

9.3 Recommendations

9.3.1 Recommendations for teaching and learning in the design studio

The findings raise a number of recommendations for teaching practice in the architectural design studio. These are placed in the context of the regulatory context of UK architectural education.

(22) Frame assignments as sustainable challenges in real-world contexts

Theming assignments explicitly around sustainable design can highlight the importance of sustainable design as a mainstream concern in architectural education. This might be through setting early agendas which set the narrative focus of a project to addressing issues of unsustainability grounded in real-world contexts. The open-ended nature of assignments in the design studio provides opportunities for students to create self-motivated, independent sustainable design frameworks given adequate initial scaffolding. Focus should move away from the production of building design and towards questioning how architecture can deal with the challenges of sustainability.

(23) Emphasise the role of the design process in learning

Developing rich and varied learning experiences should be prioritised through emphasising the design process. This involves broadening the range of creative and analytical tools used in the design process and allowing for quantitative or social analysis to be employed to complement traditional architectural competencies. Doing so will encourage critical approaches to sustainability which can be critiqued and evaluated through a range of analytical approaches, beyond the existing traditional media of the studio.

(24) Ground learning in existing experiences, values and understanding of sustainability

Students were observed to have intrinsic motivation for sustainability and there are opportunities for the studio to support these agendas in the design studio. The design studio may be operationalising the freedom of the studio to encourage the exploration of individual values. The accessibility of architecture also makes wider engagement and collaboration a distinct possibility more challenging in other disciplines. This would enhance critical learning, presenting sustainability as a plural concept.

(25) Emphasise learning over content

Teaching through specific, standalone tutorials may undermine critical approaches to sustainability and isolate it from culture of architecture. While specialist sustainability knowledge of tutors is valued by students, it should be introduced through critical and reflective interactions between students and educators. Shifting the focus of teaching interactions towards sustainable design can increase its value within the architectural studio. This might be through formal interventions such as structured discussions in tutorials or through heightening awareness of educators. Encouraging educators to adopt interdisciplinary approaches which span traditional architectural design and sustainability may encourage a shift in values towards more sustainable solutions. Using blended learning techniques can cater for a range of learning styles and enhance understanding across in all dimensions of learning. This can enable a balanced learning cycle in which the different dimensions of perception and processing of information.

(26) Encourage a wide range of perspectives on sustainability in the studio drawn from both within and beyond the profession including practitioners in other disciplines and the public.

Opening the design studio to a range of perspectives can break the self-referential cycle of the design. This can create opportunities for alternative perspectives and new ways of thinking about sustainable design.

(27) Allow space for reflection on sustainable design and critical dialogue between students and educators.

Creating space for critical reflection, both within and beyond the design studio can question underlying assumptions that structure the design studio. Reflecting not only the product of design, but also on learning itself, is necessary for effective deep learning.

(28)   Provide space for genuine collaborative learning for sustainability.

Working collaboratively can encourage the creation of shared knowledge, and challenges individual assumptions and prejudices. This may be through collective action in which a community of students can develop its own understanding of sustainable design.

(29)   Provide a wide range of sustainability related experiences beyond the design studio and the profession.

Stepping beyond the confines of the design studio can help students realise alternative perspectives as well as contextualise competing approaches to sustainable design, This might be through alternative learning environments (such as reflective seminars) as well as study trips or visits.

(30)   Allow space for teachers to reflect and learn to develop their own sustainable practice.

To encourage deep learning for sustainability in the design studio, educators must be able to reflect on the effectiveness of their own practice. This not only includes enhancing professional development among teachers but also allow space for critical analysis of their own personal pedagogies. Action research offers a methodology to help enable this.

The regulatory framework in the UK set by the ARB and RIBA may also benefit from these recommendations. Graduate criteria may be redefined to reflect a stronger focus on reflection and process as opposed to the terms knowledge and understanding. While the bulk of changes need to happen in the realm of pedagogy, the focus on outcomes of the RIBA and ARB limit their capacity for change. The recent RIBA report on sustainability and ethics (RIBA, 2018) has acknowledged the need to change teaching practices primarily by enhancing knowledge and awareness among educators. This research suggests this needs to be expanded to an understanding of reflective pedagogies which can enhance deep learning for sustainable design.

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9.3.2 Recommendations for the University of Bath

Five recommendations specific to the University of Bath department of Architecture and Civil Engineering MArch course are also made, outlined below:

(31) Mainstream sustainability in project briefs and assignments through explicit theming at both masterplanning and building level.

Theming projects explicitly sustainable led to a heightened awareness of sustainability issues. The titling of assignments effectively mainstreamed sustainable concerns implying sustainability a core aspect of design.

(32) Introduce the sustainable design framework into the design studio through specific structured workshops throughout projects.

The framework was shown to act as an effective aid to student understanding of sustainability. Using structured workshops and alternative tutorial formats can enhance critical understanding of sustainable design, help connect key concepts and generate novel design proposals.

(33) Combine "consultant" sustainability tutorials with general "architectural design" tutorials.

Separating tutorials implied an optionality to sustainability. Occasionally it meant holistic approaches and simple design solutions were missed in favour of technical solutions. Combined tutorials with design led and sustainable tutors can help to produce integrated and complementary design approaches.

(34) Provide space for discussion and interaction between peers in novel teaching formats to allow reflection on sustainable design.

Providing alternative tutor-student interactions to the desk-top tutorial and the crit can allow space for critical and reflective thinking. These may be situated in the design studio but enable group discussion and structured learning alongside the more traditional individual tutorial format.

(35) Allow students' individual sustainability experiences to form the basis for alternative design approaches.

Using individual student experiences to inform learning can help translate personal motivation for sustainable into the design studio context. This can be done through allowing students to construct personal approaches to sustainable design that draw from their own experience.

These recommendations have relevance in the context of the University of Bath's current curriculum transformation. Moving towards more holistic teaching modules which emphasise synoptic thinking, the findings of this research give insights to how sustainable design may more effectively be incorporated into a design studio system. This provides a model for learning and teaching which may be emulated by other design led subjects.

9.3.3 International architectural education

The general recommendations made may be applicable to any school of architecture which adopts a design studio pedagogy, both in the UK and internationally. While the design studio is the dominant mode of teaching and learning, its prevalence is not as widespread in international schools of architecture. For example, in Brussels the design studio only contributes about 25% of the overall degree while at University Mediterranea Of Reggio Calabria, design studio is not introduced until the 3rd year (Altomonte et al., 2010). Nevertheless, it remains a key feature of almost all global architectural education. Accordingly, the recommendations indicate how schools may bring disparate aspects of their curriculum together in a meaningful way which encourage deep learning for sustainability through a design led pedagogy.

9.4 Originality and significance

9.4.1 Originality and contribution to knowledge

The research provides a number of original contributions in the field. It provides an original framework which synthesises typologies of sustainable architecture and models of sustainability mapping. The resultant framework provides a conceptual structure for interpreting sustainable design in order to encourage critical analysis.

The research surveys and maps the range of sustainable architecture practice in in the UK. The sampling technique of "elite" participants gives a unique insight into

the approach and practices of award winning and sustainable design. The categorisation of these approaches provides an insight into potential enhancements to this practice.

The research provides an in depth analysis of the application of the framework for sustainable design within the context of a UK school of architecture. A naturalistic inquiry into how members of an architectural design studio incorporate and respond critically to sustainable design is currently absent from the literature and this research provides an insight into this from a uniquely student perspective. This extends and build upon the extensive work done by the EDUCATE programme into understanding sustainability in architecture schools.

9.4.2 Significance

The research has significance in the fields of both architectural and higher education. The specific framework developed and its application acts as a valuable case study for practitioners in architectural education to modify and adapt their own practice. Operating within a broadly naturalistic paradigm, the research can be considered transferable rather than generalizable. This is achieved through careful documentation of process and context which allows interpretation and adaption.

Teaching for deep learning is a transferable concept that is necessary in all fields where environmental sustainability is addressed. The action research approach employed in the research is a transferable methodology which can be operationalised in other Higher Education contexts. The nature of action research is that it generates knowledge through making tangible changes and has an emancipatory capacity to address social issues. The research has had direct significance on learners who participated in the process, documented by evidence of their deepening learning. Through transferring the research to other contexts, its impact on learners in a wide range of disciplines and professions may go well beyond the academic sphere.

9.5 Further work

The nature of the research is open ended and poses a number of questions for further work. The action research project is a continuing endeavour and further research cycles would inevitably further the understanding of practice and learning central to this thesis. "Living theory" emphasises the changing and evolving nature of personal theory, developed through Action Research. This is something that will continue to inform my

own professional practice.

There is also clear impact on the education at the University of Bath. Findings have been presented to the course leader and a briefing document produced. Recommendations are described earlier in this chapter with a view to instigating lasting pedagogic change.

The role of compliance with educational requirements could be examined. The RIBA and ARB are responsible for shaping architectural education in the UK and there are opportunities for enhancing their input regarding learning for sustainable design. The relationship between graduate attributes and curriculum design might provide insights into the specific culture of sustainable design in UK schools.

The research into UK practice would benefit from increasing the sample size and seeking alternative practice. Limited by the professional validation of practices as a sampling strategy may have masked the existence of extreme or unusual design approaches. This might draw into question the status quo and accepted values of the architectural profession in the UK, and reveal new sustainable possibilities.

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Appendix A: Delphi Study

A1 Background

A1.1 Validation procedures

Appendix A describes in detail the conduct and analysis of the Delphi Study conducted as a validation exercise. Rationale, limited results and discussion are discussed in chapter 7 and this appendix should be read in conduction with this chapter. It provides more detail on the specific methodology and analytical procedures used as well as offering extended discussion.

A1.2 Background to the Delphi technique

The Delphi Technique was originally developed in the 1950s (Dalkey & Helmer, 1963) as a means of obtaining and distilling knowledge from a group of experts (Ziglio, 1996). It involves controlled feedback mechanisms which allow experts to reconsider their viewpoints until a general group consensus is approached or sufficient information exchanged (Delbecq, Van de Ven, & Gustafson, 1975). The process involves administering a series of remote questionnaires in which participants are often required to identify problems, outlie objectives, provide solutions or offer predictions. The advantage of a Delphi over other questionnaire techniques is that each subsequent questionnaire assimilates the results of the previous one, offering experts the chance to "refine" their views as the group progress the overall task (Ziglio, 1996). According to Landeta (2006), a Delphi Technique has four primary characteristics:

(1) It is a repetitive process: consulting with experts twice, with feedback, allows them to reconsider their initial responses.

(2) It is anonymous and remote: this allows experts who are geographically spread to contribute to the study in their own time and large purposeful sample to be assembled far more easily than other group decision making techniques (e.g. Nominal Group Technique). It also removes negative influences of personality and status.

(3) It uses controlled feedback: the coordinator can remove superfluous information in the exchange between participants.

(4) Group statistical response: all opinions reflect the final response and typically they are measured quantitatively and statistically.

(Modified from Landeta (2006))

A Delphi is typically divided into two parts, an exploratory phase and an evaluation phase (Ziglio, 1996). In the exploratory phase, the aim is to examine the discussion around the subject and to provide additional information if required. When using Delphi as a pilot research instrument, the broad views of the participants on the issue in question define the variables for the second phase to fully explore the subject (Delbecq et al., 1975). However, when used as a survey technique to approximate results, this exploratory phase might be far more focussed. The evaluation phase brings together these views and identifies areas of consensus or disagreement. Analysis of comments may reveal reasons for disagreements (Ziglio, 1996). Pare, Cameron, Poba-Nzaou, and Templier (2013) provide a categorisation of different Delphi Techniques defined in table A1. This study uses a ranking type Delphi for its appropriateness for guiding future action and assessing value in the absence of consistent underlying natural laws (Pare et al., 2013).

Table A1: Edited and redrafted from Pare et al. (2013)

	Classical Delphi	**Policy Delphi**	**Decision Delphi**	**Ranking Type Delphi**
Focus	Facts	Ideas	Forecasting	Rankings
Goal	Consensus	Define and differentiate views	Prepare and support decisions	Identify and rank key issues
Common uses	In the natural sciences and engineering where underlying physical ''laws of nature'' guide experts' answers	In social and political contexts to analyze policy issues	In contexts where a small, well-defined group have decision making power	In business to guide future management action or research agendas

A1.3 Applying the Delphi technique

The use of a Delphi allows the collective expertise of the practitioners interviewed in Phase 4 to reflect upon the findings of the research to enhance the conceptual model and its application.

Appendix A: Delphi Study

A2 Research method

A2.1 Outline of the research method

The research employed a two stage Delphi Technique. Each stage involved a questionnaire administered online called Q1 and Q2 respectively. The stages of the Delphi Technique are described in figure A1.

Q1: Design	Q1 questionnaire design
	↓
	Pilot test of Q1
Q1: First round of Delphi	Q1 to all respondents
Q1: Analysis	Cluster analysis of Q1 (Kmeans)
	Cluster A2 — Cluster A2 — Cluster A3
Q2: Design	Q2 questionnaire design
	Pilot test of Q2
Q2: Second round of Delphi	Q2A2 to cluster A2 — Q2A2 to cluster A2 — Q2A3 to cluster A3
Q2: Analysis	Stability check (consensus value)
	Identifying differentiating statements (Kruskal-Wallis test)
	Validating differentiating statements (Kmeans clustering and Kruskal-Wallis test)
	Correlating statements into primary themes (Kmeans clustering)

Figure A1: Stages of the Delphi Technique

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A2.2 Sampling and data collection

A sample of practitioners was drawn from the professional interviews conducted in Phase 4 of the research. All 25 interviewees were contacted and invited to contribute to the Delphi study. Of these, nine agreed to contribute and six completed the first round (Q1) and four completed the second round (Q2).

Table A2: Practitioners from interviewed professionals participated in the Delphi study

Practice	Size	Position of interviewee	Nature of projects	Link to sustainability	Round 1	Round 2
F	14	Senior partner	Medium scale education, arts, culture	Award winning/green branding	Yes	No
G	180-200	Project architect	Medium-large scale mixed	Award winning	Yes	No
I	10	Architect	Small scale residential, commercial and community	Self-identifying	Yes	Yes
M	13	Partner	Medium scale Scientific and cultural	Award winning	Yes	Yes
N	65-70	Architect	Medium-large scale Residential, education and healthcare	Award winning	Yes	Yes
O	40	Partners	Medium scale Mixed use	Award winning	Yes	Yes

While this gave a range of architectural practices and sizes, it was deemed insufficient to create a Delphi Technique with multiple group sizes. This sample was therefore expanded to include architects from the Green Register of Architects. In total, 95 architecture practices from the register were contacted and 21 participated in the first round of the Delphi. Four of these practices dropped out for the second round. In total 27 participants took part in the first round and 21 in the second round.

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Table A3: Practices responded to Delhi from the green register

Practice	Size	Position in practice	Nature of projects	Link to Sustainability	Round 1	Round 2
AA	1.5	Director	Small-scale residential, community	Green Register	Yes	Yes
AB	1	Principal	Small-scale residential; consultancy	Green Register	Yes	Yes
AC	16	Partner and Architect	Small-medium scale, mixed	Green Register	Yes	Yes
AD	12	Partner	Medium scale, community and education	Green Register	Yes	Yes
AE		Architect + Associate	Small to medium scale, residential and education	Green Register	Yes	Yes
AF	3	Project Architect	Small-scale, residential and community	Green Register	Yes	Yes
AG	45	Director	Large-scale residential, commercial, education, community	Green Register	Yes	Yes
AH	1	Director	Small-scale residential, commercial, education, community	Green Register	Yes	Yes
AI	18	Director	Small-scale residential, Education cultural, community, leisure	Green Register	Yes	Yes
AJ	12	Office Manager	Small-scale residential	Green Register	Yes	Yes
AK	1	Principal	Small-scale residential	Green Register	Yes	Yes
AL	1	principal	Small-scale and large-scale residential; commercial, community, leisure	Green Register	Yes	No
AM	3.5	Director	Small-scale residential, commercial, community, leisure	Green Register	Yes	Yes
AN	45	architect	Small-scale and large-scale residential; commercial; education culture, community, leisure, health	Green Register	Yes	Yes
AO	13	Director	Small-scale and large-scale residential, commercial, leisure	Green Register	Yes	Yes
AP	160	Head of Sustainability	Small-scale and large-scale residential, education, urban design, community	Green Register	Yes	Yes
AQ	4	Director	Small-scale residential; commercial, community, leisure	Green Register	Yes	No
AR	50	Architect	Small-scale and large-scale residential, commercial, education, urban design, community, leisure	Green Register	Yes	Yes
AS		Director	Small-scale and large-scale residential, commercial, cultural, urban design, community	Green Register	Yes	No
AT	28	Associate	Small-scale residential and residential, commercial, education, urban design, public and community, leisure	Green Register	Yes	Yes
AU	350	Associate & Head of Sustainability	Large-scale residential, commercial, education, cultural, urban design	Green Register	Yes	No

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A2.3 Delphi protocol

In a "classical Delphi" (Pare et al., 2013) a series of experts seek consensus on a range of statements. Typically, Likert scales are used for evaluative contexts (Cohen, Manion, & Morrison, 2000) however this was deemed inadequate in this scenario. This was due to the likelihood of all statements receiving some form of agreement. While the interviews conducted in phase 4 revealed a series of conflicting design responses, there was little evidence of hostility or dismissiveness of alternative approaches. For example, practices who engaged in low-tech, vernacular approaches did not exhibit hostility to those engaged in high-tech approaches.

Best/worst scaling (BWS) was chosen as a Delphi method as it eliminates many of the biases involved in traditional ranking or value based techniques (Strasser, 2018). It produces statistically significant results, is more efficient than paired comparison methods. It has been shown to be particularly superior to rating scales for cross cultural analysis (Cohen & Orme, 2004; Kobus & Westner). BWS asks participants to evaluate a set of statements and identify the best and worst options. Strasser (2018) describes a method in which each statement is compared with every other statement at least once, with each statement occurring an equal number of times. Statements are presented in blocks (typically containing between 4 and 7 statements) and the respondent is asked to select the best and the worst options from the block. This approach relies on the creation of a Balanced Incomplete Block Design (BIBD), which is governed by two rules:

$$vr = bk$$
$$r(k-1)=\lambda(v-1)$$

These allow each statement to repeated and to occur with each other statement an equal number of times. Of the variables, v is the number of statements, r is the number of times each statement occurs overall, b is number of total of blocks, and k is the number of statements within each block. Finally, λ is the number of times a particular statement is paired with another statement (Strasser, 2018). For any number of statements, only a limited number of BIBDs exist, a table of possibilities is provided by Strasser (2018). From this, a table of block compositions can be created using the *find.BIB* function in the programme R (Aizak, 2017). Table A4 shows the calculated BIBD in R, for 13 statements, in 13 blocks of 4 statements. Each statement repeats four times in this

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design.

Table A4: Statement block design for first round of the Delphi

Block	Position 1	Position 2	Position 3	Position 4
1	Statement 2	Statement 4	Statement 6	Statement 8
2	Statement 1	Statement 8	Statement 10	Statement 11
3	Statement 3	Statement 8	Statement 12	Statement 13
4	Statement 2	Statement 9	Statement 10	Statement 13
5	Statement 5	Statement 7	Statement 8	Statement 9
6	Statement 4	Statement 5	Statement 10	Statement 12
7	Statement 3	Statement 4	Statement 9	Statement 11
8	Statement 1	Statement 4	Statement 7	Statement 13
9	Statement 1	Statement 2	Statement 3	Statement 5
10	Statement 3	Statement 6	Statement 7	Statement 10
11	Statement 1	Statement 6	Statement 9	Statement 12
12	Statement 5	Statement 6	Statement 11	Statement 13
13	Statement 2	Statement 7	Statement 11	Statement 12

In the initial questionnaire, a range of responses was expected. The findings of phase 4 indicated a range of approaches and this was anticipated in the Delphi. As a result, this was used to divide panellists into a series of sub-panels, based on levels of agreement between statements. This acted as a member checking procedure (Lincoln & Guba, 1985) to confirm the findings of phase 4 and the position of each practice in terms of sustainable design outlook. Subsequent questionnaires then searched for consensus between sub-panels which represented different areas of the sustainable design model proposed.

A2.4 Bias

Bias was mitigated through a number of measures including the use of BWS questions. BWS eliminates many of the traditional biases in value based questionnaires (Strasser, 2018). Traditional question responses, such as Likert scales, raise the possibility of ties between items and can introduce response style biases. These include social desirability bias (tendency to fake responses), acquiescence bias (desire to agree) and extreme response bias (Paulhus, 1991). Furthermore, the "classical Delphi" approach is useful when trying to gain a consensus among experts, however in this research, a plurality of responses is both desired and anticipated.

Ranking type Delphis provide an alternative to the "classical Delphi" approach forcing respondents to make decisions between possible options. This helps overcome many of the limitations of the classical Delphi approach particularly high numbers of tied answers and response style bias (particularly acquiescence bias and extreme

responding) by preventing "yea-saying" by forcing trade-offs. Scalar equivalence (the ability to accurately compare the scores given by different respondents) is therefore increased in ranking style approaches (Cohen & Neira, 2003). Typically, participants are only able to rank between 3 and 5 statements effectively (Cohen & Neira, 2003) and the approach is not immune to response style bias and issues with standardisation and can be overcome by using Max Difference scaling or BWS (Kobus & Westner).

To eliminate bias further, questions were presented in a random order, and statements within each question were also randomised across participants (Lee, Soutar, & Louviere, 2008). BWS does not eliminate the possibility of humane response error however the repeated nature of the BWS technique accounts for much of this error and has been shown to be more accurate than other techniques (see (Orme, 2018)).

A2.5 Analysis of the data

Analysis was undertaken to determine the level of consensus on statements and the level of stability (between rounds). Dajani, Sincoff, and Talley (1979) provide statistical stopping rules for Delphi techniques suggesting that a coefficient of consensus (CV) of less than 0.5 provides a good degree of agreement and no need for additional rounds. In order to assess stability, the difference between consensus levels of subsequent rounds should be less than 0.1 (Strasser, 2018). Initially, a "best minus worst" approach is used to convert the BWS to a ranking. The number of times a statement is chosen as a worst choice is subtracted from the number of times it is a considered a best choice (Kobus & Westner). More sophisticated alternatives include logit models or linear probability models however, for the purposes of this Delphi study and the limited sample size, this added complexity was deemed unnecessary and follows the methodology laid out by Strasser (2018). Furthermore, the design of the initial Delphi was seeking to determine where practice assign value in sustainable design, rather than to develop a comprehensive ranking. The multiple rounds of the Delphi allow a tentative ranking to be formed in the early phases to then be validated by groups of practitioners. The number of occurrences of each statement (r) is 4 times in the chosen BIBD therefore the maximum and minimum scores a statement can achieve are 4 and -4 respectively. The mean scores of each statement ($\bar{X}$) can then be calculated.

A linear transformation ($\bar{X} = X + r + 1$) is applied to each mean to give positive values which are "more familiar" to rating scales, where $\bar{X}$ is the mean, r is the

number of repetitions of each statement and $\mathcal{X}$ is the transformed mean (Strasser, 2018). This gives a range of mean scores for each statement between 1 and 9.

To evaluate consensus, the standard deviation and coefficient of consensus are calculated for each statement. CV =(SD/mean). In this case, the mean of the population was used, rather than the sample mean. This normalises the coefficient of variation relative to the entire population rather than the scores exhibited by each sample. CV of less than 0.5 is good consensus. (Strasser, 2018). CV difference between rounds can also be calculated and a CV difference of less than 0.1 is considered stable (Dajani et al., 1979).

A2.6 Clustering

Based on the findings of the interviews, it was anticipated that there would be a degree of convergence on some issues and divergence on others. The categories identified in the interview phase suggested that a number of distinct groups would be formed. After the first round the data were clustered into three groups, each of which formed a distinct Delphi panel. Principles of Delphi suggest a minimum of 5 experts per group (Rowe & Wright, 2001). Forming three clusters allowed for a minimum of 5 participants including possible drop-off in later rounds.

To cluster this multidimensional data, a K-means analysis was performed (MacQueen). K-means uses an iterative algorithm to divide the data into K clusters. This method was chosen as it requires a predefined number of clusters which was decided in this case based on the minimum number of participants to enable each sub-panel of Delphi participants (K=3). Firstly, the data were loaded into the statistics software R.

```
> setwd("~/Google Drive/PhD/DATA/DELPHI")
> data=read.csv("data.csv")
```

The k-means parameters were then defined and then the iterations run. Nstart refers to the number of initial configurations which are attempted before the algorithm is run.

```
> km.res <- kmeans(data, 3, nstart = 25)
> View(km.res)
```

The data are then visualised using the factoextra package.

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```
> library("factoextra")
> fviz_cluster(km.res, data = data, frame.type =
"convex")+theme_minimal()
```

From this process three distinct groups could be formed at the end of the first stage of the Delphi to allow the creation of sub-panels.

A2.7 Comparing groups and identifying differentiating statements

To identify key statements differentiating groups, a Kruskal-Wallis (H) test was conducted. This was used to determine statistically significant differences between independent groups of data. This method is non-parametric so does not require the data to be normalised and can be used with ordinal data (Kruskal & Wallis, 1952) The method is based on ranking and makes only general assumption about the distribution of data, unlike the assumed normality of alternative tests (Kruskal & Wallis, 1952). H is found using the methodology originally set out by Kruskal and Wallis (1952). H is found by:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{C} \frac{R_i^2}{n_i} - 3(N+1)$$

where:

C is the number of samples;

n_i is the number of observations in the ith sample;

$N = \sum n_i$, the number of observations in all samples combined;

R_i is the sue of the ranks in the ith sample.

If ties exist, each observation is given the mean rank for the tie. H is then divided by the following:

$$1 - \frac{\sum T}{N^3 - N}$$

T is the sum of $t^3 - t$ for each group of ties where t is the number of tied observations in the group. The Kruskal-Wallis test was administered by the RealStats Excel plugin (Zaiontz, 2019) and as well as being checked manually. A 0.05 level of certainty (alpha value) was selected which is standard across social science research.

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A3 Delphi Q1 design

A3.1 Questionnaire design

The first stage of a "classical Delphi" invites comments to the particular problem in broad terms (Ziglio, 1996) and can allow the participants to generate the variables and sub-categories for research themselves (Delbecq et al., 1975). In the context of this research, the interviews conducted in phase 3 of the research provided the statements for analysis. These were reduced to 13 key statements. The choice of 13 was limited by the possible creation of a BIBD, the desire to produce a questionnaire that was manageable in length for practitioners and limited the possible choices in each statement block to 4. The statements represent a compression of the key findings from the interviews facilitated through NVivo and the analytical process of coding and domain creation described in phase 3. These allowed the creation of a BWs survey which contained 13 blocks, each containing 4 statements with each statement occurring with each other statement only once. The 13 statements drawn from phase 3 were:

(1) Employing simple and/or vernacular technologies in building design.
(2) Integrating innovative technologies and materials in building design.
(3) Collaborating with likeminded and motivated clients and stakeholders.
(4) Educating clients and stakeholders in sustainable design and operation.
(5) Specifying natural building materials.
(6) Minimising building waste.
(7) Designing with respect for the natural environment.
(8) Designing buildings to enable sustainable lifestyles.
(9) Reducing embodied and operational energy through passive design and high performance envelopes.
(10) Designing for occupant health and wellbeing.
(11) Measurement and analysis of building performance.
(12) Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.).
(13) Utilising local skills and materials in the building process.

For each block of statements, respondents were asked to respond in the following way:

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- For each set of statements, please indicate what is most important and least important to your architectural practice to enable sustainability.

- There are 13 sets of 4 statements.

- For each set of 4 statements, please only tick 2 boxes (one for most important and one for least important).

- Statements deliberately repeat to enable comparison.

- When you agree (or disagree) with multiple statement please pick the most (or least) important to your architectural practice.

A box for additional statement or strategies not described in the main questionnaire was also provided. For the pilot questionnaire, comments on the legibility and format of the questionnaire were invited in an additional comments box.

A3.2 Pilot study

A pilot study was conducted with 3 participants to test the first questionnaire (Hasson, Keeney, & McKenna, 2000). The pilot questionnaire was sent to 3 practicing architects who did not qualify (and were therefore excluded) from the original study. They represented a range of companies and workload type (table A5).

Table A5: Sample of architects from the pilot study

Practice	Size	Position of interviewee	Nature of projects
PX	60	Architect	Medium scale, cultural, high-end residential
PY	170	Architect	Medium-large scale mixed
PZ	24	Architect	Commercial, industrial

Responses from the pilot study highlighted the need to explain the repetition of questions throughout as well as introducing the participants thoroughly to the concept and approach of a Delphi study. Participants described how it was often challenging to make choices between options and the possibility of negative and positive associations with each. It was decided that the purpose of this approach was to force respondents to make decisions and that the format of the questionnaire should remain. As the pilot participants were not involved in the original study, their contribution to the content of the questionnaire was excluded from the emergent themes chosen from earlier analysis. Moreover, there actual responses to the questions were considered void as they were not

on the original panel of experts that informed the creation of the Delphi.

In some cases, respondents cited one issue as the best option and in another question scenario as the worst option. This is a common feature of BWS techniques and in cases gave rise to a number of tied options. The statistical methods used (Kendall's W and variance) allow for ties.

Following the sample analysis it was decided this feature of the ranking could be addressed in the second phase of the Delphi. Statements could be refined or eliminated to remove the number of high variance responses among groups.

A4 Q1 Results and analysis

A4.1 Overall groupings

Following the protocol set out by Strasser (2018), statements were assigned either 1 ,0 or -1 depending on whether they are voted as most important or least important at each question block and for each participant. These were then summed to create an aggregate score for each statement by participant (table A6). Mean, SD and coefficient of variation were calculated for each statement across the entire population. CV was calculated using a population transformed mean (5.00) as this reflected the nature of the rating. Distortion would have occurred if used sample mean for each statement was used as lower scored ratings would have an arbitrarily higher CV.

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Table A6: Practice scores for each statement from Q1

Practice	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
AA	-3	-1	-1	0	-3	-1	2	3	3	3	1	0	-3
AB	2	-1	-1	3	-1	-1	-2	2	0	2	-4	-2	3
AC	0	-4	3	-1	1	-1	4	0	1	3	-3	-3	0
AD	0	-2	3	3	-3	-4	0	1	4	0	0	0	-2
AE	-3	-1	1	-3	-3	0	2	2	1	3	1	2	-2
AF	2	-2	-3	-1	-1	0	2	2	4	1	-4	-2	2
AG	0	1	-2	0	3	-3	2	-4	2	2	0	-1	0
AH	1	-3	-2	1	0	1	2	1	3	0	0	-4	0
AI	0	-1	-2	3	-1	-2	-4	1	4	1	3	0	-2
AJ	-1	-3	2	3	-2	0	1	2	3	-2	0	-3	0
AK	3	1	3	-2	0	-1	0	-1	0	3	-3	-4	1
AL	-2	-4	-1	1	1	0	1	-3	3	2	0	1	1
AM	1	-2	0	3	-2	-2	1	2	4	-1	0	0	-4
AN	-3	-2	1	2	-2	-4	0	4	0	3	0	2	-1
AO	0	-2	2	3	-1	-2	1	4	2	0	-3	-4	0
AP	1	-1	-1	-1	1	-3	-1	1	1	4	2	-1	-2
AQ	-2	-3	-1	1	-2	0	3	1	3	3	1	-4	0
AR	1	0	3	4	-3	-4	-1	1	-2	1	3	-1	-1
AS	0	-2	-3	0	0	0	2	1	1	0	1	3	-3
AT	-4	-3	-3	-1	1	0	3	3	4	0	0	1	-1
AU	-3	-2	3	2	-3	-1	-1	0	3	2	0	2	-2
M	-2	0	1	0	0	-2	3	2	2	4	-2	-3	-3
I	-2	0	-1	0	4	-3	2	-1	3	1	0	-4	1
F	-1	-2	-2	3	0	0	1	-2	4	1	0	1	-3
G	0	-1	-4	3	-1	-1	0	1	4	2	-2	-1	0
O	-4	-2	-1	3	-3	2	0	2	1	0	4	-1	-1
N	-3	-2	-2	3	-1	0	2	2	4	0	1	0	-4
Mean	**-0.81**	**-1.63**	**-0.30**	**1.19**	**-0.78**	**-1.19**	**0.93**	**1.00**	**2.30**	**1.41**	**-0.15**	**-0.96**	**-0.96**
Transformed mean	**4.19**	**3.37**	**4.70**	**6.19**	**4.22**	**3.81**	**5.93**	**6.00**	**7.30**	**6.41**	**4.85**	**4.04**	**4.04**
Standard deviation (SD)	**1.94**	**1.31**	**2.18**	**1.92**	**1.85**	**1.57**	**1.75**	**1.90**	**1.64**	**1.55**	**2.05**	**2.14**	**1.79**
Relative Standard Deviation (RSD)	**0.39**	**0.26**	**0.44**	**0.38**	**0.37**	**0.31**	**0.35**	**0.38**	**0.33**	**0.31**	**0.41**	**0.43**	**0.36**
Ranking	**9**	**13**	**7**	**3**	**8**	**12**	**5**	**4**	**1**	**2**	**6**	**10.5**	**10.5**

Although the CV values all fall below 0.5 representing a good level of consensus (Strasser, 2018), having only one round completed, the stability of statements could not be assessed. The ranked lists of statements for the whole sample is in table A7.

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Table A7: Ranked list of statements across all participants

Statement number	Rank	Transfor med mean	RSD	Statement
9	1	7.30	0.33	Reducing embodied and operational energy through passive design and high-performance envelopes
10	2	6.41	0.31	Designing for occupant health and wellbeing
4	3	6.19	0.38	Educating clients and stakeholders in sustainable design and operation
8	4	6.00	0.38	Designing buildings to enable sustainable lifestyles
7	5	5.93	0.35	Designing with respect for the natural environment
11	6	4.85	0.41	Measurement and analysis of building performance
3	7	4.70	0.44	Collaborating with likeminded and motivated clients and stakeholders
5	8	4.22	0.37	Specifying natural building materials
1	9	4.19	0.39	Employing simple and/or vernacular technologies in building design
12	10.5	4.04	0.43	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)
13	10.5	4.04	0.36	Utilising local skills and materials in the building process
6	12	3.81	0.31	Minimising building waste
2	13	3.37	0.26	Integrating innovative technologies and materials in building design

A4.2 Cluster analysis

Following the overall analysis of the data, a K-means cluster analysis was undertaken, as described in the methodology of this chapter. Using the predefined, K=3, the algorithm generated three clusters of 8, 12 and 7 members.
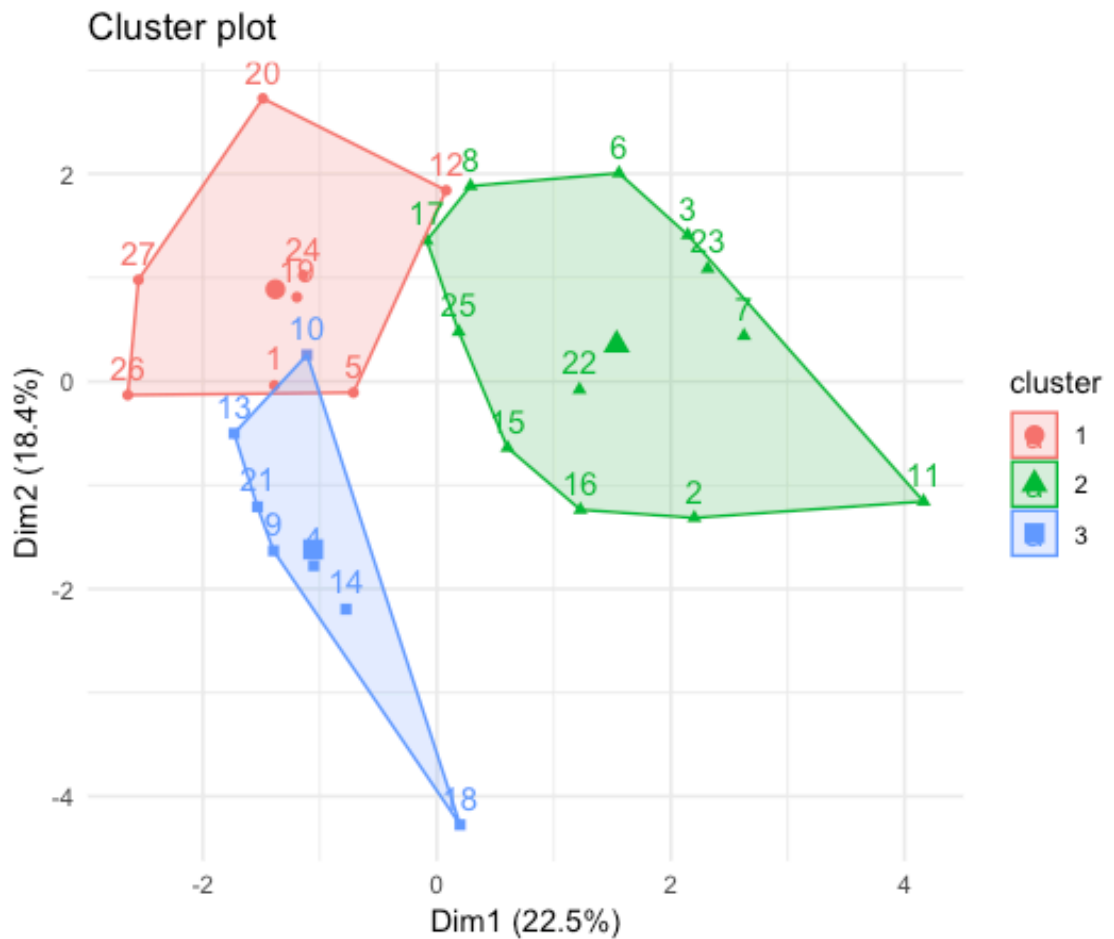
Figure A2: Visualisation of the clustering (the numbered nodes refer to each practice in the data set)

Table A8: Practice codes organised into the three clusters (number shown in figure A2 in parentheses)

Cluster A1	Cluster A2	Cluster A3
AA (1)	AB (2)	AD (4)
AE (5)	AC (3)	AI (9)
AL (12)	AF (6)	AJ (10)
AS (19)	AG (7)	AM (13)
AT (20)	AH (8)	AN (14)
F (24)	AK (11)	AR (18)
O (26)	AO (15)	AU (21)
N (27)	AP (16)	
	AQ (17)	
	M (23)	
	I (22)	
	G (25)	

The clusters then formed three individual groups that constituted the second round (Q2) of the Delphi.

Appendix A: Delphi Study

A5 Q2 design

A5.1 Questionnaire design

The second questionnaire (Q2) assumed the same format as Q1. The statements were divided into the same 13 block pattern, with four statements per block. The purpose of the second round of the Delphi was explained to participants, and they were told they were able to change their mind on their answers to respond to the results of others. Within each block, statements were ranked in order from the most important to the least important according to the overall mean scores of their respective cluster. At the start of the questionnaire, respondents were also exposed to the overall list of statements ranked in order of most to least important by their cluster. Each question was prefilled with each respondent's previous response and gave them the opportunity to change this response. In response to comments made after the first questionnaire, a number of the statements were altered in their wording. These are shown in table A9.

Table A9: Modified statement in Q2

Statement number	Original statement	New statement
2	Integrating innovative technologies and materials in building design	Integrating innovative technologies, construction techniques and materials in building design
6	Minimising building waste	Reducing demolition and construction waste
8	Designing buildings to enable sustainable lifestyles	Designing contextually to enable sustainable lifestyles

Four new statements were also introduced in a second part to the questionnaire, based on the feedback from Q1. As these were completely new, they could not be included in the block design format and retain the same questionnaire structure. Instead they were included as standalone Likert style questions. Respondents were asked if they to rank the following statements on their level of importance (very important, important, neither important nor unimportant, unimportant, very unimportant).

- Designing holistically.
- Using rigorous internal procedures to ensure sustainable design quality.
- Integrating renewable technologies.
- Designing for future needs and longevity.

A5.2 Pilot study

Q2 was tested with before deployment with the same three architects that tested Q1. Being familiar with the question formats, this replicated the process for Q2. This pilot study confirmed the questionnaire was legible and straightforward to complete.

A5.3 Response rate

I the second round, six practitioners did not complete the study. Their data were removed from the analysis. 78% of participants who completed the first round of the Delphi went on to complete the second round.

A6 Results and analysis

A6.1 Checking stability

The overall results can be used to assess stability and determine whether further Delphi rounds are required. The consensus value (CV) is the difference between relative standard deviations between consecutive rounds. A value of less than 0.2 indicates good stability between rounds and so a further round is not required (Strasser, 2018). Table A10 shows the full results with the final consensus value.

Appendix A: Delphi Study

Table A10: Q2 full results and consensus values

Practice	Cluster	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
AA	A1	-3	-1	-1	0	-3	-1	2	2	4	3	1	0	-3
AE	A1	-1	-1	2	-3	-3	-2	2	2	1	3	0	2	-2
N	A1	-3	-2	-2	3	-1	0	2	2	4	0	1	0	-4
AT	A1	-4	-2	-2	0	1	1	3	1	4	-1	0	2	-3
O	A1	-4	-2	-1	3	-3	0	0	1	4	1	3	-1	-1
I	A2	-3	1	-1	1	3	-3	2	-1	4	1	0	-4	0
M	A2	-3	0	2	-1	-1	0	3	1	2	4	-1	-4	-2
AF	A2	-1	-3	-3	-1	3	0	3	1	4	0	-3	0	0
AB	A2	2	-1	-3	4	-1	0	0	2	0	2	-4	-2	1
AH	A2	1	-3	-2	1	0	1	2	1	3	0	-1	-4	1
AC	A2	0	-4	3	0	1	-1	4	0	1	3	-3	-3	-1
AK	A2	3	1	3	-1	0	-1	0	-1	0	2	-3	-4	1
AG	A2	0	1	-2	0	3	-3	2	-4	2	2	0	-1	0
AO	A2	0	-2	1	3	-1	-2	1	4	1	2	-3	-4	0
AP	A2	-1	-3	-4	-1	1	-1	1	1	2	4	3	0	-2
AJ	A3	0	-3	2	4	-3	-1	1	3	2	0	-1	-3	-1
AN	A3	-3	-2	1	2	-2	-4	0	4	0	3	0	2	-1
AM	A3	1	0	0	3	-3	-3	-1	2	4	-1	2	0	-4
AR	A3	1	0	3	4	-3	-4	-1	1	-2	1	3	-1	-1
AD	A3	-1	-3	2	3	-3	-3	0	0	4	0	3	0	-2
AI	A3	0	-2	-1	3	-1	-2	-4	1	4	1	3	0	-2
Mean		-0.90	-1.48	-0.14	1.29	-0.76	-1.38	1.05	1.10	2.29	1.43	0.00	-1.19	-1.24
Transformed mean		4.10	3.52	4.86	6.29	4.24	3.62	6.05	6.10	7.29	6.43	5.00	3.81	3.76
Standard deviation (SD)		2.00	1.50	2.22	2.08	2.12	1.53	1.80	1.76	1.82	1.54	2.30	2.09	1.51
Relative Standard Deviation (RSD) (Q1)		0.39	0.26	0.44	0.38	0.37	0.31	0.35	0.38	0.33	0.31	0.41	0.43	0.36
Relative Standard Deviation (RSD) (Q2)		0.40	0.30	0.44	0.42	0.42	0.31	0.36	0.35	0.36	0.31	0.46	0.42	0.30
Consensus value (CV)		0.01	0.04	0.01	0.03	0.05	0.01	0.01	0.03	0.04	0.00	0.05	0.01	0.05

To confirm this stability the individual consensus values for each independent cluster was also examined (tables A11-A13). Across all statements and clusters, CVs were below the 0.2 threshold.

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Table A11: Cluster A1 consensus values

Statement	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Relative Standard Deviation (RSD) (Q1)	0.31	0.20	0.30	0.41	0.33	0.17	0.20	0.42	0.26	0.24	0.32	0.26	0.28
Relative Standard Deviation (RSD) (Q2)	0.22	0.10	0.29	0.45	0.32	0.20	0.20	0.10	0.24	0.32	0.22	0.24	0.20
Consensus value (CV)	0.09	0.10	0.00	0.04	0.01	0.03	0.00	0.32	0.02	0.08	0.10	0.02	0.08

Table 12: Cluster A2 consensus values

Statement	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Relative Standard Deviation (RSD) (Q1)	0.25	0.29	0.50	0.37	0.26	0.22	0.33	0.37	0.30	0.23	0.38	0.26	0.24
Relative Standard Deviation (RSD) (Q2)	0.37	0.37	0.50	0.34	0.32	0.25	0.25	0.40	0.27	0.27	0.40	0.32	0.22
Consensus value (CV)	0.12	0.08	0.00	0.04	0.06	0.03	0.08	0.04	0.02	0.04	0.03	0.06	0.02

Table A13: Cluster A3 consensus values

Statement	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Relative Standard Deviation (RSD) (Q1)	0.32	0.18	0.35	0.13	0.14	0.30	0.32	0.24	0.44	0.32	0.27	0.32	0.23
Relative Standard Deviation (RSD) (Q2)	0.27	0.25	0.27	0.14	0.15	0.21	0.31	0.27	0.46	0.25	0.32	0.30	0.21
Consensus value (CV)	0.04	0.07	0.08	0.01	0.01	0.09	0.00	0.03	0.02	0.07	0.05	0.02	0.02

A6.2 Differentiating statements

The Kruskal-Wallis test was undertaken across all three groups and in pairwise analyses between groups (table A14).

Appendix A: Delphi Study

Table A14: Kruskal-Wallis test after round 1. The highlighted cells represent probabilistic differences between groups to a 5% certainty.

Statement	1	2	3	4	5	6	7	8	9	10	11	12	13
Kruskal-Wallis A1/A2/A3	0.027	0.927	0.229	0.039	0.004	0.023	0.013	0.212	0.262	0.725	0.018	0.014	0.009
Kruskal-Wallis A1/A2	0.014	0.951	0.854	0.806	0.032	0.426	0.951	0.126	0.086	0.594	0.023	0.012	0.008
Kruskal-Wallis A1/A3	0.022	0.715	0.068	0.068	0.648	0.018	0.018	0.927	0.361	1.000	0.523	0.411	0.273
Kruskal-Wallis A2/A3	1.000	0.745	0.193	0.015	0.002	0.023	0.007	0.175	0.704	0.444	0.020	0.024	0.026
Difference to 0.05 certainty	A1				A2	A3	A3				A2	A2	A2

The Kruskal-Wallis analysis reveals the statements which fall outside the probabilistic value of 5% and exhibit the greatest variance. Across all groups, statements 1, 5, 6, 7, 11, 12 and 13 showed significant disagreement. Pairwise analysis reveals how each cluster differed in response to each statement. This revealed the following:

- Statements 2, 3, 8, 9 and 10 had no significant disagreement across groups.
- Statement 1 differentiated cluster A1 from groups A2 and A3.
- Statements 5, 11, 12 and 13 differentiated cluster A2 from groups A1 and A3.
- Statements 6 and 7 differentiated cluster A3 from groups A1 and A2.
- Statement 4 the level of agreement was inconclusive.

A6.3 Additional Likert questions

Four additional Likert-style questions were provided at the end of Q2 responding to comments previously made by participants. All four statements scored very highly indicating high importance across all three clusters. The Kruskal-Wallis (table A15) scores suggest no significant difference between clusters in their Likert responses to these statements. The similarity in responses is confirmed by comparing the median scores in table A16.

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Table A15: Round 2 Likert-style questions across all groups.

Statement	Overall mean	Overall standard deviation	Overall median	Kruskal-Wallis A1/A2/A3	Kruskal-Wallis A1/A2	Kruskal-Wallis A1/A3	Kruskal-Wallis A2/A3
Designing holistically	4.62	0.49	5	0.697	0.540	0.411	0.745
Using rigorous internal procedures to ensure sustainable design quality	4.00	0.67	4	0.272	0.142	0.523	0.303
Integrating renewable technologies	4.10	0.59	4	0.457	0.462	0.715	0.233
Designing for future needs and longevity	4.67	0.48	5	0.826	0.540	0.715	0.828

Table A16: Round 2 Likert-style questions median scores across clusters.

Statement	A1 Median	A2 Median	A3 Median
Designing holistically	5	5	4.5
Using rigorous internal procedures to ensure sustainable design quality	4	4	4
Integrating renewable technologies	4	4	4
Designing for future needs and longevity	5	5	5

A6.4 Universal characteristics

Despite conducting 3 independent Delphis, the statements and question structures were
the same across all studies. This allowed direct comparison between clusters, revealing
statements with significant disagreement or consensus. The overall ranked list of
statements is in table A17.

Appendix A: Delphi Study

Table A17: Ranked list of all statements across all participants

Statement number	Overall weighted rank	Overall weighted mean	Overall absolute mean score	Statement
9	1	7.43	7.29	Reducing embodied and operational energy through passive design and high-performance envelopes
4	2	6.42	6.29	Educating clients and stakeholders in sustainable design and operation
10	3	6.29	6.43	Designing for occupant health and wellbeing
8	4	6.28	6.10	Designing contextually to enable sustainable lifestyles
7	5	5.92	6.05	Designing with respect for the natural environment
11	6	5.39	5.00	Measurement and analysis of building performance
3	7	4.92	4.86	Collaborating with likeminded and motivated clients and stakeholders
12	8	4.22	3.81	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)
5	9	3.83	4.24	Specifying natural building materials
1	10	3.82	4.10	Employing simple and/or vernacular technologies in building design
6	11	3.59	3.62	Reducing demolition and construction waste
2	12	3.48	3.52	Integrating innovative technologies, construction techniques and materials in building design
13	13	3.46	3.76	Utilising local skills and materials in the building process

After the second round, there was consensus on the importance of five statements across all three clusters. These statements showed no significant disagreement universally in the Kruskal-Wallis Test, nor in pairwise Kruskal-Wallis tests between clusters. Statement 9 - reducing embodied and operational energy through passive design and high-performance envelopes (weighted mean 7.43) - and statement 10 - designing for occupant health and well-being (weighted mean 6.29) - were considered the most important and ranked first and second respectively overall. Statement 8 (designing contextually to enable sustainable lifestyles) ranked 4th with a weighted mean of 6.28 while statement 3 (collaborating with likeminded and motivated clients and stakeholders) ranked 7th.

Appendix A: Delphi Study

Table A18: Statements with universal consensus

Statement number	Weighted overall Rank	Weighted mean score	Kruskall Wallis test	Statement
9	1	7.43	0.262	Reducing embodied and operational energy through passive design and high-performance envelopes
10	3	6.29	0.725	Designing for occupant health and wellbeing
8	4	6.28	0.212	Designing contextually to enable sustainable lifestyles
3	7	4.92	0.229	Collaborating with likeminded and motivated clients and stakeholders
2	12	3.48	0.927	Integrating innovative technologies, construction techniques and materials in building design

A6.5 Cluster A1

Table A19 shows the ranked list of statements for cluster A1.

Table A19: Ranked list of all statements across in cluster 1

Statement number	Rank	Mean score	Difference from overall weighted mean	Statement
9	1	8.40	0.967	Reducing embodied and operational energy through passive design and high-performance envelopes
7	2	6.80	0.878	Designing with respect for the natural environment
8	3	6.60	0.322	Designing contextually to enable sustainable lifestyles
10	4	6.20	-0.089	Designing for occupant health and wellbeing
11	5	6.00	0.611	Measurement and analysis of building performance
4	6	5.60	-0.822	Educating clients and stakeholders in sustainable design and operation
12	7	5.60	1.378	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)
6	8	4.60	1.011	Reducing demolition and construction waste
3	9	4.20	-0.722	Collaborating with likeminded and motivated clients and stakeholders
2	10	3.40	-0.078	Integrating innovative technologies, construction techniques and materials in building design
5	11	3.20	-0.633	Specifying natural building materials
13	12	2.40	-1.056	Utilising local skills and materials in the building process
1	13	2.00	-1.822	Employing simple and/or vernacular technologies in building design

Cluster A1 was differentiated from clusters A2 and A3 by a single statement. Statement 1 (employing simple and/or vernacular technologies in building design) was strongly

rejected by the cluster, scoring 1.82 lower than the overall average (4.10). It ranked last of all the statements for this cluster. Statement 9 (reducing embodied and operational energy through passive design and high-performance envelopes) was the deemed the most important, consistent with the overall consensus.

Table A20: Differentiating statements for round 2, cluster A1

Statement number	Rank	Mean	Difference from weighted	Overall KW test	A1/A2 KW	A1/A3 KW	Statement
1	13	2.00	-1.82	0.027	0.014	0.022	Employing simple and/or vernacular technologies in building design

The pairwise Kruskal-Wallis analyses show values of below 0.05 for both pairwise comparisons with clusters 2 and 3, indicating statement 1 can be considered a significant differentiating statement.

A6.6 Cluster A2

Table A21 shows the ranked list of statements for cluster A2.

Appendix A: Delphi Study

Table A21: Ranked list of all statements across in cluster 1

Statement number	Rank	Mean score	Difference from overall mean	Statement
10	1	7.00	0.711	Designing for occupant health and wellbeing
9	2	6.90	-0.533	Reducing embodied and operational energy through passive design and high-performance envelopes
7	3	6.80	0.878	Designing with respect for the natural environment
5	4	5.80	1.967	Specifying natural building materials
4	5	5.50	-0.922	Educating clients and stakeholders in sustainable design and operation
8	6	5.40	-0.878	Designing contextually to enable sustainable lifestyles
1	7	4.80	0.978	Employing simple and/or vernacular technologies in building design
13	8	4.80	1.344	Utilising local skills and materials in the building process
3	9	4.40	-0.522	Collaborating with likeminded and motivated clients and stakeholders
6	10	4.00	0.411	Reducing demolition and construction waste
2	11	3.70	0.222	Integrating innovative technologies, construction techniques and materials in building design
11	12	3.50	-1.889	Measurement and analysis of building performance
12	13	2.40	-1.822	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)

Cluster A2 was differentiated from clusters A1 and A3 through four different statements which all demonstrated significant disagreement in the Kruskal-Wallis test at a universal and pairwise level. These are outlined in table A22.

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Table A22: Differentiating statements for round 2, cluster A1

Statement number	Rank	Mean	Difference from population	Overall KW test	A1/A2 KW	A1/A3 KW	Statement
5	4	5.80	+1.20	0.004	0.032	0.002	Specifying natural building materials
13	8	4.80	+1.34	0.009	0.008	0.026	Utilising local skills and materials in the building process
11	12	3.50	-1.89	0.018	0.023	0.020	Measurement and analysis of building performance
12	13	2.40	-1.82	0.014	0.012	0.024	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)

Statements 5 (specifying natural building materials) and 13 (utilising local skills and materials in the building process) had enhanced importance in cluster 2 compared to the overall average with means increased by 1.20 and 1.34 respectively. By contrast, the measurement and analysis of building performance (statement 11) and the adoption of national and international standards and codes (statement 12) were considered unimportant scoring 1.89 and 1.82 lower than the mean scores for these statements.

A6.7 Cluster A3

The ranked statements for cluster A3 are shown in table A23.

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Table A23: Ranked list of all statements across in cluster A1

Statement number	Rank	Mean score	Difference from overall weighted mean	Statement
4	1	8.17	1.744	Educating clients and stakeholders in sustainable design and operation
9	2	7.00	-0.433	Reducing embodied and operational energy through passive design and high performance envelopes
8	3	6.83	0.556	Designing contextually to enable sustainable lifestyles
11	4	6.67	1.278	Measurement and analysis of building performance
3	5	6.17	1.244	Collaborating with likeminded and motivated clients and stakeholders
10	6	5.67	-0.622	Designing for occupant health and wellbeing
12	7	4.67	0.444	Adopting national and international standards and codes (e.g. Passivhaus, BREEAM etc.)
1	8	4.67	0.844	Employing simple and/or vernacular technologies in building design
7	9	4.17	-1.756	Designing with respect for the natural environment
2	10	3.33	-0.144	Integrating innovative technologies, construction techniques and materials in building design
13	11	3.17	-0.289	Utilising local skills and materials in the building process
5	12	2.50	-1.333	Specifying natural building materials
6	13	2.17	-1.422	Reducing demolition and construction waste

Statements 7 and 6 differentiated cluster A3 from clusters A1 and A2. This cluster was characterised by reduced importance being placed upon designing with respect for the natural environment (-1.756 from weighted overall mean) and reducing demolition and construction waste (-1.422 from the weighted overall mean).

Table A24: Differentiating statements for round 2, cluster A3

Statement number	Rank	Mean	Difference from weighted mean	Overall KW test	A1/A2 KW	A1/A3 KW	Statement
7	9	4.17	-1.756	0.013	0.018	0.007	Designing with respect for the natural environment
6	13	2.17	-1.422	0.023	0.018	0.023	Reducing demolition and construction waste

Statement 4 appeared inconclusive. It's overall Kruskal-Wallis test showed significant disagreement between all clusters however, in the pairwise analysis there was only a significant difference between clusters A2 and A3 (table A25).

Appendix A: Delphi Study

Table A25: Statement 4 comparison

Statement number	Overall rank	Mean	Weighted mean	Overall KW test	A1/A2 KW	A1/A3 KW	A2/A3 KW	Statement
4	2	6.29	6.42	0.039	0.806	0.068	0.015	Educating clients and stakeholders in sustainable design and operation

However, it can be noted that statement 4 has an A1/A3 pairwise Kruskal-Wallis test very close to 0.05 and the C2/C3 test is already below this threshold. Indeed, it should be noted that for cluster 3, statement 4 scored significantly higher than the overall weighted mean (+1.744), the second greatest margin of difference.

A6.8 Validating analysis

To validate the analysis, the data were re-clustered. This allowed the creation of additional groups to examine if this created groups defined by polarising opinions. The data were clustered using the same methodology for Q1 however divided into four groups. Differentiating statements between these new groups could then be compared with the differentiating statements between the original clusters. Figure A3 shows the clustering analysis:

Appendix A: Delphi Study
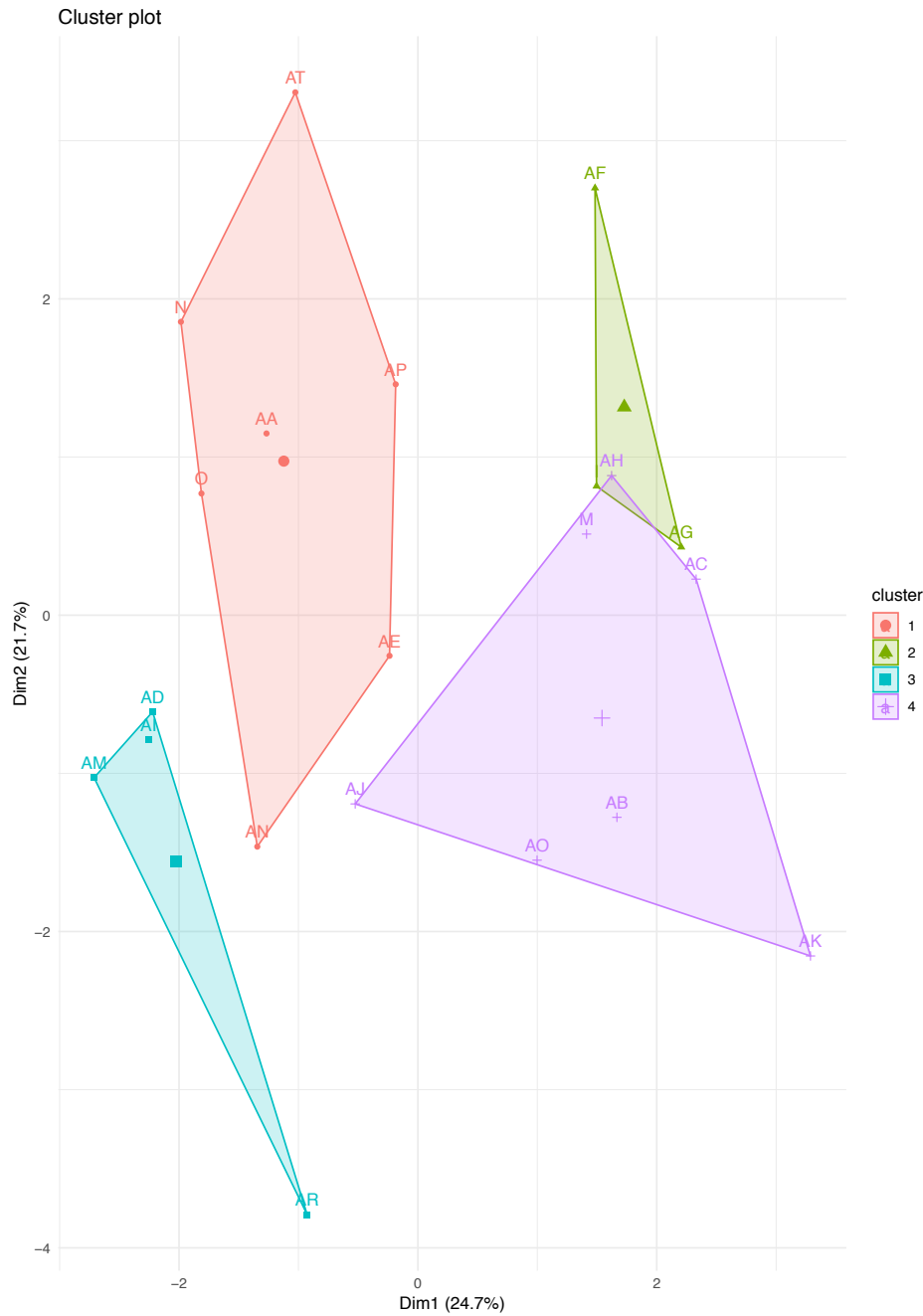
Figure A3: Q2 four cluster plot

These clusters were then analysed in the using the Kruskal-Wallis test to determine differentiating statements for each cluster. These were conducted across all statements then in each group of three clusters. Where it was not clear which clusters were causing the discrepancies (statement 4 and statement 6) further pairwise analyses were made. The new clusters were termed B1, B2, B3 and B4. These results are presented in table A26.

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Table A26: Kruskal-Wallis test after round 1. The highlighted cells represent probabilistic differences between groups to a 5% certainty.

Statement	1	2	3	4	5	6	7	8	9	10	11	12	13
Kruskal-Wallis B1/B2/B3/B4	0.013	0.678	0.142	0.154	0.020	0.078	0.027	0.161	0.202	0.325	0.002	0.004	0.012
B1/B2/B3	0.028	0.528	0.103	0.050	0.028	0.166	0.018	0.072	0.921	0.331	0.035	0.156	0.037
B1/B2/B4	0.016	0.562	0.188	0.632	0.024	0.491	0.523	0.111	0.104	0.634	0.004	0.004	0.013
B1/B3/B4	0.009	0.816	0.207	0.153	0.187	0.041	0.022	0.530	0.209	0.236	0.001	0.002	0.022
B2/B3/B4	0.258	0.513	0.172	0.162	0.012	0.037	0.021	0.221	0.133	0.191	0.011	0.025	0.055
B1/B2				0.649		0.425							
B1/B3				0.038		0.059							
B1/B4				0.482		0.749							
B2/B3				0.034		0.480							
B2/B4				0.425		0.210							
B3/B4				0.299		0.011							
B1/B2				0.649		0.425							
Difference to 0.05 certainty	D1			D3	D2	D3/D4	D3				D1/D2/D3/D4	D4	D1

In this re-clustering, in two instances (statements 6 and 11) did groups exhibited polarised opinions. In all other scenarios there was either consensus across all clusters or statement differences were unique to clusters. The same five statements had consensus across clusters (statements 2, 3, 8, 9, 10)

- Statements 2, 3, 8, 9 and 10 had no significant disagreement across groups. This is identical to the original three cluster analysis.
- Statement 1 and 13 differentiated cluster D1 from the other clusters. This is similar to cluster C1 in the original analysis.
- Statement 5 differentiated D2 from the other clusters, suggesting this cluster was previously contained within C2.
- Statements 4, 6 and 7 differentiated cluster D3 from the other clusters, similar to cluster C3 in the original analysis.
- Statements 6 and 12 differentiated cluster D4 from the other clusters representing a combination of respondents from C2 and C3 originally.

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- Statement 11 was the only statement which exhibited universal disagreement across all clusters.

A6.9 Correlating statements

A further level of analysis was undertaken to identify similarities between statements, that is where statements scored similarly within each cluster. This allows identification of correlations between statements within and across clusters. The "elbow" technique (figure A4) for identifying optimal number of statements optimal number of clusters can be determined in R using :

```
wss <- (nrow(S_5)-1)*sum(apply(S_5,2,var))

> for (i in 2:7) wss[i] <-
sum(kmeans(S_5,centers=i)$withinss)
> plot(1:7, wss, type="b", xlab="Number of Clusters",
ylab="Within groups sum of squares")
```
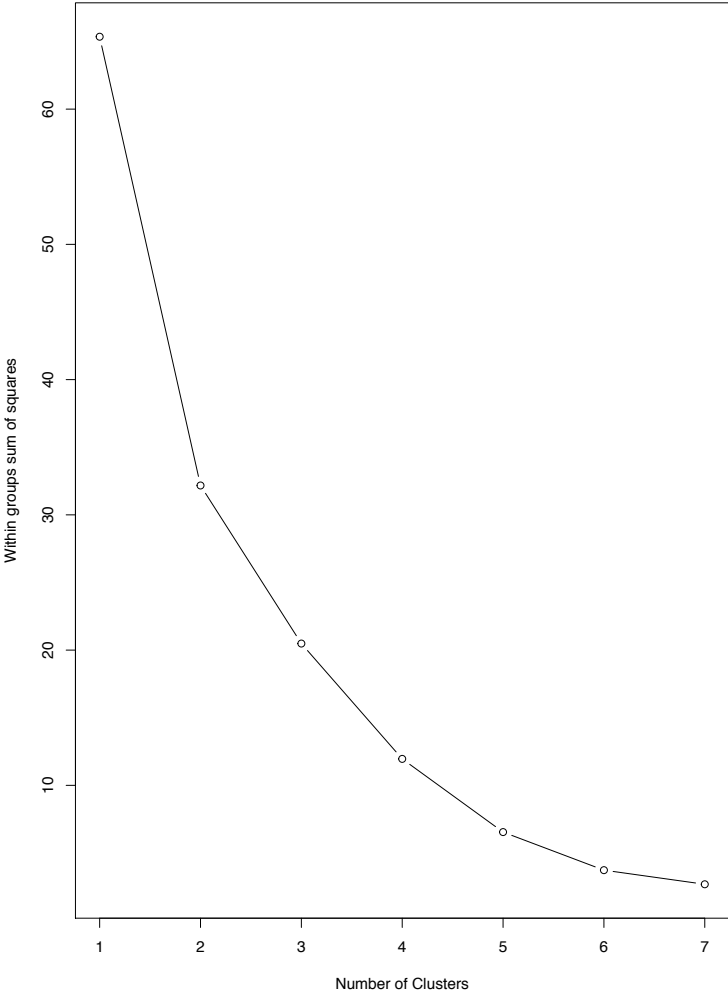
Figure A4: plot of optimal clusters showing no clear "elbow" of optimal cluster numbers

No clear inflection point showing optimal number of clusters that suggest correlation between clusters. Multiple cluster analyses of different cluster numbers are show in figure A5.

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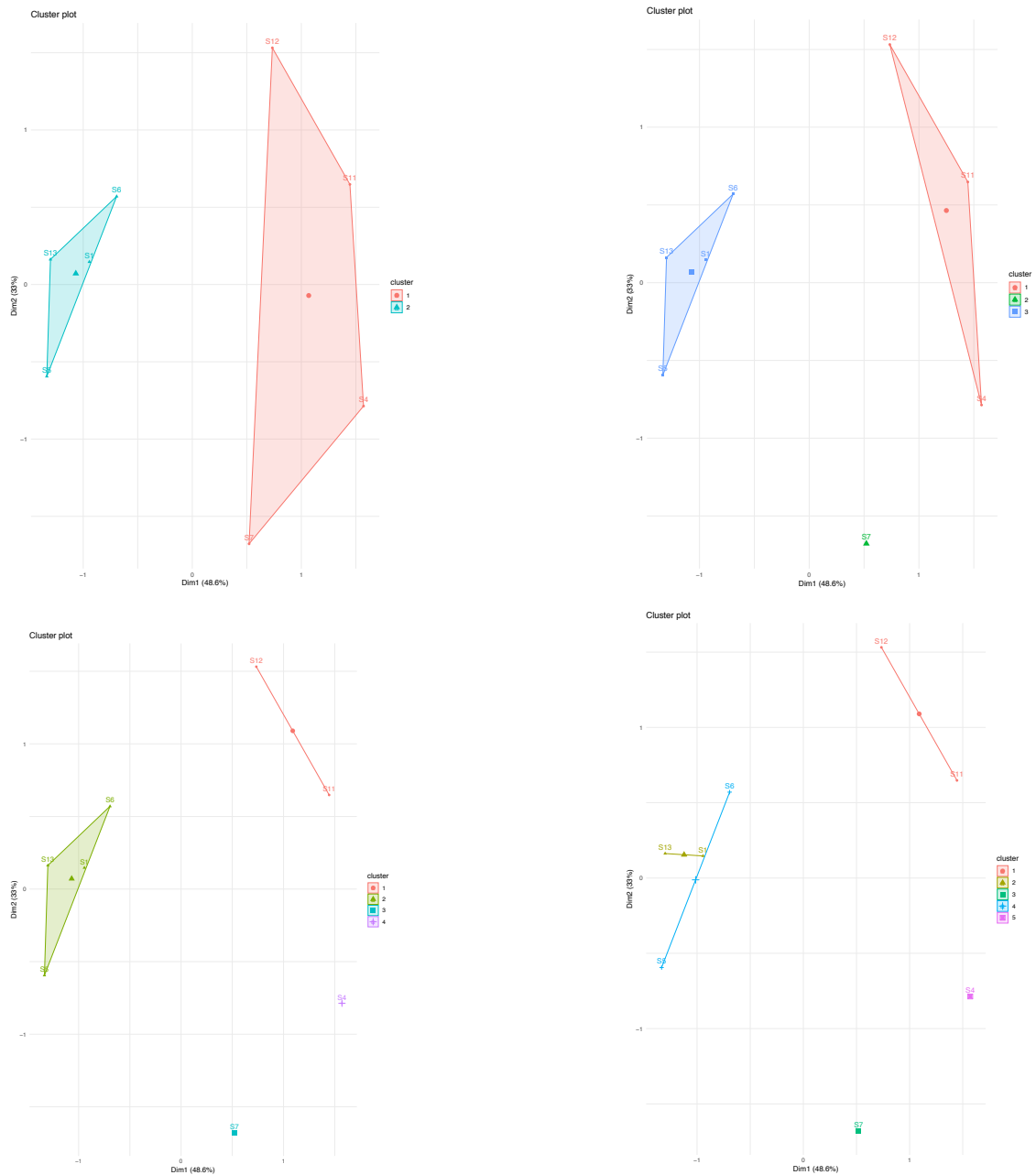
Figure A5: Clustering of statements in 2, 3, 4 and 5 clusters based on group averages.

As the number of clusters increases, differentiating statements begin to cluster by common themes. These cluster diagrams are synthesised and displayed in the tree diagram of figure A6.
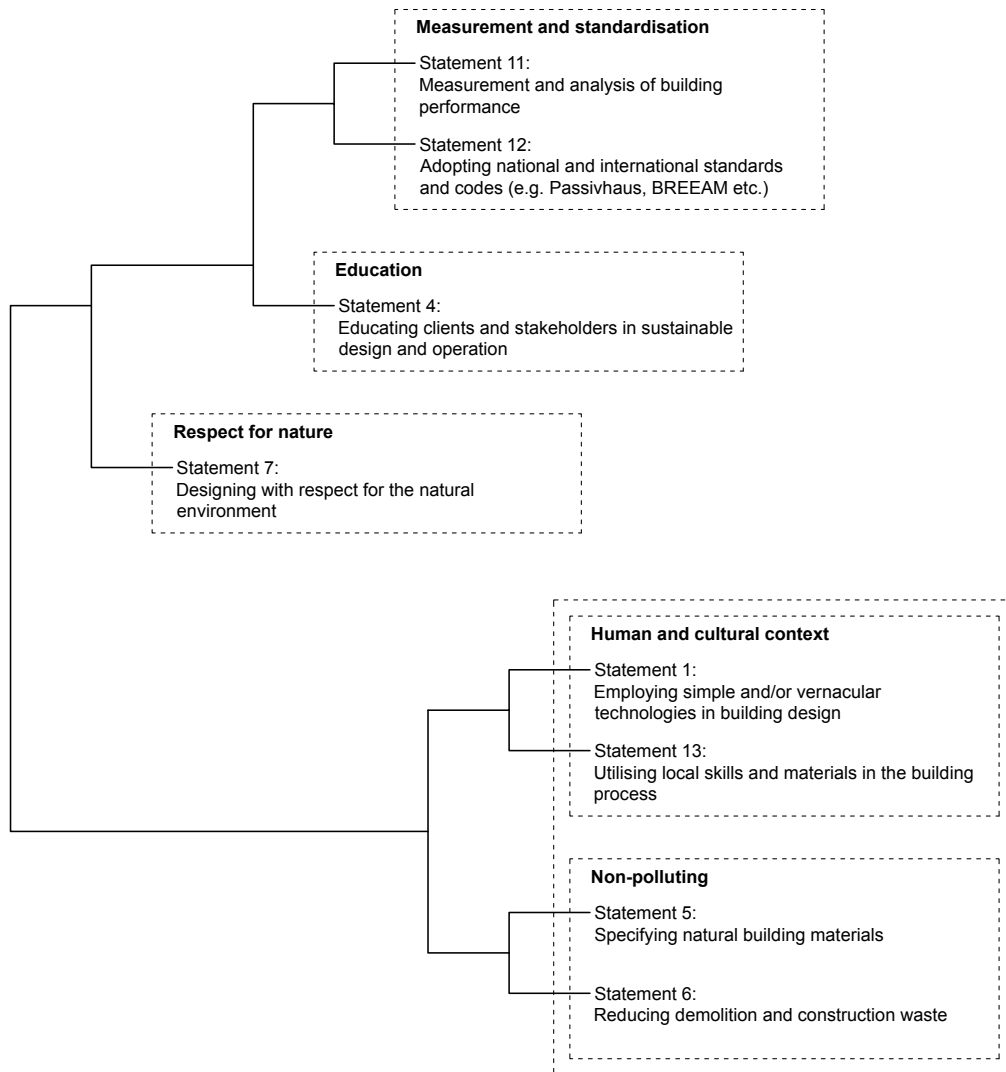
Figure A6: Tree diagram showing diminishing clustering of statements and groupings by theme.

From this clustering, themes were identified that linked correlating clusters. Five key themes emerge. A respect for nature was most weakly correlated with the other themes. Agreement about its importance was relatively universal, and it was ranked 2nd and third in clusters A1 and A2 however only 9th in cluster A3.

Educating clients and stakeholders was not correlated with any other statements at a four cluster level. This is unsurprising as this statement had the highest level of consensus among groups of the differentiating statements. This ranked 5th and 6th in clusters A1 and A2 however was the most important statement in cluster A3.

Measurement and standardisation correlated with educating clients and stakeholders at a three cluster level, however, was distinguished at the four cluster level.

Appendix A: Delphi Study

In clusters A1 and A3, these statements ranked centrally relative to other statements. However, cluster A2 was distinguished by an explicit rejection of standardisation.

Responding to human and cultural context contained two statements which were distinguished at the five cluster level. This theme correlated with a concern for reducing pollution and toxicity at the four cluster level, which also contained two statements. For cluster A1 and A3, all four statements across these two themes ranked in the bottom half of all statements. Indeed, a perceived lack of importance for pollution reduction characterised A3 and distinguished from other groups. Cluster A2 was characterised by enhanced importance placed on responding to human and cultural contexts. Synthesising this understanding of key themes with the differentiating characteristics of each cluster, key themes can be assigned to groups.

Table A27: Key differentiating themes for each cluster.

Cluster	Differentiating themes with enhanced importance	Differentiating themes with reduced importance
A1	Respect for the natural environment and measurement and standardisation	Human and cultural context
A2	Non-polluting materials and respect for the natural environment	Measurement and standardisation
A3	Educating clients and stakeholders	Non-polluting materials and respect for the natural environment

This process was repeated for the statements on which there was overarching consensus. The 2, 3 and 4 cluster plots are shown in figure A7.
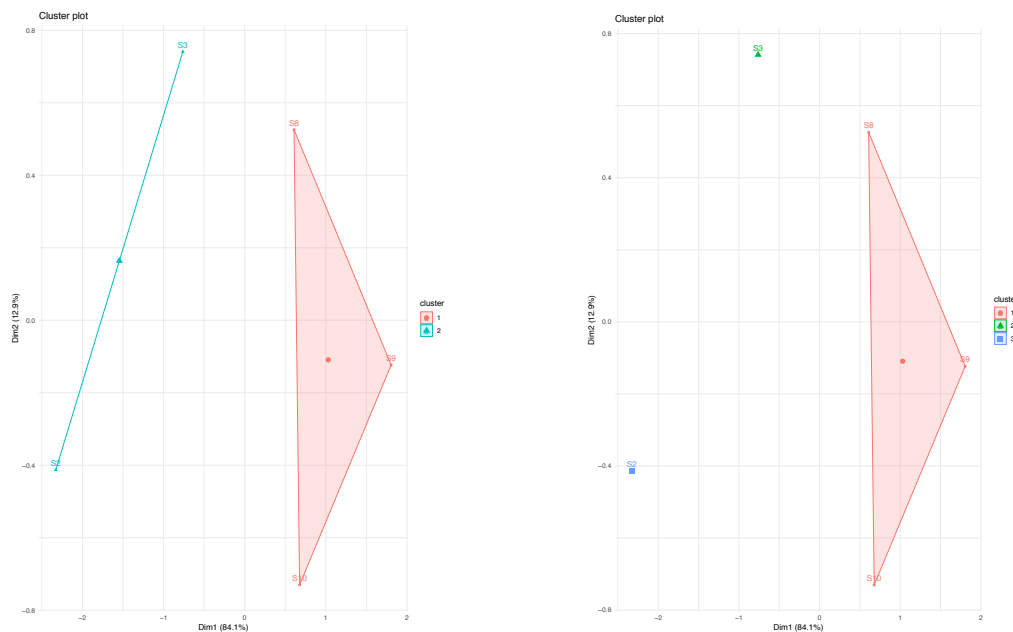
Appendix A: Delphi Study

Figure A7: 2,3 and 4 cluster plots for statements with consensus (S2,S3, S8,S9,S10)

These clusters are synthesised in the tree diagram (figure A8).

Appendix A: Delphi Study

Figure A8: Tree diagram showing diminishing clustering of statements and groupings by theme for statements with consensus.

The tree diagram reveals four emergent themes; Passive building performance, concern for enhanced quality of life for users, utilising inno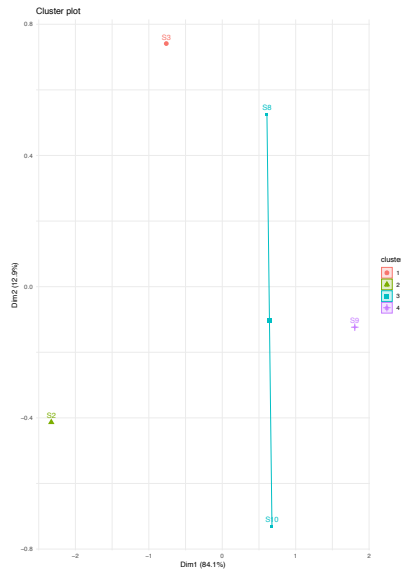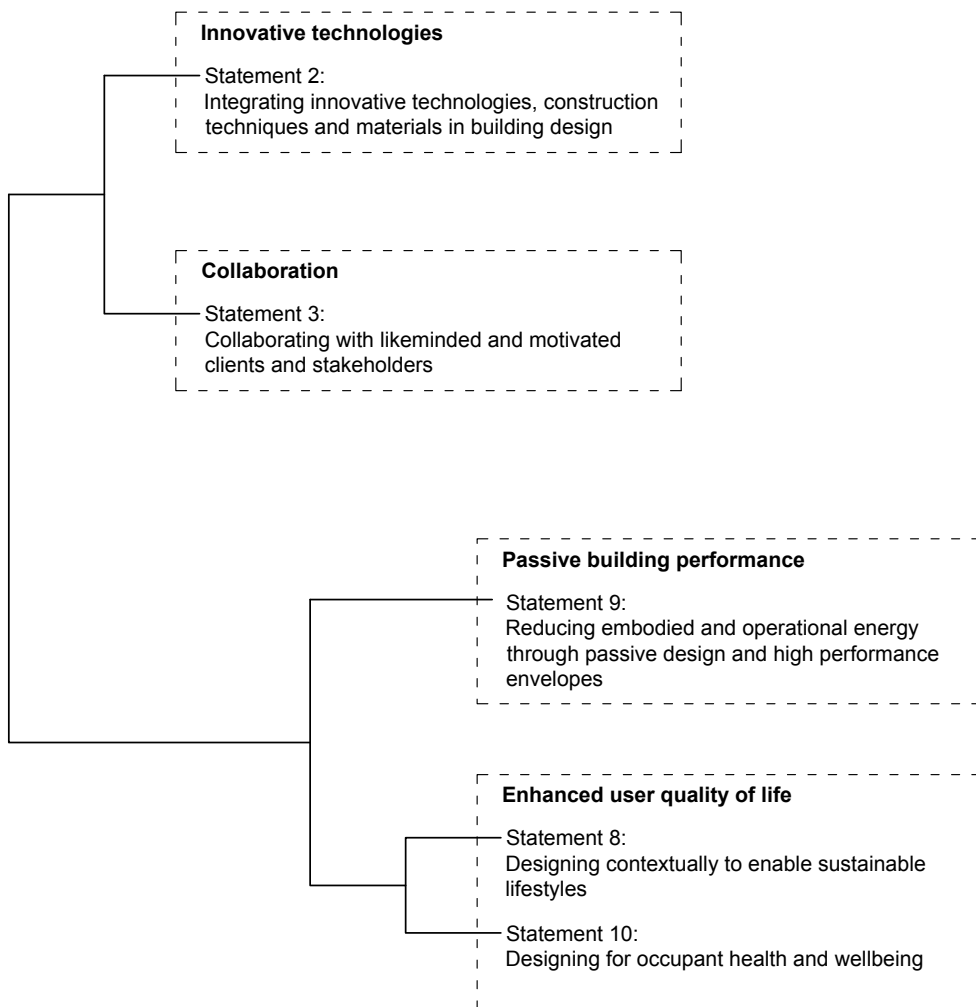vative technologies and collaborative processes. Of these, passive building performance and concern for an enhanced quality of life were ranked most important. By contrast, utilising innovative technologies ranked least important. Collaboration was considered of mid-level importance by respondents.

A7 Discussion

A7.1 Universal characteristics

Shared concern among participants for constructing high-performance envelopes that minimised energy loads, suggests the reduction of carbon still remains the primary motivator for sustainable architectural design in the UK. Building standards and certification schemes have placed most emphasis on carbon reduction (Awadh, 2017) and have shaped the discourse around sustainable design (Murtagh, Roberts, & Hind, 2016). However, the statement also implies a concern for building performance and passive design strategies. When contrasted with the almost universal rejection for integrating innovative technologies as a means to achieve sustainable design, this suggests an approach which is relies on passive and holistic systems. Indeed, this was supported by the universal agreement for the need to design holistically. One interpretation is that this statement might be considered as a challenge to holistic integration, which was considered universally important. However, it might also capture a profession-wide rejection of "technical" solutions as a means to enable sustainable design.

There was strong consensus on the importance of the building user in creating sustainable buildings. This was captured by two correlating statements: designing contextually to enable sustainable lifestyles and designing for occupant health and well-being. Moreover, educating clients and stakeholders in sustainable design and operation ranked second in importance across all groups although there was some disagreement in its importance. This suggests a human centred approach, focussing on those engaging directly with the building was common across all practices.

Appendix A: Delphi Study

Collaborating with likeminded and motivated clients and stakeholders, ranked centrally in importance across all groups. This shows a perceived limited importance of interdisciplinary and social aspects of sustainable design as being critical to enabling sustainability. This might reflect the perceived hegemony of the architect as the *master* designer, reflecting the approach described by Schön (1985) and the implications of design thinking (Dorst, 2011).

A7.2 Differentiating themes

Each individual cluster of practices was characterised by enhanced importance or lack of importance for the emergent themes. However, clusters were not characterised by opposing stances. That is, across pairwise analysis, did no single issue have polarised responses. Rather, clusters were defined by attitudes towards themes that were unique to that cluster. For example, a concern for human and cultural context was only distinct as an unimportant factor for cluster A1 however was considered significantly important in clusters A2 and A3. Indeed, only two themes (non-polluting materials and respect for the natural environment) were polarised across two clusters (A2 and A3). The relative importance of measurement and standardisation was also polarised across cluster A1 and A2 however in cluster A1 it was not considered a significant difference. The data show that rather than competing groups characterised by opposing opinions, rather each group was defined by relatively unique factors.

A7.3 Cluster A1

Cluster A1 was differentiated by a rejection of traditional and vernacular approaches to sustainable design. This was complemented by an enhanced importance placed on national and international standards, the need for building measurement and the need for high-performance building fabrics. This approach is consistent with a worldview captured *by ecological-modernism* (Blowers, 1997) placing faith in institutional adaption and minor changes. It shares similarities with the notion of *accommodation* (O'Riordan, 1989); an area of "*modest reform*" to the status-quo. This cluster also valued the respect for the natural environment which might be interpreted as a movement towards an interventionist approach which values large scale globalised environmental issues (O'Riordan, 1989). This would be consistent with an emphasis on carbon reduction and building performance.

Appendix A: Delphi Study

A7.4 Cluster A2

Cluster A2 was differentiated by placing heightened importance on non-polluting materials and respect for the natural environment. Simultaneously, there was a rejection of top down and quantitative measures. This cluster was consistent with *eco-centrism* (O'Riordan, 1989). At its extreme, the *gaianist* philosophy places humankind within a wider ecological narrative while more conservative *communalism* places faith in self-reliant communities based on renewable resources and *appropriate* technologies. Indeed, it is this faith in self-reliance that may explain the rejection of top-down or authoritative measures.

A7.5 Cluster A3 – "Social"

Cluster A3 was differentiated by diminished importance on non-polluting materials and respect for the natural environment in favour of greater importance on client and stakeholder education. This reflected the results of all respondents in placing concerns of users and stakeholders of high importance for sustainable design. However, cluster A3 was distinguished by the lack of importance placed on broader concepts of nature. This cluster sits outside the typology of O'Riordan (1989). The emphasis on social action suggests this may be mapped to the *communalist* paradigm, defined by the development of self-reliant communities. However, these characteristics also imply a human-centred attitude which diminishes the natural environment. This might be considered to capture an interventionist attitude which values faith in the application of science and human ingenuity (O'Riordan, 1989). Similarly, Guy and Farmer (2001) describe these different paradigms *as eco-technic* and *eco-social* respectively. This suggests a possible hybrid approach that focuses transformation of social systems, however does not distinguish between participatory action and top-down social intervention.

Looking deeper into the data, cluster A3's responses to other themes may provide further indication. The group's attitude towards responding to human and cultural context was not significantly different from the overall scores of all respondents. Moreover, the relative standard deviations (RSD) of the associated statements (S1 and S13) were below 0.4 indicating a good level of agreement (Strasser, 2018).

Appendix A: Delphi Study

The group's response to the statements associated with measurement and standardisation (S11 and S12) had higher RSDs (0.38 and 0.39) suggesting some level of disagreement. This theme reflected a top-down approach to sustainable design which was governed by national and international standardisation. Although not statistically significant, it suggests this theme split the group in terms of its responses. This supports the notion that cluster A3 was in fact a hybrid of human centred practices supporting either participatory processes or top-down intervention. As a further analysis, cluster A3 can be divided into two sub-clusters (figure A9).
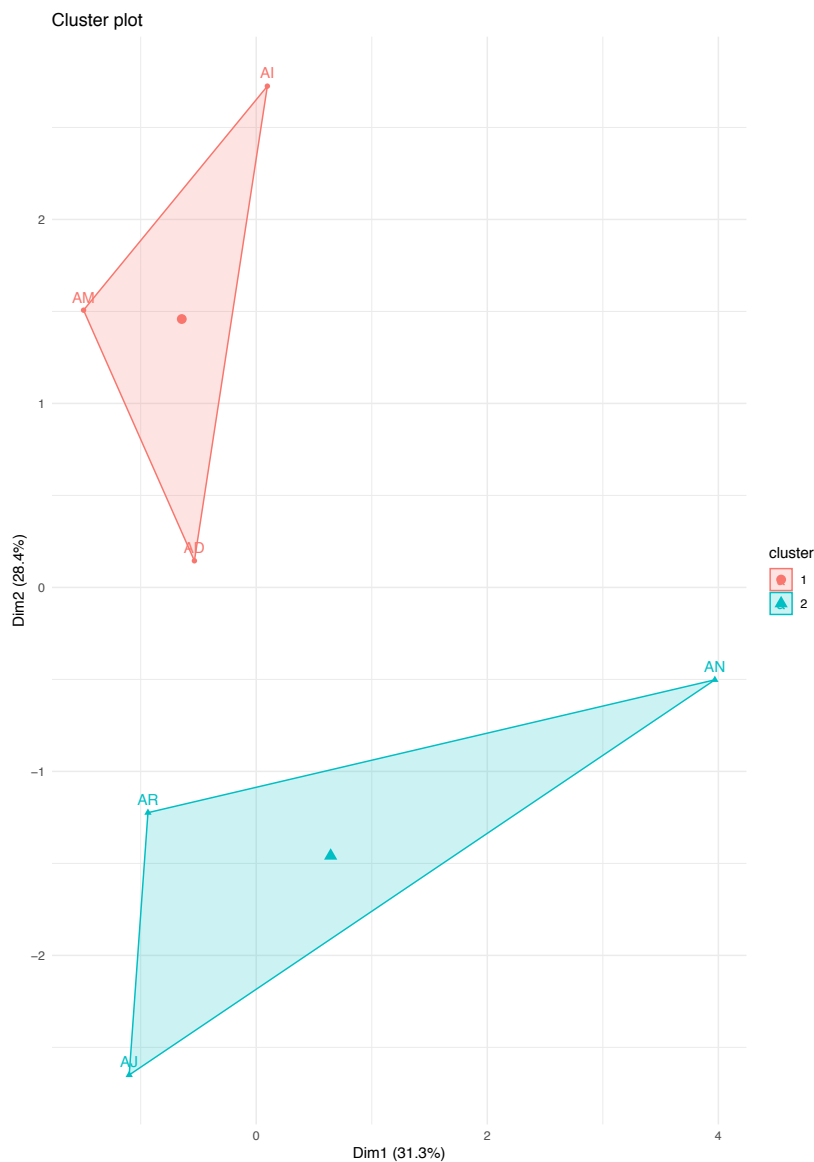

Figure A9: A3 divided into two sub-clusters.

The means for each statement were then compared across these two sub-clusters to identify significant differences (table A27).

Table A27: Comparing mean scores for sub clusters for cluster A3.

Appendix A: Delphi Study

Statement	1	2	3	4	5	6	7	8	9	10	11	12	13
Mean score Cluster A3_1	0.00	-1.67	0.33	3.00	-2.33	-2.67	-1.67	1.00	4.00	0.00	2.67	0.00	-2.67
Mean score Cluster A3_2	-0.67	-1.67	2.00	3.33	-2.67	-3.00	0.00	2.67	0.00	1.33	0.67	-0.67	-1.00
Difference between means	0.67	0.00	1.67	0.33	0.33	0.33	1.67	1.67	4.00	1.33	2.00	0.67	1.67

In this analysis statements 9 and 11 represent the largest difference. Statement 9 (reducing embodied and operational energy through passive design and high performance envelopes) was considered the most important statement universally but half of group A3 considered it significantly less important. The same half also considered statement 11 (measurement and analysis of building performance) was less important suggesting a diminished role of building performance. This challenges the wider trend across all respondents however identifies these practices as reacting against performance based metrics as a measure of sustainable design. This might suggest a less quantifiable approach which maps more closely to a *communalist* paradigm (O'Riordan, 1989). By contrast, cluster A3_1, unilaterally considered building performance to be the most important issue suggesting a faith in architectural ingenuity to elicit social transformation.

A7.6 Anomalous themes

Respect for nature and the use of non-polluting processes, appear similar in sentiment, yet there was only limited correlation between these themes. Arguably these statements may be interpreted through competing lenses. On the one hand, a respect for nature may capture eco-centric tendencies, embodying buildings that sit in harmony with nature, correlating with a use of natural building materials and the reduction of building waste (Guy & Farmer, 2001). Alternatively, respecting nature may be interpreted as an interventionist attitude through a belief that the natural environment must harnessed to enable sustainable development (O'Riordan, 1989). It is perhaps these competing interpretations that explain why the statement "designing with respect for nature" offered the least disagreement among clusters and poorly correlated with other statements. Indeed, in clusters A1 and A2, it ranked second and third respectively while in cluster A3 it ranked 9th of 13 statements still placing in the third quartile for ranked statements. This indicated a degree of universality among respecting nature.

Appendix A: Delphi Study

A7.7 Reflecting on a model of sustainable design

The research identified five differentiating themes which defined each individual cluster through relative importance: respect for nature; cultural context; non-polluting processes; technical measurability; and social transformation. However, clusters of individual practices did not oppose each other in their responses but rather placed different weightings on the value of certain sustainable themes. These themes and the correlation between them indicated the presence of three broad paradigms that characterised individual practice. These may be termed eco-centrism, techno-centrism and human-centrism.

Eco-centrism

There was a clear correlation between non-polluting natural building and a concern for local and cultural context. Indeed, these themes were only differentiated at the five cluster level. This maps closely to the wider concept of *eco-centrism*; defined by O'Riordan (1989) as a broad, all-encompassing paradigm, however more precisely considered by Guy and Farmer (2001):

> "Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and "flourishing" of local and global biodiversity." (Guy & Farmer, 2001)(p.141).

It is this shared concern for locality and nature that encompasses the eco-centric approach.

Techno-centrism

The research shows that techno-centric practices were not concerned with innovative technologies (a subject that ranked universally low) but rather might be considered as measurable building performance. Measurability might involve technical analysis but it could also be considered a conformance to national and international standards. In the language of O'Riordan (1989), this is a weak form of techno-centrism termed *accommodation* which places faith in overarching institutional values. In the context of UK architectural practice, techno-centrism is not so much a faith in technological application but a reliance on measurability and precision.

Appendix A: Delphi Study

Human-centrism

A third paradigm emerged which might be considered human-centrism. This was captured by a concern for client and stakeholder education, a differentiating factor in some clusters. Education as a means for achieving sustainable design falls outside the eco-centric/techno-centric spectrum (O'Riordan, 1989). It most closely maps to the notion of *eco-socialism* (Guy & Farmer, 2001): the "reconciliation of individual and community in socially cohesive manner" through the implication of user empowerment. However, the responses fell short of indicating the importance of genuine "participatory" processes which were not mentioned in any of the open text comments.

The findings suggest a tripartite model may more accurately reflect sustainable building design in the UK, rather than the "axes" of eco-centrism and techno-centrism previously suggested. The spectrum of alternative approaches is characterised by attitudes towards quantifiable performance, human engagement and natural ethics. The common goals of performance and human comfort occupies the centre space (figure A10). The three clusters can then be placed onto this depending on their individual weightings.
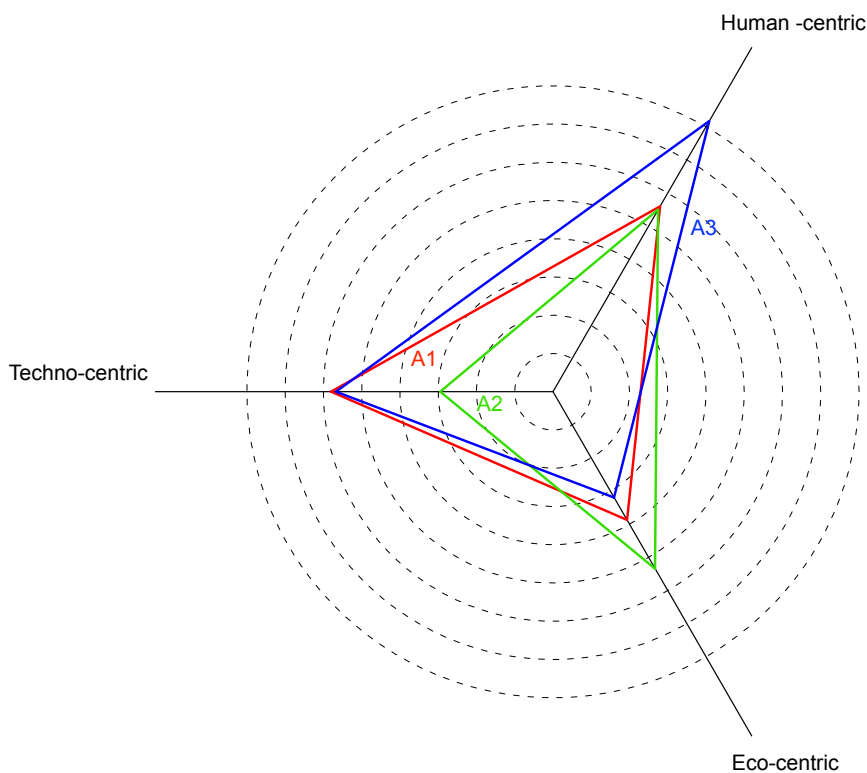
Figure A10: A radar diagram of sustainable practice based on the mean rankings for associated statements.

A8 Conclusion

The findings show that no practice conforms to a single strong individual paradigm but exhibits a mix of weighted concerns across the range of themes examined. Designing high performance building envelopes that seek to limit operational energy and carbon emissions is a defining feature of sustainable architectural practice in the UK, indicating global environmental concerns being considered most important in the field of sustainability.

Rather than a series of competing values, there was a relatively homogenous outlook across practices. Practices were differentiated by minor differences in a relatively few issues. Where differences did occur, these were under three key themes of eco-centric (nature), human-centric (society) and techno-centric (measurability).

The lack of diversity in approaches to sustainable design shows a narrow focus dealing with a limited number of issues. This is typically limited to broadly global challenges. While these are clearly important, there is a risk of neglecting more localised concerns on which building design may play a more significant role. Diversifying approaches and rebalancing the importance of these issues may encourage more contextualised responses that effect sustainable living across a broader range of scales.

Appendix A: Delphi Study

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Appendix B. Individual case studies

B1 Findings

Five mini case-studies are presented below representing a range of engagement levels with the framework. In each case, I have outlined their formal contact time and data collection for each student.

B1.1 Harry

Harry was an active member of the original action group and attended all four of the meetings. He had completed his part 1 studies at the University of Bath.

Table B1: Data collection table for Harry

Date	Event	Data type
15 February 2017	Action group meeting 1	Audio recording and observations
1 March 2017	Action group meeting 2	Audio recording and observations
13 March 2017	Action group meeting 3	Audio recording and observations
3 May 2017	Action group meeting 4	Audio recording and observations
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
8 November 2017	Action group reflection	Audio recording and observations
17 November 2017	Crit observations	Field notes
30 November 2017	Tutorial observations	Field notes
17 December 2017	Crit observation	Field notes
20 January 2018	Final masterplanning design report	Notes
30 January 2018	Framework introduction	Field notes
12 April 2018	Student feedback interviews	Field notes
25 May 2018	Final individual design report	Notes

His continuous engagement was reflected in both his masterplanning group work and individual project in which he consciously framed his strategic approach to sustainable design. In Action Group (SDAG) meetings he recognised the possibility for the framework to capture a social approach to sustainability as well as the tendency to revert to technical solutions at a larger scale. He found the framework valuable to clarify his thought processes:

> "Initially when I think about sustainability, everything isn't really in categories, just a whole cloud of different things. But with the grid thing you are able to categorise different things to give you a clearer idea." (Harry)

This clarity of thought was then used to explicitly influence his design thinking:

> "I keep having the graph in my head and it helps me focus on a particular spectrum instead of trying to do a lot of different things all over the place and just being confused in general." (Harry)

Despite his enthusiasm, in the group masterplanning project, his group showed little engagement with the framework. Their project developed clear strategies for waste management, energy, transportation, water conservation and flood protection in the city of Havana, however this were understood as top-down, centrally planned measures. Their analysis identified the important of de-centralised social action however this did not manifest itself in their proposals.

In the individual design project, however, Harry clearly used the framework to explicitly influence his design approach. He understood the unique contextual restrictions of operating in Cuba and used this to influence both his choice of building (a community exchange) as well as its realisation. This led him to a social led sustainable strategy that adopted simple technologies:

> "The adoption of low-tech, passive and socially engaging environmental approach for the project is reflective of the social context of the city and the functions of the Community Exchange. To encourage the adoption and occupation of the building by the community, the users should be comfortable and familiar with the technology used and hold a large extent of control over it." (Harry, design report)

Harry explicitly used the framework in his final design report and plotted on the location he felt his design was aiming for, based on his contextual understanding of the site.

Appendix B. Individual case studies

ENVIRONMENTAL STRATEGY

INTENTION: LOW TECH, PASSIVE & SOCIALLY ENGAGING

Encouraging
behavioural change

Traditional building
strategies encouraging
behavioural change

Behavioural change
facilitated by innovation

Socially Engaged

Traditional building
strategies

Low-Tech

High-Tech

Innovative building
technologies

Incremental changes to
behaviours and building

Socially Passive

Supporting existing
behaviours with
innovative building
technologies

Supporting existing
behaviours with
incremental building
technologies

The adoption of a low-tech, passive and socially engaging
environmental approach for the project is reflective of the
social context of city and the functions of the Community
Exchange. To encourage the adoption and occupation
of the building by the community, the users should be
comfortable and familiar with the technology used and
hold a large extent of control over it.

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Figure B1: Harry final design report diagrammatic representation of scheme

This was supplemented by his own diagram representing a hierarchy of strategies that
were instigated to provide legibility to the sustainable design approach.

Appendix B. Individual case studies

STRATEGY SEQUENCE: MITIGATION - PASSIVE - ACTIVE

ACTIVE
Central AHU
Slab Cooling

LOW-TECH ACTIVE
Localised Mechanical Ventilation
Artificial Lighting

PASSIVE
Lighting
Ventilation

LOCAL MITIGATION
Massing
Orientation
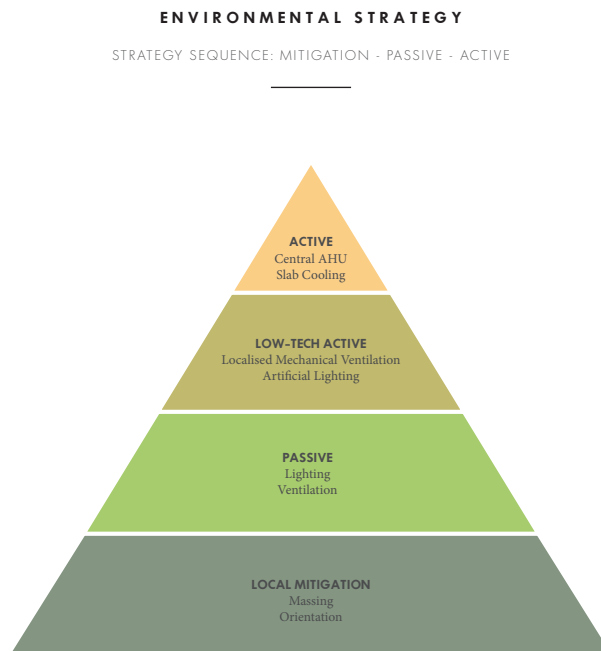
The environmental strategies for the design of the Community Exchange are adopted according to the sequence as illustrated above: local mitigation to address the issue of wind and solar impact through the massing and orientation of the building; low energy passive strategy for the everyday functioning of the internal spaces; low-tech active, and lastly active strategies to facilitate thermal comfort during hot spells.

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Figure B2: Harry organisational diagram in final design report

Harry exhibited a critical use of the framework to evaluate appropriate strategies for his design project. His building sought to encourage local residents to engage in the restoration of the built environment, encouraging collective sustainable action. Arguably these may have been developed further; his environmental approach was limited to an educational one and lacked a developed narrative for participation. In the feedback interview he spoke of how the framework had allowed him to confidently rule out a high-tech approach. He found, however, there was a perceived pressure to have quantifiable strategies and had used a digital analysis programme (CBE comfort tool) to provide this. In his final report, sustainable strategies were divorced from the primary narrative of the scheme. Despite concerning himself with broad ethical questions from the start, he confined the concept of "sustainability" to a discussion of internal comfort.

Appendix B. Individual case studies

There was evidence for deep learning in Harry's work as well as the way he spoke about his project. In early group sessions, conducted in Phase 2, his attitude appeared to be consistent with a surface learning approach. For example, when discussing what he had learnt in previous lectures he was unable to extricate underlying principles to make it relevant to his own project.

> "A lot of the lectures we've had this year it's been difficult to integrate it into our projects but you can see how they might form the basis for the work next year especially the master planning." (Harry, phase 2, workshop 4)

Yet, as he progressed through project, it was clearly visible that he was adopting a "deeper" approach. When reflecting on the work he had done in the second phase, six months later he described how the framework and structured workshops had allowed him to place different principles of sustainable in different contexts.

> "…the tutorials are useful to question the different strategies such as a high-tech strategy for waste and a low tech one for water the tutorial could be examining the relationship between both to examine how you could create a more integrated system within the masterplan. It might be different for different cities and it's OK to have it at different ends of the spectrum and if the relationship works then it works." (Harry, group interview)

When examining his completed project work he was able to link a range of themes that connected social and environmental aspects of sustainability into a coherent architectural strategy. This synthesis was based on an understanding of the social and political context as well as the principles of sustainable design, consistent with a deep learning approach.

Appendix B. Individual case studies

Table B2: Data summary table for Harry

Data type	Deep learning characteristic	Evidence
Observations	Critical understanding	Used the framework to identify limitations of technical approach to sustainable design
Project outputs	Logical reasoning	Used framework to develop coherent strategies, explicitly in design report
Project outputs	Critical understanding	Evaluated alternative approaches for sustainable design directly using model in
Interviews	Reflecting on experiences	Reflected on different principles of sustainable design in different contexts using the framework in interviews
Interviews	Logical reasoning	Described the restructuring of sustainable design strategies using the framework

B1.2 Karl

Karl took part in all the initial action group meetings and engaged with the research process throughout. He had completed his part 1 studies at the University of Bath and had taken a single year out, working at two practices, one specialising in high end residential and the other in historic building conservation.

Table B3: Data collection table for Karl

Date	Event	Data type
15 February 2017	Action group meeting 1	Audio recording and observations
1 March 2017	Action group meeting 2	Audio recording and observations
13 March 2017	Action group meeting 3	Audio recording and observations
3 May 2017	Action group meeting 4	Audio recording and observations
15 May 2017	Action group reflection	Audio recording and observations
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
17 November 2017	Crit observations	Field notes
17 December 2017	Crit observation	Field notes
16 January 2018	Student interview	Audio recording
20 January 2018	Final masterplanning design report	Notes
30 January 2018	Framework introduction	Field notes
12 April 2018	Student feedback interviews	Field notes
25 May 2018	Final individual design report	Notes

It was the Action group sessions that Karl found most effective. Speaking at the end of the project, he described how mapping different precedents onto the framework helped to "get him into the right frame of mind". However, throughout the project his use of

the framework tailed off. At the masterplanning stage, he described how he found the framework not applicable to his project:

> "Master plan level, for me, I didn't notice because of where we were working in terms of [the city] having this very open attitude towards all those moves." (Karl, Interview 16 January 2018)

He felt the context could justify any sort of approach and so the framework was potentially a limiting factor which wasn't relevant to their project. However, this was coupled with a feeling that his group had underperformed in terms of their sustainable design approach.

> "There are some things that certainly have scope for further resolution and the environmental is one of those aspects." (Karl, Interview 16 January 2018)

His final project was for a "Climate Change Adaption Research Institute" and accordingly low carbon design formed a strong part of his narrative. He adopted a deterministic process in which he used the optimisation of the building envelope for light, heat and ventilation to drive the design.

> "As with the structure of the building, in order to develop the most sustainable solution for environmental control, energy consumption first needs to be reduced before being optimised." (Karl, design report)

He described how he was aiming for a low-tech building which could act as a prototype to test new technologies. This led him to challenge the dichotomy of low and high-tech building strategies, and attempted to span this domain. Despite this aim, explicit sustainable strategies were conventional mechanical cooling and heating systems and a singular focus on carbon reduction. Sustainable design was typically reduced to technical systems, overlaid onto the architecture.

Winter Operation Schematic

During the winter months the heating load will be met using the heat generated by the data centre. A chiller will take in fresh air and cool it using water taken from the adjacent wharf. The cooled air is then ducted to the data centre where it will absorb heat generated by the servers. The air is then extracted and ducted to a heat exchanger where the low grade heat will be recovered.

The heat exchanger has its own fresh air supply which will be heated before being distributed throughout the tower and warehouse.

—— Heating   —— Cooling   —— Air Intake/Exhaust

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Figure B3: Example of technical approach to sustainable design

Speaking at the end of the project, he discussed how the framework was used to structure arguments in crits and was used to support his attitude towards technical design. While he did not use the framework explicitly in these scenarios, it provided an overarching structure to his approach. This lack of independent evaluation in the design process was clear and his report exhibited limited critical understanding of sustainable design which focussed on carbon reduction through a range of conventional strategies. Although he was exposed to (and interacted with) the framework from an early stage, a lack of continual interaction saw its use in his project rapidly diminish.

Arguably, Karl's approach to sustainable design had many similarities with a surface learning approach. The lack of synthesis and integration of concepts suggested a reiteration of standardised design strategies. In interviews he demonstrated a clear awareness of the sustainability issues, however he tended to apply a sequential thought process that involved dealing with the unsustainable consequences of particular decisions.

> "…say if you choose concrete what the ramifications are and how you can make
> concrete and more environmentally friendly material than say if you have a glazed
> building understanding the implications of glass are in terms of the internal

> conditions you need natural ventilation. It's more about understanding the knock-on effects of material choice and how you deal with those implications." (Karl, interview)

Karl's sustainable design process was consistent with how he had designed previously. In speaking of his past projects, he spoke of how sustainability always came "afterwards", following the "design". This was clearly a comfortable and successful approach which he replicated in his final project. Arguably, pressure, an absence of perceived freedom, and lack of critical reflection may have all played their part.

Table B4: Data summary table for Karl

Data type	Deep learning characteristic	Evidence
Observations	Critical understanding	Active mapping of strategies onto the framework in ESDAG sessions
Interviews	Logical reasoning	Described how framework structured information

B1.3 Anne

Anne was an active member of the Action Group from its conception however did not attend the final two sessions. Anne had undertaken three years post part 1 placement, working in Kuwait for three months and spending the remaining time at a local practice in Bath concentrating on residential and masterplanning work. She had completed her part 1 at Plymouth University.

Appendix B. Individual case studies

Table B5: Data collection table for Anne

Date	Event	Data type
15 February 2017	Action group meeting 1	Audio recording and observations
1 March 2017	Action group meeting 2	Audio recording and observations
13 March 2017	Action group meeting 3	Audio recording and observations
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
10 November 2017	Tutorial observations	Field notes
17 November 2017	Crit observations	Field notes
30 November 2017	Tutorial observations	Field notes
5 December 2017	Student interview	Audio recording
20 January 2018	Final masterplanning design report	Notes
30 January 2018	Framework introduction	Field notes
8 March 2018	Sustainability tutorial observation	Field notes
12 April 2018	Student feedback interview	Field notes
25 May 2018	Final individual design report	Notes

At masterplanning stage, her group developed a strategy that focussed on energy production and flood alleviation as well as providing valuable public and natural space. In tutorials and workshops, the group had limited engagement with the framework and it was used as a point of departure for discussion, rather than a tool to critique possible strategies. In an interview after the masterplanning project, Anne spoke about how the framework had made her realise about alternative approaches to sustainable design:

> "It made me realise about the social, because you know you have the low-tech but it made me think about it." (Anne, interview)

It made her think about sustainable design in a different way rather than "just not designing cold bridges". This increase in awareness was apparent also when she reflected upon how she had used the framework in her individual project. For her it raised awareness of issues and she used it "subconsciously".

Her final individual project (an Animal Rescue Centre) proposed to increase community awareness of animal welfare through providing safe re-homing for rescued animals. She set out a simple sustainability strategy of increasing embodied carbon to decrease operational carbon.

Appendix B. Individual case studies

PROJECT AIMS

CREATE A SETTLEMENT   COMMUNITY

DECREASE CRUELTY AND NEGLECT CASES.

INCREASE COMMUNITY ENVOLVE-MENT.

INCREASE IN AWARENESS OF THE IMPORTANCE OF ANIMAL WELFARE IN THE COMMUNITY.

THEREFORE INCREASE A PREVENTION AGENDA.

INCREASE SAFE RE-HOMING.

PROJECT ENVIRONMENTAL AIMS

LANDSCAPE

ANIMALS'WASTE

ARCHITECTURE

CARBON emission for MATERIALS

CARBON emissions for COMFORT

WATER MANAGEMENT

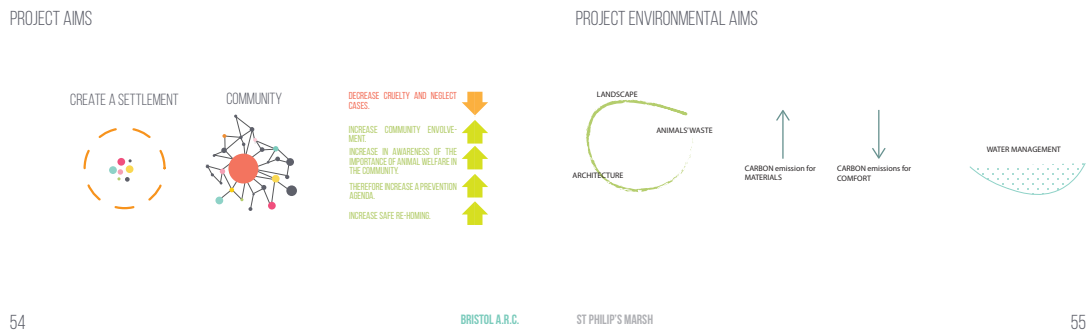54   BRISTOL A.R.C.   ST PHILIP'S MARSH   55

Figure B4: Project and environmental aims

Low-tech solutions for internal comfort and waste management were proposed, however, these were limited in scope and development. Design generators were based around practical considerations, such as the pragmatic requirement of housing numerous animals, as well a series of abstract deterministic generators, such as the range of a ball throw for a dog to fetch. Despite an initial aim to develop a community architecture, this did not manifest itself in the final project and sustainability was limited to environmental strategies and waste reduction.

Despite involvement from the start with the action research group, her approach to sustainable design could not be considered fully "deep". Sustainable strategies were applied as an overlay to meet specific problems, rather than forming the basis of synthesis through an understanding of how principles of design and sustainability interrelate. Her lack of continued engagement with the framework demonstrates the limited effect of parallel learning environments on design studio practice for some students.

Table B6: Data summary table for Anne

Data type	Deep learning characteristic	Evidence
Interviews	Critical understanding	Identified alternative approaches to sustainable design
Interviews	Logical reasoning	"Sub-conscious" use of framework to guide design decisions

B1.4 Phil

Phil did not take part in the initial action group and was first exposed to the framework in the masterplanning design studio workshops. See table B7 for his interaction and data collection. Phil had completed his RIBA part 1 at Sheffield and had two and half years' experience in practice working at medium sized practice specialising in

Appendix B. Individual case studies

residential and mixed use.

Date	Event	Data type
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
17 November 2017	Crit observations	Field notes
5 December 2017	Student interviews	Audio recording
17 December 2017	Crit observation	Field notes
30 January 2018	Framework introduction	Field notes
14 May 2018	Student feedback interviews	Field notes
25 May 2018	Final individual design report	Notes

Table B7: Data collection table for Phil

At masterplanning stage, Phil's group had demonstrated little interaction with the framework. In tutorials it had provided a useful aid to encouraging alternative thinking about sustainable design. For example, it opened up a conversation about how Rotterdam might be developed into a smart city that challenged conventional notions of sustainable design:

> "I'm interested in this idea Rotterdam is super experimental and we could be the 1st to do something really radical. It could be a spatial solution where we don't need this anymore because we got Uber maps and self-driving cars so do we need cars anymore?" (Rotterdam, group tutorial)

Despite this initial response, few of these ideas manifested themselves in the final scheme which focussed on spatial solutions through the creation of routes, connections and spatial infrastructure. This was intended to enhance the connection to the water, biodiversity, new communities and a new innovation economy. For Phil, this lack of engagement was due to the constant management of information and input from tutors.

> "It's [the framework] definitely a good way of thinking about it. I think like a lot of things you get a tutor and two days later you get another tutor says something different so it's hard to keep track of these things so how much we ran with it I don't really know. I wouldn't say we've built in it that much but I do think it's an interesting way of thinking about it." (Phil, first interview)

Phil demonstrated a keen interested in environmentally sustainable design, indeed he had undertaken a Passvihaus course. His individual project was themed around

adaption to climate change and rising sea levels by proposing a factory for the design and manufacture of floating houses. His architectural narrative was embedded in an idea about sustainable housing design for an uncertain future, specific to Rotterdam.
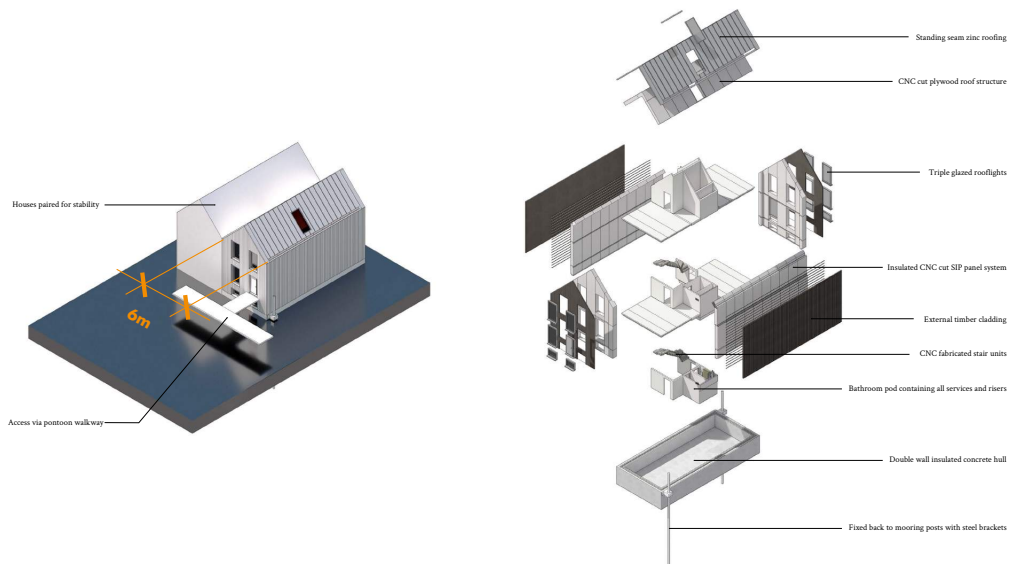
Figure B5: Example of Phil's floating housing project

When interviewed at the end of the project, Phil did not use the framework throughout his project. He felt he already had a strong and clear sustainable agenda which drove the project and so did not see the relevance of using the framework. In part this was due to Phil's innate deep learning approach in which he independently analysed a sustainability issue and then used this as the genesis for an innovative design approach. In individual interviews he spoke of his interest in Passivhaus, which he had chosen as his personal research topic, and how this was based in a critical analysis of particular architectural approaches.

> "My thing is about how adaptive we are to climate change and whether it's a good idea because we've got to acclimate quite rapidly. I think it's still a good idea that a lot of things associated with Passivhaus, such as airtightness and insulation, are not necessarily a bad thing for a future climate, but a poorly aging passive house and not really thinking about ventilation properly is where we have issues." (Phil, interview)

Appendix B. Individual case studies

Phil already demonstrated a strong conceptual understanding of sustainability and had clear internal motivation and a personal stance on its implementation. For him, the framework was redundant in his design process, which was already being clearly guided by sustainable principles.

Table B7: Data summary table for Phil

Data type	Deep learning characteristic	Evidence
Interviews	Reflecting on experiences	Described clear existing motivation and agenda for sustainable design
Observations	Logical reasoning	Used framework as basis of discussion on alternative sustainable agendas.
Project outputs	Logical reasoning	Architectural narrative embedded approach to sustainable design

G1.5 David

David did not attend any of the initial Action group meetings and was first introduced to the framework in the masterplanning project. David had undertaken his part 1 at another university and had 2 years' work experience at a range of international practices.

Date	Event	Data type
18 October 2017	Masterplanning studio workshop 1	Audio recording and observations
17 November 2017	Crit observations	Field notes
5 December 2017	Student interviews	Audio recording
17 December 2017	Crit observation	Field notes
20 January 2018	Final masterplanning design report	Notes
30 January 2018	Framework introduction	Field notes
8 March 2018	Sustainability tutorial observation	Field notes
12 April 2018	Student feedback interviews	Field notes
25 May 2018	Final individual design report	Notes

David's group engaged with the masterplanning workshop and saw value in the structure and formality of the teaching style.

> "I found the tutorial is really useful because I found you to be more objective than other tutors…I felt you knew our project when he sat down with a speech stripped away everything that you heard before and really just lay down the core principles

> and how users within our work and I thought I was really useful." (David, first interview)

However, it was not the mapping on the framework but rather the objective pedagogic style that contrasted with other tutor's approach that was considered important. The listing of specific strategies followed by a systematic questioning of motivations and assumptions allowed the group to reconsider and strengthen their sustainable approach.

David's individual project was a data centre based in the Arctic. He focussed on energy reduction by using passive cooling and ventilation systems. In sustainability tutorials, the performance led nature of the project took precedence. There was an emphasis on highly technical solutions to the energy challenges presented and the building was often represented as an extension of the machinery it housed. The consideration and interaction with users was entirely absent in these sessions.
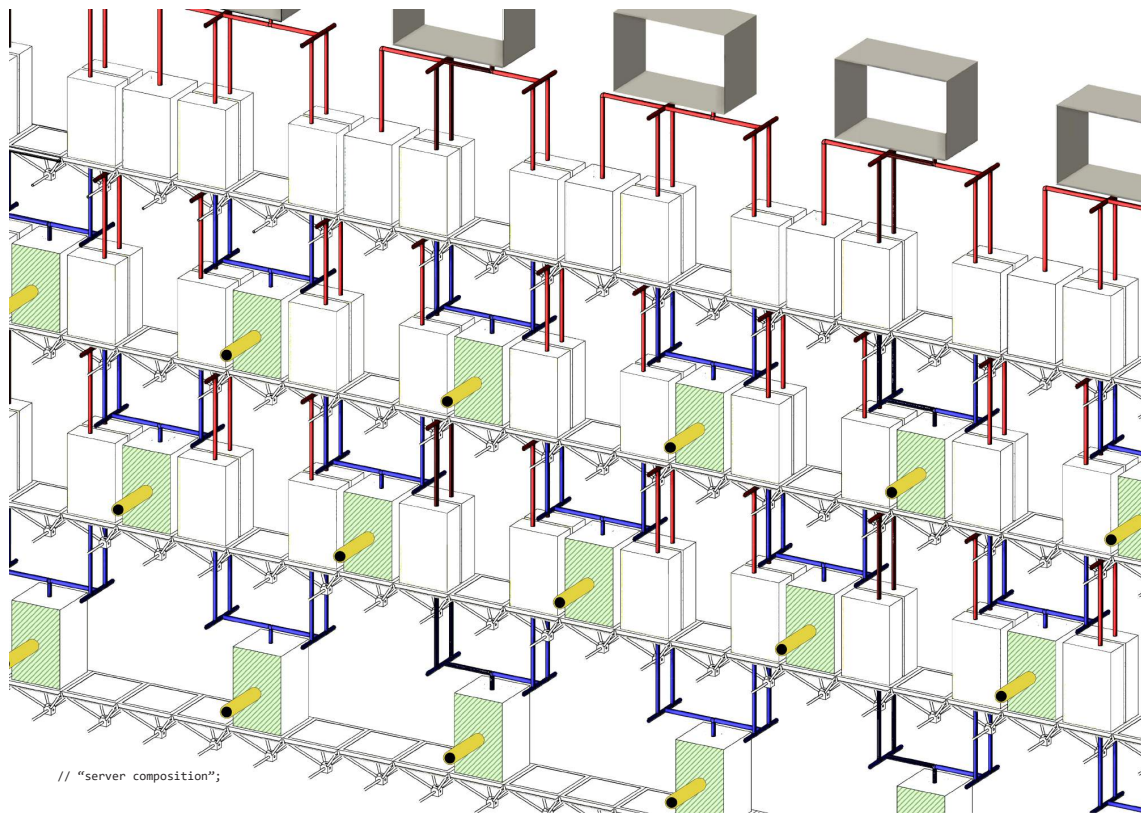
Figure B6: Diagrammatic cooling strategy

The sustainable approach of the project was framed by his rationalisation of sustainable strategies however without contextualising them within a wider framework they were limited to specific technical solutions. While the high-tech nature for the project was appropriate to both its function and context, greater critical analysis might have revealed

opportunities for more holistic strategies as well as reducing the level of abstraction implicit to the project.

David's approach was consistent with deep learning in many respects. For example, he demonstrated strong internal motivation when describing how he had developed his own brief to design something with meaningful sustainable impact.

> "The brief was for an education centre. We established a learning centre would not really be so beneficial because people will only visit now and then and I really wanted to do something higher impact. It became a big master plan and was eventually amphibious. It was a bit out there but did eventually encompass the sustainability centre and there is a community hub which could be used by the community. (David, interview)

Arguably his final project represented a holistic approach which drew from the mechanistic function of the building to infer its sustainable design solutions. This shared narrative represented a conceptual synthesis consistent with a deep learning approach. However, greater reflection might have questioned the assumption and values behind this approach. While he found the workshops a useful way of organising conceptual ideas, this was mostly through objective representation and my own critical questioning. By not using the framework, he missed opportunities for challenging strategic assumptions.

Appendix C: Interview Schedules

All interviews were conducted as semi-structured interviews around individual themes. The specific questions acted as a guideline and structure for the interview however an open ended approach allowed broader themes to be explored. In many cases responses led to a broader discussion which raised issues not anticipated by the researcher. This was particularly true in professional and tutor interviews. In many cases, responses covered subsequent questions which were then unnecessary to ask.

C1 Student interview schedules

C1.1 First Interview Protocol (interview set Phase 1) for MArch Students

First Interview Protocol (interview set P1) for M.Arch Students

13 October 2016

Timeframe: 17.10.2016 and 15.11.2016

Time per interview: 20-30 minutes

Aim of the First Interview

The first interview seeks to understand student attitudes and values towards sustainability, how these are incorporated into design work and the level of critical engagement in the design studio context. Considering a 'bottom up' approach, the research attempts to describe the challenge of sustainability from the point of view of the independent learner. The initial interview is to set a baseline understanding of the final year M.Arch students and their attitudes towards sustainability.

Objectives of the First Interview

- To gain a primary understanding of each student's architectural experience and education
- To understand student attitudes and interpretations towards environmental sustainability in the widest context

Appendix C. Interview Schedules

- To understand how each student incorporates environmental sustainability themes into their design work
- To uncover to what extent students feel their education has equipped them to deal with themes of environmental sustainability.

Design

The questions will be open ended in nature in order to establish a wide frame of reference for the following research, to encourage depth, develop a rapport with participants and reveal unexpected answers and conditions (Cohen et al., 2000, p.275).

Schedule

I am conducting PhD research looking to understand how M.Arch students understand environmental sustainability and how it is incorporated in design studio projects.

Informed consent form.

Tape recording consent.

Name

Experience and education

- Where did you complete your part 1 studies?
- Have you worked in any architectural practices? Where? When? For how long?

Sustainability

- What do you understand by the term environmental sustainability?
- The WCED define sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Would you agree with that statement?
- How important do you consider sustainability in a global context? Why is it important/unimportant/don't care?
- What role do you think architects have in meeting that aim?

Appendix C. Interview Schedules

- How can the built environment be made more sustainable and can you name some of the ways (strategies, methods, technologies etc.) that architects might employ to improve sustainability?

Sustainability in the design studio

- Do you consider your previous architecture design work at University to embody ideas of sustainability? If so, how?
- How do issues of sustainability effect your decisions in the design studio?
- At what stage do you consider sustainability in your design projects? (concept stage, strategic design, detail design, throughout?)
- You've just been on a site visit and are conducting an urban design exercise. Did issues of sustainability effect how you analysed at the site and what issues you will deal with in the masterplan?

Education

- Have you been taught environmental sustainable design? If so, how was it taught to you (through tutorials, lectures, seminars, personal study etc.)?
- Are you adequately equipped with the skills to design sustainably?
- What method or educational experience has been most effective in teaching you to use sustainability in the studio (e.g. through tutorials, lectures, seminars, personal study etc.)
- How might your education in sustainability be improved?

C1.2 Second Interview Protocol (interview set Phase 1) for MArch Students (additional questions)

Second Interview Protocol (interview set P1) for M.Arch Students

5 January 2017

Time frame: January 2017 – February 2017

Time per interview: 20-30 minutes

Aim of the Second Interview

Appendix C. Interview Schedules

The second interview seeks to build on the outcomes of the initial study of the studio which identified a number of domains that characterise the design studio. The aim of the second interview is to receive student perspectives on how sustainability relates to each of these domains. Initial conclusions were also attempted to validated or denied through the interviews.

Objectives of the Second Interview

- To gain an understanding of student attitudes towards how sustainability relates to the identified domains
- To validate or deny initial findings of the research

Design

The questions will be open ended in nature in order to establish a wide frame of reference for the following research, to encourage depth, develop a rapport with participants and reveal unexpected answers and conditions (Cohen et al., 2000, p.275).

Schedule

I am conducting PhD research looking to understand how M.Arch students understand environmental sustainability and how it is incorporated in design studio projects.

Informed consent form.

Tape recording consent.

Name

Content

- How do you consider the ILOs of the course and how do they affect your working?
- How do you feel the project assignments effect how you incorporate sustainability in your design projects?
- How do you use case studies in your design work (including precedents)?
- How important are marks and passing the course to you?

Appendix C. Interview Schedules

Experiences

- How do you feel the sustainability lectures offered in 5th year have influenced your project work?
- What is the role of tutorials (not specifically with the sustainability tutors) in developing sustainable concepts?
- Do you feel the crits help you critically analyse your own sustainable concepts?
- How did you find the 1st year crit you had to take?
- How do you conduct research around your project work? Is this the primary means of gaining relevant information?
- How have you developed skills for analysing sustainability (technical expertise)? What would help you develop necessary skills?
- What role does the design process, the act of designing buildings, have in enhancing your concept of sustainability?
- What role does social interaction in the design studio have to do with this?

Cultures

- Can you describe the attitude towards sustainability of the department and the university?
- Can you describe the attitude of teaching staff and critics?

Context

- Does the department support your learning about sustainability through the resources it provides?
- Can you describe your working patterns in the studio?
- How have study trips effected your attitude towards the environmental issues we are facing?

Motivation

- What is the primary motivation of your design work – underlying architectural ethos?

Appendix C. Interview Schedules

C1.3 Third Interview Protocol (interview set Phase 3) for MArch Students following workshops

Time frame: December 2017 – February 2018

Time per interview: 20-30 minutes

Aim of the Third Interview

The third interview seeks to build on the outcomes of the initial study of the studio which identified a number of domains that characterise the design studio. The aim of the third interview is to receive student perspectives on how sustainability relates to each of these domains. It also seeks to determine feedback on the workshop and the framework administered in the workshops.

Objectives of the Third Interview

- To gain an understanding of student attitudes towards how sustainability relates to the identified domains
- To validate or deny initial findings of the research
- To provide feedback on the framework on the framework administered in Phase 3.

Tape recording consent and consent form signature.

Name

Experience and education

- Where did you do your part 1?
- Architectural practices? Where? When? For how long?
- Age

Sustainability

- What do you understand by the term environmental sustainability?
- What role do you think architects have in meeting environmental sustainability?

- How can the built environment be made more sustainable and can you name some of the ways (strategies, methods, technologies etc.) that architects might employ to improve sustainability?

Sustainability in the design studio

- How is your previous design studio work sustainable?
- At what stage do you consider sustainability in your design projects? (concept stage, strategic design, detail design, throughout?)

Education

- Have you been taught environmental sustainable design? If so, how was it taught to you (through tutorials, lectures, seminars, personal study etc.)?
- Are you adequately equipped with the skills to design sustainably?
- What method or educational experience has been most effective in teaching you to use sustainability in the studio (e.g. through tutorials, lectures, seminars, personal study etc.)

Framework

- What was successful about the framework?
- What was unsuccessful about the framework?
- How could the framework be improved?
- Did the sessions using the framework help improve your understanding of sustainability?
- Did it effect how you designed/your learning – can you give an example?
- Has the framework/sessions changed your views or motivation towards sustain bile design in any way?
- Was the framework relevant to your work?
- Do you think it will help you design in a more sustainable manner in the future?
- Would you be interested in continuing use of the framework?

Appendix C. Interview Schedules

C2 Tutor interview schedules

C2.1 General interview protocol for tutors including key themes

October 2016

Aim of the tutor interviews

The tutor interviews aim to provide context on the design studio and understand the specific pedagogy employed by each tutor. They are also designed to give insight into the social relationships between tutors and students to add to the rich description of the design studio.

Objectives of the tutor interviews

- Provide insight into the individual teaching approaches of different tutors
- Add tot eh rich description of the social interactions that characterise the design studio.
- Assess the level of sustainable design integration into teaching

Name

Agree to take part/record interview and consent form.

Sustainability

- What is your understanding of sustainable design?
- Do you have a particular ethos or approach to teaching sustainability?

Student attributes

- What is your experience of student engagement with sustainability?
- What is the level of understanding and application of sustainability in students?
- What are the dominant attitudes towards sustainability in students?
- Do students critically engage with sustainability?

Student work

- What is the level of integration of sustainability in student projects?

- Is sustainability a motivating force for design?

The environment

- Are the studio and university as a conducive environment to sustainability?

Pedagogy

- How do you incorporate sustainability in your teaching?
- What are the most successful methods (when are students most responsive) for sustainable design?
- How appropriate is the crit as a means of assessment and feedback?
- Can you describe your role in a tutorial sessions?
- Can you describe the barriers to sustainable design in the design studio?
- What improvements could be made?

C3 Professional interview schedules

C3.1 Interview protocol for architectural practitioners

Introduction

- Name
- Position/job title/ company
- Agree to interview and to be used in the research inc. recording and research and consent
- Size of practice
- Nature of work

Outlook on sustainability

- Sustainability mean to the practice
- Sustainable values of the practice

Design process in practice

Aspirational sustainable values of a project

Appendix C. Interview Schedules

- Who defines them
- Do they drive the design
- How do you ensure they are achieved

Design process

- How is sustainability integrated
- Do you have a different process when explicitly engaging with sustainability?
- Set protocols or methods
- Application of technical tools/models
- How do you critique your design process

Collaboration

- Involving members of the public/stakeholders with sustainability

Learning

- Sources of new sustainable knowledge

Building example

- Is the project framed around sustainability (i.e. as the driver)
- How it meets certain sustainable credentials
- How did you achieve sustainable values
- How do you communicate this to stakeholders

Success

- How do you critique the assess of an approach or strategy?
- Checks from external sources, new knowledge, contextual understanding?

Teaching and learning

Experience with students

- What is their ability to design sustainability

Learning at University

Appendix C. Interview Schedules

- Is it adequate
- Could it be improved