# A Case Study of Science in a 1:1 Middle School:

# The Bling and the Underbelly

by

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**Declaration**

This is to certify that:

- This thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution
- Due acknowledgement has been made in the text to all other material used
- This thesis uses the APA (American Psychological Association) 6th edition style
- This thesis is approximately 72 000 words in length, excluding footnotes, diagrams, bibliography and appendices

Signed:

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Date: 1st August 2015

# ABSTRACT

VVC is a regional Australian middle school with an established one-laptop-per-student program (1:1). 8 years ago as a science teacher at VVC, I was part of the science education crisis (Tytler, 2007a), struggling to understand why 1:1 wasn't working as a bandaid for my teaching problems. Many students at VVC are 'students at educational risk' (SAER), and nearly 30% are Indigenous Australians. Non-mainstream students present a challenge to traditional science teachers whom the literature profiles as lecture-philic characters keen to produce future scientists (Aikenhead, 2010; Bryce, 2010). I wanted to understand the pedagogical manifestations occurring in VVC science, and examine the underbelly of our 1:1 program.

Within this context, the study examines cultural intersections between elements of the learning environment. The methodology utilises the work of Angelides (2001) and Tripp (1993) who analyse school culture through critical incidents. Grounded in naturalistic inquiry and interpretivism, my role was to document the lived experiences of students and teachers, and interpret them with the emic lens of a teacher-researcher. Data collection occurred across two years, including students' first and last science lessons with laptops. My participants were three science teachers and their two classes, with forty-three students contributing to observation and interview data.

The study reveals that although VVC may be the most established public whole-school 1:1 in Australia, at the time of fieldwork, its science teachers and students were not successfully participating in the transformative practices that 1:1 is believed to afford (Weston & Bane, 2010). At VVC, 1:1 cloaks the traditional science classroom in high-tech bling. During the study period, VVC science aligned to the where-not-how model of middle schooling, and glitches in the laptop program contributed to negative perceptions of, and experiences with, computers in science. Teachers struggled to engage their learners, bolting laptops onto existing traditional science pedagogy. Attempts at student-centred learning proved difficult to manage because of barriers related to the cohort, technical issues, digital literacies, and teacher pedagogy.

This research provides a case study of the science education crisis in a 1:1 middle school context. Key recommendations are that the school must create conditions for collaborative reform in science, including minimising barriers that contribute to negative experiences. Science teachers must embrace the ‘science for all’ philosophy that underpins contemporary science education, using innovative pedagogies and digital tools to engage ‘at-risk’ Millennials, while also supporting the development of digital literacies and learner dispositions suited to a ubiquitous computing environment. To do this, science teachers require professional learning to challenge and transform their beliefs about the teaching and learning of science.

*Keywords:* ubiquitous computing, science education, middle schooling

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| | |
|---|---|
| 1:1 | One-laptop-per-student program |
| ACARA | Australian Curriculum Assessment and Reporting Authority |
| AICTEC | Australian Information and Communications Technology in Education Committee |
| AIEO | Aboriginal and Islander Education Officer |
| Apps | Software applications |
| AC | Australian Curriculum |
| BYOD | Bring Your Own Device |
| CSSE | Cultural Studies of Science Education |
| DEEWR | Department of Education, Employment and Workplace Relations (formerly DEST) |
| DER | Digital Education Revolution |
| EA | Education Assistant |
| HLE | Hypermedia Learning Environment |
| ICT | Information and Communication Technology |
| IMT | Information and Media Technologies |
| JRST | Journal of Research in Science Teaching |
| LO | Learning Object |
| NAPLAN | National Assessment Program Literacy and Numeracy |
| NFT | Notebooks For Teachers |
| PISA | Programme for International Student Assessment |
| PL | Professional Learning |

| | |
|---|---|
| STEM | Science, Technology, Engineering and Mathematics |
| TIMSS | Trends in International Mathematics and Science Study |
| TLF | The Learning Federation |
| TPACK | Technological Pedagogical Content Knowledge |
| VVC | Valley View College |
| XXDoE | XX Department of Education |
| XXXXX | XX XXX |
| USB | Universal Serial Bus |

# CHAPTER 1—INTRODUCTION

For 8 years, I was a science teacher at Valley View College (VVC)[1]. VVC was the first wholly 1:1[2] public school in Australia. In 2010-11, during the fieldwork phase of this research, it was the only public middle school in 'an educational jurisdiction'[3], having a Year 8/9 structure that had "not been replicated anywhere else in the country" (Bell, 2012, p. 1). VVC has faced challenges that other schools are only now beginning to encounter, such as how to manage an established 1:1 program, and how to teach science in a 1:1 middle school setting. A number of contextual features make VVC a challenging work environment: over half the students are from low socioeconomic families (ACARA, 2014b); many perform poorly in state and national standardised tests (ACARA, 2014b); approximately 30% of students identify as Indigenous Australians (Bell, 2011); and there are occasional negative reports in the media (Phillips, 2010; Robin, 2010).

The overarching theme to my work as a science teacher at VVC was behaviour management, because getting students engaged in science was a struggle. A range of factors influence engagement, which relates to how students behave and need to be managed (Robinson, 2011). When 1:1 started at VVC, the positive hype about what this rock star phenomenon could do created an expectation that it could solve complex teaching and learning dilemmas. How 1:1 at VVC unfolded for me is the subject of the next section.

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[1] This is a pseudonym. All references have been edited to remove links to the school. All names are pseudonyms to protect the confidentiality of participants.

[2] One-laptop-per-student program

[3] All references to states removed to protect the identity of the school and participants

## My Initiation into 1:1

1:1 at VVC started as an election promise from the jurisdictional[4] Government. In late 2002, the state's Education Minister[5] announced there would be a "massive rejuvenation of public education in Sheepton[6]" because a review had "identified significant opportunities to make major improvements in the operation of the VVC campus" (Removed, 2002, p. 1). The bling part of this was the allocation of a laptop to every student. The Minister said that "the new technology focus and the opportunity to be at the cutting edge of education in (jurisdiction) will help to make VVC a centre of excellence in school education" (Removed, 2002, p. 1). At the time, schools, districts and states throughout the United States (US) were hooking into 1:1, and VVC used Maine's statewide middle school 1:1 as a model for best practice (Newhouse, 2008).

In 2003, while distributing the first 30 laptops, the Minister claimed: "research shows that students can have higher engagement and motivation levels, independence and confidence when engaged in electronic forms of information transfer, location and retrieval". He hoped that the school would "experience better performance in key learning areas and improved student attendance." Perhaps the most critical thing that struck me was the suggestion that 1:1 would "turn children on to learning and improve their academic performance in a range of areas" (Removed, 2003, p. 1).

In 2004, the State Government gave VVC 750 laptops as part of our "Laptops for Students Project", the "first project of its kind and magnitude in any state school in

[4] Reference to state removed to protect identity and this is done throughout thesis

[5] This source is not identifiable in the dissertation for ethical reasons

[6] Pseudonym

Australia" (VVC, 2009b, para. 1)[7]. Like everybody else in the initial phase[8] of 1:1, I thought technology would change the way students behaved. It would "turn them on to learning" (Removed, 2003, p. 1). I was a graduate teacher and I had every faith these statements were true.

After we got laptops, I spent time trying to integrate technology into my teaching. I used FrontPage web design software to dump content on the school server. These were novice webpages with hyperlinked worksheets, diagrams, and pictures. I was especially proud of my erupting volcano animation. The Learning Federation (TLF) was trialling its first set of Learning Objects[9] (Education Services Australia, 2014). I uploaded these LOs to the school server, using them when it fitted into my curriculum, and when it didn't, because *"How cool is it to have science games, kids?"* I was super-positive. I ran workshops for other staff because I was excited and hopeful about the things we could do with the new technologies. There would be no excuse for student apathy now, I thought. My lessons were on the intranet, students knew where to find stuff, and could work at their own pace. I dreamt of a utopian classroom with self-regulated learners that could use the scaffolds I placed on my intranet site to work independently. However, it didn't happen. Students came *sans* laptop, and *"I forgot my key"* was a common excuse. Kids *"lost"* work on the intranet, much like paper lost inside a school bag. Disappointingly, students were not turning on to learning science just because of laptops.

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[7] Direct quotes from websites include paragraph referencing as per APA 6th style

[8] Defined as the first 3 years of 1:1 (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010)

[9] LOs

There was pressure to use technology at a community and school level: parents wanted to send their children to VVC because of laptops[10], and administrators declared "notebooks are essential in most lessons" (DoE, 2006, p. 8). I, like other teachers, tried to use laptops in innovative ways. The school's science department purchased data probes for investigations, but that fell by the wayside because they broke easily and there wasn't a class set. I tried to facilitate self-regulated learning by having tasks accessible through my webpage, linked to outcomes, with instructions and hyperlinks to learning objects and websites. This helped some students, but most couldn't cope with the freedom. I got better at regulating off-taskers. I knew the signs well: a furtive pair of eyeballs over the top of the laptop, scanning the room for any sign of a teacher.

I tried other things. Googling was problematic, because websites were blocked or students went to GoogleLand[11]. We made music and podcasts with GarageBand. This was great for students that could navigate the software, but very few projects were finished with an eye to content, because learning how to use the program took up most of our time. We played with Flash, but again it was too time-consuming for students to learn how to use the software, with science content sacrificed for learning about technology. We inserted pictures into everything. We made iMovies of lab safety, fish gills, and eyeballs. Anything and everything was filmed or photographed when we had access to a camcorder, because in the early years laptops didn't have inbuilt cameras. The USB[12] ports were usually disabled, and file sharing was tricky business. I was on

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10 Undated comments from friends, prior to this research, who are parents of students at the school

11 My term for being lost/distracted on the internet

12 Universal Serial Bus

the ICT[13] Committee when we decided to get StudyWiz to manage online content. A lot of time was spent uploading student work, downloading it to mark, then uploading it again and sending it back. Using the laptop as a word processor was common because students without laptops could do this on paper. I started to question why students who were disengaged before laptops (*sans* accessories such as bag/pen/paper) would suddenly start engaging because of the new toy. They were not. Laptops were a compulsory accessory, yet, as an internal evaluation pointed out (Newhouse, 2008, 2011), some students at VVC weren't bringing or using them.

I reached a point where I started planning lessons without laptops. I did more hands-on stuff again, and had a niggling feeling maybe there was nothing wrong with laptops: maybe there was something wrong with me. At a whole school Professional Learning (PL) day in 2005, the school hosted Jamie McKenzie, a well-known presenter in education (McKenzie, 2014). That's when things started to click. I identified with the teachers he was describing: the content dumpers at the beginning of their journey. I wasn't as sophisticated as I thought. All that time learning FrontPage had just made me better at presenting information to students in a digital format.

In 2006, I met one of my EdD Supervisors, Dr Maor. She was interested in the 1:1 program, so I talked with her about how I had changed since the introduction of 1:1, and how I saw my students using laptops in science. I found it hard to swallow all the pro-laptop rhetoric I was hearing from admin, politicians, and researchers. What it looked like on the ground was nothing like what they were saying. I wanted to get stories from the science classrooms at VVC out there and reveal the underbelly that was making us teachers go crazy. The seeds of my EdD were sown here.

[13] Information and Communication Technology

## Some Overarching Ideas

Stories from the classroom, like this one, need focus or they get lost in learning environment variables (Fraser, 1998; Spires, Oliver, & Corn, 2012). The following sections set the scene at VVC with the temporal markers of school culture, science, 1:1, and middle schooling.

**Culture.** A critical part of the study design is the examination of culture in a 1:1 science-learning environment. Culture is "rarely conceptualized" in science education (Eisenhart, 2001, p. 209), yet it's argued "we will not understand the teaching and learning of science until we attend to" how it operates (Wood, Erichsen, & Anicha, 2013, p. 123). The definition of culture is tricky to pin down (Schein, 2004), as there are many variations. One that works within the context of this study is that culture is:

> …a pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.
>
> (Schein, 2004, p. 17)

Through my work as a science teacher at VVC, I noticed our culture wasn't really changing with new technology. Teachers are resistant to change (Cuban, 2012; Shirley, 2011), and science teachers even more so (Melville, Hardy, & Bartley, 2011). Different people in science leadership positions at VVC took different approaches to technology: either embracing or rejecting it. This resistance to change, grounded in ongoing debate over the nature of science (Bryce, 2010; Noblit, 2013), is part of the 'science education crisis' (Gough, 2008; Smith, 2010; Tytler, 2007a; Venville, 2008), explained in the next section.

**The science education crisis.** As a teacher at VVC, I was unaware I was experiencing the science education crisis. The crisis is grounded in research which suggests young people aren't interested in science and don't go on to post-compulsory study (Goodrum, Druhan, & Abbs, 2012); there aren't enough qualified people working in science related jobs, including science education (Chubb, 2013a); and the general public is not sufficiently educated in science ways of knowing (Goodrum & Rennie, 2007a, 2007b; Tytler, 2007a). Furthermore, for many years, the way science is taught in schools has been questioned (Bryce, 2010; Goodrum, Hackling, & Rennie, 2001; Millar, Leach, Osborne, & Ratcliffe, 2006a; Tytler, 2007a, 2007b; Wilson & Alloway, 2013). Usually, science teachers use the transmission model to fill students heads with facts (Goodrum, et al., 2012). It doesn't inspire students on to further study, so in Australia we are falling behind other developed nations (Chubb, 2013a), and require new ways of teaching to engage students in science learning (Goodrum, et al., 2012; Goodrum, et al., 2001; Goodrum & Rennie, 2007a, 2007b; Tytler, 2009). One recommendation is to tap into the benefits of high access to technology (Goodrum, et al., 2012; Tytler, 2007a). A common interpretation of this is the concept of ubiquitous computing, which as the next section explains, has evolved at a phenomenal pace.

**1:1.** The concept of 1:1, or ubiquitous computing, has evolved over the last 40 years so that in 2015 it means something very different to what it did in 2003, when 1:1 was introduced at VVC. For the purpose of this thesis, 1:1 refers to one-laptop-per-student (Spires, et al., 2012; Ullman, 2011). In Australia, research suggests there is a "tokenistic" approach to the use of technology in schools, and we have a limited understanding of how to do it successfully (Holkner et al., 2008, p. 96). In 2008, the Digital Education Revolution (DER) was a grand plan to improve the use of ICTs in Australian schools. The Federal Government was concerned there had been an "uneven" uptake of ICTs, where some schools were 1:1, while others were 1:10 "or worse", and "only a minority" were "reaping the full benefits of the information technology revolution" (AICTEC, 2008; DEEWR, 2008, p. 3). Theoretically, all high schools in Australia now have a one-computer-per-student ratio (DEEWR, 2013a), but it needs to be part of a package of reforms that can truly change the way education works (DEEWR, 2013a; Tinker, Galvis, & Zucker, 2007). According to DEEWR[14], high access to technology can "improve educational opportunities, boost outcomes and energise the learning experience" (DEEWR, 2008, p. 3). More importantly, our economy depends on it, with DER supposedly enabling Australian students to "achieve high quality learning outcomes and productively contribute to our society and economy" (DEEWR, 2008, p. 4). This national push for ICT saturation in schools has been hailed a success. It's made people believe "digital technology leads to enhanced educational outcomes" (DEEWR, 2013a, p. 5), and (in theory) has created a "level playing field" where low socio-economic schools (low SES) have similar infrastructure to the rest of the country (DEEWR, 2013a, p. 5).

VVC is a low SES school with high access to technology (ACARA, 2014b). VVC provides an opportunity to examine the practices of staff and students from a unique Australian perspective, as the most established 1:1 public school in Australia.

[14] Department of Education, Employment and Workplace Relations

Couple this with its middle school status, and the school is an excellent case study for the examination of 1:1 science. Middle schools are where most 1:1 research has been done. They are also a hotbed of information about the science education crisis, because this age is where researchers believe students may switch off from science, as the next section explains.

**Middle schools.** The middle school context of VVC is an important feature of the study. The distinction between a middle school and a traditional high school is that "teachers are organised into teams that: teach the same, designated group/s of students; and meet regularly to plan, review and discuss the educational needs and provisions for their specific group of students" (DoE, 2008, p. xiv). The team approach of middle school Sub-Schools can enable teachers to "better coordinate and tailor their teaching and classroom management strategies" and to "facilitate and support more cross-curricula teaching and learning tasks" (DoE, 2008, p. 39). Middle schools are philosophically innovative, where the key benefits are:

- Greater collaboration between teachers from different learning areas
- Better pastoral care and behaviour management
- Greater ability to cater for students with complex or additional needs
- Greater organisational innovation and flexibility
- Greater strategic alignment

- Greater use of cross-curricula and other progressive teaching strategies
- More holistic and better targeted professional and administrative support for teachers
- Better coordinated liaison with parents

(DoE, 2008, p. xvi)

Part of the science education crisis is about students disengaging from science somewhere in the middle years, possibly between primary and high school (Ramsay, Logan, & Skamp, 2005; Ricco, Schuyten Pierce, & Medinilla, 2010; Speering & Rennie, 1996; Tytler, 2007a, 2007b). That makes the middle school context of VVC highly relevant, because students are at the age of ‘disengagement’, and in a middle school learning environment that can potentially provide advantages over a traditional high school (DoE, 2008).

## Research Aims and Objectives

This section defines the study and presents the research questions, then explains aspects of the study that are significant to the science education community.

**Defining the study.** This study follows the ebb and flow of classroom life, sharing the hidden bits that do not make it into survey and observation schedules found in large-scale studies. The focus is on how three science teachers and their two science classes engage in science in a 1:1 middle school context, and data emerges from rich, descriptive fieldnotes that include observations and discussion with students and teachers. The culture of the learning environment, and how this culture impacts on the use of computers in science, forms the basis of the study. Critical incidents (Tripp, 1993) that describe the real life experiences of students and teachers make this more a warts n' all story than an example of best practice. Chapter 4 describes the theoretical assumptions in detail.

**Research questions.** The research questions address the broad concept of school culture from a learner and learning environment perspective. The questions are simple, but the answers reveal complex situations, including the interface between teachers, students and digital technologies.

***Question 1: The culture of the school.***

> How do factors related to the learning environment, such as the teacher, impact on the use of computers in science in a 1:1 middle school context?

This question is about factors external to the student. As well as teachers, it includes the middle school setting, laptops, and school policy.

***Question 2: The culture of the learner.***

> How do factors related to the learner impact on the use of computers in science in a 1:1 middle school context?

This question focuses specifically on the students and the way they use laptops in science. It covers factors including age, gender, ethnicity, ability and engagement.

The interconnected relationship between learning environment variables means that the boundaries between each topic are porous. The study focuses on critical incidents that best illustrate the culture of the science-learning environment at VVC.

**Significance of the Study.** This study of 1:1 middle school science contributes in a number of ways to the research literature, and the following sections describe these points of significance.

***Newhouse's hidden data.*** This study examines issues that an internal evaluation of 1:1 at VVC suggests requires further study. Newhouse (2008, 2011) has studied both initial and established phases of 1:1 at VVC. Reports generated from this research are not publicly available[15], but snippets of data are on the internet. A summary of the first phase of the research suggested there were a number of transformative changes at VVC as a result of 1:1 (Newhouse, 2008). It found that in the initial three-year implementation phase (2003-2006), teachers and students increasingly used technology. Over time, teacher's self-assessed ICT skills improved, and it was suggested that these new competencies would translate into improved student learning (Newhouse, 2008). In this phase, Newhouse found 10-20% of students "didn't like using computers, didn't want to carry a computer, didn't think they were used enough by some teachers, or didn't think they had learned enough about how to use them…the reasons for this situation are likely to be complex and varied and need further investigation." (Newhouse, 2008, p. 5). This study of 1:1 science at VVC picks up where Newhouse left off, as it examines the

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[15] The research is part of an internal evaluation conducted by WADoE during the initial phase and then self-funded by the school in the established phase. It is common for internal evaluations to remain confidential.

'complex and varied' student perspectives of 1:1 science, where many students fit the category Newhouse describes as the '10-20%' (Newhouse, 2008): those whom teachers "indicated that student characteristics such as behaviour and capability were constraints" (Newhouse, 2011, p. 3).

VVC has published findings from Newhouse's research in the established phase of 1:1, stating that ICT use at VVC "has become a natural component of the learning environments" for "most students and the majority of teachers", which is attributed to a combination of 1:1, "comprehensive curriculum" and "competent leadership" (Bell, 2010, p. 8). Newhouse was still conducting evaluations at VVC in 2009 and 2011 (ECU, 2013) but these reports remain confidential and are not available to school staff or the general public.

There is limited research of 1:1 science in the established phase of 1:1 when the novelty has worn off and things are 'natural' as Newhouse describes of VVC. This study of 1:1 science at VVC is set well into the established phase of 1:1, when 1:1 was in its 8th and 9th years.

***Apple's public hype.*** This study challenges the hype that Apple has touted on their website about 1:1 at VVC (Apple Computers, 2008)[16]. In 2008, Apple profiled VVC on the back of the Newhouse research, claiming that "repeated evaluations" confirmed "the availability of laptops has a big impact on learning at the school" (Apple Computers, 2008). They use a science example to support this claim:

16 Note that since 2008 Apple has updated its website and the webpages are no longer online. I have them saved offline and they are available on request.

> The science department recently bought a number of interfaces that allow students to measure temperature and other environmental variables. By interfacing them with the notebooks, students in a forensics class were able to learn about methods for determining time of death by following the cooling of a beaker of water, then extrapolating that information to a real-world scenario.
>
> (Apple Computers, 2008, para. 4)

Apple uses this best practice scenario to describe laptop use in a utopian classroom, because the forensics class it refers to was an elective that 'good' students chose as an options subject. While the use of a best practice scenario is inspiring, it does not accurately represent 1:1 science in the average VVC class. Unlike Apple's rosy example, this study examines the everyday realities of 1:1 science at VVC, where such digital probes rarely (never) make an appearance.

***Limited research in the field.*** This study of 1:1 science at VVC provides depth to what is a relatively untapped field of 1:1 science research in a whole school 1:1 context. One paper (Zucker & Hug, 2008) examines science in a whole school 1:1 context in the initial phase, and there is almost no published research that examines 1:1 science in established 1:1 schools, where 1:1 is beyond the first 3 years (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010). Research in established 1:1 school settings is just starting to enter the literature because 1:1 is a relatively new reform (Zucker & Hug, 2008), and "how one-to-one student laptop computing affects the broad environment of learning in schools remains under examined" (Spires, et al., 2012, p. 63).

***The whole school setting.*** Most 1:1 research is set in schools/classes where digital technologies are gifted for a temporary period, e.g. a lesson, a week, a few months, or a year. These brief 1:1 experiences provide “new media environments” that may only have a short-term positive impact, e.g. students describe the intervention as “fun”, because it’s “a different learning experience than…otherwise afforded” (Liu, Horton, Olmanson, & Toprac, 2011, p. 259). This type of setting is very different to an established 1:1 school, where technology integration is theoretically at a more advanced stage (Dwyer, Ringstaff, & Sandholtz, 1990), and as Newhouse (2008) found at VVC, computers are a natural part of the environment. In theory, VVC should have a science department with a variety of ICT affordances, where teachers have ‘transformed’ their practice with the added value of 1:1. Chapter 3 expands on models of technology integration.

***Timeframe.*** The study follows a cohort of students from their first day with laptops to their last. This is the first whole school 1:1 science study of its kind that follows the same students across 2 years, capturing the entire duration of their time at a 1:1 school. Very few 1:1 studies invest so much in the same cohort, collecting such intensive data. For example, Dunleavy and Heinecke (2007) examine 10 hours of teacher and student interview data, but their paper does not state the duration of interviews with their “sample of students from each site” (Dunleavy, Dexter, & Heinecke, 2007, p. 443). As a result, their research provides little depth to understanding student perceptions of the 1:1 science-learning environment across time and class contexts. The data provided in this study of 1:1 science at VVC illuminates students’ changing perceptions of school, science, and 1:1. The depth of understanding of 1:1 science provided through analysis of teacher and student voice is a real strength of this study.

***Teacher voice.*** Most 1:1 research tends to focus on teachers and the way they use technology (Koehler & Mishra, 2008), but teachers do not act in isolation: they are part of a bigger picture that includes money, workplace and subject specific culture, assessment, attitudes, beliefs, knowledge and skills (Ertmer, 1999; Hew & Brush, 2007; Schein, 2004; Selwyn, 2002; Windschitl & Sahl, 2002). This study of 1:1 at VVC begins to examine some of these dimensions, in particular how teacher pedagogy influences the way laptops are used in science. Common findings across other studies of 1:1 suggest teachers mainly use laptops for research and improved productivity (Dunleavy & Heinecke, 2007), and more research is needed into the kinds of barriers that prevent teachers from implementing student-centred approaches in the science classroom (Ng, 2011).

***Student voice.*** In recent years student voice in science has received more attention because governments want to better understand the science education crisis (Jenkins, 2006). This study of 1:1 at VVC focuses on student voice as a means of collecting authentic data to build a picture of class culture. All too often, student voice is collected through standardised surveys and observations, which are no good at catching fine-grained data (Fontana & Prokos, 2007; Patton, 2002), and struggle to tell an authentic story of how students view their educational experiences (Jenkins, 2006). Student voice in this study of 1:1 science at VVC cannot be found in ticked boxes or short answer written responses. It is the spoken word, often yelled across the classroom or into my iPod. With this comes a warning: the data is raw. It includes the everyday language of participants, swearing and all. Some readers may find this confronting, but it reflects the reality of VVC classrooms, providing a powerful, authentic insight into class culture.

***Emic perspective of the bricoleur.*** This study adds to the 1:1 science research field by examining what participants do (their actions), what they say (their narrative), and how I, as a participant of the 1:1 program, interpret this. My insider knowledge of VVC school culture puts a spin on both the collection and analysis of data, particularly in the use of participants' voice, the selection of critical incidents, and the vignettes (stories) created from this data. The patchwork of stories, woven from multiple critical incidents spread across time and space, are brought together following the tradition of 'the bricoleur', who attends to the data by dancing around and through a range of theoretical traditions, pulling together ideas and data in a way that best tells the story (Kincheloe, 2001; Lincoln, 2001). In this dissertation, capturing the essence of the story through the emic bricoleur's mash up is crucial to deliver the answers to the research questions. This style of research is unique in the context of Australian science education.

## Thesis Structure

Chapter 1 has provided the background to, and context of, the study. Three key reform movements acting at the time of the research serve as temporal markers, and the significance of the study relates to the history of 1:1 at VVC and the emic perspective.

Chapters 2 and 3 describe the overarching ideas of science education and 1:1, while addressing middle schooling incidentally as a contextual feature. There is an examination of factors contributing to the science education crisis. Key terms like ‘culture’ and ‘engagement’ are linked to the main theme of the study, 1:1. The 1:1 theme is broken down to look at the history of 1:1, then what the research says about 1:1 in general, and 1:1 science education specifically.

Chapter 4 provides a rationale and description of the research methodology. It provides depth to my personal narrative, and examines the concept of culture and its use in science education research. It explores the mixed methods utilised for data collection and analysis. The resultant bricoleur role of the researcher is described to enhance the trustworthiness of the findings. It then explains the significance of using an emic lens to analyse critical incidents, using reflexive praxis and storytelling.

Chapter 5 introduces the data from fieldwork. It describes the school context, including laptop policy and procedure, to set the scene for science specific stories. It starts analysing the three science teachers’ pedagogies and how they ‘do’ science.

Chapters 6, 7 and 8 provide colourful insight into the day-to-day actions and thoughts of the teenagers in the two classes. The overarching question “How do factors related to the learner impact on the use of computers in science in a 1:1 middle school context?” is examined using themes that emerged through the analysis process. Some interesting vignettes of particular students and events highlight critical incidents that act as barriers to, or support for, learning science in a 1:1 environment. The chapters build an understanding of these students doing science, with Chapter 6 introducing the key informants, and the overarching learner characteristics of gender, ethnicity, engagement and the middle years. Chapter 7 examines ‘those kids’ doing science and Chapter 8 delves further into the science classroom culture by examining ‘those kids’ doing science with laptops.

Chapter 9 brings teachers, students and laptops together. It explores cultural points of intersection in a science context, focusing on the teaching and learning of science, with attention drawn to the innovative and not-so-innovative use of laptops. It describes the way student factors, such as age and time, gender, ethnicity and literacies, all interact and play a role in the culture of science at VVC.

Chapter 10 draws conclusions from the findings relating to the culture of the 1:1 science-learning environment that are reported in the previous five chapters. It makes recommendations based on the findings for how to re-imagine science at VVC. It then summarises the contributions the research makes to the field of science education, exposes the limitations of this style of research, and makes suggestions for further study.

# CHAPTER 2—SCIENCE AND EDUCATION

This chapter, Chapter 2, illustrates how science education in Australia is changing. Science is dogged by pressure from government, industry, and education sectors all clamouring for change (AAS, 2011). Unfortunately, Australia doesn't invest enough in STEM[17] research, which is the way forward for struggling economies (Chubb, 2013b; Pettigrew, 2012; West, 2013). Schools and universities need to pump out more, and better quality, science graduates, but graduate numbers are falling (Goodrum, et al., 2012). It's known as the science education crisis (Tytler, 2007a), where over 10 years of innovative intervention in Australia has made little difference to the way science is taught in schools (Goodrum, et al., 2012). This study of science at VVC examines the curriculum and pedagogy of two experienced teachers, and one graduate teacher. It focuses on how students and teachers 'do' mainstream high school science, providing data that can contribute to our understanding of the science education crisis.

This chapter starts by examining Australian science using the term 'scientific literacy' as a basis for understanding science. It then introduces the concepts of student engagement and identity as factors that play an important, but often overlooked, role in school science. The difference between traditional and ideal science is raised as a factor that contributes to the science education crisis. 'Students at educational risk' (SAER) are flagged as a group who miss out in the traditional science classroom environment, and their place in science is particularly relevant to this study, where many students are identified as SAER. The chapter ends by explaining that there is potential for change:

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[17] Science, Technology, Engineering & Mathematics

part of the solution to the science crisis lies in hooking into the digital world that now exists as a reality for students of this generation (Martin, 2005; Ng, 2011). This will lead us into a discussion of the role of technology in education (Chapter 3).

## Science and Australian Society

A precursor to understanding science at VVC is to look at how we do science in society. For over 10 years, there have been warnings of a crisis, and a need for further investment in STEM (Chubb, 2013a; Goodrum, et al., 2001). Fast-paced mediums, such as the internet, allow direct public access to science concepts and issues (S. Lee et al., 2011; Riesch & Mendel, 2013; Taylor, 2007), but there are pros and cons to such access. Research shows that Average Joe requires support from scientists/specialists to engage in meaningful debate (Taylor, 2007). The internet is a useful medium for this, but it has created a forum for non-science bloggers whose input may not be scientific or helpful (Riesch & Mendel, 2013; Taylor, 2007). Our citizens therefore need training in how to deal with science information they come across in their daily lives, and improved scientific literacy is the key (Murcia, 2006; Ng, 2011; Tytler, 2007a). For learners like those at VVC, critical thinking skills are important for navigating online worlds and evaluating science concepts they confront in daily life. Learner dispositions, including attitudes towards particular learning styles, science and laptops, are important facets of science at VVC. These are also potentially important factors to consider in the science education crisis.

The knowledge that we need to change the way we think about science, and pressure to engage the public and school students in meaningful science, has resulted in government spending across the globe (AAS, 2011; Fensham, 2006; Goodrum, et al., 2001; Goodrum & Rennie, 2007a, 2007b; Tytler, 2007a; van Est, 2011). However, "few academics or governments…are clear about their goals and desired outcomes, and whether or not the processes they facilitate are likely to meet these ends" (Powell & Colin, 2008, p. 127). This lack of clarity stems from the ongoing argument about what constitutes good research and good science (Aikenhead, 2006; Howe, 2009; Tillman, 2009). The next section outlines the debate over scientific literacy, and how this relates to the current buzzword in science: culture (Noblit, 2013).

**Scientific literacy and the culture of science.** There's been much debate about what kind of science should be taught in schools, and what science skills students need (Aikenhead, 2006; Millar, Leach, Osborne, & Ratcliffe, 2006b; J. F. Osborne, Ratcliffe, Collins, Millar, & Duschl, 2003; Symington & Tytler, 2004; Tillman, 2009). It relates to different perceptions of the nature and usefulness of science, and what it means to be scientifically literate (Murcia, 2009). The Australian Government uses the same scientific literacy model as the Organisation of Economic Cooperation and Development (OECD), which states it's:

> …an individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

(OECD, 2009, p. 14)

There is a strong voice claiming that scientifically literate citizens have a positive impact on the economy (Chubb, 2013b; Goodrum, et al., 2012; McConney, Oliver, Woods-McConney, & Schibeci, 2011; Millar, et al., 2006b; West, 2013), but others argue the investment in science isn't worth the money (Macilwain, 2013). The ongoing wars about research, science and equality highlight the way science, like education in general (Ford, 2012; Giroux, 1991), can be perceived as a hegemonic social activity (Aikenhead, 2006; Barton & Yang, 2000; Davies, 2013; McKinley, 2007; Peca, 2000; St. Pierre, 2006; Willis, 2007; Wood, et al., 2013). There is a cultural base to science. We are given the cultural software we need to engage from those around us, yet sometimes these tools aren't helpful, or need modifying (Wood, et al., 2013). This means that scientific literacy is fluid, where the usefulness of science knowledge is dependent on audience and context (Feinstein, 2011; Murcia, 2009). Working out what we need to know depends on where we come from—our culture—and it is this that determines the social and historical aspects of scientific literacy. On one hand, our cultural group helps us to discover the world around us, but on the other, it limits us to particular methods of discourse (Barton & Yang, 2000; B. A. Brown, Reveles, & Kelly, 2005; Giroux, 1991; Schein, 2004).

There are also the trappings associated with science being a result of colonialism, which has "wrought a legacy from hell" for non-western cultures and non-mainstream ways of thinking (Noblit, 2013, p. 239). Science education research sometimes focuses on the differences and similarities between Western and non-Western models of nature (Aikenhead, 2001; Aikenhead & Ogawa, 2007; Sheehan & Walker, 2001), but there's a growing interest in sub-groups (Parsons & Carlone, 2013), points of intersection between these groups (Grimberg & Gummer, 2013), and how such transactions can lead to a cultural change in science (Barma, 2011; García, 2011; Wilson & Alloway, 2013). This is in contrast to the traditional approach to both science and research, which is based in the positivist paradigm, and asserts all knowledge exists in an objective reality (Peca, 2000). Students at VVC are confronted with two new paradigms in their lives when they enter Year 8: the culture of science, and the culture of a 1:1 learning environment. Negotiating agency in these spaces, particularly science, is difficult for students from non-mainstream backgrounds (Calabrase Barton & Tan, 2010; Chigeza, 2011; DeGennaro & Brown, 2009; Olitsky, 2006; Rivera Maulucci, 2010; Shanahan, 2009; Shanahan & Nieswandt, 2011; Tan & Calabrase Barton, 2008). At VVC, the largest non-mainstream group are Indigenous Australian students, who make up 30% of the cohort. These students may come to science at VVC with alternative views about nature and ways of knowing that don’t fit with the culture of mainstream science. Indigenous knowledge traditions and non-mainstream ways of thinking about learning are therefore important considerations of this study.

***Indigenous knowledge traditions.*** In keeping with the literature, this thesis uses the term ‘Indigenous knowledge’ to refer to non-Western ways of knowing nature, and ‘science’ to define a Western practice of the same (Aikenhead, 2006; Goodrum & Rennie, 2007b). Indigenous knowledge traditions in Australia are characterized by “an understanding of the world that is subsumed with the metaphysical and supernatural” (Chigeza, 2007, p. 10), and are very rarely given attention in school or society (Chigeza, 2007, 2011). Recent changes in national policy include an awareness of Indigenous perspectives in school curriculum (ACARA, 2014b), but evidence of how useful this is in closing the gap remains to be seen (Chigeza, 2011; Wilson & Alloway, 2013).

Indigenous students at VVC are a focus group of this study because of their poor performance in VVC reporting and assessment (personal experience and teacher communications), and data that indicates poor performance in science across Australia (Thomson, McKelvie, & Murnane, 2006). A key concept of this thesis is how both Indigenous and non-Indigenous students negotiate their way through the subject culture of science, which will provide data to improve our understanding of the science education crisis. How we define the concept of culture is the topic of the next section.

***The slippery definition of culture.*** The emergence in recent years of discussion surrounding the culture of science (Parsons & Carlone, 2013) has had little impact on science reform (Eisenhart, 2001; Wood, et al., 2013), even with top-level pressure for cultural change (Chubb, 2013b). Some argue it's because we think of culture as "a bounded and coherent set of beliefs and practices associated with a distinct social world" when it's actually "porous and emergent" (Seiler, 2013, p. 104). Wood et al. (2013) combine studies of culture in science from a variety of theoretical frameworks to come up with a definition of "cultural emergence", in the context of science, which "understands culture to be simultaneously an individual, group, and system phenomenon" (Wood, et al., 2013, p. 124). Others working in 1:1 science research agree that culture is:

> ...a complex compound, reflecting community values as they appear in student and parent attitudes, the rhetoric and espoused values of the school or district, the deployment of resources which either is in support of the espoused values or not, and the way that different priorities within the district are balanced…
>
> (Drayton, et al., 2010, p. 49)

Multidimensional models of culture place equal value on each part, and science reform failure is attributed to emphasis on just one, or parts of, each dimension (Wood, et al., 2013). Any attempts at organisational change need to address the culture of students and teachers (the operator culture/s), who operate within the broader context of school (the engineering culture), society, and the overlords of the 'executive culture', usually the people who sit at the top in government (Schein, 2004). This study of culture at VVC presents both teacher and student perspectives of the learning environment to provide a balanced view of VVC science culture.

The next section describes what we know about the culture of science education, including the culture and identities of science learners, the notion of student engagement, and how these things operate in the context of mainstream science education in schools.

## Science Education

This section describes the science education landscape in Australia. It first examines the concept of culture and identity in science. Then it describes how we do science in schools, and what it means for students that the jurisdictional Department of Education (DoE) labels as 'students at educational risk' (SAER). After introducing these key ideas, Chapter 3 will move into how the idea of ubiquitous computing has infiltrated schools and is contributing to changes in the way we do science.

**The culture(s)/identities of science learners.** The culture of learners is a crucial feature of this examination of 1:1 science at VVC, because there are always social and physical aspects to learning, as all learners are subject to "enculturation" through the process of knowledge production (J. S. Brown, Collins, & Duguid, 1989, p. 33). The term 'culture of the learners' refers to the personal and social structures that build a sense of class identity. In this study, identity is defined as the dialectic process by which individuals and/or groups perceive and present themselves to each other (Olitsky, 2006). Identity is a core part of understanding science and the culture of science education, because it acts as a "pivot to investigate the relationship between culture and learning" (Aydeniz & Hodge, 2011, p. 512). In the context of this study, the culture of the learning environment and the learners is the core of both research questions.

***Identity and border crossing.*** Nested within the concept of culture is the notion of identity, which is having a "renaissance" in research (Sfard & Prusak, 2005, p. 14). In science, identity is a relatively new thing, because traditionally, science is an objective discipline devoid of humanness (Aikenhead & Ogawa, 2007; Bryce, 2010). Traditional science classrooms ignore student identities (Meyer & Crawford, 2011) because they are considered irrelevant in a positivist paradigm. This poses a problem for students from non-western backgrounds, as well as those from the dominant western culture, who try to participate in the learning process but may slip through the gaps created when we teach science in traditional ways (Aikenhead, 2006; B. A. Brown, 2006; Rivera Maulucci, 2010). Student identity in science "involves considering broadly who students are and why they choose—consciously or subconsciously—to engage or disengage in the science classroom" (Shanahan, 2009, p. 43). There's a global trend of underachievement and disengagement from science for minority groups (B. A. Brown, 2006), including Indigenous Australians (Thomson, et al., 2006). Studies that examine the identities of science learners have found that students can code switch into science mode, but many issues are at play (Seiler & Abraham, 2009). One of the main concerns is how the language of the dominant culture, as well as the language of science, form a fluid classroom discourse that evolves through the lived experience (Roth, 2013). This can make it hard for non-mainstream students to develop their scientific literacy as they also try to keep their own agency within the subject culture of science. Studies of identity and school science have found that students can be more interested in being part of the class culture (the group) than in actual science learning (Olitsky, 2006), and the culture of traditional science education can limit the way students are able to participate, which relates to the roles and identities students enact in the science classroom (B. A. Brown, 2004; Olitsky, 2006; Shanahan, 2009; Shanahan & Nieswandt, 2011). Some groups of students find it easier to do science: the ones most able to engage in the subject culture of science are usually not minority students (B. A. Brown, 2004; Chigeza, 2011). It is also possible that students who appear disinterested in the science they're served at school can develop their own ways of understanding and doing science 'on the sly', that is, in ways that aren't immediately obvious to outsiders or other individuals in the group (Calabrase Barton & Tan, 2010; O. Lee & Buxton, 2011; Olitsky, 2006).

These ideas about identity are relevant in the context of VVC science, because 30% of the cohort is Indigenous Australians. Several Australian studies show that provision of relevant curriculum, and building positive relationships, are critical to engaging Indigenous students (Chigeza, 2007, 2011; Wilson & Alloway, 2013). Another reason identity is important is that many students at VVC are considered ‘students at educational risk’ (SAER). The SAER label is a critical element of this study, because the ‘science education crisis’ is in part due to the disengagement that characterises many SAER. The concept of engagement, which is partly defined by student identity, is a useful tool for improving our understanding the culture of science at VVC.

***Student engagement.*** This study of 1:1 science at VVC uses engagement as a lens, because when students are disengaged they are not reaching their full academic potential (Ainley & Ainley, 2011), and won’t go on to study or work in science (Chubb, 2013a; West, 2012). Engaging students in science is therefore a critical part of the solution to the science crisis (Chubb, 2013a; Goodrum, et al., 2012; Tytler, 2007a, 2007b).

A recent study of the barriers science teachers face when attempting to make their lessons more engaging revealed that the biggest hurdle is the learners’ “lack of interest/poor science self-efficacy” (Southerland, Gallard, & Callihan, 2011, p. 2193). Teachers attribute these learner dispositions to “lack of home support” and “lack of appropriate background knowledge”, which limit students’ capacity to engage (Southerland, et al., 2011, p. 2194). Students at VVC are flagged as ‘at risk’ for a number of reasons, including ethnicity, socio-economic status, and low literacy, attendance and achievement. Each of these factors could act as a barrier to engagement, particularly with technology, and require further study in the context of VVC science.

The term ‘engagement’ is used as a catechism for the myriad of emotions that form “complex pattern(s) of behaviour” that describe how a learner acts in the classroom (Ainley & Ainley, 2011, p. 4). A recent trend in engagement research focuses on student identity (Cowie, Jones, & Otrel-Cass, 2011; Gough, 2008), including culture (Aydeniz & Hodge, 2011), and factors such as gender, race, socio-economic status, and perceived notions of self (Archer et al., 2010; B. A. Brown, 2006; B. A. Brown, et al., 2005; Parsons, Miles, & Petersen, 2011; Ricco, et al., 2010; Shanahan & Nieswandt, 2011). Some studies look at learners in other ways: students’ prior knowledge, achievement, interest, and enjoyment in science, where research indicates that if students have positive perceptions of science they are more likely to engage (Ainley & Ainley, 2011; J. Osborne, Simon, & Collins, 2003). Other studies look at learning environment variables, such as the type of school and its culture (Vedder-Weiss & Fortus, 2011), or the teacher and their pedagogy (Parsons, et al., 2011). Many studies use parts of each dimension and cut across different theoretical frameworks. This study of science at VVC uses markers in critical incidents to illustrate how engagement plays a role in the culture of science in the 1:1 middle school context of VVC.

Student disengagement from science is a problem because of behavioural, social, academic and economic impacts (Fouad et al., 2010), and disengagement was the driver behind this research at VVC. With the notion of engagement in mind, the next section provides a snapshot of science education, to illustrate how student (dis)engagement has contributed to the science crisis, and to provide a temporal marker for the study.

**Traditional and ideal science.** Science teachers have long been criticised for failing to change the way they teach to suit the needs of their learners (Aikenhead, 2006, 2010; Lyons, 2006; Seiler, 2013). We know this as ‘traditional school science’ taught by ‘traditional science teachers’. Traditional school science has survived various reform attempts (Cuban, 1995; Tytler, 2007a), and much of the existing Australian curriculum is a hangover from the ‘teaching future scientists’ notion of science education (J. Osborne, Ratcliffe, Collins, & Duschi, 2006). In traditional school science:

> ...the emphasis is on conceptual knowledge, compartmentalised into distinct disciplinary strands, the use of key, abstract concepts to interpret and explain relatively standard problems, the treatment of context as mainly subsidiary to concepts, and the use of practical work to illustrate principles and practices.
>
> (Tytler, 2007a, p. 3)

This didactic approach has led to declining enrolments in post-compulsory science, and students’ negative attitudes towards science (Chubb, 2013a; Goodrum & Rennie, 2007a; Gough, 2008; Tytler, 2007a). Such teaching approaches still continue today (Goodrum, et al., 2012), when for over a decade researchers have known that student engagement depends on good teachers, student ownership of “challenging and fulfilling” learning experiences, and the relevance of curriculum to everyday life (Goodrum, et al., 2001, p. 147). There is now a strong wave of protest against traditional transmission pedagogy (Lyons, 2006) and a move towards (social) constructivist, learner-centred learning environments (Tobin, 2007). This notion of user-led learning is the ‘transformation’ that 1:1 advocates envisage stems from ubiquitous computing and is described in Chapter 3.

Atop of pedagogical change and reforming notions of science sits good leadership: research suggests that outcomes link to the change management practices of the engineering culture of school leadership teams (Waters, Marzano, & McNulty, 2003) and the top level executive culture of policy makers (Cuban, 2013a; Schein, 2004). The problem is that Heads of Science are usually traditional science educators enculturated into the 'teaching future scientists' pipeline model of science education (Melville, et al., 2011). These are the people who engineer the reform process (Schein, 2004), but it won't work unless they first understand the problem with traditional science (Melville, et al., 2011) and the cultural assumptions associated with positivism underpinning their practice (Aikenhead & Ogawa, 2007; Schein, 2004).

Part of the science education crisis stems from a changing notion of who science education is for and how we teach it. Schools are faced with the conflicting educational needs of students who will become future scientists, and those who won't, yet still require scientific literacy to lead a 'good life' (Maienschein, 1999; J. Osborne, 2006; Tytler, 2007a). Traditionally, the purpose of school science has been to present students who are destined for tertiary studies, the future scientists, with a body of knowledge relevant to their career as scientists (Aikenhead, 2006; Tytler, 2007a). The resultant pedagogy is teacher-centred, with chalk n' talk delivering standardised content to passive recipients (Goodrum, et al., 2001). A recent review of post-compulsory science indicates that it's still taught using a "didactic…transmission model" (Goodrum, et al., 2012, p. 55). This links into the ontological debate about positivism versus constructivism, which is a long running theme in science education (Matthews, 1998; Tobin, 2007).

Regardless, universities and high school science departments are encouraged to change the way they offer science, by focusing on contemporary issues relevant to students (Fensham, 2006; Goodrum, et al., 2012; Tytler, 2007a; West, 2012). This might put an end to the pipeline ideology, where it's expected that students studying science at high school aim to end up at university and then as scientists (Bryce, 2010). But top-down reform is a concern for researchers, who worry that the culture of the classroom, its students, teachers and community are overlooked in the big picture (Aikenhead, 2010; Melville, et al., 2011; Rivera Maulucci, 2010). There is pressure for change at an earlier stage, hooking students into science in the compulsory years of schooling where it's thought they might develop a less favourable opinion of science compared to other subjects (Archer, et al., 2010; J. Osborne, et al., 2003; Ramsay, et al., 2005). Research suggests that declining enrolments in post-compulsory science are caused by disengagement in the compulsory years (Goodrum, et al., 2012; Ramsay, et al., 2005; Tytler, 2007a), where competing ideologies of traditional and contemporary science intersect. Furthermore, in the compulsory years there are limited links to science in everyday life, or real-world connections to the diverse range of science roles in society, and the types of scientists that exist (Ramsay, et al., 2005; Tytler, 2007a). This study at VVC pulls critical incidents from the classroom that analyse science in the compulsory years of schooling and provide important data relating to early adolescents and their switch from primary to high school science.

Top down pressures from traditional tertiary and upper secondary science influence the way lower secondary science is taught (Fensham, 2006; Melville, et al., 2011). Middle school teachers are often upper-school trained, and model their teaching on the transmission style used in upper school and universities (Goodrum, et al., 2012;

Tytler, 2007a). Furthermore, images in the media and realities of the traditional science classroom promote conventional views of a scientist, with middle school students holding distorted views of scientists (Gough, 2008). Tytler (2007a) explains that middle years students (aged 11-15) experience science as:

> …non-negotiable, abstract knowledge, tending to use an authoritarian and narrow pedagogy which is arguably insensitive to the diverse learning needs of students. Nor does it provide the intellectual challenge associated with exploration and questioning, and substantive discussion of ideas, that middle years principles recommend.
>
> (Tytler, 2007a, p. 12)

Middle school teachers are not always abreast of the latest science educational theory, and about a tenth of middle school science teachers have no science training at all (Harris, Jensz, & Baldwin, 2005). Two of the teachers in this study at VVC have over 5 years' experience teaching science (one over 20 years), and one is a graduate. Their pedagogy and beliefs about students in Class 1 and 2 form an important facet of the study that can improve our understanding of the impact of mainstream science teachers on middle school students' experiences, attitudes and beliefs about science.

In primary schools, teachers often have limited experience of science (Appleton, 2007), but are more open to 'science for all' and likely to use engaging pedagogies (Goodrum, et al., 2001). The switch from the engaging pedagogies of primary teachers to the traditional pedagogies of high school science teachers is considered a critical factor for student engagement (Goodrum, et al., 2001), and is a factor in this research. One early Australian study found that Year 7 students thought primary science was “exciting, fun, hands-on and challenging”, and they expected science in high school to be the same, but were “bored” and didn’t develop the same quality relationships with their high school science teacher (Speering & Rennie, 1996, p. 295). This study of science at VVC manages to capture the beginning, middle and end of students’ experiences as they transition from primary school through middle school, and then ready themselves for senior high school. This unique setting will provide valuable data about how students transition between various phases of schooling, and their beliefs about science and technology along the way.

It’s in middle school that social networks become more of a barrier to learning science than a support, and learner dispositions become an important factor for student engagement (Fouad, et al., 2010). Once students start to disengage from science they have their own category within the ‘students at educational risk’ (SAER) label. In the two classes in this study at VVC, a majority of students would fall in the SAER category because of their disengagement from science. The jurisdictional Department of Education (DoE) supposedly protects the rights of these students through policies that cater to the needs of all learners, under the banner of inclusivity and SAER.

**Students at educational risk.** Goodrum et al’s (2001) review of science education in Australia and the jurisdictional curriculum documentation (XX Council, 1998) both advocate inclusivity. It’s mandated that schools must cater for the needs of all students, including ‘students at educational risk’ (SAER). SAER are students:

- who are at risk of not achieving the outcomes described in the jurisdictional curriculum documentation

- whose achievement level, rate of progress or behaviour differs noticeably from past performances and/or that of his/her peers
- who are under-performing
- who are not engaged in their schooling

(DoE, 2001, p. 3)

The SAER label works under the umbrella of social justice, and is associated with "membership of a social or cultural group", "gender", and "learning styles" (Goodrum, et al., 2001, p. 27). Achievement in science can be impacted by these factors, as well as socio-economic status, geography and language (O. Lee & Luykx, 2007; Thomson & De Bortoli, 2008).

At VVC, the large cohort of students (30%) from a non-mainstream background (Indigenous Australians) present as a red-flag group for SAER. Indigenous students form a large portion of SAER in Australia (Ford, 2012; Mellor & Corrigan, 2004; Thomson, et al., 2006). They perform poorly in science compared to non-indigenous students (McConney, et al., 2011; McKinley, 2007; Thomson, et al., 2006), and are under-represented in post-compulsory science because of "racism and prejudice" at school and in society (Lyons, Cooksey, Parnell, & Pegg, 2006, p. 23). Many also consider mainstream science education "not culturally relevant" to minority students (O. Lee & Luykx, 2007, p. 177). Female Indigenous students perform below male Indigenous students (Thomson, et al., 2006), and Indigenous students without computers at home perform below those with home access to technology (Thomson, et al., 2006). Some research suggests that while test scores may be lower, these students are just as motivated as non-indigenous students to learn, but their literacy levels restrict the ways they can engage in science (McConney, et al., 2011). Years of teaching Indigenous students at VVC led me to believe that mainstream science at VVC did not cater to the needs of these students.

As explained in the section 'The culture(s)/identities of science learners' (p. 27), there is a growing body of evidence that links working with student identities towards a negotiated curriculum that is authentic and relevant to students' lives. This 'science for all' philosophy is not easily accepted by traditional science teachers, but teachers of students from minority groups, and SAER, are beginning to realise this is the only way to get their students engaged in science (Calabrase Barton & Tan, 2010; J. Goldberg & Welsh, 2009; Wilson & Alloway, 2013). It's this quest for improved student engagement, particularly for non-mainstream students, that acts as the driving force behind this study of science at VVC. SAER included in this study provide amazing insights into the causes of disengagement, and thus serve to move teachers like me towards a more disruptive stance against mainstream education structures that inhibit reform.

**The potential for change.** We are currently in a period of national education reform, where the Australian Curriculum (ACARA, 2014a) presents the opportunity for a cultural shift in the national perception of science education. How, and if, this will occur is still uncertain. What we do know is that the key ideas within the Australian Curriculum place pressure on schools to use educational technologies across all subjects as part of what it calls 'General Capabilities' (DEEWR, 2013a). The constructivist pedagogy that underpins the Australian Curriculum Science, and the national science education programs, Primary Connections (AAS, 2014a) and Science by Doing (AAS, 2014b) is also a core philosophy behind the ubiquitous computing movement (Papert, 1990). Chapter 3 examines the concept of 1:1 and its links to constructivism, as well as the use of laptops in science.

## Conclusion

This chapter described influences on science in Australian schools. It examined the concept of scientific literacy, and its importance in a modern world where information is readily available through the media, including the internet. In a 1:1 school like VVC, constant access to the internet is a key feature of the 1:1 program. Therefore, the VVC context presents an opportunity to examine science education within a contemporary ubiquitous computing environment.

The chapter explained that our western culture controls non-mainstream philosophies that exist within/beside it, including Indigenous cultures. Contrary to progressive educational theory, many schools are still teaching to future scientists at the expense of students who won't go on to study post-compulsory science or work in science-related jobs. This means there are still conflicting ideas about who science is for. However, as the mechanisms of society change over time, there is an increasing awareness of the need for a holistic approach to science education. Nevertheless, many schools, including VVC, pay lip service to the 'science for all' philosophy. This means that 'students at educational risk' (SAER), including Indigenous Australians, continue to suffer a curriculum that doesn't meet their needs. This impacts on both engagement and academic achievement.

There is an obvious solution to this science crisis—change—however education reform is dependent on multiple factors and has a history of failure. As educators, we have a choice. We can keep going the way we are going, with our students continuing to fail because of inappropriate curriculum and pedagogy. Alternatively, we can start to make curriculum more accessible through tackling science reform with a change in pedagogy. We are already part way through a reform process in Australian schools, where there's a progression of science education from being a pipeline model for students going into university, to a focus on scientific literacy and a 'need to know' science that is relevant to the learner. In the context of VVC science, where 30% of learners are Indigenous Australians from a non-mainstream background, and a large portion of students fit the SAER category, 'science for all' would appear to be an appropriate theoretical framework to follow.

Embedded in this notion of change is the idea that technology has a role to play in science reform. This is certainly the case at VVC, where 1:1 was introduced with the intention of improving teaching and learning (see Chapter 1). The ICT General Capabilities of the Australian Curriculum also place pressure on schools to improve access to technologies. The next chapter examines the impact ubiquitous computing exerts on science teaching and learning.

# CHAPTER 3—LAPTOPS AND EDUCATION

We start this chapter with students. Through a review of the literature, Chapter 2 introduced issues associated with the science education crisis, where a key concern is student engagement. Engagement is one of the key sensitising factors in this study of science at VVC, because my experience as a teacher there was that disengagement indicated students didn't turn onto learning in a 1:1 environment as the Education Minister (2003) suggested they might.

All students are subjected to cultural pressures that influence their dispositions (Schein, 2004), including whether or not they engage in learning. In the 21st Century, how teachers use technology has the potential to 'engage' or 'enrage' their learners (Prensky, 2005). Kids today are different. We are currently experiencing a level of technology saturation that no previous generations have known (Christensen, Horn, & Johnson, 2011), where children are born into an increasingly complex information age, surrounded by fast changing technologies (Ullman, 2011; Warschauer & Matuchniak, 2010). Today's kids, the 'Millennials' known as Gen Y (born in the 80's and 90's) and iGen (born this century), want instant feedback and expect to be taught using technology because it's part of their everyday life (Barrios et al., 2004; Prensky, 2005; Shirley, 2011). If we don't keep up with fast-paced changes, students could be left behind, or their disadvantage compounded (Warschauer & Matuchniak, 2010). Keeping Millennials engaged comes at a high cost, where governments, private business, and parents spend billions of dollars on technology, and they expect results (Bebell & Kay, 2010; Cuban, Kirkpatrick, & Peck, 2001; DEEWR, 2013a, 2013b). VVC acted as a trial technology school not just for the jurisdictional state, but for public schools across Australia, and the outcomes of 1:1 were closely monitored through Newhouse's (2008, 2011) internal evaluation. There continues to be very little published literature about the impact of technology in established 1:1 schools, and schools continue to invest without really knowing what the actual (versus perceived) long-term outcomes of 1:1 are.

In Tytler's (2007a) review of science education, Australia's then Chief Scientist, Professor Jim Peacock, stated that integrating ICTs into science offered up "new connections" in a world where "collaboration is now the norm." He said that traditional science "is not fruitful in such an environment" and that "our best teachers" are those who use "the new connections technology affords" (Professor Jim Peacock, in Tytler, 2007a, p. iii). This linking of technology to good science teachers contributes to the perception that if technology is there, we should use it. That's what the 'best' science teachers are doing. Interestingly, some research indicates that ubiquitous access doesn't mean ubiquitous use (Cuban, 2013a; Cuban, et al., 2001). As this chapter will demonstrate, increased technology use is a first step in the journey towards technology integration, but the impact of technology and the concept of usefulness—its 'added value'—is not straightforward. Importantly, research suggests that the hype at the start of many 1:1 programs does not portray the long-term realities in classrooms (Richardson et al., 2013).

In 2003, VVC became a pilot school for 1:1 in Australia, with a massive amount of money spent on the provision of 750 laptops, a dedicated ICT Deputy, and an ICT technician. In 2007, the VVC website stated the outcomes of the first three years of 1:1 at VVC were that:

- Students will critically access and use ICT to support the achievement of the jurisdictional curriculum documentation outcomes;

- [it would] Increase the capacity of teachers' pedagogical practices (guided by the Principles of learning, teaching and assessment) to include the effective use of ICT to enhance students achievement of jurisdictional curriculum documentation outcomes;

- The community engages in partnerships with the College and the students to foster positive collaborative learning environments and to support student lifelong learning.

(VVC, 2007)

As explained in Chapter 1, Newhouse (2008, 2011) conducted an evaluation of the initial and established phases of 1:1 at VVC. One of the first findings of his study was increased use of technology by both teachers and students, but by the third year of 1:1 the teachers and the researcher had identified up to 20% of the student cohort were either not using, or unable to access, laptops in a ‘ubiquitous’ manner. There is little research available about teachers and students in 1:1 schools past the initial phase of 1:1, and even Newhouse’s research remains relatively unreported (Newhouse, 2008, 2011). This study of 1:1 science at VVC provides data to contribute to our understanding of the culture of established 1:1 schools, and why, with all the high-tech bells and whistles, we have disengaged students in established 1:1 schools, when ubiquitous computing is supposed to ‘improve student outcomes’ (Removed, 2003).

Globally, the impact of educational technology is “scarcely understood” (Shirley, 2011, p. 197). We need to “know more about how existing and emerging technologies are impacting on classrooms”, including “why it works in some educational setting and not in others” (Holkner, et al., 2008, p. 96). Most literature supports technology reform (Spires, et al., 2012), yet the value of its place in traditional classrooms has always been questioned (Cuban, 1994; Papert, 1987; Waller, 2007). This chapter probes the notion that 1:1 can transform the learning environment, because “what is promised at the onset of a large scale 1:1 project often is not what is actually delivered” (Richardson, et al., 2013, p. 14). This is an interesting angle for the approach to this study, where the key outcomes of 1:1 at VVC (p. 42) act as sensitising factors for data collection and analysis.

First, the chapter takes us back in time, with a look at the history of 1:1. It summarises the bells and whistles, then examines the literature in a 1:1 science context. The purpose of this analysis is to provide a background to this study of 1:1 at VVC, where much of the hype surrounding its 1:1 stemmed from evidence of the positive impact of ICTs in other settings. However, given the unique context of VVC, research in other settings may not be transferrable. Furthermore, no other studies examine non-mainstream students’ perceptions of 1:1 science in Australia, and the focus on Indigenous students and SAER makes this study an Australian first.

This literature review will demonstrate that learner dispositions can influence the way technology is used, and that digital literacies are a critical element of 1:1. This means that at-risk students, like those at VVC, present unique challenges within the potentially transformative, student-centred learning environments considered a key outcome of ubiquitous computing. The chapter will also explain that the type of technology intervention plays an important role in how students and teachers take to the innovation. This includes contextual factors such as the duration of the intervention, student characteristics, teacher epistemologies, and the culture of the school environment. The chapter begins to describe these complexities, which contribute to the challenges of designing a study that can adequately address the culture of such a dynamic learning environment.

## The Theory of 1:1

**A brief history.** The best place to start looking at 1:1 is in the 1970s, when Seymour Papert began using computers to reform and revolutionise schools, to produce "a total alternative to the school as it is known today" (Papert, 1973, p. 30). Papert believed computers could "change the culture of education", making children "producers" rather than "consumers" of technology (M. F. Goldberg, 1991, p. 69). He also knew that pedagogical change needed to accompany the new technology or it would not be transformative (Papert, 1973, 1980, 1987, 1990). Papert's projects, amongst others, resulted in schools taking a more-is-better approach to computers. The earliest wave of 1:1 occurred in the Apple Classrooms of Tomorrow (ACOT), where school districts in the United States (US) gave computers to teachers and students for school and home use. Not yet wireless or mobile, the concept was considered "innovative" for its time, and "there was unbridled hope that the introduction of technology would bring the same kind of successful transformation that had been seen in science and industry, but goals and means in the education arena were vague" (Dwyer, et al., 1990, p. 10).

The first portable 1:1 program in Australia dates back to 1989 (Poftak, 2001). Although other 1:1 programs were trialled at around the same time, none were whole school 1:1 (Albion, 1999; Stolarchuk, 1997), just individual classes within non-1:1

school contexts. Researchers were “preaching the laptop gospel” (Albion, 1999, p. 6), with reports citing “powerful results”: better behaviour, more independence, collaboration and higher-order thinking (Albion, 1999; Poftak, 2001, p. 38). This perceived “successful use of laptops in Australian schools” is considered the “catalyst” for the 1:1 craze that then began in the US (Dawson, Cavanaugh, & Ritzhaupt, 2008, p. 144).

In 1996, Microsoft’s ‘Anywhere Anytime Learning’ program was the first large-scale sponsored 1:1 laptop program in the world (Penuel, 2006). Studies of this US-based program found students spent more time on higher-order thinking tasks, work was of a higher quality, and teachers spent more time with individual students (Healey, 1999). These positive outcomes led to a rush of “chaotic spending” on educational technology (Oppenheimer, 2003, p. 43). Schools sought out 1:1 because of the perceived benefits of a transformative learning environment (Healey, 1999; Penuel, 2006), yet some research had found that 1:1 may not be transformative. There was evidence of “little or no academic improvement, technical difficulties, inadequate hardware/software/connectivity/infrastructure, little transformation of teaching practice if not supported by appropriate professional development, etc.” (Andrews, 2006, p. 18).

In 2000, the US state of Maine rolled out state-wide 1:1 in its middle schools (Muir, Knezek, & Christensen, 2004), and many more states and districts in the US and beyond have done so since (Bebell & Kay, 2010; DEEWR, 2013a; Keengwe, Schnellert, & Mills, 2011; Lowther, Strahl, Ross, & Huang, 2007; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2009; Spires, et al., 2012). The driver behind these programs is economics. Feasibility studies, like the one informing statewide 1:1 in Florida, use emotive statements like, “there is no better investment in the future of Florida than to develop 21st century learning skills in all of our students" (Barrios, et al., 2004, p. ii). With this kind of pressure to take up ubiquitous computing, it's no wonder the concept has become the backbone of many schools' learning programs, including VVC.

**Measuring the impact of 1:1.** There are different ways to look at how technology is changing the education landscape. When evaluators monitor large-scale 1:1 rollouts, they hunt for indicators of reform: forward vision; policy changes; 21st Century approaches and improved digital literacies; as well as adequate access and infrastructure (Alberta Education, 2009). Many studies use the term 'impact', and in doing so take on an evaluative stance with a "focus on the conditions under which innovations are successful" (Boyd, 2002, p. 19). While this study of 1:1 science at VVC uses the term 'impact' in its Research Questions, the way that I use the term, and measure 'impact', is different to other 1:1 research. I describe impact through a description of the culture of the learning environment. Few 1:1 studies refer to the term 'culture', and Chapter 4 summarises the methodologies of those that do.

When describing the impact of 1:1 in science, literature sometimes refers to the potential benefits as 'affordances', which are "the properties of a system, as perceived by the user, which allow certain actions to be performed and which encourage specific types of behaviour" (Cox et al., 2004, p. 8; Laurillard, Stratford, Luckin, Plowman, & Taylor, 2000; M. Webb, 2005; Zucker & Hug, 2008). Others talk in terms of 'added value' (Drayton, et al., 2010; Tinker, et al., 2007), or 'perceived advantage' (Fluck, 2008). In a 1:1 context, these are "the capabilities provided by 1:1 student to networked laptop ratio that otherwise would not be possible" (Dunleavy, et al., 2007, p. 441). All of these terms have been used interchangeably to describe a multidimensional framework that includes factors related to ICTs, the teacher, students, “other resources”, and “the relative balance of these and their interrelationships” (Cox, et al., 2004, p. 27). They contribute to the culture of the learning environment. Changing the culture of the learning environment is necessary to bring about reform that makes the most of 1:1. This is especially tricky to do in science, where we know most teachers believe in transmission pedagogy with the teacher as the sage-on-the-stage (Goodrum, et al., 2012).

I take these ideas of ‘added value’ and ‘affordances’ from the literature with me into the science classrooms at VVC as I search for evidence of their existence, but also relate these potential affordances back to the learners whom they supposedly support. The interface between these affordances, and the learners, becomes the focus of the study. Examining VVC students’ responses to the learning environment over time, particularly ongoing access to what some authors consider affordances in novel 1:1 interventions, makes phases of 1:1 integration an important contextual consideration in this study.

**Phases of 1:1 integration.** Newhouse’s (2008) finding of increased use of computers in the first year of 1:1 at VVC is a common finding of initial stage 1:1 (Bebell & O'Dwyer, 2010; Penuel, 2006), yet predictable because the technology is a novel new tool (Liu, et al., 2011). This concept of novelty, and stages of technology integration, play an important role in describing the impact of 1:1 (Alberta Education, 2009; Muir et al., 2006). Whether a school is in the ‘initial phase’ (first 3 years), or the ‘established’ phase (anything after this), influences the way 1:1 impacts on teaching and learning (Drayton, et al., 2010). Research however, usually focuses on the initial phase, and there is limited data about how teachers and students use laptops in established 1:1 schools

(Drayton, et al., 2010). This study of 1:1 science at VVC focuses on a school in its 8th and 9th years of 1:1, where two of the teachers (Jeff and Jill) have over 5 years' experience in 1:1, and one teacher (Sarah) is a graduate, new to the 1:1 school. These layered cases will serve to improve our understanding of established 1:1 schools.

The following two models of technology integration provide evidence-based research from which to hang the data analysis of this study of 1:1 science at VVC. Furthermore, this study provides an opportunity to challenge and extend our understanding of technology integration, as conceptualised in the ACOT and New Learning Ecology models, adding to the limited research set in established 1:1 schools.

***The ACOT model.*** The ACOT model of technology integration resulted from research in ACOT classrooms in the 1980s, where the uptake of computers in classrooms was described as an evolutionary process that led to increased opportunities for higher-order learning, through changes in instructional practice occurring over time (Dwyer, et al., 1990).

In the ACOT model, the first phase of 1:1, the 'entry' phase, sees the physical environment altered to cater for the new instructional technology, and teachers and students begin to learn how to use computers. I was present during this phase at VVC, where in 2003 we got power points and laptop lockers in readiness for 1:1. I was also there when the first class got their laptops, and stepped gingerly into a 1:1 environment with my students as we learnt about 'The Dock' (where shortcuts to software were held) and how to open applications such as Word and Safari. Our entry phase to 1:1 was sweet, and we held positive hopes for our future with 1:1.

The second phase of the ACOT model, ‘adoption’, sees teachers starting to use computers to teach, but their instructional methods do not change. This was me in 2004, where, as explained in the Introduction, I spent weekends making webpages and playing with apps only to discover kids’ responses and learning outcomes didn’t change. However, it’s this diligence for learning new skills, and dedicating class time to digital literacies, that leads into the third phase of the ACOT model, ‘adaptation’, where I saw students get better at using laptops, with more time for higher-order learning. Unfortunately, not all students developed a level of technical mastery enabling them to do new things, like make a podcast. This relates back to the learner: their engagement, agency, self-efficacy, and literacies, including cognitive tools. In addition, it’s about what I, as a science teacher, was prepared to accept as my role: science teacher, ICT teacher, or both.

The fourth phase of the ACOT model, ‘appropriation’, is where teachers’ mastery of the technology allows them to use it in new ways. As a teacher at VVC, I was somewhere between this phase and adaptation, in a groundhog-day like situation that I couldn’t shake. My dedication to improved digital literacies didn’t translate across to my students, but I felt there was more to their story than disengagement.

The confidence with technology that comes in the appropriation phase leads to the final ACOT phase of ‘invention’, where teachers are experienced enough to develop new pedagogical practices (Dwyer, et al., 1990). When I was a teacher at VVC, attempting to use laptops for inquiry-based learning fell flat. My transformation didn’t really work, as student-centred pedagogy left students with plenty of time to wander into GoogleLand.

The ACOT model of 1:1 integration can be transferred across to the Newhouse (2008) evaluation at VVC, where during the initial phase most teachers were using technology more, but there was limited evidence of pedagogical change. This means that VVC teachers were in the adoption phase of the ACOT model. At the end of the initial phase of integration, it's expected that teachers move towards the 'invention' phase of integration, and into a more student-centred learning environment. If this happened at VVC it would mean that during fieldwork in 2010-11, the learning environment would have evidence of new pedagogical approaches to learning. This acts as another sensitising factor in data collection and analysis for this study of 1:1 science.

Penuel's (2006) meta-analysis of 1:1 uses the ACOT model to come to a conclusion about where most schools are at with 1:1. Penuel found that most 1:1 programs are in the adaptation phase, where teachers "are adapting traditional teaching strategies to incorporate more adult productivity tools and having students work independently and in small groups, but they have not yet begun to implement widely more student-centred strategies for instruction such as project-based learning" (Penuel, 2006, p. 336). My experiences as a teacher at VVC support this assertion, and data in this study will reveal that other VVC science teachers were also hovering in this phase.

Interestingly, the ACOT program received criticism because there is little evidence of long-term gains for students resulting from ACOT's technology saturation. Oppenheimer (2003) claims that students in the ACOT program, once back in mainstream 'normal' classes, went back to being 'at-risk', just as they were before (Oppenheimer, 2003). In 2015, there is no consensus that 1:1 offers up long-term academic outcomes (Cuban, 2013a), but many agree that good teachers rely on more than just technology to improve student outcomes (Hattie, 2012). The implication here is that the learning environment is a complex beast, and the next model of 1:1 integration, the New Learning Ecology, attempts to define this complex set of interactions.

***New Learning Ecology.*** A dynamic and multidimensional process of 1:1 integration can be conceptualised by the 'New Learning Ecology' model (Spires, Wiebe, Young, Hollebrands, & Lee, 2009). This is a useful model to continue the analogy with my experiences at VVC, where the ACOT model broadly described my technology integration journey, but couldn't explain why I experienced groundhog day, stuck in the adaptation phase.

The New Learning Ecology model suggests that the 1:1 environment "can affect and be affected by the person's dispositions and actions" (Spires, et al., 2012, p. 63). It is as an evolving process, based on changing relationships between people, pedagogies and communities. This model has more of a cultural focus than the ACOT model, and is useful in describing 1:1 science at VVC, where the interface between teachers, students and laptops acts as a locale to study teaching and learning science. Figure 1 (p. 52) represents this version of 1:1 learning environment variables.

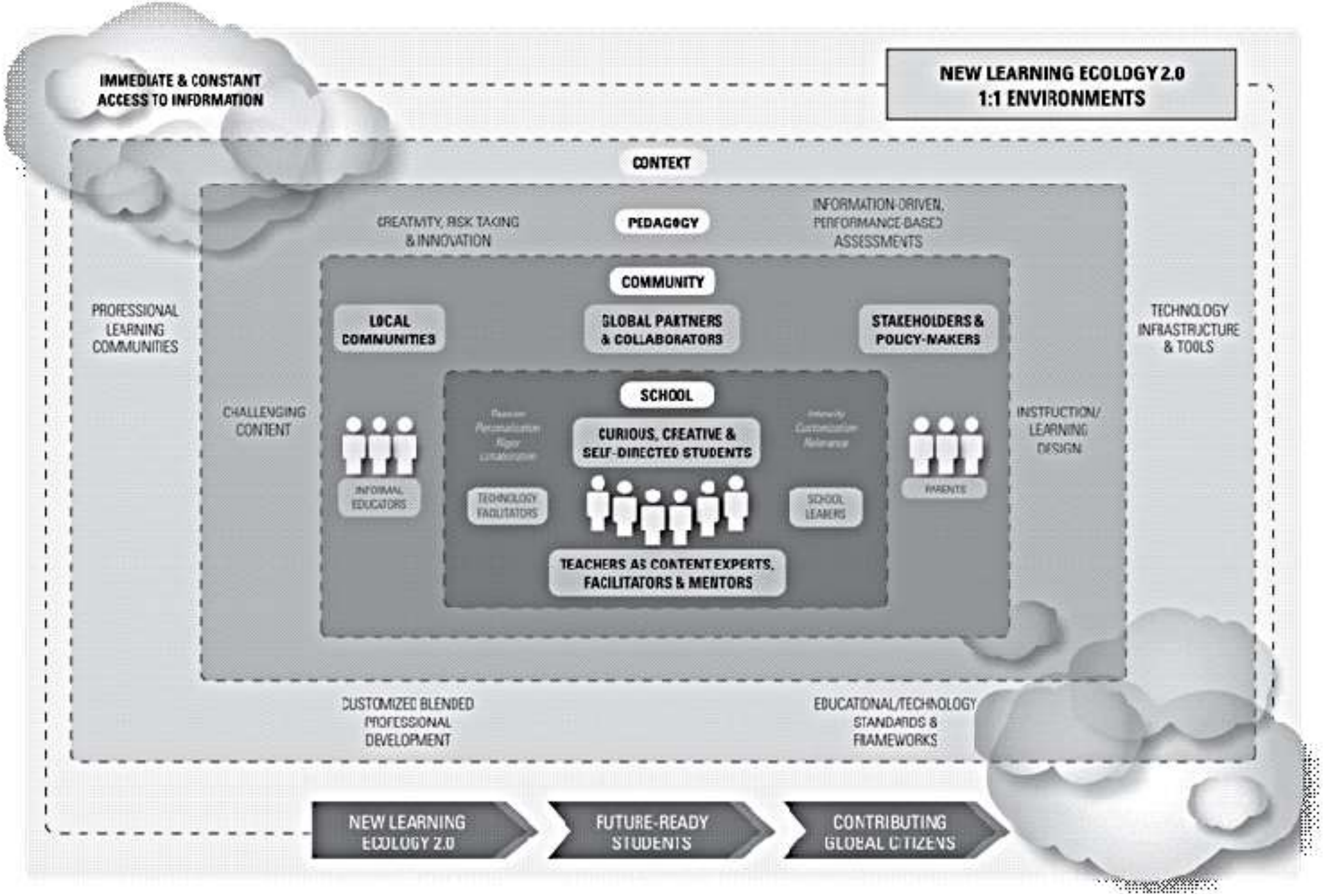


*Figure 1.* The learning ecology of 1:1 environments. Reprinted from "The new learning ecology of one-to-one computing environments: Preparing teachers for shifting dynamics and relationships," by H.A. Spires, K. Oliver and J. Corn, 2012, *Journal of Digital Learning in Teacher Education*, *28(2)*, p. 65. Copyright 2011-12 by the International Society for Technology in Education. Reprinted with permission.

The learning ecology of the 1:1 environment hinges on important features that can make or break the program. Figure 2 illustrates the four unique conditions considered fundamental for success (Spires, et al., 2012; Spires, et al., 2009). Knowing about these conditions enables participants in 1:1 programs to understand more about their roles, and the roles of other elements of the learning environment, in order to create conditions for successful 1:1 reform.

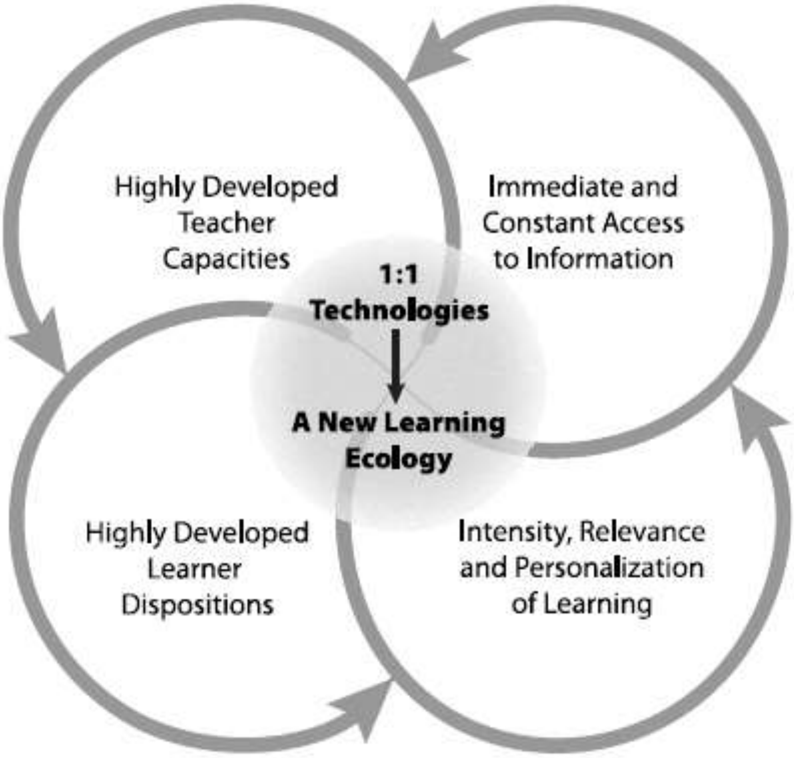


*Figure 2.* Four unique conditions prompted by the new learning ecology in the 1:1 classroom. Reprinted from "The new learning ecology of one-to-one computing environments: Preparing teachers for shifting dynamics and relationships," by H.A. Spires, K. Oliver and J. Corn, 2012, *Journal of Digital Learning in Teacher Education*, *28(2),* p. 64. Copyright 2011-12 by the International Society for Technology in Education. Reprinted with permission.

The first of these unique conditions is about access. 1:1 enables users to get information when they need it, without waiting. It allows them to access the internet and the affordances there, such as social networking and the chance to collaborate with people in other places. These user-driven experiences promote engagement in learning, because it becomes more relevant, authentic and meaningful. This personalisation empowers students to become independent learners. Freedom to access information as needed gives the learner an opportunity to become more creative, and to explore ideas not present in teacher-driven curriculum. This relies on teachers being able to scaffold learning tasks for their students to facilitate learning. Spires et al. (2009) provide an interesting science class vignette in their explanation of this model, where the teacher scaffolds internet research, and students must find, justify, evaluate and synthesise information. In this context, and in any online learning environment, students are required to have good self-regulated learning skills, and teachers need to be able to help them do this for the 1:1 learning environment to be successful. This appears to be the biggest stumbling block in 1:1 programs, where teachers hold the reigns and control learning, rather than allowing for the creativity and student-driven learning experiences that are modelled as best practice in the literature (Christensen, et al., 2011; Cuban, 2013a).

Both the ACOT model and the New Learning Ecology focus on the notion of transformation from a teacher to student-centred learning environment, which Papert envisioned as the ultimate goal of ubiquitous computing (Papert, 1990). This is what I was seeking, yet never quite managed to achieve, as a science teacher at VVC.

**Transformation!** Some believe that 1:1 alone can act as a “magic bullet” (Ullman, 2011, p. 54), transforming relationships between factors in the learning environment (DEEWR, 2013a; Spires, et al., 2012). Several recent dissertations have sought out evidence of instructional change resulting from 1:1. Christman’s (2014) research in the initial phase of 1:1 in a school district in Pennsylvania found increased teacher and student use of technology, improved perceptions of technology, and a shift towards student-centred learning. Branch (2014) studied initial phase 1:1 at a rural high school in West Virginia, with similar results: increased use of technology and more student-centred learning experiences. These changes in the first years of implementation are common, with similar findings in the Newhouse (2008) study at VVC. This current study of 1:1 science at VVC in the $8^{th}$ and $9^{th}$ years' of 1:1 aims to provide a deeper understanding of the long-term impact of 1:1.

The New Learning Ecology model (p. 51) provides an overview of the conditions required for transformation in a 1:1 learning environment: constant access, good teachers who tailor curriculum to student needs, and students who want to learn. But an important consideration when looking at transformation data is the context: novel 1:1 settings (e.g. Baggott la Velle, Wishart, McFarlane, Brawn, & John, 2007; Keengwe, et al., 2011; Lowther, Ross, & Morrison, 2003; Mouza, 2008) are different to initial-phase schools (e.g. Bebell & Kay, 2010; Dunleavy, et al., 2007; Lowther, et al., 2003), which are again different to established schools, where staff are more likely to engage in transformative pedagogies (Drayton, et al., 2010; Dwyer, et al., 1990; Frank, Zhao, Ellefson, Penuel, & Porter, 2011). There is very little published research dealing with established 1:1 schools (Drayton, et al., 2010), particularly research that follows a cohort of students over time through science. My study of science at VVC will follow the same cohort of students across 2 years, from when they enter until when they leave the 1:1 school environment.

As the New Learning Ecology model explains, teachers and students are crucial factors to consider when describing the transformation of the learning environment. This study of 1:1 science at VVC provides rich, authentic data stemming from in-depth, long-term analysis of two classes. Of particular importance is the focus on students, where student voice in 1:1 science is a relatively untapped area for research. As the New Learning Ecology model explains, students must have appropriate learner dispositions to work effectively in a 1:1 environment. They must be “curious, creative, and self-directed” (see Figure 2, p. 53). My experiences at VVC were that the learners were not ‘turning on to learning’ with laptops in science. Many of the students at VVC are ‘students at educational risk’ (SAER), and with that come issues of equity and access. Shapley et al. (2009) studied middle schools with a high proportion of disadvantaged students in their large-scale review of 1:1 in Texas. The study came up with results that are not altogether consistent with the ‘transformation’ idea that’s part of the ACOT and New Learning Ecology models. Shapley et al. (2009) found that even though teachers in 1:1 schools were more open to student-centred learning, by the fourth year of 1:1, laptop use declined. They linked this to technical issues, school management, and teacher pedagogy. They found that being in a 1:1 school did not improve student engagement, self-regulation, attendance or achievement. By the fourth year of 1:1 “schools as a whole...had difficulty keeping laptops in the hands of students” (Shapley, et al., 2009, p. 28). Some schools were going back to more traditional 1:1 models and making their students less accountable, because they had so much trouble maintaining laptops when student were responsible for them (Shapley, et al., 2009). At the end of the first 4 years of 1:1, only a quarter of the schools were successfully ‘immersed’ in technology. Many schools faced barriers to implementation, such as: “administrative turnover, noncommittal teachers, insufficient professional development, inadequate school infrastructures, and laptop management problems” (Shapley, et al., 2009, p. 89). Newhouse’s (2008) evaluation of initial phase 1:1 at VVC also found that by the third year of 1:1 laptop use had declined. This study of science at VVC aims to examine the way that laptops are used at VVC in the established phase of 1:1. This means that teaching and learning science in a 1:1 environment are important factors, where the theory of constructivism plays an important role.

***Constructivism and Constructionism.*** Underlying the transformation theory of 1:1, and progressive science pedagogy, is the learning theory of constructivism (Papert, 1990; Tobin, 2007). Researchers argue that constructivist pedagogy enables higher-order thinking, and "social constructivism suggests that learning is a socially-mediated experience for which individuals construct knowledge based on interactions with their social and cultural environments" (Maor & Fraser, 2005, p. 222). Today, the notion of social constructivism, or the sociocultural theory of learning, is more popular than the idea that individuals construct their own knowledge without external forces acting upon them (Tytler, 2007a). This dissertation does not use the two terms (constructivism and social constructivism) interchangeably, but for ease of use and readability 'constructivism' refers to the social constructivist theoretical framework.

Constructivist learning environments are "standards based, student centred, and inquiry oriented" (Park, Jang, Chen, & Jung, 2011, p. 248). Computers are a useful tool in such an environment, allowing users to become the producers of knowledge rather than just passive consumers (Christensen, et al., 2011). Papert coined the term 'constructionism', after Piaget's theory of constructivism (Papert, 1990). Constructionism asserts that not only is knowledge constructed by the learner through their own experiences (an internal process), but the learner also engages in the social process of making/sharing products and ideas (Crotty, 1998; Stager, 2005). Social constructionist theory has worked well with SAER who struggle to engage in mainstream schools and society (Stager, 2005). This kind of learning theory was difficult for me to enact as a teacher at VVC, where the social construction of knowledge was tainted by behavioural bedlam, and I was plagued by self-doubt each time my meticulously planned 'social constructionist' projects failed.

Developing a constructivist learning environment is often hampered by constraints within the school and education system (Newhouse, 2002, 2008, 2011). One of those constraints in science can be teachers' pedagogical content knowledge (PCK) (Park, et al., 2011), as teachers need to be able to transform their own content knowledge into something attainable for their students (Park, et al., 2011; Shulman, 1987). Chapter 2 explained that many science teachers don't have the appropriate professional knowledge to be successful in constructivism, because they're enculturated into mainstream, traditional science philosophy. If teachers like me aren't able to pull off the constructivist learning environment, maybe, as some authors suggest, 1:1 could be another cultural reform failure (Christensen, et al., 2011; Cuban, 2013a; Oppenheimer, 2003).

**Cultural reform…failure?** We are now in our third decade of educational technology research (Hayes, 2007), and it's dawning that measuring the impact of 1:1 is a bit tricky (O'Donovan, 2009; Rasmussen & Ludvigsen, 2008). Some argue that 'e-permeation' hasn't changed what we do, just improved current practice, or made it easier to do (Christensen, et al., 2011; Martin, 2005). Others complain computers make learning less meaningful: "it cheapens, rather than deepens the work" (Oppenheimer, 2003, p. 355). The problem with many existing 1:1 programs is they act as replacement technology within old teaching and learning paradigms, where the new technology just slots in: “books replaced by webpages, paper report cards with student information systems, chalkboards with interactive whiteboards, and filing cabinets with electronic databases” (Weston & Bane, 2010, p. 10). Many wonder why technology is not making more of an impact (Cuban, 2013a; Zhao & Frank, 2003). This is the wrong way to ask the question, because there’s too much focus on computers and not enough on the people who use them, or the massive cultural reform required to use computers in innovative ways (Papert, 1997).

During my time as a teacher at VVC, there was an assumption that increased exposure to technology led to more advanced stages of technology integration: the longer we used laptops, the better we would get. However, research suggests that while teacher uptake of technology is a crucial factor, their beliefs about teaching and learning can be barriers to successful integration (Bebell, Russell, & O'Dwyer, 2004; Donovan, Hartley, & Strudler, 2007; Dwyer, et al., 1990; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Frank, et al., 2011; Koehler & Mishra, 2008; Newhouse, 2011; Ng, 2011; Spires, et al., 2012; Yerrick & Johnson, 2009). To realise the potential of ubiquitous computing, the culture of schooling has to change (Papert, 1973). This requires a radical cultural shift in society that is only possible with support at district, state, and national levels (Alberta Education, 2009; Christensen, et al., 2011; Cuban, 2013a, 2013b; Hayes, 2007; O'Donovan, 2009; Papert, 1987). The 1:1 project at VVC was an attempt by the state, in the throes of an election campaign, to deliver an innovative program to disadvantaged students. For me, what sounded great during that election campaign quickly became a headache, as VVC teachers tried to mash new tools into the existing cultural constructs of the school. Unlike VVC school administrators who went to visit Maine's 1:1, the vision of constructivism was not clearly articulated to teachers at VVC, so we didn't understand its importance.

Interestingly, governments like to use best practice examples that highlight how the transformation to a student-centred learning environment can occur (DEEWR, 2013a; Hayes, 2007; Rasmussen & Ludvigsen, 2008). The problem with these case studies is that it's not reality for most teachers (Rasmussen & Ludvigsen, 2008), because a range of factors prevent teachers from implementing 1:1 using constructivist pedagogy. These barriers can be seen as related to the structure of the organisation (our schooling culture), our teachers (and their own beliefs about learning), and the technology itself (Zhao & Frank, 2003). These ideas are important because through this study I want to find out more about why science teachers find it so hard to ditch their traditional views on teaching and learning, and the role of technology in the process of transformation.

It's not just me that thinks technology isn't used enough, or it's used in the wrong way. In the US, where 99% of schools have ubiquitous computing and internet access, there is a marked underuse of digital technologies in schools (Cuban, 2013a; Zhao & Frank, 2003) and science classrooms (Butler Songer, 2007). The gold standards placed on digital products and practices are not transferrable from school to school (Oppenheimer, 2007). In places where you would expect improved test scores, such as in Maine and Texas where they've adopted state-wide 1:1, there's "little in return for their investment with test scores rising in some subjects and schools, no difference in others, and declines in others" (Shirley, 2011, p. 197).

Knowing that change relies on a shift in school culture, examining reform must start with a criticism of top level leadership at district, state, and national levels (Alberta

Education, 2009; Cuban, 2013b; Hayes, 2007; O'Donovan, 2009; Papert, 1987; Schein, 2004). The problems with technology reform centre on school structure and how we as a collective are resistant to reform of any kind (Cuban, 2013a; Zhao & Frank, 2003). As a teacher at VVC during the initial and established phases of 1:1, I felt this collective resistance, particularly in the science department, where we already had trouble using inquiry-based pedagogy because of the tension between curriculum accountability and digital literacies, as well as learner dispositions. The next section looks at what is potentially the greatest conundrum of 1:1, the digital literacies of teachers and students.

**Digital literacies.** The concept of digital literacies is at the same time a great outcome and challenge of 1:1. It’s a complex concept embraced as a “new form of literacy” (Martin, 2005, p. 130), yet exists as a genre within traditional literacy (Chase & Laufenberg, 2011), with technical, cognitive and social/emotional components (Eshet-Alkalai, 2004; Eshet, 2012; Martin, 2005; Ng, 2011). If digital literacies are not developed enough, with the appropriate mix of components in the right context, they can inhibit ‘immediate and constant access to information’ which is a key condition for the success of ubiquitous computing (Spires, et al., 2009). Here lies the problem, because the rush to deliver technologies often overlooks these details (Richardson, et al., 2013). The development of digital literacies for teachers and students relies on, among other factors, professional learning (Richardson, et al., 2013), learner dispositions, and the values or goals of the educational institution (Chase & Laufenberg, 2011).

As a participant in 1:1 at VVC, I felt staff were not well-informed of the learning theory behind 1:1, particularly since our school leaders had spent time in Maine where Seymour Papert, the famous advocate of 1:1 and constructivism, was the driving force behind its 1:1 (Muir, et al., 2006). Being unprepared for technological change is a common finding across Australia, where during the Digital Education Revolution (DER), computers were delivered to schools before staff were ready, and so were never used effectively (DEEWR, 2013a). Understanding the importance of teachers' 'technological pedagogical content knowledge' (TPCK or TPACK) is a core condition of 1:1. It relates to the interaction between a teachers' knowledge of their subject, pedagogy, and technology: it's "an understanding of how teaching and learning changes when particular technologies are used" (Koehler & Mishra, 2008, p. 16). It forms part of the 'highly developed teacher capacities' of the New Learning Ecology model (Spires, et al., 2009), where a combination of these TPCK components act as the foundation for transformation from a teacher to student-centred learning environment. The TPCK model (Koehler & Mishra, 2008) argues that the content knowledge every teacher needs is different, but teachers need to know their subject in order to know how to teach in a technology rich environment. Empowering teachers to be part of the reform process, and providing them with the research-based evidence to support particular pedagogical approaches, is potentially the key to successful reform. This was what I didn't see as a teacher at VVC, and therefore I struggled to make links to the deeper, transformative purpose of 1:1.

It's not just teachers who are responsible for learning: students bear some of the responsibility too. The New Learning Ecology explains that one of four conditions for the success of 1:1 is that learners need to "be disposed toward self-direction and monitoring…to critically engage information from…any online resource…these skills include understanding bias, evaluating reliability, and determining the accuracy of information" (Spires, et al., 2009, p. 10). It's this self-regulated learning, and a disposition towards learning a certain way and using certain tools, that becomes problematic when dealing with disengaged at-risk students like those at VVC. It becomes a red flag issue when literacies are added into the mix.

Eshet (2012) describes six thinking skills that come with being digitally literate, which contribute to highly developed learner dispositions:

- photo-visual skills (understanding messages from visual displays)
- reproduction skills (utilising digital reproduction to create new, meaningful materials from pre-existing ones)
- branching skills (constructing knowledge from non-linear, hypertextual navigation)
- information skills (critically evaluating the quality and validity of information)
- socio-emotional skills (understanding the “rules” that prevail in cyberspace and applying this understanding in virtual communication)
- real-time thinking (the ability to process large volumes of stimuli at the same time, as in video games or online teaching)

(Eshet, 2012, p. 1)

There are different emphases on these skills in the contexts of our lives, meaning that what’s important to know for one person may not be important for another at that point in time (Martin, 2005). This fluidity is similar to the description of scientific literacy described earlier (p. 22). Because there's a need-to-know basis for digital literacies, learners will display each in a different "magnitude" (Eshet, 2012, p. 268). They form part of the social justice debate about the impact of technologies, commonly referred to as the 'digital divide' (Waller, 2007; Warschauer, Knobel, & Stone, 2004).

***The digital divide.*** One of the only long-term comparative studies of 1:1 and non-1:1 schools found that "economically disadvantaged" 1:1 students developed their digital literacies on par with "economically advantaged" students in non-1:1 schools, and that "technology immersion substantially narrowed the technology proficiency gap between economically advantaged and disadvantaged students" within 1:1 schools (Shapley, et al., 2009, p. 56). In another school which only takes students from low socio-economic backgrounds, a digital divide exists based on ethnicity, where almost half of the non-Caucasian students "rarely or never" used computers, while only 25% of Caucasian students reported the same (Zucker & Hug, 2007, pp. 12-13). Both studies highlight the importance of providing SAER with access to computers so they do not fall further behind. This is one of the ideas behind 1:1 at VVC, where a solution to issues of attendance, achievement and engagement was to give students laptops (Removed, 2002, 2003). This study of 1:1 science at VVC examines the way that 'students at educational risk' (SAER) use laptops, and adds to the sparse literature on the affordances of ubiquitous computing for minority students and other SAER.

There have been warning bells about the impact of 1:1 on minority groups and 'at risk' students all along. The digital divide theory suggests that providing schools with laptops and associated bells and whistles won't change outcomes for disadvantaged students (Hollingworth, Allen, Hutchings, Kuyok, & Williams, 2008; Waller, 2007). The 'knowledge gap hypothesis' even proposes that people with poor digital literacies are less likely to benefit from 1:1 (Bonfadelli, 2002). That's because there is more to overcoming barriers to learning for these students than just technological innovation. Change at the level of the family, and our culture, must be effected for long-term improvement (Warschauer & Matuchniak, 2010). Research suggests that digital literacies of students are directly related to parent(s) (Notten, Peter, Kraaykamp, & Valkenburg, 2009), socio-economic status (Notten, et al., 2009), gender (Drabowicz, 2014), minority status, and how much time students spend using computers at home (Kuhlemeier & Hemker, 2007; Pack, 2013). This is relevant in the context of this study because many of VVC's students come from a low-socioeconomic background, 30% are from a minority group, and/or may not have the home life required to support the development of digital literacies and science learning.

Concerns about social justice permeate the idea of ubiquitous computing, adding another layer to what we already know about the science education crisis. If students from minority groups are struggling to engage in science, adding laptops, with the associated concerns about digital literacies, may widen the gap, rather than close it. This concerning issue is a sensitising factor in this study of 1:1 science at VVC, which was used during data collection and analysis. Next, we move further into the literature relating to 1:1 science.

## 1:1 Science

This section examines the use of computers in science, with a focus on 1:1 schools. Unfortunately, much of the available 1:1 science research is part of large-scale reviews of whole state/district/school levels, and there is very little set at a class or student level. This makes it hard to draw comparisons between studies, or find any that deal with the issues in this dissertation in the same way.

As Professor Peacock points out in Tytler's review of science education (see p. 41 earlier in this chapter), there is a real opportunity for the use of networked computers in science. Computers are useful for a diverse range of purposes in science, such as:

> …improving scientific understanding, implementing constructivist and inquiry-based pedagogies, designing "authentic" opportunities for learning where students "do" science, engaging young girls with scientific activities, even beyond their male peers, motivating heretofore unmotivated students, improving scores on standardized tests, and increasing the frequency of scientific behaviours in students…

(Wofford, 2009, pp. 30-31)

In the context of VVC students, these sound like promising affordances, and it's exactly these kinds of outcomes that educators at VVC expected from 1:1. As I've touched on many times in this literature review, there are barriers in the learning environment that make accomplishing these outcomes problematic. The following part of the literature review splits in two: one section focuses on teaching science, and the other on learning science.

**1:1 and teaching science.** A relatively recent review of Australian science education found that "the most common teaching resource" in Australian science classrooms is still the "science textbook", and that "the use of digital learning resources seems to be limited" (Goodrum, et al., 2012, p. 53). This is a concern given the large amount of money spent on ICTs, for example through DER (DEEWR, 2013a). An earlier section of this literature review explained that science teachers are renowned for resisting change, therefore Goodrum's findings are not surprising. This resistance is everywhere. In the US, Drayton et al. (2010) conducted the first study of its kind in established 1:1 schools, finding that traditional old-school science pedagogy is so entrenched that 1:1 has little impact. The ACOT research from the '90s found that teacher training is the most important factor for successful 1:1 (Dwyer, et al., 1990). Teachers today are "digital immigrants", where unlike their students, the "digital natives" (Education and Training Committee, 2006, p. 195), they haven't grown up with comparatively high levels of technology access (Bebell & Kay, 2010), and their digital literacies are usually less developed (Education and Training Committee, 2006). Although research tells us teachers in established 1:1 programs must continually engage in professional learning to keep up-to-date (Spires, et al., 2009), many science teachers feel overloaded and struggle to keep up (Drayton, et al., 2010).

Teachers in the initial phase of 1:1 need different types of professional learning to those in established 1:1 programs. The initial phase can leave science teachers feelings stressed and inadequate, because they don't have appropriate digital literacies (Stolarchuk, 1997). In this phase, teachers need more training in basic digital literacies (Donovan, et al., 2007), but as these skills improve, training should focus on subject specific technologies, and how different types of digital literacies can support science learning (Klieger, Ben-Hur, & Bar-Yossef, 2010). These are important considerations in a school like VVC, which has a mix of both graduate and experienced teachers, with a range of digital literacies.

Science teachers are certainly the key to the student-centred learning environment that Papert first described as a potential outcome of ubiquitous computing in the 1970s (Papert, 1973). Some science education research supports Papert’s assertion that technology can lead to transformation. Yang’s (2002) study of a middle school science class in its third year of 1:1 found that the teacher had switched from “transmitter” to “facilitator” (Yang, 2002, p. 4). Klieger, Ben-Hur and Bar-Yosef (2010) also looked at science teachers in the third year of 1:1, and found teachers had switched from being the “holder of knowledge” to “instructor and guide” (Klieger, et al., 2010, p. 196). In contrast, Drayton et al. (2010) found a wide range of pedagogies operating in established 1:1 schools, even where teachers had well-developed digital literacies and support, including “high quality equipment, deep and prompt technical support, extensive teacher education, and a highly elaborated, technology-rich curriculum” (Drayton, et al., 2010, p. 48). They found a direct correspondence between teacher pedagogy and use of laptops, where traditional teachers use laptops for transmission, and more progressive science teachers (e.g. those whose pedagogy centres on constructivism) were more likely to have student-centred learning activities with laptops. Branch (2014) found that science teachers were less likely than teachers in other learning areas to change their instructional strategies as a result of 1:1. Even with all the hype that surrounds the affordances of ubiquitous computing, the literature is yet to establish that science teachers in established 1:1 schools permanently transform the way they teach science from teacher to student-centred pedagogy. This current study of 1:1 science at VVC is situated in a context that is able to examine this issue, where two teachers have over 5 years' experience in a 1:1 setting, and one teacher has none. This is an ideal opportunity to examine the way teachers use technology in an established 1:1 school. The next section moves into the literature that deals with learning science in a 1:1 context.

**1:1 and learning science.** The evidence linking teacher pedagogy to transformation is about student learning, because teacher change leads to students doing things not possible before (Spires, et al., 2012). It starts with the things students use laptops for in science:

> …virtual dissections, virtual field trips, student development and presentation of iMovies, WebQuests, laboratory write-ups, drill-and-practice for statewide tests, databases and spreadsheets, and the creation of Web pages…digital, interactive textbooks; Internet-based simulations; word processors; digital drop boxes; email; formative assessments; computer-based and stand-alone graphing calculators; probes and associated software; and video cameras…

(Zucker & Hug, 2008, p. 593)

These kinds of activities cover a range of value-added opportunities, such as increased productivity through apps like Word. However, as standalones, they do not represent the student-centred learning that 1:1 advocates suggest is the most important transformative change related to 1:1. Current trends in research shift the focus from how much technology is used, to the quality of use, because greater use doesn't equate to improved outcomes (Butler Songer, 2007). The following section reports on the literature associated with two themes that address the transformations expected of 1:1 at VVC: improved engagement and academic achievement (Removed, 2003).

***Engagement.*** Chapter 2 explained that the term ‘engagement’ refers to student behaviour, and their disposition towards (and against) certain styles of learning.

Student engagement with ICTs in science has tended to focus on learner preference for particular digital tools. Many studies examine the impact of hypermedia learning environments (HLEs), which are known at VVC as ‘interactives’ or ‘games’, and boys in particular identify with this ‘gamer’ mentality (Muehrer, Jenson, Friedberg, & Husain, 2012).

When looking at engagement, the newness of a technology, particularly a new HLE, can skew data in its favour because of the novelty effect. Berry and Wintle (2009) compared a 1:1 and non-1:1 class of a science teacher, and measured student engagement as on/off-task behaviour. They found students in the non-1:1 class were noisier, worked less, and spent more time socialising than the 1:1 students. It’s possible that the novelty of the technology meant that students appeared to have high levels of engagement and motivation in the short term (Hwang, Chu, Shih, Huang, & Tsai, 2010). As the novelty wears off, engagement and motivation could decline. Newhouse (2008) found that VVC students’ motivation to learn with laptops did not decline over time. This current study of 1:1 science provides an opportunity to examine this issue.

Some studies show the same level of engagement exists in 1:1 and non-1:1 science classes, where the high expectations and well-executed lessons of the teacher (Mabry & Snow, 2006), along with the school culture (S. Lee, et al., 2011; Muehrer, et al., 2012) hold the key to engagement. There’s also evidence that students have trouble regulating behaviour in online environments, both alone (Colwell, Hunt-Barron, & Reinking, 2013; Hug, Krajcik, & Marx, 2005) and in collaborative groups (Winters & Alexander, 2011). Shapley et al. (2009) claim there are fewer discipline issues reported at 1:1 schools compared to non-1:1 schools, but this applied only in the first year of 1:1. After the initial excitement wore off, students in both types of schools became increasingly dissatisfied with school (Shapley, et al., 2009). This highlights the importance of examining 1:1 over a period of time, and in the context of how long the school, its teachers, and students, have been part of a 1:1 program. The parameters of this study at VVC (see 'Significance of the study') make it a unique opportunity to study science in an established 1:1 environment.

***Learning.*** A gap in the literature is a lack of empirical research into the effect of 1:1 on academic achievement, even though it's an expected outcome for most 1:1 programs (Penuel, 2006). Few studies measure conceptual gains of students in 1:1 science in 1:1 schools (Drayton, et al., 2010; Zucker & Hug, 2007), and a recent review cites only two studies where achievement in science improves as a result of 1:1 (DERNSW, 2010, p. 7). One of these studies (Dunleavy & Heinecke, 2007) cannot be considered a 1:1 school context, because it compares 'at-risk' classes that were given laptops while other classes in the same school were not. Academic achievement is not a focus of this study of 1:1 science at VVC because the links between technology and achievement are not easy to assess. Instead, generalisations about student ability come through teacher judgement and my assessment of work samples.

An evaluation of the Texas 1:1 program (Shapley, et al., 2009), and a school district in Michigan (Ross, Lowther, Wilson-Relyea, Wang, & Morrisson, 2003) both found no impact of 1:1 on standardised science test scores across multiple 1:1 schools. Good test scores and improved student performance are more likely a result of progressive philosophies found in democratic schools than simply a result of 1:1 (Vedder-Weiss & Fortus, 2011; Zucker & Hug, 2007). The only study of 1:1 science in Australia found that “laptops in science did not help to increase student cognitive achievement” (Stolarchuk & Fisher, 2001, p. 34). There have been several studies that show links between 1:1 and science achievement, but either the effects are “small” (Dunleavy & Heinecke, 2007, p. 19), or the study itself is (Berry & Wintle, 2009), and therefore making broad sweeping statements about the impact of 1:1 on science achievement is not possible.

The link between 1:1 and cognitive achievement in science is not conclusive. However, it may be more beneficial to think in terms of affordances. Drayton et al. (2010) examined science teacher logs kept during a year-long study of three established 1:1 schools, and looked at the added value of different software and hardware. They found that Word was used to “improve the look and quality of work”, and helped with “poor handwriting and spelling”. Teachers believed it “improved students thinking, organization or understanding” (Drayton, et al., 2010, p. 20). Students used Excel to “evaluate, compare and analyse data”, but teachers believed it didn’t always help them understand how to do their own graphs, and sometimes they didn’t spend time thinking about what the graphs meant (Drayton, et al., 2010, pp. 20-21). The limited use of probeware surprised the authors: one of the schools didn’t have them, and probes were mentioned in only 25% of teacher log entries at the other two schools. For those teachers that did use probes, they believed they helped students in “seeing the unseen” and contributed to “thinking, reflection, or understanding”, and “increase[d] engagement, motivation, and student-directed learning" (Drayton, et al., 2010, p. 24). The range of science software used was diverse, but limited by what was available in each school. A common theme was that science software needed to "enhance the learning environment by increasing students' engagement, their investment in investigation of their own questions, and their meaning-making about scientific phenomena" (Drayton, et al., 2010, p. 25). Programs such as GarageBand and DreamWeaver were used to this effect in a range of contexts. School email systems were also of value, and the majority of teachers reported that it helped students get "feedback or help", but that this was sometimes inconvenient and overwhelming for the teachers (Drayton, et al., 2010, p. 26).

In another study of science at a 1:1 school (Zucker & Hug, 2008), a student survey uncovered patterns of technology use in Physics, and these were similar to the uses seen in other 1:1 science classes. Over half the students reported using their laptops at least once a week for: collecting and analysing data; online assessments; communicating about science; word processing; internet research; and simulations (Zucker & Hug, 2008, p. 590). Each of these activities is a means of increasing productivity or aids the research process.

Researchers know that inquiry learning in science can be enhanced by the use of educational technologies (Baslanti, 2008; Kim & Hannafin, 2011; Kim, Hannafin, & Bryan, 2007), but it's unclear if 1:1 itself is critical, because factors such as teacher pedagogy come into play (Kim & Hannafin, 2011; Kim, et al., 2007). Computers, and their associated software and hardware, e.g. digital probes, are a form of "inquiry empowering technologies", useful during laboratory investigations to "gather and analyse data" (Hofstein & Lunetta, 2004, p. 41). In a more general sense, internet research is a form of inquiry, and 1:1 can increase the amount of science fact-finding that students can do on their own (Mabry & Snow, 2006). Online research offers a number of affordances not seen in non-1:1 classes, but finding relevant information on the internet can be difficult. Providing access to new media environments, like the internet and HLEs, does not mean students will learn more. Winters and Alexander (2011) found that without teacher guidance, students left to fend for themselves in a HLE[18], either alone or working in groups, don't do any better than they would in a non-HLE environment (Winters & Alexander, 2011). Another similar study found that the length of time students spent searching websites was inversely proportional to the amount of work done (Cromley & Azevedo, 2009, p. 300, Table 3). One small study using a WISE[19] tutorial found that students with higher digital literacies would "rush through" the activity and were less likely to engage in the inquiry process, whereas students with lower digital literacies spent more time doing the activity as it was designed to be used (Wecker, Kohnle, & Fischer, 2007, p. 141). Research shows that when students are left to work alone, in pairs, or small groups to perform online research, they need to be effective self-regulated learners with strong intrinsic motivation to learn, particularly if the task involves complex science concepts (Winters & Alexander, 2011). Unfortunately, science teachers don't often explicitly teach digital literacies (Probert, 2009), and students can be left to fend for themselves.

There's a difference between using digital resources, which are "computer-available information source containing facts, perspectives, or information on a topic of interest…text, pictures, simulations, video, or other interactive formats" (Butler Songer,

[18] Hypermedia Learning Environment: "technology environments that give students access to different representations of data and information, such as text, diagrams, graphs, and video." (Winters & Alexander, 2011, p. 408)

[19] Web-based Inquiry Science Environment

2007, p. 475), and digital technologies that can be used as cognitive tools. Butler-Songer's (2007) cognitive tools framework has received attention across 1:1 literature as advocates look for tangible evidence of academic outcomes (Weston & Bane, 2010). Table 1 details Butler-Songer's summary of the potential added value of ICTs in science.

Table 1

*Learning Dimensions and their Associated Technologies* (Butler Songer, 2007, p. 483)

| Learning dimension | Associated technologies |
|---|---|
| Learners think critically about scientific ideas and/or compare with real life conditions | Modelling, simulations, and visualisations |
| Learners critically evaluate and communicate scientific ideas | Online critique and discussion resources |
| Learners formulate knowledge such as scientific explanations from evidence | Online scaffolding tools |
| Learners using appropriate tools to gather, analyse, and interpret data | Computer-based data collection and analysis |

Webb (2005) describes cognitive tools in terms of 'acceleration', meaning that they help students learn content faster. This can be done through using modelling and simulation software in the place of experiments, or as an aid during experiments, and studies have shown this can help students with less developed thinking skills work at a higher level (Huppert, Lomask, & Lazarowitz, 2002). The ability to use cognitive tools links with digital literacies, because students who do not have well-developed digital literacies will not achieve the same cognitive outcomes as students who do. An earlier section called this the 'digital divide'. It's an important sensitising factor in this study at VVC, because there are 'students at educational risk' (SAER) in the specific classroom contexts that are the focus of this study.

## The Newhouse Evaluation at VVC

Before moving into the Methodology chapter, an explanation of Newhouse's (2008, 2011) evaluation at VVC will provide further insight into the case study site, and lead into the methodology for my own study. Data from Newhouse's study is important to consider in the context of this current research. The literature review has highlighted that phases of technology integration impact on outcomes, with some studies showing decreased use of technology over time. Newhouse's (2008) evaluation of the initial phase of 1:1 at VVC found that prior to 1:1, only 16% of teachers used computers on a daily basis. During the first year of 1:1, this jumped to 45%. Likewise, student use of computers doubled from one to two hours per day. Interestingly, students perceived they used laptops less in the third year—an estimated 1 ½ hours per day. Newhouse found only 27% of teachers were using technology in ways that might lead to improved learning outcomes in the third year of 1:1, but he suggested that this would increase as teachers developed their digital literacies. The evaluation claimed that laptops contributed to a change in learning environment culture, where students were more in control of their own learning because of ubiquitous access to technology and the constructivist pedagogy that comes with 1:1. Importantly, the study also found that even after 3 years, students still believed that laptops helped them learn. Newhouse pointed out that "this is a positive finding since once the novelty had worn off if the computers were not being used well, student perceptions were likely to become negative" (Newhouse, 2008, p. 5). The ICT Deputy and Sub-School structure were both considered crucial to improving "flexible autonomy" and overcoming organisational barriers "such as short time periods, disintegrated curriculum, segregated curriculum specialist teachers, and bureaucratic management of digital resources and support" (Newhouse, 2011, p. 4). These findings are in no way indicative of cultural reform failure. In fact, these positive findings suggest that 1:1 at VVC may have had a profound impact on VVC school culture.

Data from the second part of the Newhouse study, in the established phase of 1:1, is much harder to get hold of. One of the key findings published in 2011 was that “earlier gains were maintained although the school struggled to counter the natural rate of turnover of staff” (Newhouse, 2011, p. 3).

Because data from the Newhouse study is not public, there is no clear picture of the way that technology is used in science at VVC, and importantly, how it’s used to facilitate user-led, student-centred teaching and learning in science. Combining the established phase research with science means that this current study of 1:1 science at VVC is a valuable source of data relating to the impact of 1:1 on science in established 1:1 schools.

## Conclusion

This chapter introduced the concept of ubiquitous computing, and its potential to transform the learning environment. Phases of technology integration were flagged as important considerations when discussing 1:1, and while much of the chapter focused on the idea that technology can transform the learning environment from teacher to student-centred, there’s limited evidence of this in established 1:1 schools, particularly in science. This is a very significant point, and this current study of science in the 1:1 context of VVC will further enhance our understanding of science in established 1:1 schools. The chapter introduced two models for technology integration as ways to describe technology use in classrooms. The ACOT model and the New Learning Ecology model both provide a framework for the analysis of data in this study of 1:1

science at VVC. The chapter identified that many schools invest heavily in computers, but there's not enough long-term investment in the teachers that are tasked with using them (DEEWR, 2013a; Holkner, et al., 2008). The section '1:1 science' explained there is little research into the day-to-day experiences of science teachers and students in established 1:1 schools. Yet the literature suggests that computer use can decline over time in established 1:1 schools, and this is possibly a function of engagement or novelty. This is very significant in terms of what this current study of 1:1 science can contribute, given that the context is over 2 years, and in an established 1:1 school in its 8$^{th}$ and 9$^{th}$ years' of 1:1.

The literature review concludes that the culture of teaching, science in particular, is resistant to change, and transformation through 1:1 is not a clear-cut outcome. This review creates a space in which to offer new insight, and it's here that my study of science in an established 1:1 school will deepen our understanding of both science and 1:1. The literature presented in the last two chapters highlights the complexity of the topics (1:1 and science), and this study aims to make these complexities more concrete through in-depth qualitative study.

As we now move further into the specific context of the study, the focus returns to the learners. The literature review suggests that SAER are potentially hit with a double whammy of disadvantage when science and technology combine. The students in this study at VVC therefore present as a cohort of interest, because of learner and learning environment characteristics. The following chapter describes the methodologies employed and the type of data that this study utilises to examine the culture of science in a 1:1 middle school context.

# CHAPTER 4—METHODOLOGY

Chapter 3 confirms that it's not possible to compare much of the 1:1 research literature because of methodological and contextual differences between the studies. This means that making judgements about technology is context specific. In this light, the art of storytelling is a useful strategy. Storytelling enables readers to judge how well things are going in the classroom, without relying on numbers (for example from test scores, surveys, and observation schedules) that don't provide in-depth data of the culture of the learning environment in which the research occurs. To take this further, in 1987, Papert argued experimental studies of computers in schools would fail because it's difficult to control variables:

> The treatment methodology leads to a danger that all experiments with computers and learning will be seen as failures: either they are trivial because very little happened, or they are "unscientific" because something real did happen and too many factors changed at once.
>
> (Papert, 1987, p. 26)

Unfortunately, research in science classrooms is often grounded in positivism (Howe, 2009), relying on pre-post test design, even though these researchers come from a broad range of fields (Moss et al., 2009). This current chapter justifies my non-experimental approach, and locates the study across several theoretical frameworks, using the concept of 'the bricoleur'. The chapter starts with the perplexing story of how I waded through theoretical frameworks. This reveals the mindset for my methodology, and the journey of a mainstream science teacher into sociology. After describing this evolution, the chapter moves to methods of data collection and data analysis.

## Personal Experience with Science and Research

Authors hint at the epistemological struggle that can occur as the world of philosophy opens up (Bayne, 2009; Denholm & Evans, 2006; Pasque, Carducci, Gildersleeve, & Kuntz, 2011). Such a journey enables researchers like me to "step out of positivistic discourses that limit the transformative and emancipatory potential of education and educational research" (Kress, 2011, p. 261).

I started my doctoral journey ignorant of non-scientific ways of knowing (Meyer & Crawford, 2011), because I've had a positivist view of the world since doing a science degree. Science teaching did not challenge my notion of numbers-are-data. I believed that the scientific method was the truth, and other forms of research were airy-fairy work of The Arts. I assumed my doctoral research would use a positivist paradigm and quantitative methods (Peca, 2000). I would conduct surveys, and observe behaviours using frequency and duration measures. These are common methods of data collection, and many well-known survey and classroom observation schedules are used in science education research (Aldridge, 2011; Fraser, 2007).

**Embracing my critical self.** Through the coursework component of my doctoral program, my theoretical perspective changed. I realised students are not numbers. I began to understand that science is a socially constructed discipline (Aikenhead, 1997, 2010; Bayne, 2009), "jerry-rigged to a degree" by scientists themselves (Kincheloe, 2001, p. 680). Reading 'Cultural Studies in Science Education' (Roth & Tobin, 2006) spun my head on issues of social justice, such as how ‘the elite’ participate in the construction of scientific knowledge (Bryce, 2010; O. Lee & Luykx, 2007). I decided it was important to use a critical stance, exposing power struggles that shape class culture. I aligned with critical researchers, who use their work “as a form of social or cultural criticism” (Kincheloe, McLaren, & Steinberg, 2011, p. 164) and who share the assumptions that: thoughts, facts and relationships are social and historical constructions; privilege and oppression occur as a result of accepting the status quo; and most research reinforces these social norms (Kincheloe, et al., 2011).

As Chapter 1 explained, the findings of early 1:1 research and media reports about VVC did not sit well with me. I wanted to expose the ongoing struggle with disengaged youth: to give outsiders a truthful impression of how things worked in science at VVC. This truth would depend on my reliability as both a source, and interpreter, of data. My experiences as a teacher at VVC give me a particular perspective of science, educational technologies, and middle schooling. Rather than making the study invalid (Pasque, et al., 2011), this emic lens enhances trustworthiness and authenticity (Freeman, deMarrais, Preissle, Roulston, & St. Pierre, 2007; Patton, 2002; J. White & Drew, 2011). I am honest about where I fit into the research. Lincoln (1995) calls this ‘positionality’: a way of knowing research is real and authentic, because “detachment and author objectivity are barriers to quality, not insurance of having achieved it” (Lincoln, 1995, p. 280).

There is more acceptance now of teacher researchers than in the past (Huberman, 1996), but still: “teachers must have more voice…and must join the culture of researchers if a new level of educational rigor and quality is ever to be achieved” (Kincheloe, et al., 2011, p. 165). Even though research in science has undergone a “revolution” (R. White, 2001, p. 457), most science teachers are still part of a traditional bunch, with the majority placing their bets on positivist, quantitative methods.

The interpretivist framework became my epistemological ally, because in this paradigm the researcher exposes their background, leaving the judgment of truth to the reader (Crotty, 1998; Freeman, et al., 2007; Patton, 2002; Schwandt, Lincoln, & Guba, 2007). My lens became focused: shaped by the ‘knotty’ experiences that led me to particular methods and interpretations of data (Schwandt, et al., 2007). I ditched the idea that research is objective, and relaxed into an understanding that personalities can colour research to make it easier for readers to apply their own criteria for trustworthiness.

**Insider, outsider: the changing role of the researcher.** Science teachers are rarely researchers because there is limited time, support or recognition for it (R. White, 2001). Teacher practitioners face criticism from purists who think we do not know how to “rise above…preconceptions and avoid distortions and self-delusion” (Huberman, 1996; Zeichner & Noffke, 2001, p. 299). I use my preconceptions as a lens for data collection and analysis. My self-delusion as a participant in 1:1 is a source of strength, as it enhances my ability to craft a narrative of 1:1 science at VVC. I am the subject and object of the research, using reflexive stories about other science teachers and students to develop my own practice. These attempts to “get behind the curtain” (Kincheloe, et al., 2011, p. 171) using different emic angles, represent the patchwork, teacher-led research that many consider the key to transformation (Huberman, 1996; Kincheloe, et al., 2011; Zeichner & Noffke, 2001).

However, my role changed when life circumstances (parental leave) created a shift from an emic to somewhat etic perspective. I was not working at VVC during the fieldwork phase of the research. Being a partial outsider meant I did not have the same level of access. I had participated in the 1:1 program since its inception, but the longer I was on leave, the less of an insider I became. There are many examples of researchers who are various shades of emic-etic (B. A. Brown, 2006; Henstrand, 2006), because the role of the researcher is not always fixed (Adler & Adler, 1987). Knowing how the role of the researcher informs epistemology is crucial, because all frameworks rely on a researcher's previous knowledge to aid in the formulation of hypotheses or as a means of creating new constructs (Guba & Lincoln, 2004).

The temporal and spatial distance afforded by my leave provided a level of neutrality that had previously been missing. There was less of an 'us' versus 'them' mindset. Rather than automatically siding with teachers, I became more open to student perspectives, particularly SAER. I link this period with a shift towards a critical stance. My values had changed, and so too my theoretical framework(s).

## Culture as a Lens in Educational Research

The culture of the learning environment is a focus of this study, and Chapter 2 introduced its slippery nature. While not easy to pin down, it is possible to mash up multiple definitions successfully, leading to new knowledge and understanding (Kincheloe, 2001). Henstrand (2006) took competing theories of culture and "synthesized the two approaches" in a study of school reform (Henstrand, 2006, p. 19). Goodenough's (1981) theory that culture is determined by the overall input of subgroups was used to organise specific categories for analysis (individuals, sub-groups, the whole group). After defining groups, the study examined changes within and between sub-groups over time, using the culture theory of Geertz (1976). This theory relies not on defining categories, but detailing events to provide "thick description" (Geertz, 1976; Henstrand, 2006, p. 18). Henstrand argued these theories were "complementary rather than contradictory" (2006, p. 18), because a combination of the two created specific and holistic categories for data analysis.

This study of science at VVC utilises the idea that sub-groups (e.g. teachers and students) share ideas that become culturally accepted if they solve problems, and 'thick description' through vignettes and critical incident analysis paints a picture of these interactions. Chapter 1 provided Schein's (2004) definition of culture that also influences this research design. The next section highlights the limited culture data that exists in 1:1 science literature.

**Tiptoeing around culture in 1:1 research.** Since 2000, an increasing number of papers deal with the culture of science (Seiler, 2013), but it's still relatively uncommon in 1:1 science. Most 1:1 research is done by outsider academics (see for example: Dawson, et al., 2008; Lowther, et al., 2007; Mabry & Snow, 2006; Owen, Farsaii, Knezek, & Christensen, 2005; Shapley, et al., 2009). While there are plenty of meta-analyses of 1:1 research (for example: Andrews, 2006; Barrios, et al., 2004; Boyd, 2002; DERNSW, 2010; Penuel et al., 2001), few explicitly tackle culture.

***Use of the 'c' word in 1:1 research.*** This section describes 1:1 studies that use, or implicate, 'culture'. Not all are set in a science context, or in established 1:1 schools. This highlights the limited research that deals with the 'culture' of 1:1 science-learning environments.

Mabry and Snow (2006) document cultural transformation arising from the implementation of a new 1:1 program. They compared 1:1 and non-1:1, through observation, interview and survey, and found a shift from teacher to student-centred pedagogy. This transformation is like the golden goose outcome of technology integration, where students become the creators of knowledge rather than consumers of it (Christensen, et al., 2011). Using similar methods, an evaluation of the first year of a statewide 1:1 program in Alberta (Alberta Education, 2009) found no significant cultural changes at 1:1 schools. These cultural changes were neither defined nor elaborated, just hinted at as ‘21st Century Skills’ (Alberta Education, 2009). Klieger et al. (2010) describe a shift in “digital culture” resulting from 1:1, where digital communication becomes easier, and teachers start to use technology more (Klieger, et al., 2010, p. 196). Drayton et al. (2010) found that 1:1 quickly becomes part of school culture, but existing “school culture can significantly hinder teacher uptake of the new technologies” (Drayton, et al., 2010, p. 43). Shapley et al. (2009) attribute 1:1 with “expanding the educational boundaries of the school” (Shapley, et al., 2009, p. 81). They use “Innovative Culture” as a survey section, and found that teachers in initial stage 1:1 schools feel this cultural change more than teachers at non-1:1 schools. They use the term ‘culture’ as a point of reference for ‘things’ that scaffold successful 1:1. Green, Donovan and Bass (2010) give these cultural features labels: school climate; communication within and between schools and the wider community; collaboration between staff; and progression towards improved digital literacies. Pack (2013) had the opportunity to study two initial phase 1:1 schools and clearly identified positive school culture as critical to staff engagement with technology. Fundamental to this was the collaborative and collegial nature of staff culture, which included peer-to-peer professional learning.

None of these studies delve into day-to-day aspects of 1:1, and none use the spoken word of students to describe class culture. Pack (2013) suggests that comparing teacher and student perceptions in 1:1 schools is an important next step in 1:1 research. This is where my research will make an important contribution to the literature. The next section illustrates a specific way to describe the culture of schooling, using 'critical incidents' as a unit of analysis.

***Angelides mash-up definition of school culture.*** Angelides (2001) uses a mash-up of Hopkins, Ainscow and West (1994) and Schein's[20] (2004) cultural markers as categories to describe school culture as:

- Observed behavioural regularities when teachers interact in a staffroom [and] language they use and the rituals they establish
- The norms that evolve in working groups of teachers in terms of lesson planning or monitoring the progress of students
- The dominant values espoused by a school, its aims or mission statement
- The philosophy that, for example, guides the dominant approach to teaching and learning of particular subjects in a school
- The rules of the game that new teachers have to learn in order to get along in the school or their department

[20] The original edition is 1985, but the 2004 version is more recent

- The feeling or climate that is conveyed by the entrance hall to a school, or the way in which students' work is or is not displayed

(Hopkins et al, 1994, p. 88)

Substituting 'teacher' for 'student' and 'staffroom' for 'classroom' can flip this framework into a description of science class culture. To gain access to such information requires insider knowledge. This is where my emic perspective comes in, and this definition of culture enhances the trustworthiness and validity of my research, as I am the emic researcher describing the culture of a work environment that I know.

***Tripp's critical incidents.*** A feature of Angelides work is the use of 'critical incidents'. There are varied definitions of the term (Halquist & Musanti, 2010), but some educational researchers use David Tripp's (1993) definition. Tripp defines critical incidents as a subjective creation: "not things which exist independently of an observer…but like all data…are created" (Tripp, 1993, p. 8). They include the hidden or the mundane, meaning there is "an interpretation of the significance of an event…a value judgment" (Tripp, 1993, p. 8). Angelides calls critical incidents "surprises followed by reflection" or "problems followed by solutions" (Angelides, 2001, p. 26). Reflection on critical incidents can tease out underlying assumptions that build the culture of the classroom and/or school. This strategy underpins the collection and analysis of data in this study of 1:1 science at VVC. The next section delves into the theoretical frameworks that inform the study design.

## Relevant Theoretical Frameworks

Today, it is accepted that we can choose parts of methods for research, and there is no longer a clear line between quantitative and qualitative research (Johnson, Onwuegbuzie, & Turner, 2007; Schwandt, et al., 2007). The following sections describe the theoretical frameworks that inform the design of this study.

**Naturalistic inquiry.** Critical theorists argue strict adherence to a single methodology can hinder development of knowledge, and this is one reason naturalistic inquiry has gained popularity in recent years (P. Green, 2002). The use of naturalistic inquiry begins with a study of culture, as "context is viewed as holding the key to all meaning" (P. Green, 2002, p. 5). Naturalistic inquiry uses the language of those studied to create authentic data, and this focus on voice is shared by the interpretivist paradigm (Schram, 2003). Research using naturalistic design involves "studying real-world situations as they unfold naturally; [it is] non-manipulative and non-controlling; [and has an] openness to whatever emerges" (Patton, 2002, p. 40). Whilst being open to 'whatever emerges', this study of 1:1 at VVC is grounded in the concept of culture, acknowledging that culture acts as the lens through which we view the world, and is the dominant feature of our environment that shapes the way we think and behave (Crotty, 1998).

This study of 1:1 science culture at VVC combines autoethnography and layered case study to gain an emic perspective of the science classroom through naturalistic inquiry. The research acts as a case study of a particular school and 1:1 program (VVC), as well as a case study of two classes (Class 1 and Class 2), their teachers, and the individual students within these classes. These are purposeful samples, where "cases for study are selected because they are information rich and illuminative, that is, they offer useful manifestations of the phenomenon of interest" (Patton, 2002, p. 40). Note the apparent contradiction between being 'open' to natural occurrences, and purposeful sampling of particular cases for observation and analysis. Bridging two methodologies works for me, as the focused lens of purposeful samples (e.g. a particular student or event) enables me to analyse other phenomenon around it to create 'thick description' (Geertz, 1976; Kress, 2011).

**Interpretivism.** The term 'interpretivism' describes a broad field of qualitative research (Howe, 2001). Rather than collecting "knowledge for the sake of knowledge" (Patton, 2002, p. 215), interpretivism is about agency and action, that "enables and promotes social justice, community, diversity, civic discourse, and caring" (Lincoln, 1995, pp. 277-278). It can be a form of critical research, whose purpose is to "aim at illuminating tendencies for domination, alienation, and repression within extant institutions, and seek to promote conscious emancipatory activity through exploring negative effects and contradictions of what is unquestioned" (Apple, 1990, p. 133).

My research started as a question about laptops in science, and quickly became a study of the culture of science education at individual, class, school, and societal levels. As an interpretive researcher, I attempt to "understand meaning in context" (Moss, 1996, p. 21), which is the "lived experience" (Garrick, 1999, p. 150) of VVC students and teachers. The lived experience of teachers and students comes through in interview transcripts, but analysis of the dialogue is subjective, couched in my own experiences. My experiences enhance authenticity because I am also a participant in these lived experiences, contributing to school culture over a period of 8 years prior to the research, then as a participant observer during fieldwork. This opportunity for a participant to act as an interpreter gives the project an authentic edge. The next section situates the methodology in the realm of the interpretive bricoleur.

**All roads lead to Bricoleur.** 'Bricoleur' refers to "a handyman or handywoman who makes use of the tools available to complete a task" (Kincheloe, 2001, p. 680). The interpretive bricoleur "understands that research is an interactive process shaped by one's personal history, biography, gender, social class, race, and ethnicity and those of the people in the setting…a quilter [who] stitches, edits, and puts slices of reality together" (Denzin & Lincoln, 2011, p. 5). In a methodological sense, the strongly subjective concept of bricoleur hints to others that "you really don't know anything about research but have a lot to say about it" (Kincheloe, 2001, p. 680). What it really means is that the researcher is open to new ideas, happy to work as an interdisciplinary "love child" (Kincheloe, 2001, p. 683) in "methodological eclecticism" (Lincoln, 2001, p. 694).

Bricoleur is part of "creative" naturalistic inquiry, where the researcher "remains open" to all possibilities (Patton, 2002, p. 402). Critics argue that the bricoleur isn't refined enough—it's "superficial", and "attempting to know so much" is/can lead to "madness" (Kincheloe, 2001, p. 681). Lincoln (2001) believes that the bricoleur is "far more skilled than merely a handyman…searching for the nodes, the nexuses, the linkages, the interconnections, the fragile bonds between disciplines, between bodies of knowledge, between knowing and understanding themselves" (Lincoln, 2001, p. 694).

My critical self likes the notion that bricoleurs "possess the insight to avoid complicity in colonized knowledge production designed to regulate and discipline"

(Kincheloe, 2001, p. 685). The idea is that you spend a lot of time stuck in theory, and come out the other side pulling threads from different webs to make a new one just right for what you are doing. It can "provide a new angle of analysis, a multidimensional perspective on cultural phenomenon" (Kincheloe, 2001, p. 686). It's hard to do, because you need to get deep into every facet of the topic and it takes a lot of time. But being so engaged, the bricoleur is informed on multiple perspectives and "able to address the complexities of the social, cultural, psychological, and educational domains" (Kincheloe, 2001, p. 687). Put simply, it works well with critical theory (Kress, 2011), and adds some spice to the concept of mixed methods.

***Bricoleur in 1:1 science.*** Sharma (2008) found only five peer-reviewed articles related to bricolage in educational research. This doesn't mean researchers aren't mixing their methods, and teachers in particular are quite good at it. For example, Hanley (2011) talks about teachers as masters of the bricoleur, using participatory Web 2.0 tools like Facebook and Twitter to circumvent the restrictions of more cumbersome applications. There seems to be a link between bricoleur and the rejection of traditional science. The bricoleur doesn't see knowledge and events as fixed in time and space, but know that "knowledge is always in process, developing, culturally specific, and power inscribed" (Kincheloe, 2001, p. 689). No 1:1 science study utilises the concept of bricoleur as a methodological consideration. Sharma (2008) uses bricoleur not to manage methodology, but to frame an understanding of how a science teacher in India manages daily complexities.

This study of 1:1 science at VVC is the first of its kind (in a whole school established 1:1 context) to pull together a mixed methods design where critical theory and culture frame the study. The focus is on the voice of those usually disempowered in the research process. How this works as a valid form of research is the subject of the next section.

## Mixed Methods and Triangulation

The term ‘mixed methods’ commonly refers to research that blends quantitative and qualitative methods (Greene, Caracelli, & Graham, 1989; Johnson, et al., 2007). It can also be about using different data collection methods “within a qualitative inquiry strategy…to test for consistency” (Patton, 2002, p. 248). It’s a way to enhance the trustworthiness of a study through “triangulation” (E. J. Webb, Campbell, Schwartz, & Sechrest, 1966, p. 3). Triangulation is based on the assumption that all methods contain flaws, therefore combining them nullifies weaknesses by drawing on the strengths of other methods (Denzin, 1978; Fitzpatrick, Sanders, & Worthen, 2004; Greene, et al., 1989; Patton, 2002; E. J. Webb, et al., 1966). This enhances validity, and has been a cornerstone of sociological research since the 1960s (Denzin, 1978; E. J. Webb, et al., 1966). Some argue it’s more than just a source of validity, because “it adds rigor, breadth, complexity, richness, and depth to any inquiry” (Denzin & Lincoln, 2011, p. 5).

Different levels of triangulation are woven through this study at VVC: the varied data sources (observation, teacher and student interview, documents) corroborate what my insider eyes see. Simple quantitative data, such as the number of students in class and/or with laptops, is used to support qualitative analysis, for example if Student X reveals in interview that she *“wags”* on days where she has a double block of science, I use quantitative data (attendance records) as evidence to support this.

**Comparative mixed method 1:1 research.** Penuel's (2006) oft-cited review of 1:1 considered "experimental design" or "statistical analysis of survey data, grounded theory, comparative case study analysis, or ethnographic analysis" as reliable research (Penuel, 2006, p. 335). This left the author with only 30 papers, and supported an earlier 1:1 meta-analysis that found "there was too little research-based evidence…the overall methodological quality of the studies was weak" (Penuel, 2006, p. 329; Penuel, et al., 2001). Other 1:1 reviewers also make judgment calls about reliability (Bebell & O'Dwyer, 2010; Hew & Brush, 2007).

This study at VVC utilises qualitative methodologies similar to other 1:1 research, including observation, interview and document analysis. A comparable scale mixed method study followed two science teachers in their first year of 1:1 (Garthwait & Weller, 2005). In that study, there were no student interviews, however survey and teacher interviews were utilised and verified by classroom observations. Their data were comprised of 8 teacher interviews, 22 classroom observations, 22 teacher emails, 17 classroom handouts, 10 webpages, and 53 news articles. The authors claimed validity through data triangulation, using the assumption that no one method can truly describe phenomena (Eisner, 1992; Patton, 2002, p. 248; Willis, 2007).

Larger scale 1:1 studies also use similar mixed method approaches. An evaluation of 1:1 at a large high school used observation, interview, focus group and survey data, however the report and journal articles focus only on survey data (Zucker, 2009; Zucker & Hug, 2007, 2008; Zucker & King, 2009). Many 1:1 studies rely on quantitative methods (see for example: Alberta Education, 2009; Dunleavy & Heinecke, 2007; Keengwe, et al., 2011), even though there are alternatives that provide 'richer' description of phenomena (Crotty, 1998; Moss, 1996; Patton, 2002; Pepper & Wildy, 2009). Likewise, there are few studies of the science-learning environment that use qualitative methods, and most of these are in Asian classrooms (Fraser, 2007). Branch's (2014) study of initial phase 1:1 at a school in the US managed to gain access to three science teachers as part of a larger project (note he was also the school administrator), however the duration of the only interview wasn't noted in the dissertation. These science staff contributed to surveys, their class records pre- and post-1:1 were examined for instructional change, and observations of two lessons (30 minutes each) were included in analysis. This study also included one student focus group, however the duration of this interview was also not disclosed.

This study at VVC aligns with paradigms that favour in-depth interview and observation over survey, because they provide depth over breadth (Fontana & Prokos, 2007; Patton, 2002). The study draws strength from small sample size and qualitative methods. It uses "multilayered and nested case studies, often with intersecting and overlapping units of analysis" (Patton, 2002, p. 298), e.g. comparison between teachers and their classes, as well as between students within and across the two classes. The style of sampling and interview are critical and interpretive, and this chapter covers these approaches and their justification in detail.

## Ethics

All reference to specific, named documentation that could identify the school, and commentary on it, has been removed to protect the anonymity of the research site and participants within it. The ethical compact between the researcher and participants was negotiated at the outset of the project. The teachers in the study were fully aware of the purpose of the research, because they had been working with the researcher as a colleague in the science department of the school and the style of research was clear through informal conversations. We had already developed a relationship built on trust and honesty because of our collegial status. All participants were provided with opportunities to review data, comment on emergent findings, and the way their voice was portrayed, through an iterative process extending over a two-year period. The agreement between the researcher and the participants was that the study would ‘tell it like it is’.

## Data Collection

For many researchers, the line between data collection and analysis is blurry (J. White & Drew, 2011). This applies to qualitative research like mine, where the researcher takes notes in the field, and begins ‘troubling’ the data through critical incidents and autoethnography. There is a subjective, selective purpose to this ‘troubling’. In my case, the choice of who to talk to, and what to watch for, were based on my honed teacher radar. I often focused on disengaged students, and sometimes the antithesis, the engaged ones. Qualitative studies draw strength from non-random purposeful sampling of “information rich cases” like this, which can “yield(s) insights and in-depth understanding” (Patton, 2002, p. 230). This requires a back-and-forth between data collection and analysis where the data can lead the researcher in new directions (J. White & Drew, 2011). The next sections describe data collection and analysis.

**Study timeline.** Fieldwork began in March 2010, in the first week with laptops in science, and ended with the final laptop lesson in November 2011. Appendices D and

E detail interview dates, and Appendix F summarises the time involved in collecting observation and interview data.

**Sample size.** The study follows two classes, consisting of 43 students who gave informed consent, and their three teachers. Other small scale 1:1 studies use only one or two classes (Berry & Wintle, 2009; Garthwait & Weller, 2005; Mouza, 2008), as do novel ICT interventions (for example: Kim & Hannafin, 2011; Nicholas & Ng, 2009; Yerrick & Johnson, 2009). It's not a limiting factor, because "the validity, meaningfulness, and insights…have more to do with the information richness of the cases selected and the observational/analytical capabilities of the researcher than with the sample size" (Patton, 2002, p. 245).

**Recruitment of participants.** Eight teachers taught science at VVC during the study period. One resigned, one was Deputy for a year (Jeff), and another three had only one or two classes for a year or less. This meant that in 2010, three teachers could be included: Jill, Sarah, and Lee (another science teacher). These three teachers, plus Jeff in 2011, were enthusiastic about the project and signed consent forms, as well as the three Education Assistants (EAs) working in their classrooms. Verbal consent to participate was gained from two Aboriginal and Islander Education Officers (AIEOs). One each of Jill and Sarah's Year 8 classes were chosen (Class 1 and Class 2) because they were characteristic of typical cases (Patton, 2002), with approximately 28 students of mixed academic ability and behaviour. I met with these two classes in early 2010 to explain the project and send home consent forms. Jeff took over as the Class 2 science teacher in 2011.

Over the 2 years, 65 students could have participated in the study, but some were transient, and some did not return parent consent forms. 66% of parent consent forms (N=43) were returned, compared to 81% of student forms (N=53). This is a greater percentage than other high school studies, where some have a return rate as low as 50% (Oliver & Corn, 2008; Schibeci et al., 2008). Appendices D and E provide a list of student details, and a short description of informants is provided in Chapter 6 ('The key informants').

**Observations.** Observation has become popular in science education research in the past 20 years (R. White, 2001). Over the 2 years of the fieldwork phase of this research, I made random observations of Class 1 science 28 times, and Class 2 science 25 times, totalling 73 hours. This is a substantial duration compared to other studies. For example, Berry and Wintle (2009) use only one lesson. Oliver and Corn (2008) observe 120 different classes for 15 minutes each (30 hours). In contrast, on a much larger scale, Dawson et al. (2008) collect 400 hours of observation data, spread across 11 school districts and an undisclosed number of schools/classes/teachers.

My observations were unobtrusive. I spent time in Form Class getting to know students. Form is a 20-minute pastoral care lesson at the start of each day, where students have free time. I went to 3 Form classes for observation in 2010 (total 60 minutes), and 20 Form classes in 2011 (total 400 minutes). I didn't count 'pop in' visits to Form as direct observation, and in 2010, there were lots of 'pop ins'. There was a change in the way I conducted observations and interviews over 2010-11 because of science teacher pedagogy. In 2011, it was difficult to get time with students in science because teachers did more chalk n' talk. This was particularly relevant in Jeff's class.

His behaviour management did not allow for ‘free talk’ time and this made it hard to converse with students. Therefore, in 2011, I spent more time talking with Class 2 students in Form.

In science lessons, I sat at the back while teachers conducted the introduction to the lesson. Then I joined a student, or a group, to participate in the rest of the lesson. I wanted to see what was, and was not, happening with laptops. This “sensitising concept” (Patton, 2002, p. 279) remained a feature of every stage of data collection. “Typical cases” (Patton, 2002, p. 236) were usually a description of how students went about doing a task, using the cultural markers of Angelides and Tripp (see pp. 87-88). Then “extreme case sampling” (Patton, 2002, pp. 230-234) described events and/or students that were not part of the lesson plan (e.g. off-task behaviours). Sometimes the unit of analysis was an event, other times it was a student. This openness meant that fieldwork was opportunistic, and emergent flexibility was an important part of the data collection process. As well as being a way to describe critical incidents, direct observation allowed me to get a heads up on issues of interest (or not) for interview (Patton, 2002, pp. 262-263). Fieldnotes included things like:

- the number of students present, and names of those present and absent
- who had laptops and who didn’t
- the task for the lesson
- what students were doing (verbal and non-verbal)
- what the teacher was doing
- how the laptops were used (or not)
- types of on and off-task behaviours
- how the lesson made me feel

These fieldnotes were long rambling affairs (see Appendix C), therefore this thesis uses very few raw data extracts, but draws extensively on information from them.

**Interviews.** Student interview in 1:1 science research is limited to several papers. Mouza (2008) uses eight focus groups comprised of four students (40 minutes each). Kim and Hannafin (2011) conduct pre-post interviews with 19 students (20 minutes each), as well as short 3-5 minute interviews. They combine this with transcripts from class recordings, as well as work samples, fieldnotes, and survey. From an Australian perspective, Stolarchuk's (1997) thesis uses three focus groups, with 16 students, as a source of qualitative data (Stolarchuk, 1997).

There are examples of student interviews in science where computers are used in non-1:1 settings. For example, Maor and Taylor (1995) utilised an in-class informal interview technique (conversation) during a HLE intervention in two classes. Nelson (2012) talked with 12 students for 30 minutes, but it wasn't just in a science context. Other papers hint at student interviews but then do not reveal the language (talk) of the students.

I fit my research into this gap, using student voice as data. Informal interviews were the best option, as research suggests students clam up in formal settings (Bassett, Beagan, Ristovski-Slijepcevic, & Chapman, 2008; Fontana & Prokos, 2007; Kvale, 2007; Lemke, Kelly, & Roth, 2006; Pepper & Wildy, 2009; Roth & Middleton, 2006). There are also issues of recruitment and engagement in interviews with teenagers (Bassett, et al., 2008). Furthermore, the power imbalance between children and adults stands as a challenge to authenticity where voice is used as a measure of truth (Eder & Fingerson, 2002). Because children can be more easily influenced by the research process than adults, it is up to the researcher to ensure these voices are exposed in a "reflexive and transparent" manner (Spyrou, 2011, p. 161), using examples that paint a picture of individual children as well as whole groups (Ryan, 2010).

Interview data provide rich qualitative description, and gives participants an opportunity to reflect on meaning (Patton, 2002). Conversational interviewing is a successful research method that can elicit truthful responses (Patton, 2002; Roth & Middleton, 2006). It's been called 'yarning' when it involves research with indigenous groups (Power, 2004), as well as 'unstructured interviewing' (Fontana & Prokos, 2007). In the context of this study, yarning/unstructured interview offers an informal setting for students to voice their opinions and engage in discussion about science.

In this study at VVC, there were 84 recorded student interviews with 33 students; 18 teacher interviews with four teachers; and one interview with two Education Assistants (EAs). This generated 700 pages of interview transcript (one page = approx. 300 words); 17 hours of student interview (170 000+ words); and 8 hours of teacher interview (44 000+ words—a total of 24 hours of recorded interview data. The following sections describe the student and teacher interview techniques.

***Student interviews.*** Appendix B lists some of the interview questions used when talking with students in Class 1 and 2. To get into these questions, I asked students about their work, starting with openers, like *"Hey, do you mind if I sit with you for a bit?"*; *"Can I ask you some questions?"*; *"Watcha doin'?"* If a student said no, looked at me funny[21], or appeared nervous, I left them alone. If they said, *"Ok"* I asked further hook-in questions, like: *"How's it going?"*; *"What are you guys up to?"*; *"What do you think*

[21] The teenager look that says "leave me alone"

*about…?"* Students then had the opportunity to talk freely about this, and conversations usually went off-topic, to be steered back onto science and laptops with occasional probing questions. This was an important part of "gaining trust", as researchers often need to engage in "throw away" discussion (Kingsley, Phillips, Townsend, & Henderson-Wilson, 2010, p. 5) to "access the setting" (Fontana & Prokos, 2007, p. 43).

Groups of 3-5 interested students sometimes formed an impromptu mass-interview. These were effectively focus groups, however not purposeful samples. There were 11 focus groups over the 2 years. The remaining 73 interviews were with individuals (N=40), or pairs of students (N=33). On two occasions, focus groups took place in Form Class, but this proved difficult because of its short duration and continual student movement.

*Interviewing Indigenous students.* Mellor and Corrigan (2004) found there is little Indigenous voice in the literature, and suggest the "integrity" of research "will be enhanced by formally incorporating the Indigenous voice" (Mellor & Corrigan, 2004, p. 50). Only one Australian study focuses on the spoken word of Indigenous students in science (Wilson & Alloway, 2013). It uses a vignette to analyse student engagement in their first science lesson in high school. Direct quotes from the lesson demonstrate Indigenous students' perspectives, and the authors suggest we should expect the unexpected when working with disengaged children and those from non-mainstream backgrounds (Wilson & Alloway, 2013). There is one other author who has published work about Indigenous students in Australian science, and the argument is similar: more time should be spent gaining trust and sharing experiences of Indigenous students in science (Chigeza, 2007, 2011).

In this study at VVC, there are 19 Indigenous students (approx. 30% of the cohort). 11 of these students chose to participate in the study (N=9 boys; N=2 girls). The voice of these contributors shines through loud and strong in subsequent chapters.

***Teacher interviews.*** I spoke with teachers informally before, during, and after observations, as well as through email and one or two formal interviews. Appendix B lists formal interview questions. The formal interviews lasted 30 minutes to an hour, and provided ample data about pedagogy. The snippets of talk time in class helped to clarify phenomena and provide direction for observation, interview and document data collection. Personal experience as a teacher, and a direct relationship with these science staff as a colleague meant I was careful not to impose on teacher time.

**Documents.** Documents from various sources form part of data triangulation. They include student work samples, WADoE planning documents, timetables and emails. Appendix G summarises the documents and their purpose. Documents serve to 'back up' observations and interviews, e.g. an incomplete worksheet left on a desk confirms a student did not participate in the lesson; or students' digital folders expose the dearth of digital evidence of 'work'. The next section provides details of the data analysis used in this study.

## Data Analysis

Science education researchers need to focus on culture as a "structure and mechanism that can inform research and policies developed to address the numerous challenges in science education" (Parsons & Carlone, 2013, p. 1). There are two parts to this: on a "micro" scale it requires "in-depth investigation…rich and deconstructive in nature"; on a "macro" scale the study needs to be "adaptable to large-scale economies" (Parsons & Carlone, 2013, p. 1). To achieve this, this study of 1:1 science at VVC tells rich and deconstructive stories about teachers and students, and examines them in a broader cultural context through the discussion and conclusions in Chapters 9 and 10. Appendix C provides a sample of how this came together as fieldnotes, journal writing and analysis of critical incidents. The next section explains the components of critical incident analysis, and how this relates to storytelling and reflexivity.

**Critical incidents.** This study of 1:1 science at VVC uses critical incidents to analyse data. The critical incidents chosen in this dissertation exemplify the main themes that emerged though the data over the two-year period of intensive in-depth data collection. Data presented are not generalisations because they are built out of the evidence of two years of intensive classroom-based research that captured the voices of teachers and students as they emerged through interview, conversation and observation of science teaching and learning, in all its manifestations, at the case study site.

Critical incident analysis is a form of case study methodology that uses four categories to frame analysis (Tripp, 1993, 1994):

- Who (people)
- With what? (things)
- Experiences what? (events)
- When, where, and with whom? (context)

This style is a merging of data collection and analysis. Tripp explains that case studies must have both the "common" and the "unique" to analyse phenomena (Tripp, 1994, p. 4). For example, some features of the learning environment, e.g.

textbooks/laptops, are common across schools, but some properties, e.g. the way laptops are used, are unique to the setting. In this study, examination of the four key elements to a case (the dot points above) took place using autoethnographic journal writing, which then transformed into a narrative from within the classroom.

Critical incident analysis focuses on the way we compare new phenomena to our existing categories (Figure 3). For example, I have categories that I use in my role as a science teacher. In this study, I analyse classroom practice with an eye for phenomena that grate against my existing categories. For example, I spent much time working with disengaged students, and through my experience with them, I shifted the focus of some of the analysis to teacher pedagogy. From these critical incidents, new ideas about teaching and learning science can emerge, and it informs my work as an educator.

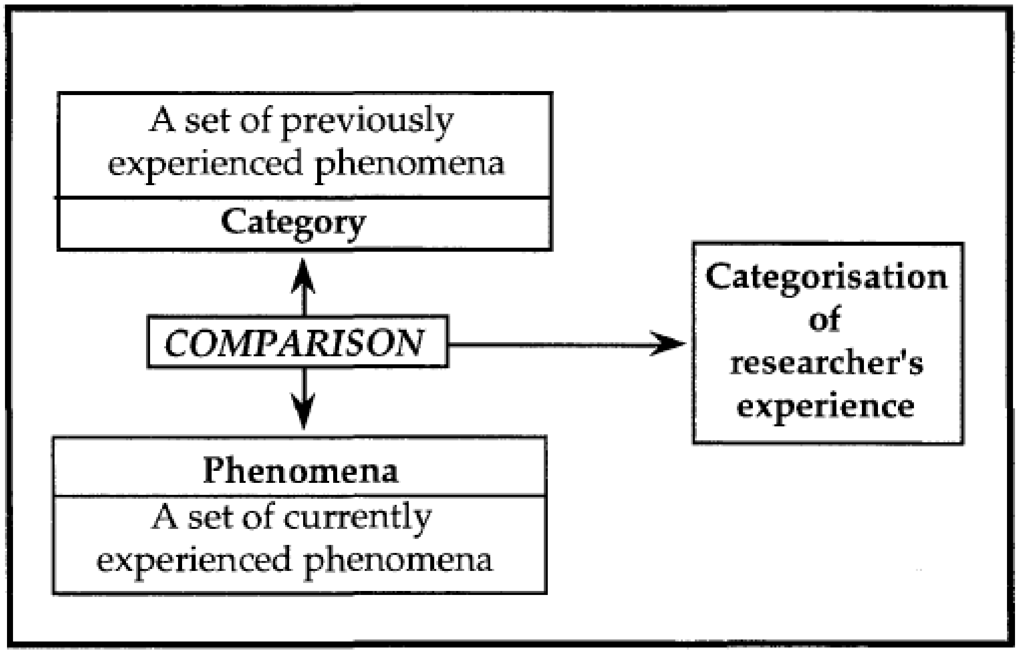


*Figure 3.* The categorisation of phenomena. Reprinted from “Case study: Creating the data” by D. Tripp, 1994, Paper presented at the *Qualitative Approaches in Educational Research Conference* at Flinders University. Copyright 1994 by the Flinders University of South Australia. Reprinted with permission.

Figure 3 explains how my perceptions as a teacher-researcher can change as I compare my preconceptions with current experiences. Another way of describing this might be that my experience in Class 1 and 2 as an observer, not a teacher, was an 'eye-opener'. The next section explains how vignettes capture the phenomena I experienced as critical incidents.

**Storytelling/vignettes.** Numerous terms describe the act of storytelling in research, such as: autoethnography, portraiture, narrative, and vignettes (Humphreys, 2005; Lawrence-Lightfoot, 2005). White and Drew (2011) define a "story" as direct verbal quote and "narrative" as the "crafted, intentional, written version" (J. White & Drew, 2011, p. 5). I'm going to use the term vignette, and define it as narrative that enables the researcher to "construct a window through which the reader can view" events (Humphreys, 2005, p. 842). Nevertheless, I have also used the term 'story' throughout this thesis, not to be confused with the academic definition of White and Drew. I say 'story' to represent the whole case, including the vignettes and their associated critical incidents. I've also used the term autoethnography. It's just another word for story. Spry (2001) believes autoethnography enables her to "express passion and spirit I have long suppressed" as an academic (Spry, 2001, p. 708). I attempt to portray this expression of spirit in this dissertation. Pepper and Wildy (2009) use the term "wakefulness" to describe the power of narrative (Pepper & Wildy, 2009, p. 18). To be awake, one must focus on what is real—the truth—found through reflexive practice.

**Reflexivity.** Storytelling/narrative/whatever you want to call it relies on reflexive practice. Huberman (1996) believes narrative is "slippery" because, whilst evocative, "no evidence" is required, merely "insinuate[d]" (Huberman, 1996, p. 136). While it may be considered by some a dangerous act of "self-indulgence and narcissism", the risk is nothing compared to the level of detail such stories provide about researchers' assumptions (Humphreys, 2005, p. 853). As a researcher, I act as "part of the context for the findings", and my reflexive practice involves "an ongoing examination of what I know and how I know it" (Patton, 2002, p. 64).

Reflexivity enhances the trustworthiness and truthfulness of a study (Humphreys, 2005; Patton, 2002), because it "reminds the qualitative inquirer to be attentive to and conscious of the cultural, political, social, linguistic, and ideological origins of one's own perspective and voice as well as the perspective and voices of those one interviews and those to whom one reports" (Patton, 2002, p. 65). Patton's framework for reflexive inquiry is useful in this study, as it crosses all of the major themes addressed in the research questions. His framework uses "culture, age, gender, class, social status, education, family, political praxis, language, values" as "reflexive screens" and asks questions about the people who are studied, the researcher, and the audience (Patton, 2002, p. 66). Lincoln (1995) links reflexivity to the point in the research process where the researcher subjectively analyses their practice and "create(s) personal and social transformation" (Lincoln, 1995, p. 283). Transforming my own beliefs and professional practice has been a huge unexpected side effect of this research, and something I am especially pleased with.

## Conclusion

This chapter described my background to enhance the trustworthiness of the study. It explained that I have borrowed ideas from a range of frameworks. As a mixed method bricoleur, I use naturalistic inquiry, interpretivism and the concept of culture. The narrative built from honest conversations with participants, combined with critical incident analysis, gives the study a truly emic perspective. This is a unique way of examining the 1:1 science classroom, and serves to provide outsiders with a realistic, raw experience of day-to-day life in two science classes. The following chapters uncover these perspectives.

# CHAPTER 5—THE SCHOOL AND ITS SCIENCE TEACHERS

This chapter is the start of the story about Class 1 and 2. It begins with a description of VVC school structure, the make-up of the two classes, and a pastoral care feature of middle schools known as Form Class. It then details the laptop program: its policy; supports; the concept of 'take home'; the key and the charger; what it means to be on 'lockdown'; and pressures placed on teachers. The chapter also describes the science teachers of Class 1 and 2: Jill, a science facts guru; Sarah, a mature age graduate; and Jeff, the classic traditional male science teacher. These teachers are instrumental in setting the tone of the classroom and play an integral role in the culture of science at VVC. The vignettes in the chapter introduce students as they interact with teachers, exposing teacher beliefs about teaching and learning.

WARNING: Student language can be colourful. The speech of participants (in italics) is uncensored, to express the richness of the data and create strong emic perspectives of 1:1 science at VVC. This discussion in this chapter then leads into Chapter 6, with its focus on the culture of the learners.

## School Structure

VVC switched from being a traditional high school (Yr. 8-12) to a middle school, complete with redesigned learning spaces, in 2003 (Removed, 2002). VVC has a Principal and three Deputies. In 2010-2011 there were "up to 46 teachers and 39 non-teaching staff working in full-time or part-time capacity" at VVC (Bell, 2011, p. 1). In 2010-11, the majority of VVC's 450 students were "of European descent", with approximately 30% Indigenous Australians and "2% Christmas Island Malay" forming the rest of the cohort (Bell, 2011, p. 3). A significant number of students at VVC are from low-income families, and while the school performs on par to ‘like’ schools, over 80% of students are ranked in the lower half of the state cohort in national and state standardised tests (ACARA, 2014b; Bell, 2011). Literacy and numeracy are issues at the school, as is attendance and behaviour. VVC occasionally makes local and state news for issues related to student behaviour (ABC Online, 2008; Phillips, 2010; Robin, 2010).

In line with middle-schooling philosophy, the school is split into cross-curricular teams (DoE, 2008): there are five Sub-Schools, and each Sub-School Leader (SSL) is responsible for managing approximately 150 students and five teachers, who teach English, Maths, Science, Society and Environment (S&E), and Health and Physical Education (H&PE). Science is allocated two single blocks (50 minutes each) and one double block (100 minutes) per week. There’s a Sub-School meeting once a week for teachers to share information relating to their student cohort. Whilst VVC science teachers participate in Sub-School meetings, they’re limited to pastoral care rather than curriculum. There is a strong focus on pastoral care, which is a key part of the school’s middle schooling philosophy, described in school reports and on the school website:

> The Sub-School structure has a team focus and is designed to develop closer relationships between teachers, students and families/caregivers. It enables all stakeholders (school and home) to respond collaboratively to student needs by providing support, encouragement and assisting in problem solving as the need arises.
>
> (VVC, 2009a)

VVC has the usual student support services in place: Education Assistants (EAs) for Schools Plus (SP)[22] students, and Aboriginal and Islander Education Officers (AIEOs) for Indigenous students. It has programs to cater for the diversity of students: reading classes for low literacy students; the Indigenous Tutorial Assistance Scheme (ITAS); the Football Academy for Indigenous boys; the Netball Academy for Indigenous girls; and Students Hairdressing Integrating Education (SHINE), a beauty program for girls with attendance/behaviour issues. There's also an academic extension class for students who gain top scores in their Year 7 NAPLAN[23] tests, and Follow The Dream for Indigenous students who aim to go on to tertiary studies.

VVC does not differ from traditional models of schooling in key areas where middle schooling often splits from the pack (DoE, 2008). Class size sits at approximately 28-32 students, which is no different to the average high school. VVC has streamed classes within Sub-Schools, as well as the school-wide academic extension class. 'Specialist' rather than 'generalist' teachers take students for discrete discipline-based lessons, and each core subject receives the same amount of instructional time. Most of the time that science teachers spend in Sub-Schools relates to pastoral care. There was no evidence of cross-curricular programs of work involving science teachers in 2010-11.

**The two classes.** Class 1 and 2 represent typical cases for VVC. The distribution of boys and girls is about equal. The percentage of Indigenous students in Class 1 and 2 (29%) was representative of the school average (30%). There were 16 Indigenous males

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[22] Students who meet criteria for disability as per guidelines (WADoE, 2014b)

[23] National Assessment Program Literacy and Numeracy

in Class 1 and 2 (25% of total cohort), but only nine were included in the study, because seven boys did not return the student and/or parent consent forms. In contrast, there were only three Indigenous females (5% of total cohort), and one of them chose not to participate. The Principal did not give consent for home contact (for undisclosed reasons), therefore I was unable to make phone calls or home visits to gain verbal consent. The section entitled ‘The key informants’ and Appendices D and E provide short descriptions of students who returned both consent forms.

The research took place in 2010 and 2011, before the introduction of the Australian Curriculum (ACARA, 2014a). At this time, VVC science teachers were still using the jurisdictional curriculum documentation, operating in the state’s schools since 1998 (XX Council, 1998). The state curriculum acknowledges the diversity of learners and their abilities, and that not every child is at the same level in their progress. To illustrate the ‘at-risk’ nature of the learners in Class 1 and 2, a generalisation can be made about VVC student achievement. VVC Annual Reports from 2010-11 indicate that 30% of VVC students perform in the bottom 20% of the state for NAPLAN (Bell, 2010, 2011). They also show that 40% of VVC students were in the bottom 20% of the state for the science component of the jurisdictional standardised testing regime, and nearly half failed VVC science with a D grade or below (Bell, 2010, 2011). A C grade indicates a student is working at the expected level for that year, while students with limited achievement (D grade) require support to make progress (DoE, 2014a). This is important in the context of VVC science, where both teachers and students understand that the cohort is not working at the expected level, but still teachers forge ahead delivering textbook curriculum while their students fail. Furthermore, school performance data presented in annual reports and on the My School website doesn’t show an improving trend in student test scores across time. The next section explains what Form Class is, and how it has transformed into a resource accountability lesson more than one of pastoral care as intended.

**Pastoral…where's your laptop?!** At VVC, pastoral care is the first class of the day, known as Form. I went to 23 Form classes (460 minutes) to observe how teachers and students interact. When teachers are not nagging about absentee notes, uniforms, or laptops, it's a free time lesson, where students hang in social groups, or have free time on laptops. Interestingly, the 1:1 program defines the teachers' role in Form. They don't choose to be laptop monitors, but that's what they are. As Class 1's Form Teacher, Jill has to see the laptop, charger, key and bag every day. Jill says the whole process is *"a pain in the arse,"* and she is *"nasty with it because I have to be,"* hassling the kids: *"I will nag and nag and nag and eventually make them go down and get it if they don't bring it."* Jill further explains her role as Form Teacher in frustrated tones:

> *Something I hate is, as a Form teacher, I'm a bitch! I have to be a nasty bitch from the moment they arrive at the start of the day: "Where's your laptop? Get it out!" Gotta check the numbers, and—we're supposed to, but somebody doesn't—somebody* [inferring Jill] *checks chargers on Mondays, and laptop screens on Wednesdays, and that they have them the other days. Umm, coz it's ridiculous! Sometimes it's not always enough time. If I had…if I was checking both that, and numbers every day, then it just wouldn't be enough time…Maybe we need Form teachers that aren't directly teaching these kids, because it's just something I've gotta nag and nag and nag, and…and, but at the same time that's bonding time I'd hate*

*to lose, coz I think I have a better rapport, coz I'd rather have that little bit of bonding time with them than not have any at all, or have it with some other kids that I'm never gunna teach…*

Jill, March 17, 2011

Later in the year, the situation is no different. Jill is fed up with students arriving to science without laptops after the effort she puts into laptop administration in Form:

*I have an extensive nag program at the moment, so I make sure these little buggers bring their laptops…organise themselves. In Form, none of them* [laptops] *were missing, but by the end of the day, I think there was about four kids in here that didn't have one. They just put it away. They say "Oh it's flat"* or, *and you know they know they can bring their cords and I'll let them use them, plug them in.*

Jill, August 11, 2011

The issue of not bringing laptops to class was picked up by the Newhouse evaluation (Newhouse, 2008) summarised in Chapter 3. While it's a school-wide phenomena, this study describes the problem in the context of science. Chapters 7 and 8 'trouble' the problem of laptops further, but first there is a description of how the 1:1 program works at VVC.

## Laptop Program

At VVC, every student receives a laptop at the start of the year, complete with carry bag, charger, a locker in the Sub-School, and key. Students are responsible for the laptop, and carry it with them during the day. They can take the laptop home at night, or store it in their locker.

**Policy and technical support.** WADoE doesn’t provide technical support for Apple products (DoE, 2014b), so VVC funds its own technician, who services all 500+ laptops. In Term 1 2010, laptops didn’t arrive until Week 5 due to a new contract, and a switch from state to school based funding for the program. Then in Term 2 2010, laptops were out of operation for another five weeks while the school tried to work around a WADoE system upgrade. This was a major source of frustration for teachers and students. To make matters worse, in Term 1 Jill did not have access to a data projector, and although she had her personal laptop, she couldn’t hook it up. ‘NoteBooks For Teachers’ (NFT) is a WADoE project that rents laptops to teachers, but Jill claims, *“they’re slow and crap”*, and many teachers, including the teachers in this study, don’t bother with NFT. VVC teachers can borrow Apple laptops from the school, but in 2010, when the laptop program became school-funded, there were less available. In early 2010, BettyBoop (an EA) complains about her laptop being taken off her. She says it prevents her from helping students because she doesn’t know how to work the machine. This problem is highlighted in Sarah’s class in Term 1 2010, when she can’t work out how to access the internet because she can’t find Applications Manager on the Dock.

**Take home privilege.** Students can take their laptop home every night, even though many, like Keisha and Nigel, say they *“don’t get homework”*, or *“don’t do it anyway.”* Form teachers, SSLs and Deputies can revoke take home privilege, but it doesn’t happen often. At the start of Year 8, most students can’t wait to take laptops home for the first time. Jill hassles people about their consent forms in Science. She walks around with a checklist threatening *"No form, no take home!"* Matt can't take his home because he doesn't have a school bag. He argues with Jill about this, yet she can't allow it, because *"it's school policy"* that students take laptops home in a backpack. This is so other people can't see the laptop (and steal it). Students like Matt, who are already disadvantaged (he's SAER for a number of reasons), are further disempowered by this prerequisite for take-home policy.

**The key and the charger.** Students are responsible for the laptop charger and key to their laptop locker. These two important items are required for the day-to-day success of the 1:1 program. Students must purchase a replacement key ($25) if they lose theirs. Often this results in particular students being without a key if they don't pay in a timely fashion, like Keisha who goes months without one, claiming, *"Mum's waiting for Dad to get some money from work."* Students' laptops remain in their locker until they pay up, and there is discussion amongst staff about access and equity.

There is a power point for charging laptops in each laptop locker. To save carrying a charger all day, students are encouraged to charge laptops overnight. Some students do not plug their laptop in because it's *"a bit fiddly"* or they *"can't be bothered."* Students are therefore required to carry their charger to class and use power points in the classroom. This is a problem if students don't carry the charger. Jill has no sympathy for students who choose this option:

> *Oh! The chargers! If they don't have to bring the charger they won't, because the extra weight it adds, poor babies…and you know how small those chargers are! Ahh, and getting them out of the lockers is a pain in the arse…*

Jill thinks that students should be able access a laptop regardless of whether they have their key or charger. She is all for equal access. Jill thinks students are *"disadvantaged"* being upstairs in Science, because they can't access the laptop or charger as easily as other classes. It places pressure on her students to be better prepared than students who can access lockers from classrooms in the Sub-School. There's only one Master Key for each Sub-School that unlocks all the lockers, and it's kept with the SSL who is usually teaching. Normally, Jill sends students from Science down to the Sub-School to get their charger and/or laptop. This means an adult *"down there"* has to deal with her students. Jill says other staff in her Sub-School *"have a problem with it"*, because it means they are acting as laptop monitors when they should be teaching or are on 'Duties Other Than Teaching' (DOTT). One day, in Block 6 (the last period of the day), Jill's class is complaining about flat batteries and chargers. Jill explains she can't send them to get laptops and chargers anymore. There have been complaints about the class causing disruption when walking to the Sub-School. Jill tells me *"they yell and whistle and bang on the windows."* In this lesson, instead of allowing students to the Sub-School, Jill tells them to *"work with someone who has a laptop."* This is a great work avoidance strategy for students without laptops, as the person with the laptop is the one left to do all the work.

Lee[24] agrees that the 'must have laptop and charger' rule is a loophole, a grey area of policy, that allows students *"another way"* to *"waste class time."* She says students will request *"Can I go get my laptop?"* or *"Can I go get my charger?"* after recess and lunch, because policy states laptops are put away at breaks to minimise damage. Lee knows that teachers then can't say, *"No, you can't get your laptop"*

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[24] The other science teacher whose classes were not included in the research

because *“technically the student is fulfilling a school rule.”* In Lee’s classes, this means that *“fifteen minutes of class time is wasted just going to get the things.”* It’s the same in Jill and Sarah’s lessons, where much of the delay in starting and continuing lessons relates to laptop technicalities.

**The pressure.** Part of the pressure for science teachers stems from just being a 1:1 school. Jill and Sarah believe there are implied expectations for technology use, and that they are *“being watched”* by Admin. Jill explains:

> *They* [Admin] *like to push us a lot. They’re certainly encouraging! Um, but I use it* [laptops] *a lot anyway...but I dislike having to document it every time I use it* [sigh]*...it shouldn’t be like a big formal review every time we use the laptop! It’s a tool. I’m not there to teach, I know it’s horrible, but I’m not there to teach laptops. I will use it as a tool to encourage learning, but I’m not gunna go out of my way to...*

This quote illustrates a commonly held belief amongst science staff that digital literacies take up too much time, and that it shouldn’t be part of the science curriculum. Being 1:1 increases the pressure to dedicate science time to learning how to use technologies. The next section further explores these science teachers’ beliefs about science teaching and learning.

## The Way Teachers Do Science

This section contains vignettes that illustrate the culture of the learning environment in the context of Class 1 and 2 science teachers. The vignettes focus on how teachers impact on the use of computers in science in a 1:1 middle school environment (Research Question 1). First, the absence of collaborative meetings is raised as a precursor to describing teacher practice.

**Collaboration.** The VVC Science Department sits physically and ideologically apart from the Sub-School structure adopted by VVC as part of its middle schooling philosophy. Science is upstairs, and the rooms don't share windows like in the Sub-Schools. Contact with other science staff is minimal. There's no shared DOTT, out-of-hours meetings, or collaboration. Jill sums up her life in *"the box"*:

> *I don't see a lot of other teachers up in Science, coz once you're up there you're sort of boxed off, you don't even see the other science teachers. So I see nobody!*

VVC science teachers do share meeting time with other Sub-School staff. This is a way of keeping on top of pastoral care, but doesn't extend to pedagogy or curriculum. In 2010-11, the absence of science meetings contributed to poor communication between science staff. The practice of science staff must be viewed as teachers working independently. The following sections describe the practice of the three science teachers who taught Class 1 and 2.

**Jill (Class 1 teacher).** Jill is an experienced science teacher who taught in another challenging high school prior to VVC. Lee thinks Jill should teach *"upper school or university"*, because she *"knows so much it makes me feel stupid."* Whilst Jill's content knowledge is amazing, some staff[25] consider her behaviour management *"problematic."*

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[25] For confidentiality purposes these details are excluded

***Pedagogy and behaviour.*** In science, Jill uses positive behaviour management strategies, which for her means ignoring negative behaviours, so she can *"focus on the kids who want my help."*[26] Jill likes to stand at the front of the room and lecture. When she finishes talking, she moves between tables providing help to *"those who want it."* For a brief period at the start of 2010, desks were in groups, but Jill quickly reverted to rows, as there was *"too much off-task behaviour on the laptops."* Jill warns me of the cohort, *"you need to be prepared for their lack of work."* This low expectation is countered by the different expectations she has for different students. For example, her expectations of low literacy students are different to others, like her group of *"good girls."* Jill tries different things to encourage students to work at their level. She writes on the board so low-literacy students can copy answers, and directs students to sections of webpages, even the exact sentences she wants copied. She sends students to websites with scaffolded cloze worksheets, and negotiates different amounts of work for different students, e.g. low-literacy kids do four questions, other kids do all of them. She even sets up collaborative groups so that low-literacy kids work with students who have more chance of finding the right answers and stay on task. Jill blames poor performance on low literacy and attendance, telling me many students are *"below 80% attendance...they miss a lot of work"*, and they *"struggle"* to keep up. Jill repeats some lessons for these students, because *"many of them are probably seeing parts of the info for the first time."* It's hard for her to juggle these students and her *"regular attenders"*, who are *"able to breeze through."*

Jill likes the concept of self-regulated learning and self-paced lessons using laptops, and has programs of work on the school intranet, her VVCNet wiki, *"so my*

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[26] All quotes in this section are Jill unless otherwise stated

*more able kids aren't always held back."* Jill thinks she "*badly neglects"* her *"normal"* students. She is *"not able to help them through when they need it"* because *"others in the class are very weak and demanding."* These 'others' include the majority of the class, and all of the Indigenous boys. Jill openly admits, *"I feel my behaviour management is pretty weak."* She is very tolerant. On rare occasions when Jill's patience wears thin, she says things like, *"Now I'm feeling a certain amount of disrespect"*, but it's hard to tell she is angry because her voice doesn't change. Jill's relationship with her Indigenous students is a tricky one. Jill tells me she is *"intimidated, especially by Aboriginal boys"*, and she finds it *"difficult to control a class with so many off-task boys."* Jill plays a balancing act. She needs to keep the group leaders onside, or others will *"copy"* their negative behaviour. She ignores their lack of work to prevent confrontational behaviours, like yelling and verbal abuse. Sometimes this means the boys huddle around a laptop playing games, totally off-task and left to their own devices.

In one Year 8 lesson after lunch, Matt, Luke, Leo and Bill are flicking girls with a tea towel, climbing on desks, and making threats, e.g., *"Kate you Fuck! Shut your hole!"* Jill struggles on with her lecture, and after reprimanding Matt, he gives her the finger, yelling, *"Get that up there!"* The EA is heads-down at the front with her student trying to keep focused. Jill keeps ignoring this disrespectful behaviour, because the *"good"* kids at the front are engaged and asking questions. It's so normal for these boys to be disengaged that everyone else just gets on with it. Jill asks the boys to *"be quiet"* several times and makes non-committal threats that do nothing to signify a real level of concern, such as *"Let's get started. Wasted about 10 minutes. We'll make that up at recess tomorrow if we have to guys. In the meantime, shoosh."* She misses most of the towel flicking and desk climbing, because she's facing the whiteboard. Matt tells her to *"Shut* *up!"*, and she finally makes the decision to *"send them to the Sub-School"* because *"I don't like being told to shut up by boys who are wrecking my class."* The boys won't go, and there's no one to make them. Jill looks to me for support. I open the door and usher them out with *"C'mon guys, let's go."* Matt leaves with some fanfare. Outside he tells me he's *"bein' naughty"* because this morning in Form Jill said he was *"retarded"* for hanging out a window. There is a long story that goes with it, involving a laptop held out a window. Ethically I cannot describe the scenario, because it involved a student who did not wish to participate in the study.

Jill's take on science and behaviour is different to mine. This is something I have drawn out from critical incident analysis, where the things I was experiencing in Jill's class either resonated with, or grated against, my experiences in similar situations as a teacher. Jill believes the negative things that happen in her class are the result of large class size and the student cohort:

> *Left on my own, the first thing I would do is cut the class sizes down to twenty, and then we can do some real hands on stuff…There's two sets of kids we have here. There's the kids that are able to do abstract thought, for want of better…and then you've got your concrete kids. And your concrete kids have to see and manipulate to really understand what you're talking about. Um, we can make them rote learn the abstract stuff and hope they remember it when they're capable, but it's not as valuable as them actually understanding it, applying it.*

I think Jill has a confused view about constructivism. Jill's understanding of science learning splits her students into 'abstract' and 'concrete' groups. My understanding of constructivism is that 'concrete' experiences lead to new 'abstract' ways of thinking: prac[27] then theory. Nevertheless, it comes back to behaviour, because these *"concrete kids"*, which are all of her Indigenous boys, cause problems for Jill, and are often disengaged during 'abstract' lessons. Jill claims I don't see the majority of the problems because 'concrete' kids are on their best behaviour when I'm around, *"your just being there changes how they behave."* Some of the most confronting scenes occur during prac work, which Jill provides for her 'concrete' students. I feel sorry for Jill, because there are very few occasions when senior staff, including Jill's Head Of Learning Area (HOLA), Sub-School Leader (SSL), or other school administrators, are around to witness the crazy scenes in her classroom.

***Pracs for the concrete students.*** Given that Jill thinks her concrete kids need practical hands-on learning experiences, she is *"not confident using hands on with these guys, as many will not use the time productively."* Nevertheless, over 2 years I saw some instances of practical work. I saw students boil water, heat metal balls, make electrical circuits, and test balloon rockets. Students also told me about other pracs: a heart dissection; making ice cream; using a Vandergraph machine; rock classification; and Lego robots. Jill finds it frustrating that students *"think they like pracs"*, yet they *"will not follow instructions" and "do not follow through in results and discussion."* The laptops sometimes come in handy during prac lessons. Jill says most students *"don't like writing"* especially during prac, so laptops enable them to record activities using PhotoBooth and/or ComicLife, making it seem less like work:

> *…if the photos are there I know they've done it…they've worked through and they've broken it into steps, to take the photographs in steps.*

[27] In this dissertation the term 'prac' describes practical sessions/activities in science.

> *Sometimes they don't, and you'll just have a series of photographs, but you can tell that they haven't broken it into steps in their own mind. And your methods. Usually I'll get them to take photos of their results and that as well. There's a before and after sort of scenario. Um, but I've actually found it better for the method to break up their method into steps and then they can write their steps in their method. I would imagine it helps low literacy kids, but I would imagine it only helps them in the same way it helps the high literacy. It's just another way to get it into a…to organise it basically to themselves. I think that there are things that they can do on the laptop, that if it was just writing, they wouldn't do at all.*

Laptops make it easier for Jill's students to document their understanding of practical activities. However, a number of students do not bring their laptops (e.g. Matt and Bill), so there is little evidence of progress.

Jill's take on what it means to conduct investigations in science is different to mine. At the start of 2010, I saw a number of lessons where laptop use during prac took me outside my comfort zone as a teacher. These were crazy times, where my fieldnotes contained exclamation points and questions about behaviour management. In retrospect, I had written wearing traditional science teacher goggles. I did not like seeing chairs out and bags scattered. I did not like students running around (apparently) off-task. Jill saw things differently. When I saw students burning hair, Jill thought, *"at least they're changing variables."* When I wondered why Jill didn't get everyone to shut laptops when she was trying to talk, Jill thought at least *"some of them were doing what I asked."* In 2011, Jill does not often use laptops in practical lessons because of the risk of damage.

***Research and HLEs.*** Jill uses laptops for web-based interactives (HLEs), and web-based research using specific websites, accompanied by a hardcopy worksheet, because *"there's a lot of crap on the internet."* Jill doesn't think student search techniques improve after 2 years at VVC: *"they still don't know how to do a proper search, and if it's not in the top three links, it doesn't exist…and they don't get you can't put one word in and get the answer!"* Jill scaffolds internet searches in various ways. She doesn't let students Google answers because *"There's so much trash on there! They'd just end up coming up with the wrong information and teaching themselves the wrong thing...they Google everything, unfortunately they don't always get the right answer."* She directs students to Wikipedia *"because I know that it's fairly concise coz they got their encyclopaedia format…coz everything else is just over their head."* In 2011, Jill notices a new trend, where students:

> *…type the whole question in and Google it! Not the search term or whatever they're looking for, but y'know, with punctuation and everything! And I'll tell you what, nine times out of ten, doing it that way; they'll hit the answer because somebody's got the answers, word for word* [gawwaff]*…laziness!*

Jill uses HLEs *"a lot"* for *"things which are hard to model"*, like motion and electricity. In late 2011, I spent 7 hours (not all at once!) with students as they worked through HLEs about motion. I noticed students clicking quickly through the HLEs searching for answers, but not reading the text. They skipped bits that didn't have information (e.g. animations) and hunted for key words. The so-called 'fun' bits were not fun. They were *"boring."* When I tell Jill some of the choice comments, she is not surprised: *"I didn't presume they liked 'em, but I thought they preferred them to notes* *and bookwork."* She doesn't seem to mind that students are bored: *"Next time I might do more fill-in-the-gaps sort of stuff, where they have to actually physically go page by page."* When she realises some students do not like the voiceovers, there is a simple solution: *"If you don't like the voice, read it yourself and turn the volume off!"*

***Hitting walls.*** Jill ends the study period having come full circle in her laptop journey. Jill has tried and given up on most of the high-end production type uses of laptops. She *"ended up scrapping"* digital portfolios because of constant excuses for lost work, like, *"Oh it got wiped", "Oh it didn't save", "Oh, I had to swap laptops", "Oh, I did it on so-and-so's laptop and they're not here today."*

There is a conflict between the way Jill likes to deliver curriculum and collect student work samples, and the policy of the school. The school wants people to 'go digital', but Jill has tried it and does not like it. Jill likes students to *"print a lot of work"* but knows *"I'm probably gunna get bitten sooner or later on the cost side…they're really pushing us on photocopying this year, and I hate it."* Her student work is hardcopy, because *"if it's on paper, I've got it."* Jill *"hates marking digital copies"* because it takes *"double the time."* It takes too long to get work on and off laptops, and *"it's very hard to track their work"* because StudyWiz, the school platform for file sharing, is *"unreliable."* Jill creates assessment tasks on paper because it's *"easier marking"* and *"easier to check progress."* Rather than being tied to her computer, checking and marking uploaded work, Jill likes to walk the room, and *"give feedback by scrawling some notes on paper."* She can physically see *"how much you've done"* this way, because *"if it's writing it on the computer, I don't know where you're at!"* Jill also finds it easier to communicate with parents without laptops, because unlike digital work, which has to be found and transmitted, *"physical copies can be shown easily."*

In 2011, Jill adopts a less is more approach, because she found herself and her students continually *"hitting walls"* with laptops. Pre-2011, she did more StudyWiz, VVCNet, file sharing, GarageBand, podcasts, iMovies, and writing up experiments. By 2011, she preferred not to use these time-intensive applications/activities, because students spent too much time learning *"how to use the programs"*, and there were too many *"technical potholes."* Jill thinks that *"some of them…50%…think it's* [the laptop] *a game machine…a toy."* In 2011, Jill gets tough. She threatens detention for laptop misuse. Students must close laptops when she is talking. Laptops are used less in experiments: for a balloon rocket activity students can't take laptops outside to film *"because they'll get damaged"* (there have been a few cracked screens). However, by then, students do not want to film anyway, because it's become *"boring."*

At the end of 2011, Jill is so disillusioned with laptops she suggests the school needs to get rid of them altogether, and have *"iPads for the textbooks and everything back to paper imo."*[28] Jill gives students the option of paper work, because this caters for students who, for various reasons, do not have a laptop, and just do not want to use them. She calls this *"flexibility."* Students keep coming to her class without their laptop and/or can never find their work on them. She has to have two lessons prepared at all times: one for laptop students and one for those who don't bring them. It is very time consuming, and *"it sucks…so annoying."* Jill's strategy for students who do not bring laptops is that *"I usually try to make sure they do something less interesting, coz then it becomes a punishment, which I think is appropriate."*

[28] "imo" = in my opinion

The overarching theme to Jill's work is that her students misuse equipment and want to be disengaged, and laptops just add to the problem: *"they're still, a lot of them are work avoiders as well, misuse of the games and things, but it's less about the game and more about the avoidance of the work."* Task avoidance, and student disengagement in general, is a major problem in Jill's class, but it characterises the general culture of science at VVC. Jill's style of teaching follows the traditional approach of 'sage on the stage', and although she attempts to use practical work to engage her students, her need to provide 'abstract' or 'concrete' experiences really highlights the discord between her theory of science teaching and learning, and constructivism.

**Sarah (2010 Class 2 teacher).** In 2010, the Class 2 teacher, Sarah, is a mature-age graduate. Sarah's take on laptops is a case study of how a new, inspired graduate struggles to work through issues with technology. During the study period, Sarah took few risks with laptops. Her measured approach was due to the advice of her 2010 Head Of Learning Area (HOLA) who resigned at the end of Term 1.

***Accountability.*** When Sarah's HOLA resigned in her first six months of teaching at VVC, he spoke of *"concerns"* for *"accountability"* which influenced the way Sarah used laptops. Sarah, forced to sink or swim (*"keep her head above water"*[29]), had no performance management or mentoring after this. Even with Jeff coming on board as the HOLA in 2011, Sarah talked about limited communication: *"He sort of hasn't really said…we've just handed in programs and that's that…I don't know…"* Sarah claims she didn't receive any laptop training from the school (*"No, none"*) but she has a laptop

[29] All quotes in this section are Sarah unless otherwise stated

from the VVC loan pool. Sarah knows there is an after-school voluntary *"club"* for *"laptop stuff"*, but she expresses her dislike for professional learning (PL) after school, because she's *"too tired."*

Laptops were often unavailable in Semester 1 2010, so Sarah's first HOLA recommends bookwork, which is *"more reliable."* Sarah relies on her data projector to transmit information from her laptop, because in many lessons the laptops fail, and, as Sarah explains *"the whole lesson falls apart…we've all got data projectors in our rooms, so we're able to pretty much do what we were going to do, but the kids don't have access to the technology, so, um..."* Sarah struggles to use laptops in her lessons. Class 2 uses laptops in only 8 of the 20 lessons observed in 2010. These were research lessons, where laptops are a tool for Googling answers, and the information placed in Word, PowerPoint or Pages. Sarah didn't use HLEs because *"I haven't found any science games they can play. I sort of haven't found anything really suitable, which is a bit of a shame, because the kids like doing that* [playing games]*."* Sarah doesn't print student work samples, of which there are few anyway. She thinks there's a strong message from school administrators that it's not ok to print or photocopy. In an administration style voice, she mimics *"No, we don't have the budget."*

One of the most notable features of Sarah's lessons is the lack of practical instruction that usually comes with being a middle school science teacher, and the total absence of laptop use during pracs.

***Pracs.*** You could count the pracs I saw in Sarah's classroom on one hand. Sarah believes laptops don't help students learn science concepts because *"they need hands on for that"*, yet ironically her students do not do prac *"because of their behaviour."* In a heart rate experiment, students took their pulse using repeated trials. Laptops weren't used for data collection (e.g. recording data in a table), because Sarah wanted a hardcopy of student work. Each group had a piece of paper, and copied numbers from the class table on the whiteboard. Sarah modelled the process from the front of the room in a lock-step fashion. Even with this level of control, students like the boys at Cozza's table, who are mainly Indigenous students, get nothing done.

I talk with Sarah about the potential to use laptops during practical activities. She reveals some concern for her own digital literacy, for example she doesn't know how to use Numbers (a program like Excel available on laptops), so doesn't use it. She can use Excel, but doesn't believe the time it takes to create a data sheet is worth the effort. It doesn't support students, who must manually create graphs and tables for statewide standardised testing[30], because *"they need to draw a graph and they don't have a laptop to do it."* Sarah also has clear ideas about student capabilities. She doesn't think they need to learn about Excel, because it's *"gunna be of no use to them for anything, unless they're going to be using Excel later in life"*, and *"they may have forgotten those skills anyway if they don't use it between the end of Year 9 and the end of Year 12."*

***Pedagogy and behaviour.*** Sarah rightly believes Class 2 is difficult, because *"at times they were unteachable…Block 6s, sometimes Block 5s, you know, after lunch…afternoons were hopeless with them…you needed to get them in the morning in order to get them fresh."* Block 6 really is a nightmare. I observe a lesson where at least five students arrive 15 minutes late, then sneak out to hang out the balcony window

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30 This assessment tool ceased in this jurisdiction in 2013

adding their names to tags on the wall. Sarah doesn't even notice because it's that chaotic. Similar scenes occur throughout the year.

Sarah uses traditional science teacher pedagogy. Like Jill and Jeff, her room is set up with rows facing the front. She tried group desks for a few weeks, but *"they socially couldn't cope with the group situation."* There was a lot of off-task behaviour on laptops, and Sarah did not know how to deal with it:

> *I couldn't see what they were doing on the computers…the minute that you turn your back or you walk away, or you walk towards the front it's 'Apple' or whatever it is, and they're back onto whatever. And no matter what you block, they're finding some other way around it - some other bypass proxy, some other thing to get onto wherever they want to be.*

Sarah knows students spend a lot of time off-task on laptops, but with desks facing the front, she must stand at the back of the room to see screens. This doesn't happen often. I sit at the back of the room and watch students play games and surf the net. Most are quiet and not distracting others. Whole lessons go by where Sarah doesn't check what students are doing at the back. If students want her help, they go to her desk at the front. If not, there is little interaction. The loud and confrontational students get all the attention, not students who are quietly doing their own thing on laptops. The dummy effect[31] works well in Sarah's class. This is where teachers use laptops to placate students so that they don't engage in disruptive behaviours. It's common practice in VVC science.

[31] In other countries a 'dummy' is known as a pacifier and its use has the effect of keeping babies/small children quiet.

Sarah clearly makes known her preference for *"chalk n' talk"*, albeit instead of writing on the board, she uses a laptop and projector. Sarah thinks this transmission through technology is *"easier for me to get the information across, I can get lots of graphics and it caters for the visual learners and it caters for those that want to read the information."* Sarah likes students scribing from these presentations, and they do this using a laptop or paper. Many choose not to use laptops, because they don't have to. Sarah gives them a choice. Sarah thinks scribing is important:

> *Because I want them to have a record of some sort that they've actually been at the lesson and that they've, whether they've learnt anything from it, but they've actually taken something, and they have something concrete that they can then go back and study.*

When I look through some of the 'good' students' laptops at the end of Year 8, there are few work samples, even scribed Word documents. *"Where are they?"* I ask Sarah, and she doesn't know. Sarah doesn't use laptops to collect and mark student work, because:

> *It's very difficult to mark that way. Um, just the physicality of going online and being online and physically trying to...deciphering a way to....so you're either gunna track changes, how are you going to physically do this?...It takes so long! I have tried, and it took me more than a whole weekend to do a whole class online, it was ridiculous. Never did it again.*

Like Jill, Sarah tries and then discards digital tools that seem to be too hard or time consuming. This could be related to digital literacies of teaching staff, but because

Jill is experienced with laptops (and has the required digital literacies), it is more likely to be a consequence of the technology in its current form not meeting teachers' needs.

Towards the end of 2010, Sarah's frustration and disappointment with Class 2 is evident. Sarah thinks students don't like science, or see the relevance of science to everyday life. She also is not sure about students' ability to move forward in life:

> *What I can tell you is that none of them are EVER going to use science after they leave school, and despite the fact they will be doing science in Year 10, they will NEVER do science again! Pity help the mining profession, hairdressing profession etc. etc...if they never use science! You can't tell them!*

Sarah doesn't think much of laptops either, saying after a year working in a 1:1 school that *"I guess for some of the low ability kids computers are working, but for most of the kids, I think they're more of a hindrance than a help."* Sarah doesn't believe in their affordances, but this relates to her negative experiences with them, and she has no professional learning (PL) opportunities to move her beyond such beliefs. Over the year, Sarah's teaching consistently takes a 'sage on the stage' approach, and her traditional beliefs about teaching and learning, in particular her focus on theory over practical experience, categorise her as a traditional science teacher.

Jeff took over Class 2 in 2011. He also became HOLA to fill the leadership vacuum created in 2010. Unfortunately, he is too late for Sarah, whose opinions about laptops are firmly entrenched.

**Jeff (2011 Class 2 teacher).** Jeff has over 20 years' experience in a variety of school roles as middle and senior school science teacher, science HOLA, Sub-School

Leader, and Deputy. In 2010, Jeff was Deputy in charge of student behaviour, and in 2011 is science HOLA. Students go to Jeff for behaviour management in both 2010 and 2011. Jeff has power to suspend students, which is something only a few administrators can do.

Jeff has a firm belief that his job is solely to teach science. Students come *"to learn science"*, and their emotional needs should be met elsewhere, because *"we aren't psychologists."* These views are consistent with the pipeline science philosophy, which ignores the identity of students.

Unlike Jill and Sarah, Jeff is free to attend PL in school hours, because he doesn't have a full teaching load. This PL includes shopping for ICTs:

> [I] *went out to a, with the Deputy Principal to a, I dunno what you wanna call it, Toy Exposition, if you like, ahh, looking at eBeam and some of those sorts of things…*[32]

Jeff has increased exposure to new, innovative technologies. He uses the latest 'toys' in his lessons e.g. Mimeo. Interestingly though, Jeff incorporates this technology into his existing transmission pedagogy. The next section, 'Control', explains how this works.

***Control.*** Jeff's lessons are highly structured, and his room is very tidy. Jeff has a wiki on VVCNet. Most of his curriculum is there, including pdf book chapters, worksheets, HLEs, web links, along with other *"bits and pieces."* I shared a room with him one year, and learnt a lot about classroom management and traditional science

[32] All quotes in this section are Jeff's, unless otherwise stated

during this time. The key to Jeff's style is lock-step control. Jeff's lessons are different to Jill and Sarah. He waits outside for the class to arrive. Students line up, enter quietly, and stand behind desks until his command to sit. No laptops come out until he finishes delivering instructions. Like Jill and Sarah's rooms, the desks are in rows facing the front. He uses this *"boring seating plan"* for monitoring laptops, but unlike Sarah and Jill in 2010, Jeff has a new *"toy"* that helps him: he uses Mimeo Smartboard technology with a remote, so he can stand at the back of the room, use the laptop with remote, and see student screens at the same time. This avoids the hassle of students being at the back and off-task as in Sarah's lessons. Jeff models where students should be in their work. His laptop is a navigation tool that prevents students from getting lost:

> *Ok, so basically my laptop mirrors, for the most part their laptop, so I've set it up as part of the environment with the wiki pages and stuff like that, so rather than having to say, "Can you see this part of your screen?", I want 'em to have the same screen I've got, and they can look up what I'm doing, see the bigger picture rather than worry about minute detail on their screen...upside to me being at the front doing it is I can stop, talk to a point, move on, stop, talk to a point, move on. I can control it a lot easier.*

Jeff believes he can *"control the environment"* of the classroom by using sage-on-the-stage pedagogy. He models with *"all eyes to the front"* and *"laptops closed."* This way, he avoids the *"waste of time"* that comes with students trying to find things on the wiki *"again and again and again"*, which is just *"another way for them to avoid work."* Jeff takes this chalk n' talk approach to laptops when sound is involved. He plays digital resources through the projector with the class speakers, because:

> *If everyone's doing it, if they don't all have headphones, and they don't, then what you have is not everything started off at the same time. You get nice lovely stereo effect, a wall of mashed sound, and then it becomes 'I've gotta turn it up louder so I can hear it' and it just gets...it's a waste of time.*

While it makes Jeff look like a control freak, his lessons are less hazardous than Jill and Sarah's lessons. There are no crazy times. It's ghostly silent, and even I am too scared to raise my voice to more than a whisper when I am talking with students.

Another tool of Jeff's is the bribe. He makes bargains like:

> *Assuming everyone's done the right thing…Block 2 we'll watch Mythbusters…but, if you go to sleep on the desk, then that's not everyone doing the right thing, is it? Yes? So, you need to be going flat skip.*

This reinforces the notion that laptops are a tool for work, because students access work through the laptop, then relax and watch a movie (not through their laptop) as a reward.

***Playing catch-up.*** Jeff tries to use laptops to enable students to work at their own pace, but given the nature of the cohort, and the low attendance of some students, it means there are always students *"playing catch up."* Jeff believes laptops *"gives kids access"* to *"self-paced"* programs of work, specifically his wiki pages. Within these self-paced units are *"learning objects"* (HLEs) that engage *"some"* students because they are *"hands on."* Like Jill, Jeff uses HLEs from The Learning Federation (TLF), though he admits the available HLEs *"don't teach them everything"* but *"help* *consolidate things."* They are also a distraction for students who don't work well in an online environment.

Jeff uses the wiki when dealing with students who have been absent. It allows them to *"play catch up."* Jeff instructs these students to *"sit over there, or in your seat, and you just catch up…or you can put 'em in another room."* Because Jeff's curriculum is accessible on the wiki, students are free to *"go back and hunt through things, and drag it back up"* if they need to. This also allows students to revise work without needing to access Jeff. However, these uses of laptops are limited by students' poorly developed self-regulation, which is in part related to literacies.

***Literacy.*** Jeff believes literacy is important when working online. Unlike Jill, Jeff doesn't like students using Wikipedia. He *"usually direct*[s] *'em to stay away from Wikipedia"* because:

> *It can have easy answers, but a lot of it just dribbles on, and the kids don't know how to screen through all of that, and then they just go lost* [waves arms airy-fairy]*…and they don't know what to do with it.*

Jeff's average and high literacy students can cope with internet searches, but laptops make things *"worse"* for *"really low literacy students"* (e.g. Chris). Jeff says websites with *"just small print and lots of words"* cause students like Chris to *"switch off immediately"* because *"when you don't have clean pages it's harder to see and read."* Jeff counters this by scaffolding search tasks with a worksheet and directing students to selected websites. Jeff's literacy concerns are not just for *"low literacy kids."* A new trend *"in the last eighteen months"* sees worksheet questions typed into search engines (e.g. 'Ask How'), then copied as an answer. Jeff worries *"they still haven't* *learnt anything coz they haven't read anything."* Jill has the same concern about information being collected and not processed. However, where Jill says it is *"laziness"*, Jeff thinks *"it's a simple quick strategy"* and he is *"not gunna condemn a kid for it."* Jeff thinks students are looking for quick and easy ways of doing science work, and he calls it *"their work habit of avoidance."*

***Their work habit of avoidance.*** There are students in Jeff's class who he believes will attempt anything to get out of work, and this explains his lock-step approach. Even before practical lessons, students work as a whole class to read the prac instructions, which are a pdf file on Jeff's wiki. Jeff walks between rows as students use the highlight function in Adobe Reader to highlight key 'doing words'. For students without laptops, Jeff has printed instructions. Jeff always has two sets of work, just in case a student is *sans* laptop. It is rare, because Jeff is strict with detention for such a misdemeanour. I talk with Jeff about students not bringing laptops to science. He links it to learner disposition. Jeff thinks some students, particularly those with low literacies, are *"less personally motivated to learn."* With Jeff's long history in the classroom, he suggests it has been this way since before laptops: *"I remember before the laptops, it's still the same problem."* Jeff places the origin of this behaviour, *"a work habit of avoidance"*, at a time before kids attend VVC, *"so by the time they get to us we're already looking at that, and it's just becoming exacerbated. It doesn't really seem to matter too much what system* [1:1 or non 1:1] *we use."* He blames negative attitudes on experiences in primary school.

Jeff does not think any of the Class 2 students engage in his science lessons, and *"even the good kids don't care...there's nothing any of us can do to make them."*

Unfortunately, Jeff has Class 2 twice a week in Block 6, the last block of the day. School-wide, this is a notorious lesson, which Jeff sees as a *"waste of time"* because *"brains are shut down, they're already goin' home."* This is another reason for the lock-step nature of his lessons. Jeff needs to control student behaviour, and ensure students are on task. This control is evident in the way he allows students to use his wiki. Jeff directs students to one or two tasks at a time, because *"if you don't put some kind of boundaries on it they'll just go, for want of a better word, feral…feral all over the shop."* He likes the strategies he has in place because *"you start to curtail some of the time wasting."* Overall, Jeff thinks laptops are *"another tool to avoid work"*, and he enjoys a good ambush at any time of day:

> *I'm looking for certain body language, which is a giveaway: the eyeballs twitching over the top of the thing, looking to see where I might be. But if they're gunna go, they're gunna go. If you're gunna catch 'em I'll usually give 'em a chance to get involved in stuff, and then I'll just wander around or look like I'm getting lost and then turn up right behind 'em, which I'm very good at doing.*

Jeff doesn't think methods of work avoidance that students use on laptops are *"different to what I've seen on paper really, basically it's just a variation on a theme."* Jeff shares some of his favourite time wasters with me: *"I've lost my work and I don't know where it is"*; playing with magnification settings; colour coding and sorting folders *"for the eighteenth time."* Jeff believes students should do these things *"at home, in their own time."* It's frustrating, but he's used to it after years of *"the same old thing"* in the laptop program.

Jeff is okay with students who are off-task on their laptop that are doing *"something that was a lesson"* (e.g. a Learning Object), but there *"are some kids who spend their time trying to play games and that's their objective, they're a slightly different kettle of fish."* Jeff's take on these students is interesting:

> *They are the ones who do not want to be engaged. They're not just disengaged, they do not want to be engaged…and as far as they're concerned, we're interfering with their social thing. This laptop is theirs, they will do with it what they damn well please, and what they wanna do is play games.*

For Jeff, as with all science teachers, it is an ongoing battle to get laptops to science, and to have students engaged in science learning.

***On constructivism.*** A previous HOLA introduced the theory of constructivism to science staff at VVC. Teachers, like Lee, use the model. Jeff's views are that VVC students are not yet ready for constructivism:

> *I think there is a certain amount of sage-on-the-stage. It is 'these are the facts, you need to know them.' It's like saying you need to know your times tables quite honestly. Y'know all the other stuff, you need basic information from which you can then, well, operate off. There's certain base information which I, I think students just need, it's rote learning it's the only way to describe it. Something that they can sit there and their brains can churn over, engage, explore and all that sort of stuff. And then they're operating with something, otherwise they're like, looking for the black cat in the black room, it's not there.*

Chapter 6 further examines ‘the black cat in the black room’ theory that VVC students do not have the knowledge and skills to navigate VVC science curriculum. It opens up the dilemma of either teaching to student needs or teaching the standard curriculum. Jeff’s theory is out of whack with the Australian Academy of Science, which advocates the use of constructivist teaching and learning across all age groups (AAS, 2014a, 2014b), as does the Australian Curriculum (ACARA, 2014a).

## Conclusion

This chapter described general school structure, laptop procedures, and teacher pedagogy, including beliefs about teaching and learning at VVC. Chapter 1 explained that progressive educational theory underpins middle schooling, which can provide a more holistic educational experience for children in early adolescence over a traditional high school structure. This chapter revealed that VVC science is structured as a specialist subject, just like a normal high school. For science teachers, the dual role of Form and Science teacher creates a tension that is based on the administration of the laptop program. This impacts on the development of positive relationships between staff and students.

During the study period, there were issues related to access to technology. Semester 1 2010 was a write-off, because a new laptop contract, then a new WADoE operating system, combined with general technical issues, meant laptops weren’t available much of the time. There were also access issues related to ‘take home’, the key, and the charger over the 2-year study period.

The data explored here illustrate that science teacher practice in the context of the 1:1 middle school at VVC supports the culture of traditional school science. Jill, Sarah and Jeff use traditional transmission pedagogy. This contributes to the limited collaboration between teachers, students, other classes, schools, and the community. In VVC science, laptops are used mainly for word processing, research, and modelling. There is evidence of laptops being used occasionally in practical lessons, but it’s not popular because of safety and engagement issues. In their lessons, teachers’ attempt using bling software, but their students just *“aren’t there yet”*, and multi-modal forms of delivery and production are *“too time consuming.”* Jill, Sarah and Jeff agree that as science teachers they don’t have time to teach digital literacies. Jill and Sarah don’t trust technology because they have too many negative experiences. Teachers are constantly trialling new technologies, which they replace with ‘reliable’ hardcopy ways of doing things when it gets too hard. The chapter concludes that teachers are constantly cycling through the beginning stages of technology integration presented in the ACOT model. Furthermore, teachers were unable to provide or maintain student-centred experiences in the long term, which is the transformative outcome expected in ubiquitous computing environments. The next chapter begins to describe the student perspectives of the science-learning environment and the culture of the learners at VVC.

# CHAPTER 6—THOSE KIDS

Chapter 6 starts to build a picture of the learners in Class 1 and 2. It focuses on important cultural themes emerging from the data: gender, ethnicity, age, and engagement. The chapter also includes student perceptions of the learning environment, which is critical in the development of classroom culture (Olitsky, 2006; Wood, et al., 2013). Each theme is drawn out into vignettes (stories) created through critical incident analysis. In Chapter 4, 'Data Analysis' (pp. 102-106) described in detail how critical incidents and vignettes relate to each other, where critical incidents are woven together to build vignettes relating to the culture of science at VVC. Appendix C provides an example of the critical incident analysis style used in this study as it relates to a specific, time delineated event (one of Jill's 'research' lessons). Often, multiple critical incidents captured information relating to the same theme (e.g. how boys and girls share group work tasks). Often, there were many examples of a theme, which teachers, students and/or the researcher were able to intuitively understand was part of 'how it is'. In these cases, individual critical incidents transform into vignettes (stories) that bridge across time and students, to capture common phenomena. For example, 'Girls are idiots' (p. 153) and 'We share the work' (p. 154) describe gender-linked tension relating to science and digital literacies. These vignettes are built from multiple critical incidents spanning multiple lessons, merged to succinctly illustrate the phenomenon. Chapter 4 (p. 103) explained that critical incidents and storytelling are a merging of data collection and analysis. Through the lens of the 'bricoleur' (p. 90) these stories provide specific examples of overarching phenomena that relate to the culture of teaching and learning at VVC.

The first section of this chapter is a who's who of key student informants. This is important because identity comes across as a fundamental component of science culture at VVC, and it helps the reader gain insight into students' personalities.

## The Key Informants

This section acts as a short biography of key student participants, listed in alphabetical order. Appendices D and E list all of the participants.

**Jill's class.** Vignettes in these chapters will demonstrate that Jill's class present spectacular displays of disengagement, particularly as a Year 8 group. Jill's tolerance for the students is extended because, as explained in Chapter 5 they are also her Form class.

***AK47*[33]*.*** In 2010, Jill refers to AK47 as *"very bright"* and part of *"the princess crowd."* By 2011, AK47's socialising means her schoolwork suffers. AK47 *"likes"* taking part in small focus groups, because she can *"concentrate"* without the distraction of *"boys."* By the end of Year 9, AK47 *"hates laptops"* because *"they're boring."* She can't wait for 2012, when she will attend a private school, *"because it's better."*

***April.*** Jill warns me to *"watch out"* because April *"gets vindictive"* when feeling left out. Luke says April is *"Number 1 Dobber, right there!"*, so students avoid her. Boys make threats towards April, e.g. Bill threatens things like *"I'll bash you if you don't shut your mouth."* In a couple of lessons, April hides under a desk crying. April

[33] All student names are pseudonyms, and students were able to choose their own names. For example, some students chose to use their social media pseudonyms.

often looks like she is doing important business on her laptop, but she is fluffing/GoogleLanding. It's her escape from reality.

***Bill.*** Jill considers Bill the *"leader"* of her Class 1 Indigenous boys. Bill is a dominant Indigenous male featuring in many of my fieldnotes. He runs hot and cold. He's sometimes focused on learning and ignores his peers, or sometimes socialising, and sometimes off-the-wall disrespectful. Bill rarely brings his laptop to science. It frees him up to socialise, and reduces his accountability for laptop tasks. While this is common to all students, there are no consequences for Bill. Jill pretty much ignores most of his negative behaviours. He is away a lot in 2011 due to family illness. Jill complains Bill has *"been away all term he's missed so much."* He doesn't catch up, and even being part of the Footy Academy[34] doesn't improve his performance in science.

***Chelsea.*** Chelsea came to VVC in 2011. She is confident, well adjusted, and easy to talk with. Jill says *"chatting"* and *"socialising"* means Chelsea doesn't work well, but Chelsea thinks she *"gets way more done than those other kids"* (referring to the Indigenous boys). Jill tells me *"her literacy's a little low"*, and Chelsea hides this with her 'out there' personality. Chelsea can reason well verbally, but struggles to write things down, or comprehend website texts.

***Earthworm.*** In 2010, Earthworm sat with AK47 and they were the 'it' girls. Jill says Earthworm is a *"capable student"*, but distracted by her peers. In 2010, I observe Earthworm working well on individual tasks, but *"losing it"* having *"giggling fits"* doing group work. Earthworm admits she could do better, but believes she is doing well

[34] The specialised sports program available to Indigenous boys at VVC

compared to *"those boys"* who *"don't do anything and are mean to the teacher."* Earthworm left because of bullying in early 2011. Jill is *"disappointed with the others"* (AK47, Chelsea, Nigel, Sammy), because their behaviour proved instrumental in the move.

***Fairy.*** Fairy has a stutter that Jill says is *"a processing disorder."* In 2010, Fairy is disruptive as a defence in response to bullying. For example, boys like Matt pretend they want to *"go out with her"*, meanwhile teasing her for *"talking funny"* and *"being a dog."* In 2011, Jill says Fairy is *"quite capable"*, but *"won't talk because of her stutter"*, and *"won't write things down because she doesn't like typing."* Consequently, Fairy has few work samples after 2 years of science.

***Jemima.*** Jemima is a conspiracy informant. She always lets me know what Jill and the other students are doing wrong. Jill says Jemima is a *"capable student"*, but Jemima often gets away with fluffing on her laptop instead of doing science. Like Mia and Kelly, Jemima gets her science work done quickly so she can have free time. She is away a lot in Semester 1 2011.

***Jim.*** Jim joins Class 1 in 2011. He is a 'Schools Plus' (SP) student with a physical and mental disability, who tells me *"I'll get a million dollars when I'm 18 coz I was hit by a car."* Jim needs constant support from his full-time EA, Bugs. Jim's peers use him to create disruption. This makes both Jill and Bugs angry. For example, Bill, Leo and Luke tell him lies to make him angry (e.g., that Keisha called him a *"black cunt"*), then he *"loses it"* and yells, pushes desks, throws things, and hits people. Bugs the EA says *"his peer group are cruel"*, and Jill is frustrated his *"cousins"* make him angry just to get a reaction.

***Kate.*** Kate attends only in Semester 2, 2010. She is loud and confrontational. Kate adds drama to the class, and features in fieldnotes because of disruptive behaviour. Kate *"hates"* Fairy, demanding that she *"talks properly."* Kate is subject to bullying herself. Bill thinks she is a *"dog mutt"* and there's always back-and-forth abuse. Aside from these emotional encounters, she sometimes engages in science. Kate believes she has *"learnt a lot about science from TV."*

***Keisha.*** Keisha identifies as an Indigenous Australian. She doesn't get along with other students, especially Indigenous boys. Keisha is very disruptive across the 2 years, engaging in back-and-forth arguments across the classroom. Jill and Bugs believe she has an undiagnosed learning disability. Keisha has very low literacy. There is no science work on her laptop, and only a few work samples in her hardcopy portfolio at the end of Year 9.

***Kelly.*** Jill suspects Kelly has *"undiagnosed autism."* Jill says Kelly is *"the best science student in the class"*, but this relates to her conceptual understanding and inquiry skills, not interpersonal skills. Kelly talks only to Mia, and therefore does not work well in groups.

***Leandra.*** Leandra, one of only two Indigenous females in the study, was only in class a couple of times when I was there, and never with her laptop. Jill believes

Leandra's poor attendance has a negative impact on her science achievement and the development of digital literacies.

***Leo.*** Leo is an Indigenous male who lives at the boarding house. He is often without a laptop, and easily distracted by friends. We did not do recorded interviews, because Leo thinks it's *"shame*[35]*."* We spoke often in class.

***Luke.*** Jill claims Luke is *"the brightest Indigenous boy in the class"* but *"it's a shame"* he does not use his talents. Luke is a desk jumper, and likes to hide under tables when Jill has her back turned. In one lesson in 2011, Luke is sitting with Leo at the front of the room, and they hijack Nigel's laptop to play games. This means Nigel can't do his work, but Nigel defers to them, saying *"they can have it."* Luke didn't actively engage with me, but would answer questions when I was talking with his peers (e.g. Leo, Bill, Matt). We did not do any recorded interviews.

***Matt.*** Matt is a disengaged Year 8 Indigenous male. He's always late after lunch, rarely brings his laptop, rarely stays in his seat, and is often off-task. He went away in Term 4 2010 to visit family in another town, before moving to another class in 2011. Matt has low literacy, and often features in my fieldnotes when there are disruptive behaviours.

***Mia.*** Jill says Mia is one of two *"top students"*, even though Mia says she *"doesn't like science."* Mia sits with Kelly, and other students refer to them as *"the*

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[35] 'Shame' is a term used to indicate a feeling of embarrassment. It is used regularly at VVC, particularly by Indigenous students.

*geeks."* Mia spends a lot of time not doing science. She finishes tasks quickly to get free time, then draws or Googles manga[36]. Mia doesn't talk, unless it's to Kelly.

***Nigel.*** Nigel has low literacy, which impacts on the way he engages in science. He relies on others for *"help"*, and does not attempt tasks on his own. Jill sits him up the front so she can offer support. It also means Nigel is close to her desk for reprimanding, which sometimes occurs when he is off-task waiting for help.

***Sammy.*** Sammy and Nigel are in each-others pockets when not separated for *"mucking around."* Sammy is often off-task on his laptop, in GoogleLand, or playing games, waiting for someone to *"make him work."*

***Simon.*** Simon has Asperger's Syndrome. His part-time EA is Bugs. Both Jill and Bugs talk about how the laptop is a distraction for Simon, rather than a tool for science. I see him in GoogleLand a lot. When Bugs isn't *"standing over his shoulder…he gets completely lost on the internet…he spends the whole time just Googling…"*

**Sarah's/Jeff's Class.** In mid-2011, the Class 2 Sub-School Leader (SSL) is at her wits end with behaviours from the class. There are *"bad kids being dumped on us from other Sub-Schools"* and it's changing the class dynamics *"from bad to worse."* This is an accurate description of Class 2 throughout 2010 and 2011. Bios of the students follow.

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[36] 'Manga' are comics created with a particular Japanese styling. Known as 'anime' when 'animated' as motion events e.g. cartoons.

***Barry.*** In 2010, with Sarah as a teacher, Barry was disengaged and disruptive. In 2011, with Jeff, Barry couldn't get away with the same behaviours. Barry, Chris, Cozza and Daz hang out together with other boys who chose not to participate in the study. Barry is a role model because he is a leader in the Football Academy. He doesn't like Jeff. He's always talking about *"bashin' 'im."* Barry tries to talk to me about parties he attends on the weekends, where he sees *"girls kissing"* and he *"gets drunk."* I try to avoid these side tracks, but on one occasion ask him about how this affects his role in the Footy Academy. He tells me they are told not to *"drink or take drugs"* and he *"feels good, coz I know I don't do drugs, but I drink a little."* At this point Cozza butts in and points out *"You drink all the time, you Alcho!"*, with Barry arguing *"Mmm your arse, that's Chris!"* I had to engage in lots of 'throwaway' conversations to gain the trust of students like Barry.

***Boi.*** Boi is Cocos-Malay, and hangs out with students like Barry and Chris. Boi was not outright rude to Sarah like most other boys in 2010. He often attends without a laptop. Boi is an observer, who is happy to sit around and watch other boys play games on laptops.

***Butter.*** Butter is a capable student but often absent during observations. Butter hangs out with MashCambella and other disengaged students, and it's difficult to engage her in conversation.

***Cement.*** Cement was in Class 2 in 2010. She's a 'good' student who sits with other 'good' girls. They are the group who fly under the radar in this study because they're just trying to get on with things while the world explodes around them.

***Chris.*** Chris is an Indigenous male with very low literacy. He's a leader in the Football Academy, and spent time in Perth for a leadership camp. Chris isn't allocated EA time, but can't work from websites or use textbooks. Teachers find it hard to cater to his needs. Sarah avoids him, and Jeff isolates him. In 2010, it seems like Chris exaggerates when he complains *"sometimes I ask teacher for help but she doesn't come around to me…she comes round to me and then leaves me."* He's not far off the mark. There's also usually no AIEO to help him because they're absent or dealing with behaviour management issues elsewhere.

***Cozza.*** Cozza doesn't do well in science. He's intelligent, charismatic, manipulative and argumentative. He tries to maintain his 'no shame' image as an Indigenous male. He's a wanderer. In 2010, Sarah constantly tells him to sit down, or ignores him. She's inconsistent, yet her soft spot is evident, and she tolerates him without much disciplinary action. One lesson, with Barry, he escapes and runs around out the door, downstairs, onto the oval and back again, without her even noticing. The AIEO is there but chooses to ignore them both too. In 2010, Cozza is usually shadowed by an AIEO/EA/teacher, or all three. He likes the idea of someone being on his side. He likes advocates. He is a gamer. In 2011, with Jeff, this was near impossible. There was tension with Jeff in 2011, because Cozza spent a lot of time trying to avoid science *"work."* Cozza can read, he just doesn't understand much of what he's read, yet it is too *"shame"* to have his teacher explain things. He'd rather be off-task and failing. He chooses to stir the pot, and clearly enjoys *"that teacher's sooky face"*—Jeff's frustrated and disciplinary moods.

***Daz.*** Daz is an Indigenous male with very low attendance. His frequent absences make it hard for him to find a place within the classroom. Teachers talk about his *"shocking"* home life. He has an IBP[37] and IEP[38] that run across all classes. These are modified to cater to his needs, but they do not capture the real need, which is a stable home life. We never did a recorded interview, because I felt it would stop him from talking. We had some good unrecorded yarns though. Daz is what's known as a disruptive student.

***FluroGangsta.*** Fluro loves to complain and rally against her version of injustice. In 2010, she refers to herself and friends as *"the best students."* Sarah does not agree. Fluro harbours deep resentment for the boys in class whom she refers to as *"the natives."* Fluro is openly racist and derogatory. I found her difficult to reason with.

***Jemma.*** Jemma is a 'cool' chick. She wafts negative comments like *"laptops are gay"* around in interview but isn't very descriptive. Jemma likes to agree with her peers, and inserts affirmative grunts where appropriate, e.g. if Nicole says something *"true."*

***MashCambella.*** MashCambella was a great informer in 2010, but not a good student. MashCambella is a classic example of a disengaged teen. Her relationships with peers and teachers are often confrontational. Sarah tiptoes around Mash because she *"picks her battles."* In early 2011, Mash tells me she *"hates her mum"* and *"I don't like adults."* She was the least engaged female in this class, often off-task with nothing good to say about laptops or school.

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[37] Individual Behaviour Plan

[38] Individual Education Plan

***Mouse.*** Mouse didn’t go to school in 2010. Her background identifies her as SAER. She performs very poorly in science, and is well over 2 years behind the standard for Year 9. She doesn’t talk, and the couple of lessons I spent with her were very concerning, because she just had no clue. Her Sub-School Leader (SSL) was in the process of trying to obtain specialist psychologist services for her in mid-2011 but this didn’t eventuate.

***Nicole.*** In both years, Nicole was a sporadic attender. Nicole likes science, but doesn’t like Sarah or Jeff. Her relationship with Barry is a source of ongoing tensions amongst her social group.

***Rukia.*** Rukia is an academic character, but not very social. Rukia sits up the front and always looks like she is working. She’s hard to get talking, but contributes important information about ‘good’ students and how they operate in a crazy class like this.

***Seal.*** Seal sits with MashCambella and is difficult to engage in science, or in talking about science. Seal is the ultimate disengaged student. Sarah does not try to engage Seal. She leaves her and Mash alone *“to avoid conflict.”*

***Smurf.*** Smurf is keen to be involved in the study and gives his opinion a lot, but left VVC halfway through 2010. Smurf has good digital literacies and provides useful feedback at the start of the study from the perspective of a student who wants to engage in learning and is excited about laptops.

***TimTam.*** TimTam is great friends with MashCambella. She is disengaged and does not think much of science.

## Gender

The previous section began to describe students in Class 1 and 2. A part of the culture of the learners in Class 1 and 2 is disengagement. There are real and perceived differences in the behaviour of boys and girls, with boys more likely to display extreme behaviours. The next two sections, 'Battle of the sexes' and 'Gender-linked preferences in a digital world', present data relating to these gender differences.

**The battle of the sexes.** The relationships between male students and their female teachers are different to their relationship with Jeff, whose leadership status gives him more power. Sarah and Jill tend to ignore the disruptive behaviour of boys, particularly Indigenous boys, to focus on students who *"want to learn."* This is the quiet group of girls who do their work. Students perceive the different gender roles that are played out in class. Girls think boys are more likely to be off-task *"on games and mucking around"*, and *"they don't do their work."* However, boys argue girls also *"play games"* and *"talk"*, but as Smurf points out one day, *"they do it quiet."* The following subsections provide evidence that both girls and boys engage in off-task behaviours in science.

***Girls are idiots.*** In mid-2010, Smurf *"chips in"*[39] on girls he claims haven't done an assignment, because *"they've been playing games* [on laptops] *the whole time."* I

[39] Informs others of opinion without being asked to contribute

observe this over several weeks: FluroGangsta, Jemma and TimTam play games instead of doing research. At the end of the assignment period, FluroGangsta has one PowerPoint slide that says *"Lactobacillus the cute pink bacteria"*, accompanied by a *"cute"* Google image of bacteria. In the final lesson, Jemma and TimTam quickly draw a very average poster on paper because it's *"too hard"* to produce one on a laptop. Smurf tells me this is because *"girls are idiots…like my mum…she can't use a computer."* Smurf's digital poster, created with Pages, is one of the best, so his peers call him a *"nerd."* Smurf loves to help others improve their digital literacies, e.g. he shows Fluro how to insert a saved image into Pages, but there's tension and lack of reciprocity from females (Fluro rolls her eyes). Smurf links his well-developed digital literacies to his Dad, who *"has a PS3, an X Box360."* However, Smurf also claims *"I showed him how to use the technology…I'm the person in the house who knows how to use every electronic device."* When Smurf leaves town in Semester 2 2010 *("back to Darwin with Dad")*, Sarah's class is noticeably missing its technology guru.

Girls aren't the only students who don't finish the Bacteria assignment. Most students spent their time surfing the net for cool pictures (girls), or are off-task in other ways. For example, Cozza spent his time playing a game where sheep jump a fence, because *"science gets a bit boring."* With help from an AIEO, he had *"some ideas I'm gunna do"* written on paper, but he throws this on the floor for Sarah to put in the bin before the final lesson.

***We share the work.*** Some girls share answers with boys as part of a social exchange. According to Jill, AK47, Earthworm, and Chelsea are *"capable"* girls, who flit between appearing busy, socialising, and working. They distribute the workload between themselves, Sammy and Nigel, by taking turns to find answers on websites. The girls often end up doing work delegated to the boys, who are too busy *"on games."* Sammy and Nigel happily pass the time by surfing the net, exploring software, chatting, playing games (if they can find one), even throwing pencils out the window. One day in Year 9, Sammy has been moved, and Nigel is 'working' alone (Appendix C includes details about this day). The girls ignore him. Nigel says he *"feels real weird, coz I don't know what to do really."* He doesn't like using his laptop because *"it's too hard to find answers"*, yet he doesn't like textbooks either. He has both open on his desk. Jill says Nigel's low literacy *"is an issue"*, but it is more *"about effort."* Jill structures tasks so there are parts everyone can do, but Nigel lacks confidence, and spends the lesson waiting for answers from the girls or Jill. Sammy later says Nigel *"always mucks around…doesn't do his work, and just copies off me!"*, but after conferring with AK47, who claims *"Not even!"* he admits, *"when I get stuck I ask the girls"* too. Sammy says they *"have a plan"*: first port of call is the internet, then girls, then if girls don't know, the teacher. After that, they just hang out. They try not to bother the teacher because they believe she has to spend time with the *"other boys who are always mucking around."*

**Gender-linked preferences in a digital world.** The previous vignette, 'The battle of the sexes', illustrates gender-linked roles in science. There are also gender-linked time wasters when it comes to laptops in science. These are the topic of this vignette. The first three critical incidents focus on girls, and the last one zooms in to the boys.

***MashCambella's (un)hidden world.*** MashCambella is obsessed with using her laptop for off-task purposes. In 2010, Sarah leaves her at the back of the room in her own *"emo"* (Sarah's words) cyberworld. In March 2010, Mash finds the 'Cyanide and Happiness' website. In August 2010, Mash still loves the website, and monitors the site's jokes in every science lesson. The following fieldnotes describe what this looks like:

> *Mash isn't doing the worksheet. Instead, she's looking up 'Cyanide & Happiness' cartoons on the internet. It's her favourite. She shows me the archive on http://www.explosm.net/comics/2144/ and I have a bit of a laugh. I get panicky when the teacher comes our way, as some of the comics are rude (see Figure 4), but Mash stays cool:*
>
> *K* *Ha. That's rude. Here quick, the teacher's coming, watch out!*
>
> *M* *She'll leave*
>
> *K* *Hey?*
>
> *M* *She'll leave me*
>
> *Mash doesn't think she'll get in trouble for not doing her work, and is so engrossed in the cartoons I get bored and move on to talk with other students. She does a good job of emitting the emo vibe, and these cartoons definitely suit that sort of demeanour. There is an element of despair to her behaviour, hidden behind the mask of toughness. There's also no work being done, but she isn't causing trouble for other students and so her behaviour goes unchecked. When I ask Sarah about this later, she rolls her eyes and tells me "She's a real delight, that one." Sarah knows Mash spends her time in GoogleLand, but leaves her to it because it's easier*

*than arguing. Mash's attitude is very frosty, and some lessons (like now) even her friends can't interact with her.*

Extract from fieldnotes, Class 2, August 19, 2010

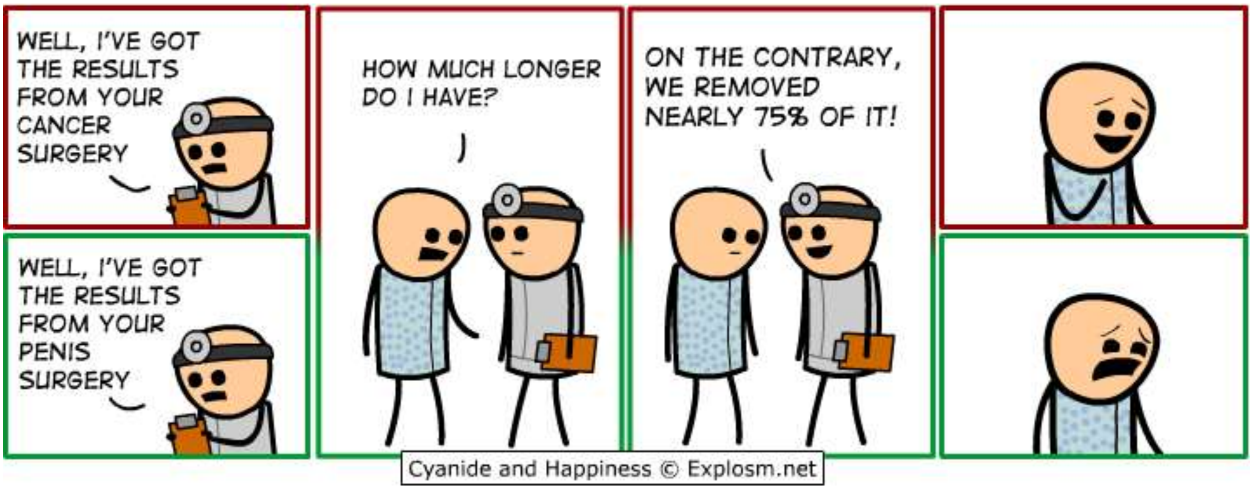


*Figure 4.* Cyanide and Happiness comic (DenBleyker, 2010).

Mash uses comics such as Figure 4 to start rumours about boys. These kinds of references start back-and-forth call-outs across the room, especially with Barry and Chris. Mash is able to make crude jokes related to human body parts without interference. This low-level bullying continues with the help of 'Cyanide and Happiness'. In 2011, Jeff puts Mash at the front in science. She can't go to GoogleLand anymore, but it doesn't improve output or attitude.

***Social networking.*** Girls believe they use social media more than boys do. They're right. Jill's girls spend time maintaining their personal wikis on the school intranet, VVCNet, but *"none of them boys do."* In both classes, groups of girls obsessed about particular websites. In Sarah's class, TimTam, FluroGangsta, Lion and Jemma share jokes from ‘Cyanide and Happiness’ on www.explosm.net. In Jill’s class, Mia, Jemima, Fairy, Kelly, Anne, April, Abby and Keisha like manga comics on www.zerochan.net. Both classes swap preferences. One lesson there might be a rush on Cyanide because of rude jokes, other days they crowd around cool manga art on Zerochan. In the latter part of 2010, it was all about VVCNet, because MySpace and Facebook were blocked, and students had just worked out how to set up wiki profiles on the intranet.

For students like Keisha, the sole purpose of a laptop is social networking. Without social networking capabilities, Keisha doesn’t value the school laptop. She chooses not to take her laptop home in 2011 because it doesn’t connect to her home internet. At home, Keisha shares a computer with her brother, but they *“always”* argue because she’s on Facebook *“all the time.”* Keisha, Bugs the EA, and Jill agree that Keisha uses her school laptop *“non-stop”* for cyberbullying and socialising. By mid-2011, the technician removes all networking capabilities from her laptop. This makes Keisha’s laptop less interesting, and for much of 2011 she is without her laptop in science, sometimes by choice, sometimes due to damage.

***GoogleLanding manga.*** Like Kiesha, even good girls use laptops as part of the disengagement toolkit. In late November 2010, Jemima and Abbey trawl through Zerochan when Jill is lecturing. Jemima says this isn’t something she always does, *“I don’t usually play on my laptop when she’s talking”*, but today she’s *“tired”*, and doesn’t want to listen to a lecture, *“so, I was like, oh, okay, so I’ll just, like, mess around for one lesson.”* Jemima and friends *“really like their comics.”* They trawl the net for *“random”* manga all the time, *“usually during lunch and in the morning.”* Anime is their favourite GoogleLand pastime because they're all into drawing, and like to *"look at the pictures and colour."* They like the idea that *"fans can post their own pictures on there",* but they can't do it because they don't know how to use their laptops to make artworks. Mia has tried using some of the paint programs but they're *"too hard."* She spends a lot of time in science drawing on paper—purely manga, no science.

***Boys and games.*** Boys aren't interested in *"girl stuff"* on websites like Zerochan and Cyanide. Boys want to play games, any games. It's not possible to keep them off Maths games, because they're unblocked for Maths. Jill always warns certain boys *"if you're on that game I'll be pushing to have your laptop removed."* It's an empty threat. Every lesson, students like Sammy hunt the internet to find unblocked games. The boys in Class 2 even know someone who can *"bypass the proxy server."* Boys play games because adults (Jill/Sarah/EA/AIEO) turn a blind eye. Jill explains this as a behaviour management strategy: *"You trade off. I can have this kid being a complete pain in the arse, or I can ignore the fact that he's on a game. ...and I know I do it, and I hate the fact that I do it, but sometimes you just…"*

In 2011, Jeff's structured lessons meant it was harder to be off-task, but somehow boys manage to fly below the radar, playing *"games"* as part of the curriculum. Cozza, for example, played a Lunar Cycle LO (Education Services Australia, 2011) for three weeks. He kept going back to it on the wiki, but didn't attempt the associated *"work"* (worksheets) because it was *"hard"* and *"there's too much."* Jeff tries to include games because he knows boys engage with gamer HLEs. Sometimes Jeff offers them as a reward, but this means boys who struggle, like Cozza, never have permission to play. For example, the moon phases curriculum included the Moon Phases LO, conceptual knowledge questions, then the construction and analysis of a graph. Once through these tasks, which Jeff acknowledges *"you'll be in the minority"*, there is a physics game on his USB *"that will probably drive you insane."* Rukia (a girl) is the only student who gets this far. Students like Cozza are still clicking through the LO weeks after they should have finished. Cozza loves games, and the LO is as close to a game as he can get. It doesn't matter to him that he doesn't understand the concepts. He just randomly clicks and manipulates the LO without paying attention to the content.

**Section summary: Gender.** Although both boys and girls use laptops as part of the disengagement toolkit, there are gender-linked preferences for off-task activities: girls prefer social networking, whereas boys prefer games. For both sexes, laptops act as a pacifier. The class culture of allowing students the opportunity to be quietly off-task on laptops means teachers can focus on students who, as Jill says, *"want to learn."* However, this raises questions about who science is for, the place of SAER in science, and the role of the teacher. The next section begins to examine the idea that gender and ethnicity are both factors that impact on student engagement in science. These factors in combination build a profile of SAER at VVC, and the way that gender and ethnicity contribute to science class culture at VVC.

## Ethnicity

This section demonstrates the role of ethnicity in the 1:1 middle school context of VVC. Two critical incidents highlight issues of poor attendance. 'Racism' uncovers negative perceptions and behaviours that impact on the way students do science. This leads into data that describe the way Indigenous boys manage their identities and use laptops in science.

**Attendance.** The school applauds the Football Academy and SHINE for getting students to school (Bell, 2010, 2011), but science teachers consider attendance to be a problem. According to school reports, half of the VVC cohort are at-risk due to poor attendance, and the majority are Indigenous students (Bell, 2010, 2011). Jill and Jeff talk about low attendance as a key factor related to poor achievement. They believe that when students miss science it's hard for them to catch up when they return. The critical incidents 'SHINE' and 'Extreme family circumstances' illustrate attendance problems for Indigenous students.

***SHINE.*** Keisha attends school so she can go to SHINE, but half of these sessions are during science. Combined with her special reading lessons, Jill says Keisha misses *"a lot of science."* This has an impact on her engagement and achievement. A good example is Wednesday mornings in 2011. Keisha comes to school for SHINE and starts her day in Form. Science is the double block straight after Form, and these 'doubles' are when prac work occurs (if it does at all). However, Keisha has to leave halfway through science for SHINE. She usually misses the practical sessions. Keisha doesn't bring her laptop on these days because she doesn't need it for SHINE. Her *sans* laptop condition means she's set up to contribute very little to science lessons. Much of her time is spent engaged in class gossip. Jill keeps her near the teacher's desk to *"keep an eye on her."*

***Extreme family circumstances.*** An example of the impact of poor attendance is Bill, who was away all of Term 2 in 2011. He returns in Term 3 with poor self-efficacy, and engages in lots of socialising to regain some agency. He knows he's behind in science, and even acknowledges he's hit a rough patch in his schooling. He actively seeks me out in some lessons because, he says, *"it'll be good for me* [him].*"* He's had family issues outside of school, and his return sees him struggle to contribute to science dialogue.

An extreme example of a poor attender is Daz, whose experiences in Science are not regular enough to provide the skills needed to understand science in daily life. He is back and forth between school, suspension, being out bush, and 'wagging'. The school doesn't know where he's been a lot of the time because of the *"difficulty finding a responsible adult."* His 2 years in VVC science are punctuated by acts of aggression and disobedience. It's expected that he will fall through the cracks, because as Sarah and his SSL explain, he has *"a terrible home life."* Daz is away so much in 2011 that my attempts to get more involved in his story are left at a dead end.

**Racism.** Racism rears its ugly head every now and then, and exists as an undercurrent all the time. In the context of this study, the following critical incidents serve to illustrate the futility of laptops in the face of such stress.

***We're disrupted!*** In 2010, FluroGangsta and Butter argue with Barry, Chris and Cozza. There is always tension and verbal abuse. Fluro and Butter don't like *"those boys"* (Indigenous boys) because *"they are hell lazy and heaps annoying."* Fluro wants to *"kick them in the nuts"* because *"they threatened to kill me…they won't shut up when we're trying to do our work and stuff…we're disrupted!…we get in so much trouble and they just get to walk around and do what they want."* Fluro openly talks about how *"those boys smell"*, amidst other derogatory and racist remarks. They see two sets of rules, one for *"us"*, and one for *"those boys."* They think Indigenous boys have *"freedom of speech, but we don't"* and question why they get *"all the privileges"*, like the *"Footy Academy."* I take my concerns to Sarah, who tells me there is no point reasoning with them because *"mum and dad think the same thing."* Fluro later tells me her parents are angry with the school because of bullying from the boys, and that they *"came to school to complain to the Deputy when I got told off about it."* Sarah tries to explain to the girls that it's an age/gender thing, and nothing to do with ethnicity. One lesson she points out a non-Indigenous boy doing things the girls associate with The Boys (wandering, calling out, poor work ethic), and says, *"That's boys at this age. Boys are about 2 years behind in maturity than girls, and you just have to learn to accept that. That's how life is."*

***Nicole fighting for her man.*** Some students stay away from school because of conflict between Indigenous and non-Indigenous students. Nicole is a non-Indigenous girl who has been in *"heaps"* of fights with Indigenous girls, because she *"goes out with Barry."* She's been dating Barry since primary school, but it causes friction. She has been physically attacked numerous times, and vigorously defends herself. Jemma says, *"she can fight, Miss."* Nicole's teachers show concern for her attendance, and she is part of the SHINE program. Nicole explains why this does not improve her situation:

> *It's just hard trying to find the energy for being here coz everyone just, like, annoys you, especially at like recess and lunch, everyone just like, picks on you, coz they all just like…so you just don't even want to come to school. Everyone just starts on you for, like, no reason. So then if you're just, like, at home, at least that way you can just talk to your mum, you can*

*just chill. Where if you're here, it's just, like, just tiring, just coz it's annoying.*

Nicole wants to be a Marine Biologist. She thinks science is *"good"*, but the social side of school, the bullying, makes her hide at home. Nicole knows her poor attendance means she is behind, but it comes second to bullying. I talk with Jeff about Nicole's situation. He says *"the bullying is bad"* but *"it's bad everywhere…there are twenty or thirty girls who are making things difficult at the school."* He doesn't have a solution, and says *"it's the outside stuff, like Facebook, being brought into school."* I suggest there should be a school-wide solution, but Jeff is hesitant to get involved in social issues. He suggests the school could *"put on an annexe and give us some psychs and social workers, because we're not trained, we're here to teach science."*

***Keisha and The Boys.*** Keisha's relationship with Indigenous boys is problematic. One lesson in Year 9, Bill accuses Keisha of being a *"racist dog"* for calling his group *"black cunts."* There is video evidence. Bill threatens *"I'm gunna get my cousins to smash you…you gunna get your white arse smashed"*, punching the air. Someone calls out *"Cunt!"* then Jill reprimands, *"None of that language!"* The abuse becomes more covert, with sly looks and mouthed comments. Keisha is involved in multiple high-profile situations like this in 2011. Keisha has a punch up with Jim in August 2011, and both are absent for some time afterwards. Bugs says Jim *"gets a ten day holiday* [suspension]*…and her family will decide when to send her back."* Keisha even has her laptop smashed in late 2011 during another altercation:

*I was sittin' there at the front, and then he, um, picked up the, picked up…he wouldn't leave me alone an' he thinks I's gunna hit 'im. So 'e*

> *picked up a Lego an' pegged it at my screen, an' everybody thinks I was the cause of it…Ahh, everyone got put into groups, and I wasn't, so Miss sat me up the front goin' on to this program on the computer, some science program I was doing. Yeah she put me up the front by myself, and he wouldn't leave me alone, and he kept on hittin' me, turned my computer off and everything, and he kept on doin' it as well. An' he, I told 'im to go away an' leave me alone, an' even the teacher told 'im to leave me alone. An' then, I got up, to sit up, an' get up to go see Miss, and then he picked up a Lego, coz he thinks I's going to hit him, but I wasn't. He got a Lego, an' threw it past, it prob'ly went like that* [angles arm towards where it goes past her ear and onto screen] *an' then hit my laptop screen an' smashed the bottom of it, where it smashed one side of it. I...I was...angry!*

Jill finds it hard to manage Keisha without a laptop. The pacifier effect (or lack of) is an important point to consider with students like Keisha. Keisha presents a complex case that indicates 1:1 has limited impact on learning outcomes for 'students at educational risk' (SAER). The next theme digs further into the notion of identity, with a focus on Indigenous boys.

**Identity and Indigenous boys.** Indigenous boys exhibit behaviours that do not sit well in the traditional science classrooms at VVC. The critical incidents that follow serve to illustrate how Indigenous boys attempt to create and maintain their identity in science. The concept of discursive identity is relevant here, because the ability to switch between cultural groups, to “maintain dual membership in multiple cultural spaces” (B. A. Brown, 2004, p. 813) is what Indigenous boys at VVC attempt to do, or oppose.

***A bunch of black boys?!*** Teachers identify Indigenous boys as a group: *“Those Boys”*, *“The Boys”*, *“Indigenous Boys”*, and *“The Academy Boys.”* This is a source of tension. In mid-Year 8, Sarah tries to label Cozza’s group for a prac, but it doesn’t go down well, as my fieldnotes explain:

> *Sarah gives each group a name, written in the table on the whiteboard. Sarah uses ‘Footy Academy’ for Cozza’s group. He calls out “Why’d you have to put Footy Academy? Coz we’re a bunch of black boys?!” It’s a challenge. I see his point, but I also see hers. Most of the boys at the table are wearing Footy Academy shirts. Sarah ignores him.*

Extract from fieldnotes, Class 2, June 21, 2010

Sarah didn’t mean to offend Cozza by her group name. In this lesson, there was a lot of off-task behaviour from Cozza’s table. While the AIEO managed to diffuse Cozza’s aggression, and helped the boys contribute to the activity, only one boy had a laptop, and none of the boys at the table had any written evidence of their participation in the prac.

***Shame versus intimidation.*** Indigenous boys in Class 1 and 2 exhibit behaviours that mark them as SAER. They are often late, arrive without gear (laptop/pen/paper/bag), are loud, aggressive, and avoid work. Reasons for not having a laptop are varied. They might have *“forgot”* the key, *“it’s broken”* or they just *“didn’t want to”* bring it. They might not have a bag, and it’s *“too heavy”* to carry anyway. It’s hard to unravel why these things happen, because it's culturally inappropriate to talk about things that are *"shame."* Indigenous students tend to shut down when speaking about sensitive issues, and VVC staff talk about some of The Boys having a *"rough time"* at home. Jill admits *"the Indigenous boys"* intimidate her, and in Sarah's class, Barry and Cozza admit they are *"the worst"*, but only much later in Year 9:

> *I used to be the worst, runnin' in an' outta class all a time…I used to chip 'er…tell 'er I miss 'er…I want 'er come back! I feel sad for bein' naughty in her class now…I feel sorry for teasin' 'er all the time…she was way better…she was boss…she didn't really go off 'er cheeks as much…*

There is a tension between teachers not wanting to shame the boys and having to manage disruptive behaviours. AK47 and Earthworm think it's unfair there are different expectations, where *"the boys are annoying…they, like, don't do any of their work."* FluroGangsta explains, *"Them kids are always noisy…they just muck around with laptops."* Mia believes the teacher *"has to spend more time with them…coz they're not learning."* These views suggest that expectations for Indigenous boys are less than for other students. I believe these boys are disruptive to avoid the shame of not being proficient at science. This is part of the discursive identity assimilation process that Brown (2004) and Olitsky (2006) describe when examining identity in science.

***Bill's leadership.*** AK47 says Bill is *"the only one"* of *"those boys"* who does any work. Bill's participation in science is inconsistent. Bill can be a wanderer, name caller and bully. Footy Academy staff rarely visit science (only twice during my observations), but they have a dramatic effect on Bill's behaviour. In one lesson, I watch the turnaround in Bill as the Academy leader walks in: he stops wandering, sits down and attempts textbook work. In another lesson, after having had a 'talking to' by Academy staff, Bill shows signs of managing his behaviour to suit the expectations of his science teacher. He sits away from his group, and attempts to moderate them, yelling at *"them boys"* to *"Stop bein' dopey!"* as they engage in calling out, swearing, bullying, and inappropriate physical contact with others. He asks questions of the teacher that are on topic, and contributes to a class discussion on cancer. He answers a very specific question about chromosomes that Jill directs to the whole class. Jill asks *"What is the genetic makeup of males?"* and he yells *"44 XY!"* over and over (he stole the answer from one of the girls). In another lesson, he works with Luke heating metal balls with a Bunsen burner, and for the most part ignores the other boys who are burning hair and melting pens. In Year 9, the regular AIEO, who is also a Footy Academy teacher, often sits with Bill. One day, I watch Bill and the AIEO chat their way through a science lesson. The conversation draws Chelsea in, who Jill reprimands several times for being off-task. Jill does not hassle Bill about science work when he sits with an AIEO, but it creates a two-tiered set of expectations. Students like Chelsea use Indigenous boys as an excuse to put less effort into their work. Chelsea doesn't feel bad about it because, *"compared to those two* [Bill and friend], *I've done more."* What concerns me about Bill is that he demonstrates he is able to participate in the cultural practices of science given the right set of circumstances e.g. having a male leader from the Footy Academy present. According to Brown's (2004) model of assimilation, Bill demonstrates 'maintenance status' of his identity. He attempts to do science when he is trying to 'be good' e.g. when he answers a chromosome question. However, he also puts his own cultural spin on things, e.g. by yelling out his answer. Brown believes these are "cultural markers" that allow students from minority groups to "maintain cultural identity" (B. A.

Brown, 2004, p. 825). The idea that Bill can engage in science but chooses not to is an important facet of VVC science. Jill's attempts to engage Bill are usually on her terms, and this has an impact on his disposition to engage or not.

***Science proficiency.*** Bill's case illustrates that Indigenous boys can participate in science, and modify their behaviour to assimilate into the classroom culture of science. It's about finding the balance, and creating conditions to ensure these boys have the 'learner disposition' that motivates them to engage in science. Unfortunately, science teachers seem unwilling or unable to find ways to engage these boys. An example of a missed opportunity for making connections and promoting engagement follows.

In 2011, Jeff gives students a worksheet on tides. This proves interesting for Cozza, who starts to talk about hunting practices along the river with those around him. Cozza is proud to share hunting stories that stem from the topic of fishing. This is not a mainstream discussion, and Jeff shows little interest. An extract from Cozza's dialogue reveals he is actively thinking about the concept of finding food, and although he has limited experience with fishing on the shore, he talks about his regular hunting expeditions with family along the river:

> *I hope we see some piggies* [on our next trip]*...On motorbikes...Huntin'...at* [place name]*. Y'know there's pigs there, Miss? And kangaroos?...Pig trap! Nahhh! Why don't they just hunt it?...Pig fart right there!...Is the pig yours? Oh, it's a wild boar...Eat it?...them little ones...Not the big ones, big tough ones. Too tough, too. You use 'em as dog meat. Or you just chuck 'em away. Yeh...The rabbits, yuck yuck. They got pussy yellow eyes, eeugh. You gotta chuck it away. An' if you, they're*

> *like...I hit one over the head, like there* [points to head]...*Grey ones, like grey kangaroos, they stink*...[clicks tongue for yes]...*Only the red ones...The 'marlus'...So we just leave 'em, let the grey ones run...Only when they...If they don't, if they too much we just shoot 'em* [bullet and gun noise]...*And kill, poison the foxes or Tsss* [noise for dead animal].

Jeff didn't rate the conversation as on-task, even though it started out that way. Cozza completed his tides worksheet quickly with the help of other students, then became disengaged from a graphing task related to tides. This is when he started his dialogue about his hunting experiences. He was having a yarn. Jeff could have linked the hunting stories to the time of year and month, and then back to fishing. However, dealing with concepts outside of the textbook is not part of science curriculum at VVC. If it was, students like Cozza might be more engaged. It's also important here to identify that just because Indigenous boys might say they don't like science, or their science teachers, it doesn't mean they don't show science proficiency. The problem is that it's not consistent across time, and many other factors come into play, which make it easy for things to get out of control.

***Spectacular oppositional displays.*** There are multiple examples of extreme oppositional displays in science at VVC that involve Indigenous boys. At the start of Year 8, Daz is already in a lot of trouble in science. In a notorious Block 6 lesson, almost as soon as he arrives, he makes a spectacular exit. Daz was late, without his laptop *("forgot my key")*, and insulted the teacher, calling her a *"kunyi dog."* After he storms out, he is not sure what to do, so he hangs out in the stairwell, sticking his head in the door, calling out across the balcony, whistling. We talk on the stairs (Daz does not want to be recorded), and he eventually calms down. Daz tells me he likes laptops, because *"when the teacher's talkin' it's borin' an' when we get to go on the laptops it's not."* I ask him why he doesn't bring his laptop to science, and he changes the subject. Daz doesn't display the next type of oppositional display: being invisible.

***Being invisible.*** Indigenous boys act like they don't care about science, yet they deal with shame by making oppositional displays or being invisible. This is also partly related to literacy. All but two Indigenous boys are flagged as 'low literacy' and participate in special reading lessons. Because of low literacy, the boys are unable to read science texts and require significant scaffolding of tasks. This doesn't occur in Sarah's lessons. Jill and Jeff attempt to scaffold, but there is still the problem of boys being unable to access information in a way that other students can. For example, Chris oscillates from extreme opposition to invisible. In Year 8, he spends a lot of time on maths games, which is his way of hiding. In Year 9 with *"strict"* Jeff, Chris doesn't have access to games, yet he still isn't engaged in science. This is noticeable one lesson, where Jeff gets the whole class to read pdf book sections as a class. Chris hunches head down over his desk as others call out answers. He's staring at the document, highlighting some of the 'key words' called out by other students, but he has no idea what the text is about. Jeff knows better than to ask Chris for answers. His exclusion from the lesson in a way avoids shame, but he has no power in this classroom culture.

Other students, like Barry, know they can achieve, but openly admit *"my brain doesn't develop like that"* when exposed to the teaching strategies used in VVC science. Barry exemplifies the disengagement that is the consequence of inappropriate pedagogy. He doesn't tune in to lectures through humans or technology, doesn't engage in worksheet fact-finding missions, and doesn't engage with HLEs, therefore science knowledge flies *"over his head."* He's unable to contribute to academic discussion or complete his work. He can't communicate his ideas about science in ways that teachers require him to, even though he is considered *"smart"* by his peers. It's little wonder then that many of my fieldnotes contain reference to him sitting hunched over a laptop playing games, hiding.

**Indigenous boys using laptops in science.** There are many examples of Indigenous boys using laptops throughout other sections of this study, but the next two vignettes are specific to Indigenous boys and laptops. These are pulled out here because they provide a succinct description of the culture of the learners, particularly Indigenous boys, in Class 1 and 2.

***At least they're changing variables.*** In Year 8, Chris tells me he just *"plays with laptops"* in science, and therefore *"they should take them off us coz us boys don't do work in Science."* This is an accurate assessment of Indigenous boys in science at VVC. In early Year 8, during an experiment, the Class 1 Indigenous boys (Matt, Bill, Leo, Luke) are running amok. They're running and jumping around the lab, plucking hair from random heads and burning it over the Bunsen Burners. It's pandemonium. Jill accepts it though, because *"at least they're changing variables."* She even scaffolds the task, providing each student with data in a photocopied table so they can write up the experiment on paper if they don't have a laptop. However, the boys don't engage with written work. They leave the worksheet on their desk untouched during the evaluation phase of the practical:

*The Boys haven't done any work for the experiment on their laptops (or at all), yet they have their laptops open. They're not working, they are playing games on the internet. They do not listen to the teacher at all and focus on the games. They are quiet and sitting in their chair now, rather than up and running around and burning things. It's calmer.*

Edited fieldnotes, Class 1, March 12, 2010

Jill uses the laptops as a pacifier to stop the boys running around. She tolerates games as a way to gain time with other students who are engaged in the task. After the lesson, an EA tells me that Indigenous boys do not use laptops for science, they are always off-task on them: *"I don't mean to be disrespectful, but all they do is look at pictures of themselves in the Footy Academy."* The perception that there are two sets of expectations, one for The Boys, and one for everyone else, is a common theme. The underlying premise relates to how teachers manage the boys. The leadership shown by teachers is tricky to balance with the identities, because it relates to power and control. The next critical incident describes how Cozza manages to evade work in Jeff's class by using his laptop.

***Cozza, laptops and power.*** Cozza doesn't have any digital work samples, and is inconsistent in bringing his laptop to science. In 2011, Jeff makes sure all students have a hardcopy portfolio *"up there at the front."* Cozza likes the opportunity to annoy others as he moves between his desk and portfolio, flicking paper in their face, stopping to ask for gum, or pulling hair. In one lesson, he uses his laptop to access tasks Jeff has on his VVCNet wiki. Cozza's laptop is not organised, yet this is no different to most other students. However, his digital literacies are low, so it takes him longer to wade through the mess of files that he stores on the hard drive. In one lesson, Cozza is on Jeff's wiki, randomly clicking hyperlinks. He repeatedly clicks on the Lunar Cycles .zip file. It doesn't open so he keeps clicking, not thinking to minimise the screen and check the desktop. There is so much *"crap"* there it's impossible to see new downloads. We try to find his science folder. Cozza opens *"Science Labs"*, but it's just another download. After careful scrutinising, we find a 'Moon Phases' folder, open it, then Cozza realises it's been done *"ten times."* Cozza is not interested in cleaning his desktop, and doesn't care how many times he opens each of the digital resources. He hunts for interactives to play, saying, *"I just do 'em and then don't even know what they called!"* When Cozza does interactives, his brain isn't there. In the 'Lunar Cycles' HLE he quickly clicks through without reading text or attempting to 'know' the material. It's clear he doesn't understand the concept, but because he's done it *"like 10 times before"*, he passes the test. However, he still doesn't know why we have moon phases. Jeff comes around to model it with a torch and ball, but Cozza doesn't engage with him. There's too much power at stake. As Jeff walks away, Cozza starts on his normal tirade of death threats. Cozza is unable to manage his learning with a laptop, but it's not just because he doesn't have highly developed learner dispositions related to digital literacies. It's also because his relationship with Jeff is strained, and Cozza regains agency through his oppositional displays.

**Section summary: 'Ethnicity'.** Tensions about ethnicity are a real issue at VVC. Racism at VVC is part of the school culture. It relates to social issues that extend beyond the school environment. Negative student behaviours, such as truancy and disruption, link to racism. Indigenous boys struggle to engage in proficiency behaviours in VVC science. Many oppositional behaviours result from leadership roles outside of science (e.g. Footy Academy) being at odds with expectations of students in mainstream science.

Both the Gender and Ethnicity themes expose issues relating to the use of laptops in science. They also present concerning cultural features of the classroom that impact on the way students use laptops in science at VVC. The next theme focuses on the broad notion of student achievement.

## Engagement/Achievement

The literature review explained that students can be at-risk across a range of areas, including gender, ethnicity, socioeconomic status, literacy, and disability. Appendices D and E identify 14 students in Class 1, and 10 students in Class 2, as SAER. This statistic covers over half of the study cohort of 43 students. Jeff sums it up as *“even the good kids don’t care.”* However, it’s more than not caring. The following critical incident illustrates that Jeff has deep concerns for the cohort, whose academic background he likens to *“the black cat in the black room.”* Following on from this is a critical incident that unravels where the negative perceptions come from. Negative perceptions of science are a major contributor to poor engagement, and subsequent poor achievement, in science at VVC.

**The black cat in the black room.** Jeff describes the cohort as *“not starting where we want to be”* academically because *“their base knowledge is poor.”* He believes some students are working at their year level, but *“that’s probably more their environment at home and stuff which they’ve absorbed that from.”* Jeff says the 5Es constructivist model used in Primary Connections[40] is beyond VVC students. They don't have *"base knowledge...something that they can sit there and their brains can churn over, engage, explore and all that sort of stuff… and then they're operating with something. Otherwise they're like, looking for the black cat in the black room, it's not there."* Jeff's interpretation of the 5Es model is that it's only useful once students have had science facts drilled into them through rote learning, when they're *"somewhere at the end of Level 3"* (jurisdictional language about achievement). This explains a lot about the way Jeff exposes his students to science concepts. He doesn't think they have the capacity to construct knowledge for themselves until he's provided them with facts. Jill and Sarah also believe students need to know facts before they can apply them, but the problem is that the cohort don't have the learner dispositions to self-regulate and work effectively in an inquiry environment. Jeff's theories about this feature in the next critical incident.

**Where the negative perceptions come from.** In late 2011, Jeff summarises VVC students' perception of science:

> *A lot of kids just don't wanna do Science, and they're sayin', "It's not that I hate the teacher, it's not that I hate the thing, I just don't like the subject, I don't get it"…It's like, this is a whole new thing for 'em, they've never seen it before…and now they're just, they just come in, and they're scared to death of it…It's because Science in primary school is given such a low priority to everything else that they're gettin' the opinion that it's not worthwhile and therefore…or the opinion they get, the vibe, they get from*

[40] Primary science curriculum created by AAS and endorsed by WADoE

*their primary teachers, "It's just, it's really too hard", "I don't get it", "I don't understand it." They make little comments like, "Look I don't really know"... um, all the time. Then kids think "my teacher didn't understand", "this is a too hard subject" and we already got shut off minds. And no matter how many times you tell them, train 'em especially at the start, "Science is one of the best subjects" because quite simply, if you learn from your mistakes then you are doing science, an' if you get things wrong, and you can demonstrate where it went wrong and at, next time wouldn't do that, then it doesn't matter what the end result was, you've demonstrated you've learnt something.*

This quote illustrates that Jeff believes negative student perceptions come from primary school, and students' experiences with science are limited. However, data from this study suggest that students are indoctrinated into traditional high school science culture at VVC, and the middle years at VVC have a profound impact on student perceptions of science. Students see that their achievement in science at VVC is limited, with the perception of failure a common theme. Nicole and Jemma say:

*It* [work] *always comes back and it's always like, D and stuff. It's honestly not that hard, and it's like, it's like, we feel like we do do good, and like everyone has the same answers, and he just gives, like, everyone harsh grades. Like, everyone gets Ds in our class!*

They believe that student apathy stems from continual failure. Poor achievement is a reason to tune out, because their efforts are not good enough and they will never pass. This has implications for standardised science curriculum that is taught in high school, because it impacts on students' self-efficacy. The following section delves into the idea of disengagement in science at VVC also being linked to the age of the learners and the context of the middle school.

## The Middle Years in a Middle School

This section addresses the concept of age and time in the context of the middle school. The vignette 'Age, behaviour and changing perceptions of cool' illustrates that the novelty of laptops wears off as time passes. This occurs at the same time that students start to mature, resulting in observable change in general student behaviours coupled with a general perception that both laptops and science are not cool. The vignette 'Life after laptops' illustrates that some Year 9 students have concerns about leaving a 1:1 school as they move into Year 10, whereas others are keen to get away from the 1:1 environment. These vignettes prepare the reader for the next chapter, which will examine how students participate in science at VVC.

**Age, behaviour and changing perceptions of cool.** Staff at VVC link behaviour to age, with Jill claiming that by Year 9, students *"have matured a lot…they're not academically mature...they're not much better academically, but yeah, they're a lot more decent."* In Year 9, students lose their *"childish"* ways, and begin to *"put a bit more value into what they learn."* Jill distinguishes this from engagement: students do not *"re-engage"*, just *"put a bit more effort in"*, and *"not everyone"* gets better, *"just enough to make it nice."* There is also a temporal shift in student perceptions of laptops. At the start of Year 8, students have preconceptions about how *"cool"* laptops are. They want to do *"fun"* things like *"play games"* and *"make movies"*, but quickly realise science games are not *"fun"*, and movies are *"too hard."* The next critical incident illustrates where this disengagement begins in Year 8.

***The start of the disengagement.*** BettyBoop the EA explains that in Year 8 the *"nerdy types wanna show off how clever they are, and wanna do all the wrong things"* on laptops. However, halfway through Year 8, laptops are no longer a standalone novelty. Jill thinks students become *"completely disillusioned, coz they realise they have to carry it around"*, then students discover laptops are *"another way"* to *"muck around and everything."* This is a double-edged sword, because of the risk of having to *"do work if you bring a laptop."* By mid-year 8, students decide laptops are *"dopey"* because cool websites are blocked. Some students *"hate"* laptops: they're *"poxy"*, *"annoying"*, and *"boring."* The common use of laptops in Class 1 and 2 as a textbook only compounds this view. Students develop a green eye for newer technology. Halfway through Term 2 in 2010, students have only just got their laptops back from being reimaged (a ten week hiatus). Some students have enjoyed not having to carry them around. Smurf suggests, *"Why can't we just get a touch screen one, like, y'know, them iPads?"*

Things change, and *"by Year 9 they just wanna play games…or lock them away"* (BettyBoop). The notion that it's ok to come *sans* laptop is an ongoing struggle. In Year 9, it relates in part to the understanding that when students leave VVC to attend the upper school, they are no longer part of a 1:1 school. The next vignette, 'Life after laptops', follows this line of inquiry to demonstrate how students feel about moving out of a 1:1 school.

**Life after laptops.** Laptops are a blip in the educational timeline of children in Sheepton, because 1:1 is the only public school with 1:1 in the town. Jill saturates her lessons with laptops and *"interactives"* because *"they're gunna get chalk n' talk next year when they go to Year 10 and all of a sudden they're back to notes and bookwork."* However, students are bored of HLEs, and bored of scribing into Word. By late Year 9, students are ready to leave laptops at the middle school. Nigel recalls *"it was exciting at the start of last year when we got 'em, but then like, half way though, 'bout second term or so* [in 2011] *gettin' real boring."* AK47 has a clear idea of what it means to be in the last science lesson with laptops at the end of 2011. She is itching to lock hers away forever, *"waiting for this day for, like, 2 whole years now!"* Jeff is somewhat incredulous, scoffing:

> *These kids don't know what they've got, because they've not been in high school without one…so they don't know that the option is "Guys we're using textbooks, we'll be using paper" and a hell of a lotta writing, and that's really it. Or, and worksheets, it'll be Death by Worksheet type thing…*

Jill doesn't like the laptop program though. She's supportive of AK47s views, and, as the critical incident 'Hitting walls' explains, Jill wants *"iPads for textbooks"* and *"back to paper imo."*

In late Year 9, Students talk about what it will be like *"over at the other school."* One of the main concerns relates to word processing, and the next critical incident, 'Concerns about handwriting', illustrates this.

***Concerns about handwriting.*** At the end of Year 9, students worry that they will be disadvantaged at the senior school, because *"nobody really knows how to spell that good coz we got Word…and the Dictionary."* Nicole is concerned about how *"laptop years"* will affect her education at senior school. She worries, *"You're kinda relying on the laptop, when next year you're not gunna have it, you're just gunna go back to pen and paper."* This is interesting, given she rarely uses, or brings, her laptop. Nicole doesn't *"see what the point is"*, and she *"prefers pen and paper"* anyway.

Keisha also explains the fear of life after laptops: *"We go back to textbook work…it's gunna be hard, because we all got used to using the laptops, and our fingers got used to using the laptops, not pens."* Keisha and April worry their writing *"isn't neat."* They think they will *"lose concentration more"* at senior school, when they look from whiteboard to paper, copying notes by hand. They like laptops, because they can access information on their screen without having to look to the whiteboard. They do not want to go *"back to textbooks."* It is important to point out that at this stage of Year 9, Keisha has no laptop and she is feeling a bit nostalgic.

## Conclusion

This chapter introduced the key informants. It described gender-linked perceptions and preferences relating to science and laptops, with social networking more of a girl thing, and games more for boys. The chapter exposed controversial issues relating to ethnicity, including racism, power and identity. In addition to the learner attributes of gender and ethnicity, the notion of achievement and what it means in the context of science was flagged as an area of concern. School-wide data and teacher judgements indicate that students perform poorly in science. Teachers believe that students do not have an adequate understanding of science conceptual knowledge to work with the learning theory of constructivism. Student engagement in science is linked to performance, with low student self-efficacy determined by poor grades. Furthermore, the age of the learner within the context of a 1:1 middle school also presents challenges. Laptops start as a novelty, becoming a burden as the novelty wears off.

These learner attributes support the assertion that many Class 1 and 2 learners are ‘students at educational risk’ (SAER). Chapter 7 presents data that illustrate the way students do science at VVC. This leads into Chapter 8, where the presentation of the finer details of the use of laptops in science adds depth to how learner attributes impact on the use of computers in science in a 1:1 middle school context.

# CHAPTER 7—THOSE KIDS DOING SCIENCE

This chapter continues to build a picture of the class culture of science at VVC. At the forefront is ongoing tension, illustrated in 'Conflict with science teachers.' 'Being cool, having fun' examines student perceptions of the science-learning environment, and 'Science in daily life' describes students' notions of science in the real world. These themes work together to present a case for how learner perceptions impact on the use of computers in science in a 1:1 middle school context, which is the focus on Chapter 8.

## Conflict with Science Teachers

In science at VVC, tensions between teachers and students are palpable. These problematic relationships form an integral part of class culture, contributing to negative student perceptions of science. The vignettes that follow are examples of these ongoing conflicts from a student perspective.

**Student perceptions of Jill.** In fieldnotes, I describe Class 1 behaviour in 2010 as *"absolutely feral"*, especially after lunch. Earthworm sums up what this behaviour means for the class: *"We haven't learnt much, because, like, everyone always, like, has no respect for the teacher."* There is always off-task behaviour on laptops. One after lunch lesson begins as an atom lecture, and students are, unsurprisingly, *"feral."* Jill stands up the front and provides both electronic and hardcopy periodic tables. She models how to find different elements using her laptop and projector:

> *Alright, this atom here…1, 2, 3P. P for proton, P for positive, so this one proton, has the properties…so if you've got 3, again look at the periodic table, you find atom number 3, there it is there, and it is Lithium…*

I struggle to engage. Kate sneaks under desks as Jill talks to the projected images on the whiteboard. The Boys are bullying Kate, throwing things, calling her names, such as a *"fucking dog."* It is hard for Kate to *"ignore them"* as instructed. Jill makes repeated requests for students to *"stop that noise"*, because *"you're being rude"*, and she tells Kate to *"get off the floor and sit at the desk properly."* Kate snaps, yelling *"Miss! I hate you!"* Jill calmly replies *"Hate me quietly then"*, as she continues lecturing. Many of the students who Jill says are *"good"*, like Jemima, are off-task on laptops. Jemima tells me she chooses to be off-task in GoogleLand when she cannot deal with another after lunch lecture and *"naughty kids."* She *"usually listens"* to Jill, *"but sometimes she can just go on, so I go...I just kinda pull out my laptop and go 'oh she'll go on for a while'…"*

In one Block 6 lesson in Year 9, Jill reprimands Sammy, a *"good kid"*, for throwing items out of the window, being loud, and GoogleLanding. Jill makes repeated requests for him to *"move"*, but he ignores her. With encouragement from Nigel, he tells Jill, *"For fuck's sake, go fuck yourself!"* Jill replies, *"Say it a little louder, Sammy, and you'll get 10 days."* She means 10 days suspension, and Sammy settles down. Later Jill tells me Sammy is *"getting too big for his boots."* Sammy says he was annoyed because another boy was *"being naughty too"* and was not in trouble. Jill picks her battles, and knows she has more chance of Sammy listening than the other boy, who she tries to *"tolerate"* for the sake of peace. Jill's experiences mirror those of Sarah, whose students also exhibit extreme behaviours and little respect for the teacher.

**Student perceptions of Sarah.** By mid-2010, Class 2 students realise that Sarah *"never"* lets them use laptops, because, MashCambella says, Sarah *"doesn't trust us."* When Sarah allows laptops, there is subterranean off-task behaviour, and in Mash's case, she openly flaunts it. Sarah is the only teacher who can catch Mash off-task because *"she's more darty…she jumps around so she can see the laptops…she's creepy."* Smurf agrees Sarah is *"sneaky"*, but that she's *"ignorant…she's that thick she can't see"* when they are off-task. He thinks Sarah is like his parents: *"a bit old and not really up with the technology."* Jemma says Sarah's ignorance is because she *"never"* walks around the room to check laptops like other teachers. Fluro and Mash love to argue with Sarah, pointing out perceived injustices to her, e.g. *"I aint jiggy with it!"*, as she stands behind her desk. One lesson, Sarah writes their names on the board *("It means detention, Miss")* for pushing a girl whose pen they take by force. They complain it's not their fault, they didn't know they would need to write, and *"what's the point of bringing the laptop then?"* Mash gets feisty and yells, *"Don't write my name up there! I won't go to detention!"*

Like MashCambella, certain boys cannot be challenged. Barry brags about being able to *"muck around"* without consequence, because Sarah *"doesn't do nothing."* He thinks Sarah *"won't know"* work doesn't get done because *"she doesn't check"*, and even if she did, *"we'll just say I dunno…I always get away with it...sit here and do nothing."* There are no consequences, just low expectations.

During an interview at the end of 2010, it's impossible to get a coherent sentence out of Chris, Barry and Boi. Sarah's sent them out of class with me to stop the running, yelling and noises, but they're hard work. Barry says science is *"shit"*, and he doesn't like Sarah: *"She crap!"* and *"she talk too much."* Chris doesn't like science either because of *“that teacher”*, who makes it *“boring.”* Boi just goes along with whatever these two say.

In 2010, the general sentiment in Class 2 is disengagement from science and laptops. Sarah’s response to this student disengagement—ignoring it and chalking it up to the cohort—forms part of the problem.

**Student perceptions of Jeff.** The Indigenous boys are a good marker for how Jeff’s role as a dominant male impacts on class behaviour. Barry and Cozza complain they don’t have opportunities to misbehave in Jeff’s class in 2011, after the ruckus of 2010 with Sarah. However, they big mouth threats of violence when Jeff cannot hear. For example, Jeff earns the title *“sooky ‘ole”* for his stern demeanour. Cozza keeps a page in his science book dedicated to weapons he will use on Jeff: *“Look at my weapons, Miss, look at ‘em all! These weapons I’m gunna kill ‘im with!”* Cozza *“hates”* Jeff because *“he old school”*, and says one day *“I’m gunna rip ‘is head off.”* One lesson, Cozza quietly suggests to Chris, *“How ‘bout I knock ‘im out? How ‘bout, eehhh?”* feigning punches in the air. These threats are a badge of honour and give him a role within his group.

Chris’ behaviour in Jeff’s class in 2011 is a turnaround. He sits to the side and barely speaks. Barry is a changed boy too, but still *“hates science…coz o’ that teacher.”* Of Jeff, Barry threatens he will *“smack that teacher, I hate ‘im, ‘e gunna get smacked!”* Barry doesn’t accept Jeff’s role: *“That teacher’s my boss?! He not my boss, I be ‘is boss!”* He contemplates what he will do to *“that old bastard”*: *“I reckon one day I go right off at ‘im, I smash this laptop over ‘is ‘ead…I’d be bang bang bang bang!*

*Smashin' in there!"* Barry's laptop flies through the air as he feigns punches onto an imaginary Jeff's head.

Students dislike Jeff because he controls their behaviour through his no-nonsense demeanour and detention. Jeff was a Deputy, so there is an inherited fear, a shared history of this powerful role. Nicole and Jemma don't like having a teacher like Jeff who *"yells over our shoulder."* They think Jeff is too strict, and he *"never shuts up, he just keeps talking."* Jemma says she *"just goes to sleep"*, and Nicole agrees, *"yeah, you have to"* because he is a *"crappy teacher."* I perceive Jeff as giving clear, explicit instructions. He doesn't talk for more than 5-10 minutes. Nicole says *"last year* [with Sarah] *we used to be able to get away with everything, it was just funny and, like, everybody was just hell shit stirrers and stuff, where now he's always, like, on the look, and you can't do anything."* They don't think this impacts on their work, because they just *"not do work more secret."*

With all these negative views on science teachers, there is still hope for science. The next section explains that students enjoy the infamous practical lessons.

## Being Cool, Having Fun

This theme focuses on fun. 'We love experiments' presents data about experiments and their associated socialising/collaborating, then 'We hate work' deals with the flipside. Throughout the study, students expressed various negative terms for science: *"boring, hate, torture, forced, not interested, shit, poxy, geeky, nerdy, negative, dislike, frustrating, kunyi* [Wajarri for bad/boring]*."* Data indicate the general student perception that science is not cool, and this links to their understanding of the purpose and usefulness of science in everyday life. First, this section explores the most engaging part of science: the practical lessons.

**We love experiments!** Students value out-of-seat activities above all else, but *“gettin’ out seats an’ doin’ experiments”* (Cozza) does not happen often. Students complain there aren’t enough *“fun”* experiments, but the concept of fun is problematic. Chelsea says, *“It depends what experiments…coz, like, if we do the boring electricity ones they’re just boring, but if we do, like, the ice cream and the Bunsen Burners, then it’s fun.”* There’s a wow factor associated with fun practicals, where twisting wires to make a globe glow is not on the same level as, say, eating ice cream or burning something. The following incidents illustrate two sides to pracs: the positive impact on student engagement; and the problems that occur because of being out of seats.

***The heart dissection.*** Students love the Year 8 heart dissection. Straight after the *“awesome”* event Cement gushes, *“It’s like, something you could tell your kids, because it’s, like, an experience!”*, and she recounts gory details as others feign vomiting. Cement and Jemma think this real dissection is better than the virtual dissection they did in Health, *“because you can feel it, and see it with your own eyes.”* Even a year later, AK47 can recall the feel of the ventricles and atrium, and the blood clots in blood vessels. She relishes describing the prac to Chelsea. This is an important message for teachers who use digital resources: nothing beats the real thing. The engagement in this activity is its novelty and goriness, the shock factor, and the way that students are able to interact. These social experiences are critical to the ‘fun’ factor.

***The social experiment.*** *"Fun"* practicals may not involve science learning: it can be *"fun"* being off-task and/or out of seats. For example, in early Year 8, just being out of seats doing something social, filming metal balls heated with a Bunsen, is *"fun"*: students are engaged in *"socialising"* and admit this is the best part of the lesson.

In 2010, Class 1 students use PhotoBooth, ComicLife, and iMovie to document several science investigations. Laptops are held over Bunsen Burners and teetering off sinks to get good shots. Shoving laptops in peoples' faces to take photos proved popular but controversial, and there are arguments about personal space. The footage means Jill can extend the analysis phase of the inquiry, rather than trying to get the whole lot done in a lesson. Looking at photos allows for consolidation and revision, but many students, like Matt, have worked out if they don't bring a laptop they don't have to *"work."* Others are carried away by the social nature of the lessons and don't conduct the activities or document them with laptops. In these types of lessons, the potential exists to use laptops for science learning, but it appears too hard for the teachers to manage student behaviour.

The notion that students value socialising is illustrated after the technical dramas of Semester 1 2010. Students reminisce about *"before",* which is the ten weeks of Semester 1 when laptops didn't work. Lion, Rukia and Brick didn't like the way laptops changed the learning environment. They preferred science *"without laptops"* because they did *"more out of seat stuff."* Once laptops became operational, they noticed they spent more time sitting down, and this limited their social interaction. By Year 9, engagement in practical lessons with laptops is not evident. No one uses PhotoBooth anymore, because *"it's boring"*, and there is less rampant socialising because social groups are well established. However, the use of laptops during experiments is a rare event anyway because of safety concerns, as illustrated in the next critical incident.

***Daz and his own explosions.*** Sarah worked out that laptops and practicals don't mix early in Term 1 2010. Like in Jill's class by this time, Class 2 students have decided that bringing laptops is a waste of time, because they never get to use them. This extract from fieldnotes of a routine practical in early Year 8 highlights the disjuncture between student expectations and the reality of practicals:

> *…It is Block 6. It takes 15 minutes for truants to get to class. No laptops today. Sarah tells everyone to leave them in bags because it's a distraction. Sarah explains the task: students must draw a map of the lab and the location of equipment, such as a conical flask, tongs, and safety glasses. The workstations set up at the side of the room have items to be measured (e.g. Find the mass of an eraser using an electronic balance, calculate the volume of the beaker). Sarah is constantly interrupted by latecomers. The girls up the front find it hard to listen.*
>
> *During the prac, some students stay in their seats, pseudo-working in workbooks. The majority are noisy and off-task. Students claim "I'm just doin' this" and pretend to go to a workstation. The prac's a great excuse for socialising. Sarah becomes 'dark' at the front of the room. Her tone is fed up and angry. She starts yelling, e.g., "I've had enough!" Daz and Cozza think it's a big joke, and keep talking. Sarah calls out Daz, who challenges her:*
>
> *D* *Yeah, what?!* [with attitude]

*T* *You'll have to go to* [the Sub School Leader]*!*

*D* *Nah, fuck this!*

*He throws his bag down, calls her a "Kunyi dog" then storms out, slamming the door. Sarah is standing behind her desk at the front. "Keep working" she says to the rest of the class. The lesson carries on with only a few students engaged in the prac. The rest are talking, waiting for the bell. Sarah asks me to follow Daz because she can't get in contact with the SSL. I find Daz on the stairwell. He hasn't gone to the SSL office as requested. I ring the SSL, she can't take him, she's teaching. I talk with Daz about science until the bell.*

Edited fieldnotes, Class 2, March 16, 2010

Daz represents what the student cohort think, but he acts it out in a different way. Students expect *"explosions"*, so the measuring tasks in this prac don't engage them. Daz created his own behavioural explosion because he was bored. He complains the activity is *"not an experiment"*, and it doesn't meet his expectations of high school science, because *"Isn't science really for experiments? We don't do any experiments."* He's right, there are few. Sarah, as a graduate, has a hard time trying to find experiments that she can manage.

Students in both classes believe experiments are rare because of these *"naughty kids."* It comes down to trust, with Jemima telling me her teacher, Jill, *"doesn't trust some people, because they don't do what they're told."*

Knowing that students have clear ideas of what they consider engaging, fun science, the next vignette continues to present data that suggest students do not like science because it's too much like hard work.

**We hate work.** At VVC, there is a perception that if you're *"good at science"*, or *"like"* science, you're a *"geek."* If you also *"like laptops"*, it increases the stigma. It's a constant source of bullying. The critical incidents that follow demonstrate what 'work' is in the context of science.

***All the theory.*** In 2011, Nicole and Jemma ponder the reasons they dislike science. Nicole suggests it is because of *"all the theory"*, but says, *"I guess you have to do the gay stuff before the good stuff."* They have no idea what good science is, with Jemma suggesting this is because *"good stuff"* is *"something he* [Jeff] *hasn't given us yet!"* Without 'good stuff', the value of science is lost on these students. Teachers drill into them that *"theory"* is a precursor to understanding science, and this relates to teachers' beliefs about science learning, e.g., *"rote learning"* comes before *"constructivism."* In late Year 9, AK47, Sammy and Nigel are grudgingly doing web-based interactives, with an understanding that the reward is a practical lesson. I ask how they know this, and Sammy tells me, *"Miss said that we have to get all of this done and then we can have some fun next week."* Jill is reinforcing the notion that prac is fun, but this creates a perception that laptops are part of *"work"* that takes place outside of *"fun."*

***We work for free time.*** Even students defined as *"geeks"* don't like science. For example, Mia finishes *"work"* quickly so she can have free time to draw and engage with manga comics. Free time means a break from *"work."* It again reinforces the perception that science is not *"fun."* Mia regularly spends over 10 minutes a lesson drawing/on Zerochan, because she finishes set tasks before others. She likes this, and says that it's *"good for the teacher"* because *"she is busy"* with other students. Jill allows students free time because it is part of the behaviour *"trade-off"*. Jeff has similar bribes. The bribe system is well entrenched and doesn't foster a positive class culture of science learning.

***Closet smartie.*** Disruptive students like Barry are considered smart by peers, but choose to act out extreme behaviours. Barry is a leader of the Indigenous boys and his behaviours have a direct influence on the tone of the classroom. Barry is one of many bullies, but also a closet *"smartie."* One lesson in Year 8, Barry is (literally) bouncing off walls, makes whooping noises, and teasing people who are working. Boi informs me, *"He smart, just doesn't wanna act like it…that's how we roll."* It's an example of the culture of the classroom not valuing achievement, and this is more prevalent for Indigenous males like Barry, who has a *"wicked"* image to uphold. His quest for maintaining a sense of identity in science is very important. The age of the learner, and the unique environment of the middle school, magnifies the association between science, laptops and uncool geekiness.

***Cutting and colouring.*** This incident is an unusual case of an engaging science lesson, which involves the mind numbing, but extreme-behaviour curtailing tasks of cutting and colouring. It gives an idea of the type of busywork that students in Class 1 and 2 are used to, and feel comfortable with. In September 2010, it's the end of term and laptops are on lockdown. Normally these after lunch lessons are mayhem. Today though, everyone's engaged in their task. This is what's so engaging (says Jemima):

> *She gave us one piece of paper...we had to cut out the pieces of the paper, we had to cuuuut...And they're all muddled up and then we had to put them back into place...one by one...we haven't learnt all this, like, we've only learnt the tibia and femur...it's the human body...your leg...it's the bone...the bone structure...a jigsaw…*

Bill *"borrows"* Jemima's jigsaw because she's finished before him. It's almost collaboration. They talk about people they know who have broken bones before. Grisly tales. Jill tells me *"there's not much to see…it's just a fluff task."* Nevertheless, this hands-on activity allows students to develop visual representations of the musculoskeletal system. There is some off-task behaviour, but nothing like mayhem I usually witness. For example, AK47 and Earthworm tell me they are *"making glue spiders"*, because they *"finished in five minutes."* They're enjoying the lesson because there are low expectations of them, and no bookwork. There's a bit of abuse between Kate and The Boys (normal for this class), but the overall vibe is calm. This calmness allows students to discuss the task without emotional outbursts that stem from the boredom of lectures, and lectures with laptops. This is another example of the dummy effect .

One of the main concerns about the data in this section is that generally, students are not engaging in science. To change students' perceptions of science, the literature suggests developing an understanding of how science relates to everyday life (Aikenhead, 2006). This is the focus of the next theme.

## Science in Daily Life

The critical incidents that follow illustrate perceptions that students have about science in their own lives. In Chapter 6, Jeff talked about the origin of students' negative perceptions of science, believing it relates to students' limited experience with science in primary school. However, the middle school structure of VVC is also limiting. Students don't have positive Year 10-12 role models found in upper school, which is over 5km away. Students don't do excursions or incursions that demonstrate science pathways. This is as much a consequence of timetabling, where short 50-100 minute lessons do not lend themselves to field trips, as it is teacher pedagogy. VVC students rely on VVC teachers and peers to develop their understanding of school, science, and laptops. This small pool offers little in the way of challenging experiences, or a vision of how science extends from the classroom into everyday life. Furthermore, there are clear misconceptions about who science is for, as the critical incident 'The mad scientist' suggests. The theoretical component of science lessons at VVC is quite intense for students who do not see the relevance ('Butter's question of relevance', p. 196). Even top students, like Mia, express no interest in continuing science in upper school ('What I need in the future', p. 197). The data in these critical incidents contribute to the idea that VVC science is not engaging or meaningful for the cohort.

**The mad scientist.** Research suggests student perceptions of science change when they transition from primary to high school (Archer, et al., 2010; Goodrum, et al., 2001; Speering & Rennie, 1996). In a series of interviews at the end of Year 8, few VVC students can name science jobs. Keisha and April went to a primary school that was part of a statewide science enrichment program. They reminisce about *"making chocolate"* and when Keisha *"put in the right ingredient but I put too much in an' almost blew up the science room!"* (vinegar and bi-carb). When asked about science jobs, though, they get stuck:

*Me* *Can you think of the name of a job that might involve science?*

*K* *Experiments?*

*Me* *But what's the person who does experiments called?*

*A* *Mad scientist?*

Keisha and April struggle to link the role of a scientist to job options. The perception of a mad scientist as the only science career fits with research suggesting students have a distorted view of science and what scientists do (Scherz & Oren, 2006). For other students, posing the question *"What kinds of jobs have got science stuff in them then?"* with a prompt *"Think of jobs with animals or plants maybe…"* resulted in creative workplace roles: *"Animalologist…Parkeologist…Plantologist…Scientologist…"*, and my favourite *"Haleminetphotolographer."* This is a person who studies rocks: 'mine' and 'photo…grapher'.

When I talk with Jill and Sarah about how they portray science to students, they admit their curriculum focuses on conceptual knowledge. Sarah even says she *"hasn't taught them anything about the value of science or science in daily life."* Interviews with Jeff in 2011 suggest he attempts to portray the usefulness of science by sharing his passion for the subject *("science is one of the best subjects").* However even with his encouragement, students question the relevance of science, particularly the focus on content.

**Butter's question of relevance.** Even after the most engaging lesson of the 2010 year, the Heart Dissection (p. 187), students are at a loss to understand why they have to do theory about it. An extract from fieldnotes links this to students' not understanding how the concepts relate to their lives:

> *Butter comes out with the random statement "Why do we have to learn this?" during Sarah's chalk n' talk answers. It's a bold and challenging question. Sarah replies, "Just because", and keeps writing out answers on the board. Butter hasn't said this one-on-one to Sarah as she could have earlier in the lesson. The room is dead silent when she asks. I think it's a teachable moment, but so is getting through the answers? What would be better: knowing why it's important to know about the circulatory system, or memorising the pathway of blood? Butter's question relates to her not caring about why or how blood flows. Ignorance on the topic won't affect her life (or so she thinks now). Nicole and Barry sit right at the front, under the teacher's nose, and spend the theory time not taking any notes. "Why?" asks Nicole "I don't do work in science." Sarah seems to know this and doesn't intervene or convince her otherwise.*

Edited fieldnotes, Class 2, August 23, 2010

Throughout the fieldnotes associated with this lesson are examples of students who really engaged in the practical, only to totally disengage when theory was required. Opportunities presented themselves for Sarah to make critical links between the heart and how we survive, but her goal was to present information on the board about blood pathways. There was no discussion about heart health. These side topics would engage the gore-loving cohort in thinking about how it relates to them, and thus provide crucial evidence that yes, our hearts are important. This was Sarah's first lesson doing a heart dissection, and her desire to present the facts overshadowed how to make it relevant to students.

**What I need in the future.** Mia, the top student in Jill's class, believes she won't need science in the future. She ranks science second last of all school subjects, just before sport. She says, *"I only care about stuff I'm gunna need in the future, like English."* Kelly suggests, *"she just doesn't like science"*, which Mia confirms multiple times over the 2 years. Mia thinks that science won't get her a job, but English will: *"You can get into a better job and stuff…with writing."* Over the 2 years, Mia contributes to the Zerochan social media platform and spends her free time working on it. When I raise concerns with her about using science time to do comics, she says her parents and teachers know. Mia would benefit from an extension IEP that caters to topics of interest and improves her engagement in science. To make science relevant to Mia's life, I would include activities that relate to manga, because as Mia says *"you get to use your creative drawing and stuff"* and that's what she likes doing. Mia likes *"way more freedom"* found in Art and English. Her desire to follow creative pathways is marred by the structure and curriculum of VVC science. It's unfortunate that a girl like Mia has already developed a negative perception of science, and has already made the decision that science is not relevant to her life. She's the poster girl for the science education crisis.

## Conclusion

This chapter presented data relating to the way that students do science at VVC. It started by explaining that students have acrimonious relationships with their science teachers. The public spats influence the tone of the classroom, and therefore class culture. The chapter began to describe student experiences with science, including the things they love and hate. Clearly, the preference for practical activities is linked to collaboration and socialising. Unfortunately, teachers limit socialisation because of behaviour management issues, and this is a source of conflict. 'We hate work' lifted the lid on the general feel students have for science: too much theory, too much 'work'.

This chapter establishes that science at VVC isn't cool. The context of the middle school environment does little to broaden students' understanding of the relevance of science, it's place in society, students' current lives, or future careers. The chapter concludes that the needs of science learners in Class 1 and 2 could be better met with a shakeup of both curriculum and pedagogy. The next chapter works on the premise that laptops were introduced at VVC to, as the Education Minister said in 2003, 'promote engagement and achievement'. If this assumption is correct, the addition of laptops into the science mix should have some positive impact. Chapter 8 presents the data relating to 'those kids doing laptops' in science at VVC.

# CHAPTER 8—THOSE KIDS DOING LAPTOPS

This chapter presents data relating to laptops in science at VVC. It takes a mainly student perspective, but to give the reader a balanced view includes my observations and those of Jill, Sarah and Jeff. The first theme, 'Excess baggage', tackles the problem of students not wanting to bring laptops to science. Newhouse (2008) identified this as a school-wide problem at VVC. The second theme, 'Science with laptops', addresses potential affordances (and the underbelly) of 1:1 as identified in Chapter 3. This chapter, Chapter 8, plugs the gaps left by previous chapters, giving a fine-grained description of the culture of science education in the 1:1 middle school context of VVC.

## Excess Baggage

Chapter 5 identified that VVC science teachers are frustrated when students come to class without laptops. Jill sees this as an intrinsic student characteristic, rather than a direct response to laptops, because *"you gotta keep in mind these kids don't bring pens to school…y'know, to bring a pen is too much, so carrying a laptop is...."* Jeff links the phenomena to students' poor work ethic: *"I think the average kid's work ethic seems to be down, all we hear is a whining about having to carry the laptops."* He believes this is the reason students *"forget"* their key, and *"don't bring laptops upstairs."* The two critical incidents that follow present data that indicate students think laptops are too bulky, and aren't good for their image.

**Take 'em to the chop shop.** In Term 2, 2010, after just 10 weeks with laptops in science, Smurf has some advice for school administrators:

> *Why can't we take 'em to the chop shop? An' chop 'em down an' make 'em so light you can't even feel 'em?...Why don't you just have 'em on the desk, and then you just, like, log in to the…log it into...Nahhh! What you do Miss, is you have like a little zipped up thing in the desk that has to store your laptop, and you just lift it up and then you open the lid and then you just type into it…*[If the desk breaks] *You move...then you move to a different desk...*

Smurf is Class 2's ICT guru, and his ideas echo those of his less tech-savvy classmates. The portability of networked devices is important to students' image, and they would rather leave bulky laptops in the classroom than lug them around. The 1:1 literature consistently points to portability as a key requirement of a good laptop program: after all, the whole point is being able to go 'anywhere, anytime'. Unfortunately, at VVC, lugging the laptop around is neither practical nor cool. Many students put laptops away at lunchtime, with Jeff explaining that *"they get rid of their laptops so as soon as the bell goes* [at the end of the day] *they can just bolt."* AK47's complaint is a common cry: *"I go home every day and I've got a sore back from my laptop…it weighs you down and hurts your back, and if it's on your shoulder, it presses down and it hurts your shoulder."* AK47 says teachers don't care, because they *"think about themselves, and what they want to be done."* Nigel believes teachers *"think that we have nothing in our bag but our laptops, but like, see we've all got food and like, water bottles and stuff."* Chelsea agrees, and says their bags are even heavier if you *"add in jumpers and that, then it's just so huge and enormous."*

Students worry about what will happen to laptops on the way home on the bus. Chelsea tells me that *"laptops break…not that I've broken it, but they're just so easy to* *break."* She, like others, takes the bus home, and says *"the bus is so crowded your bag's most likely gunna get pushed down and the laptop'll get broken…it's not cool…when you have this massive thing on your back…that gets in the way…and hits some poor kid…when you're squashed on the bus."* Lack of portability makes laptops an issue that relates to student identity both in and out of school. The next critical incident describes what it means for public image.

**Public image.** Students don't want to carry laptops for fear it *"makes you look like a loser", "nerd", or " retard."* At the end of Year 9, when asked how students feel about laptops, Nigel says *"only the nerds like 'em"* and AK47 goes further, telling me *"pretty much all the children hate them."* However, even so-called *"nerds"* don't like laptops, with both Mia and Kelly outright declaring *"laptops are gay."* Image is important to all students, and at VVC, it's not cool to carry around an item symbolic of *"geek"* in public. By the end of Year 9, cool kids like Barry and AK47 don't bring bags, take laptops home or to science, so the concept of carrying them is irrelevant in their lives.

## Science with Laptops.

The previous section, 'Excess baggage', suggested that students have negative perceptions of laptops because they're too heavy and bad for public image. This section, 'Science with laptops', further demonstrates the perceived and actual values and barriers related to laptops in science. Digital literacies, as described in the literature review, weave their way through these critical incidents, and are crucial to understanding the culture of science at VVC.

In Chapter 7, 'The middle years in a middle school' explained that student perceptions of science decline over time, with 'Where the negative perceptions come from' suggesting that students bring perceptual baggage to science. Jeff thinks none of this relates to laptops—*"ultimately it's an unrelated issue"*—because students come to science preloaded with these perceptions. Data in Chapter 7, however, indicate that a number of internal factors contribute to these negative perceptions, including the teacher and the curriculum. This section adds evidence, suggesting that laptops also contribute to negative perceptions of science at VVC.

**Laptops can go live in the tip!** In late 2011, I spoke with four Year 9 students, who wholeheartedly agreed that laptops could *"go live in the tip."* I posed the statement *"I like using my laptop in science"* as a discussion prompt, and the animated response went like this:

*All* *No!*

*Nigel* *Laptops can go live in the tip!* [laughter]

*K* *So, you don't like...?*

*AK47* [interrupts] *Yeah, I hate laptops!*

*Chels* *It's so annoying, coz we gotta take it in, then out, then in, then out*

*Nigel* *They're really annoying when you take 'em...*

*Chels* *this massive thing on your back!*

*Nigel* *...to class when you don't need 'em*

*Chels* *Exactly!*

*Nigel* *Like, I wish they would tell you so we could just leave 'em*

*Chels* *Exactly! Exactly! Like they say "Take your laptop to every single lesson!", but then, half the time we don't end up using it!*

*AK47* *The teacher reckons* [cranky voice] *"Oh laptops are helping us"*

*Chels* *No, they're not!*

*AK47* *They're boring*

*Nigel* *And then the teachers rely on 'em too much, like if the system crashes they get all shitty coz there's nothing to do*

AK47, Nigel and Chelsea, August 3, 2011

These students' experiences with laptops led them to believe carrying laptops around was a waste of time because they didn't use them enough. Interestingly, these same students also complain when they do use laptops. Jeff and Jill explain this as a consequence of being what the research calls a 'Millennial', where technology is accepted as a normal part of the learning environment and students don't know how good they've got it.

**They're hell technologic.** When things don't go smoothly, it's easy to blame laptops, and as the quote above illustrated, students do. The perception that laptops are to blame for boring lessons is one that began in early 2010, with the roll out of new laptops and a new jurisdictional Department of Education (DoE) platform. In their third lesson with laptops at the start of Year 8, Class 2 students *"wasted"* the whole lesson trying to *"make the thing* [laptop] *work."* They were eager to go online and *"do work",* but most gave up and spent the lesson chatting. Sarah labelled the lesson *"a waste of* *time",* cementing her assertion that *"you can't rely on laptops."* By the end of Semester 2 in 2010, most network issues are solved, but students have already developed the perception that laptops are unreliable. A short vignette captures Class 2's first disenchantment lesson:

> *Sarah stops talking in the middle of the lesson (!) and students start the task. Sarah says, "You don't need your laptop until you've got your word" (students will research the definition of a science word for a poster). Busy noise begins, with a disappointed sigh from some as they get out pens. The laptops stay packed away. Sarah stands at the front and allocates students a word for their poster. Students get out laptops and go to open Firefox to Google their word. The noise is excited, as if students are happy they finally get to use their laptops. This is the third time they use laptops in science, and may explain why they are following teacher instructions about when it is/isn't appropriate to have them out. It's at this point there are some real hiccups.*
>
> *Over half of the class can't access the internet. The Dock has disappeared and so have all the application icons that are normally on it. The noise becomes distressed, with lots of calling out:*
>
> *"Miss! It's not working!"*
>
> *"Mine's fucked!"*
>
> *Is this lesson the start of their disenchantment with technology?*

Edited fieldnotes, Class 2, March 5, 2010

There are many lessons like this, where partial productivity results from technical issues. There is frustration, boredom, and orders to *"Stay in your seat!"* while waiting for the teacher to come and help. Smurf complains, *"Very rarely we can get onto the internet when we need to"* and most of the time he *"just sits around"* waiting for the laptop to work. Students, like Earthworm and AK47, perceive laptops to be *"hell technologic"* and unreliable, *"a pain."* By the end of Year 8, Earthworm chooses not to bring her laptop to science, or use it, because *"I don't have much patience, when they get the little circle thing* [the busy icon], *it like, really annoys me, I feel like punching the screen!"* She believes it's easier to work on paper, because her work is less likely to get lost, or *"go away, like, delete, if you don't save it right."*

A 'technologic' problem is the perception that laptops are hard to use. Students with less experience with technology, or particular software, are less likely to try new things and enjoy the experience. When given a choice, students opt for using software they are familiar with, rather than being frustrated learning something new. In mid-2010, when Sarah's class work on a bacteria poster, most choose Word or PowerPoint, because *"we used them all the time in primary school, like a million times."* Students with more developed digital literacies, like Smurf, choose Pages, which is a new program. Yet many give up all attempts at a digital poster after a couple of lessons, and choose paper because *"it's easier"*.

At the end of Year 8, AK47 and Earthworm say laptops *"always mess up"* because *"it can, like, delete, and it all gets wiped off."* They believe this has a negative impact on their grades, and they prefer doing science work on paper, because *"on paper, it's final."* Earthworm says her laptop *"doesn't have a hard drive"* and she can't save work to her home folder. Her hardcopy portfolio is almost empty, and she claims she does work on her laptop but it *"doesn't save."* Jill thinks this is a bad excuse, suggesting that *"if this is true"* then *"the computer has been wiped about 50 times this year!"* However, sometimes laptops are broken, and students are not issued with a replacement. In early March 2010, in the first-ever week with laptops, Simon is watching other students film a practical lesson. He can't film because he doesn't have a laptop. He tells me he *"bent down to pick something up and the desk just went whhoooa, and the laptop fell on the floor…something bent."* Simon says he doesn't know why it's taking so long to get his laptop back, because it should be fixed straight away: *"it's something so easy the technician can fix it themselves."* He refuses to participate in the practical because *"I don't have a laptop so I can't."*

In August 2010, Jemma is without her laptop for over a month. She *"doesn't mind"*, and spends her time in science *"helping"* friends, because *"the bottom"* of her laptop was *"bent"* when *"someone stepped on it."* I ask why her laptop has been gone for so long, and she tells me *"they had to take it apart and everything, get the guts out and put it into a straight one"* and *"it'll cost $5000 for a new one."* She says her mum *"doesn't really care, she'll pay for it."* It seems like Jemma is proud to share her story with others, and she enjoys being without the responsibility of a laptop, because it removes her obligation to *"carry it everywhere"* and *"do work."*

**We never use 'em anyway.** A common complaint is that students *"never use laptops"*, particularly during experiments. In Sarah's class, students talk about wanting to film and narrate experiments with iMovie, rather than write a report. MashCambella likens practical reports to *"torture"* because *"we get forced to* [hand] *write."* She, like others (Smurf, Boi, and Jemma) perceives laptops make things easier. However, the class doesn't use laptops for practical work, because of behaviour. Chapter 7 explained that experiments are already rare. Jeff's experiences with laptops during experiments are not positive:

> *If it's potential to damage the laptop and it's potential with that particular class, like* [Class 2] *for example, that they're not gunna be careful, I'm not about to put a laptop at risk, and put them in the firing line, because I know I'm setting them up to fail, and I know there's a potential for something to go wrong. And the laptops take up a reasonable chunk of space…it's nothing but bad news…*

Jeff's beliefs in 2011 continue what Sarah already knew about Class 2 in 2010: don't trust them with laptops around water or fire. Although no laptops are destroyed in Class 2 because of this kind of damage, as Jeff says, the potential is there.

There are also issues of being off-task on laptops during prac. After one prac in early Year 8, girls in Jill's class (April, AK47, Jemima and Mia) explain why they didn't get the prac write up done, or even film the experiment:

> *You remember, boiling the water and the salt and the sugar...Yeh we burnt our hands!...I didn't write nothing down!...And I think that…we take advantages of the laptop, like with PhotoBooth last week…They were taking photos that were not necessary!...There was tantrums over one corner...People were touching other people's laptops...That was Sammy and AK47, they were running around with laptops trying to get photos of each other...Tantrums...*

These *"tantrums"* are common, and it's safer just to have laptops out of the way.

**Zooma fast typing.** While students rarely use laptops during practicals, when they do, there is an overuse of word processing. The benefit of this is that all students learn to type. In Year 8, Nicole complained it took *"too long to type."* By the end of Year 9 however, her digital literacies have improved, and she is more confident, saying *"It's easier doing it on the laptop, coz like you just type it up, so it literally takes like fifteen seconds."* Everyone agrees all students' typing skills improve. Even students like Daz can type with two hands, and most don't have to look at the keyboard. Although students like Nicole and Jemma have become *"like zooma"* fast typers, they think *"tables are shit"* on laptops, and prefer paper because it's easier to rule up. This is a consistent feature of the cohort, who revert to paper for more complex tasks, like ruling up tables and drawing graphs. At the time of this study, such skills were required for the jurisdictional education test (see Sarah's comments about graphing, p. 128).

Students acknowledge typing is a skill they have all mastered, but it doesn't make for great science. Just like the 'old school' ways that are still so prevalent in upper school science, students at VVC are subjected to copious note taking from the whiteboard. This kind of transmission puts a negative spin on laptops, which are merely replacing older technologies rather than creating new opportunities. Even those students who are engaged in science are bored with note taking. AK47 claims Jill *"always"* makes them copy notes from the projector into Word. She *"hates it"*, and even though Jill *"explains"* what the projector says, it *"doesn't help us learn"* because *"we're all too busy copying it down to hear."* By late Year 9 though, she has decided she *"learns more"* when Jill explains things, and prefers this over any type of laptop activity *"because she explains it better than the computer."* Chelsea doesn't like using laptops for learning theory either, and says when copying notes, *"you'll see the words but you* *never take anything in."* This is an unusual turn of events, because these girls often complain about Jill's lectures. But it provides a clear picture of just how boring the laptops have become, when students prefer chalk n' talk over using them.

**SAER.** BettyBoop and Bugs believe some SAER, specifically some Schools Plus (SP) students, *"love laptops."* BettyBoop, who's been at VVC since 1:1 started, thinks the school intranet, VVCNet, is *"good"* for SP students because it *"provides routine and structure."* There's no excuse for being lost in a mountain of instructions, and her students can get *"straight into it."* Betty says VVCNet *"evens out the playing field a bit"*, and her students *"don't feel so different, because everyone has the same thing on their screen."* She can stand back and give them more independence, and no one knows her students are behind the rest of the group: *"they don't have to answer all the questions, say if there's ten they might answer six or something."* However, this type of self-paced learning gets other SAER, like Cozza, unstuck because there is less pressure to keep up, and it's less likely the teacher knows you haven't done any work. There is also the issue of what happens when EAs are spread thin, as is the case in both Class 1 and 2, where EAs must work with a number of students.

Take Jim, for example. Jim is unable to navigate the laptop without constant support. Jim needs to be shown how to find information on the wiki each lesson. His EA, Bugs, types and reads for him. At the same time, she is dealing with Keisha and a number of other students. Like most SP students, Jim *"doesn't like to be different"*, and it's good for him to be able to access the same material as other students, albeit with constant EA support. However, when Bugs is working with other students, Jim is in GoogleLand or fluffing. Jim is unable to use laptops to locate information, or create work samples on his own. Bugs thinks the work set by Jill is *"too hard"* for SAER like Jim and Keisha. The laptops add to the problem, because there is too much information to trawl through in the 'research' tasks that students undertake in science.

**Research and critical literacies.** Research and fact-finding missions are a core affordance of laptops in science at VVC, but it's problematic. Brick and Lion's impression of science mid-Year 8 is that they spend *"all the time"* finding information on the internet, and then regurgitating it as PowerPoints. Likewise, in Year 9, students are bored with fact-finding missions and few complete set research tasks. The reasons for this are complex and relate to digital literacies and learner dispositions.

In VVC science, the amount of pages, tabs and hyperlinks students have to sort through makes finding and using information a nightmare. The development of photo-visual skills takes up too much time in digital environments such as Wikipedia, iMovie and Numbers. Students who struggle to navigate software can't access relevant information. For example, being unable to find downloaded material stops students before they get to the part where they need to read/comprehend/write texts. This ability to collect and interpret digital data is not one that science teachers spend any time on, even though the skill of 'reproduction' is required for synthesising information from different sources. It's here that VVC students' low literacies become apparent. One part of the problem with a hyperlinked digital world is the amount of inaccurate information it contains (Eshet, 2012). Trust issues are associated with the development of socio-emotional skills that are required to navigate the "risky" online world (Eshet, 2012, p. 102), but it's beyond the capacity of many students in Class 1 and 2 to make accurate judgements about the validity and truthfulness of information. For example, in mid-Year

8, FluroGangsta obtains all the facts for her bacteria poster from Wikipedia. It's a copy and paste spectacular. She, like others across the 2 years, looks for single word or sentence answers from one source rather than creating a new sentence of her own. She trusts Wikipedia, because it *"has all the answers."* When I suggest some of the information may be wrong she argues, *"I don't see why they'd just, like, start lying about lactobacillus."* Part of the problem is that students don't have enough background knowledge to make judgements about what they find on the internet, so they copy and paste information they don't comprehend. Eshet calls these information literacy skills "the art of skepticism" (Eshet-Alkalai, 2004, p. 100), whereas Jeff thinks that VVC students lack basic conceptual understanding of science concepts.

Students at VVC have developed additional strategies for research. One is that they type a question into Google to get the answer. Jeff thinks it's a survival skill to counter low literacy. However, without critical literacy filters to validate websites, students are vulnerable to misinformation (Eshet-Alkalai, 2004; Eshet, 2012). Students like Fluro, who is often critical of her own teacher, are not so tough on internet authors. These students are at a critical age, where they still believe what they're told. This is especially relevant in science, where scientific literacy depends on an individual's ability to make sound judgements.

VVC students need to be able to collect and interpret digital data "creatively" (Eshet-Alkalai, 2004, p. 97), reproducing, but not copying it word for word. This skill requires ongoing management in Class 1 and 2 as copying directly from websites is a trait of the cohort. Students with good reproduction and information literacy skills, like Chelsea, take information only from sites that have some credibility, e.g. 'Ask.com'. In May 2011, Chelsea types questions from a hardcopy worksheet about the rock cycle into www.answers.com, then finds answers to *"copy and paste."* One of her questions is *"What is a type of igneous rock?"* She types this into Google images just for something different, and the word *"amphibolite"* comes up with a picture. She tries pronouncing the word unsuccessfully a few times, copies the picture and information into Word, and then quickly moves onto the next question. By using different search engines, Chelsea is checking the validity of each site, and confirming she has the correct information. She is the only student who comes up with 'amphibolite' as an answer. She's also one of the only students who finish with some good quality answers. The boys behind her (Bill and friends) jeer, but they copy her responses down too. Chelsea says this type of internet research can be *"harder"* than looking in a textbook, because *"sometimes it won't give you exactly that answer you want."* She likes it when Jill gives them simple textbook questions, where they only have to search one page in a book. It's easier. The way that Chelsea can manage multiple websites and access further information is a testament to how laptops can take students to new places in their quest for knowledge. Unfortunately, it's all too rare in VVC science because of low literacies.

The ability of students to process multiple sources of information at the same time—"real time thinking skills" (Eshet, 2012, p. 267)—is something students, including low-literacy, begin to master immediately in Year 8. They then proceed to become proficient at subterranean off-task behaviours, including toggling work and non-work screens. Yet interestingly, many students in Class 1 and 2 are not good at organising themselves or their work. One of the hardest skills for students to master is their 'branching' skills: the ability to work in a multi-dimensional digital learning environment (Eshet, 2012). Branching skills are required when using hyperlinks in programs like Wikipedia (Eshet, 2012). Jill and Jeff believe multi-dimensional websites take students off-course into GoogleLand. Eshet (2012) found that this ‘disorientation’ can be overcome by working on mental models, concept maps, and “other forms of abstract representation” (Eshet, 2012, p. 270). At VVC, there were no attempts at this kind of modelling in the lessons I attended, and no evidence on laptops or in portfolios.

**They’re only, like, for games.** Jill estimates over half of her students think laptops are a *“game machine or toy”,* and the expectations surrounding this mean that she *“struggles”* to engage them in science with laptops. Perhaps she misunderstands her students. In Year 8, AK47 doesn’t count any of the items in her online science folder as *“science work”*, because *“they’re only, like, for games.”* At the end of Year 9, during a HLE lesson, AK47 exclaims, *“FML*[41]*! I just don’t wanna do it again!”*, and Sammy sympathises, *“It’s so annoying! Coz why do it every week? Basically every lesson!”* AK47 says she *“never remember any of it”* but does her work because *“we wanna get it finished, so then we can just sit and talk.”* When I explain to Jill that the class is bored of interactives, she is worried. She says:

> *I try to get them to do interactive stuff and they…because I don’t like just giving ‘em pages and pages of notes. Y’know, coz that’s the other option if they’re not doing the interactive stuff, and they can’t do pracs everyday coz we just run out of stuff to teach. Ah, then the only other option we’ve got is chalk n’ talk! And bookwork! And they’re gunna get bored real fast.*

The drill and practice simulation HLEs, like the ones that Jill and Jeff use, can “empower” students to find more information themselves, and they rely less on the

[41] Commonly used text-speak for “fuck my life”

teacher (Dunleavy, et al., 2007, p. 446). These kinds of scaffolds do not appear to work in this way in Class 1 and 2. Laptops enable students to collect and view information, but students seldom use this information for higher-order thinking.

There is an opportunity to use HLEs for low literacy students, but this affordance is not fully realised at VVC and the tools available are not sophisticated enough. Many HLEs, like Moon Phases (Education Services Australia, 2011), incorporate synchronistic literacy in their design, which allows users to read-a-long with text and models while the computer 'talks' (Eshet-Alkalai, 2004). I saw this tool used in both Jill and Jeff's classes, but with unintended outcomes. Rather than engaging learners, these HLEs are *"boring"* because they're *"work."* Students place little importance on playing properly: they click-click through the activity and abuse the voiceovers. BettyBoop explains that this is a characteristic of *"at-risk"* students, who don't want to be seen to need extra help.

In mid-2011, I spend time observing Class 2 students work through a HLE and worksheet about the Earth and Moon. Rukia preferred the HLE over the worksheet, because *"it moves, and then it's got, like, more detail and every time you move it you can see, like, the phases."* The other two students I worked with were lost. Mouse couldn't do any of the HLE or worksheet. She had no concept of moon phases after several lessons playing the interactive. Chris couldn't read the directions, but sat quietly at his desk clicking buttons. His attempts at answering multiple-choice questions in the game were guesswork, and he played the game repeatedly to avoid the next task, a worksheet that he said was *"too hard."*

Teachers use these kinds of HLEs as a staple in their curriculum, thinking that students love to play games, therefore they'll love to play science games. Unfortunately, the two are not congruent. The science games available at the time of this study require further development to make them appear cool and useable to middle school students. When students are bored with HLEs, and they have their laptops open, it leads to subterranean off-task behaviours.

**Subterranean off-task behaviours.** Cozza and Barry think science is *"shit"* when they watch a video mid-Year 9. Cozza says watching things on a screen is *"hard to understand"* and Barry explains his *"brain doesn't develop like that, so I can't understand."* Ironically, half an hour into the video, Barry *"started open my laptop up, tuk tuk tuk* [simulating laptop keypad noise]*...Play gamessss!"* Laptops are a useful way to engage in subterranean off-task behaviours. Jill says laptops provide *"more opportunities to misbehave without being so obvious"* because *"if they're not working on a laptop, it looks like they're working, but you know there's games or whatever on the screen."* Jill uses off-task behaviour on laptops as a pacifier. She claims *"it's actually sort of beneficial"*, because *"if somebody's misbehaving on a laptop it's a lot less disruptive than when they're misbehaving without a laptop. You don't have such an issue with people out of seats and that, like you would have if they're normally misbehaving."* Jill accepts off-task laptop behaviour as a *"trade off."*

When students find a new game, it can be a welcome distraction from science. For example, when Sammy and AK47 find an unblocked online piano, other students try it. By the end of the lesson, it's old news and not cool anymore. Chelsea tells me *"it's hard to find 'em"*, but they have a *"friend"* who knows how to bypass the proxy server. AK47 shows me another favourite, at http://googlepacmangame.com*:"Google Pacman...it just looks like you're on normal Google homepage."* Chelsea tells me sometimes science is *"so boring"*, and other students are playing games *"so I just play...then they get hell catchy and you just get into 'em...then you just stay on it..."* This says something about the quality of science education at VVC if students are prepared to play Google Pacman instead of participate in a science lesson.

## Conclusion

This chapter presented data examining student experiences of science with laptops. The main message is that students struggle to engage in science with laptops. 'Excess baggage' revealed two key reasons for students not bringing laptops to science: they're not portable enough; and they're not cool. These perceptions translate into practical reality for teachers who must deal with *sans* laptop students. This relates to the 'Science with laptops' theme. What constitutes good science, and good science with laptops, is a constant source of tension between teachers and students. The critical incident, 'Laptops can go live in the tip!', along with most of the other critical incidents throughout the last few chapters, paints a picture of just how negative student perceptions of science, and laptops in science actually are.

Chapter 3 identified two standout affordances of ubiquitous computing: unlimited access to resources, and access to creator software that enables users to become producers rather than consumers of knowledge. In this chapter, 'SAER' presented data that suggest SAER, including Schools Plus students, can benefit from ubiquitous access to resources because it makes them feel more included, but at the same time, data suggest it can also exclude them because they can't access information and create work samples on their own. This is particularly relevant where ethnicity and low literacies are involved. The chapter identified word processing as a key affordance of laptops ('Zooma fast typing'), but in the context of science at VVC, it has an underbelly. Chapter 5 explained that VVC science teachers are prone to lectures. Providing students with another note taking tool enables this transmission pedagogy to continue, and contributes to negative experiences which lead to negative perceptions of science.

Data in this chapter suggest affordances are muted within the tightly bound, teacher controlled learning environment of VVC science. Data in Chapters 5 and 6 began to uncover that teacher pedagogy is a reason for student disengagement from science, however this chapter presents data suggesting it goes deeper, with other contributing factors including: technical complexities ('They're hell technologic'); access ('We never use 'em anyway'); the contradictory idea that laptops are used too much for the wrong things ('They're only, like, for games'); and difficulty managing behaviours because students are good at concealing their subterranean off-task behaviours. Another concerning finding is the complex challenge that arises when dealing with research and critical literacies in science. At VVC, the development of learner dispositions that improve students' abilities to use laptops is not a feature of the science curriculum, which focuses on conceptual knowledge at the expense of everything else. This is a well-cited criticism of mainstream science education that contributes to the science education crisis, as explained in Chapter 2.

In conclusion, while this chapter has provided examples of technology bling (affordances), the underbelly of 1:1 contains real issues that impact on the use of computers in the middle school science context of VVC. The multiple perspectives of teachers, students, and the researcher, presented in Chapters 5 through 8, serve to illustrate the culture of science at VVC, and suggest this culture is restricted by certain learning environment factors that make transformation difficult. The next chapter,

Chapter 9, will answer the research questions, and explain how these learning environment factors act as barriers to teaching and learning science at VVC.

# CHAPTER 9—ANSWERING THE RESEARCH QUESTIONS

Chapters 5 to 8 present data that illustrate the complexity and richness of the culture of science at VVC. Chapter 5 described the structure of the VVC middle school, including the laptop program and its science teachers. Chapter 6 introduced the student participants, where vignettes describe critical incidents relating to gender, ethnicity, achievement, age and time. Chapter 7 presented data relating to the way students 'do' science, including conflict with science teachers, perceptions of 'good' and 'bad' science, and notions of science in everyday life. Chapter 8 filled in the gaps about students' perceptions of laptops in science, presenting data relating to the affordances and underbelly of 1:1. All of these chapters provide examples, through vignettes and critical incidents, of what the culture of science at VVC looks like.

This chapter, Chapter 9, brings together the data from the previous chapters to answers the research questions. It begins with the culture of the learning environment, where Research Question 1 asks:

> How do factors related to the learning environment impact on the use of computers in science in a 1:1 middle school context?

The chapter then moves to focus on the culture of the learners, and the artefacts, values, and assumptions relating to how students 'do' science at VVC. Research Question 2 asks:

> How do factors related to the learner impact on the use of computers in science in a 1:1 middle school context?

Further analysis and synthesis of the data from the previous chapters here in this chapter enables the identification of a number of key findings with respect to these questions. This will demonstrate the ‘bling’ and the ‘underbelly’ of science in the 1:1 middle school context of VVC. As explained in Chapter 3, the literature usually talks up the bling, blind to the potentially negative long-term outcomes that exist as the underbelly of established 1:1. Data presented in Chapters 5 to 8 uncover the reality for participants in the established 1:1 program at VVC. Much of what participants say and do indicates that 1:1 has failed to facilitate the transformation anticipated by both the ACOT model and the New Learning Ecology model. This study, in fact, identifies a very different reality for the culture of science in an established 1:1 school. Chapters 5 to 8 reveal this culture. The ‘mash up’ that now follows is a distillation and discussion of factors within this culture. These constitute the key findings of this study.

## The Culture of the Learning Environment

The answer to Research Question 1 draws together data to support the key finding that the culture of the science-learning environment at VVC does not focus on much needed reform. As the literature review explained, being focused on improvement is an important part of innovative school culture: it’s a feature of successful 1:1 schools and schools where innovative science teaching and learning occur (Drayton, et al., 2010; Melville, et al., 2011; Tytler, 2007a; Zucker & Hug, 2007).

Chapter 5 described VVC learning environment artefacts, such as the structure of the school, including Sub-Schools, the laptop program, school policy and procedures. It also described the way teachers ‘do’ science. Evidence in the preceding chapters indicates these artefacts contribute to a learning environment culture that maintains the status quo, which is the dominant culture of western science described in the literature review as ‘traditional’. This is, disturbingly, a common finding in science education research (Tytler, 2007a). Findings in this chapter will expose the paradox of policy, structures, and the role of leaders in the process of ‘cultural assimilation’ into our monolithic global education system (Christensen, et al., 2011; Cuban, 2013a). Analysis of the cultural artefacts of the learning environment serves to explain how the culture of the learning environment impacts on the use of computers in science at VVC (Research Question 1).

**Innovative use of ICTs doesn’t stick.** Chapter 3 explained that phases of technology integration signpost the constructivist transformation associated with ubiquitous computing. During the initial phase of 1:1 at VVC, teachers were becoming more confident with technology, using it more, and using it differently (Newhouse, 2008). This puts VVC teachers in the ‘appropriation’ phase of the ACOT model of technology integration (Dwyer, et al., 1990), where they’re experienced enough to use laptops for new things. This study of 1:1 science at VVC, however, indicates there is limited evidence of teachers moving beyond the appropriation phase, into the ‘invention’ phase where they use and retain new pedagogical styles.

A key finding of this study is that with snapshot data, it is possible to misconstrue the practice of VVC science teachers as being in the ‘invention’ phase of technology integration. Data in Chapters 5 to 8 provide examples where teachers are shaking off old-school transmission pedagogy and spending more time as a facilitator of learning. Teachers trial new technologies and teaching styles: HLEs are used for modelling complex concepts and promoting higher-order thinking, inquiry research is used to gather data, and production software, such as PhotoBooth/iPhoto, is sometimes used to gather (but rarely analyse and interpret) data during investigations. '1:1 science' (Chapter 3) stated these are common uses of technologies in science. However, analysis of extensive qualitative data from this longitudinal study (extending over 2 years) reveals that nothing innovative sticks in VVC science. There's always a trigger—a barrier—that sends teachers scuttling back to old favourites, like lectures and cloze worksheets. It's a groundhog day of technological innovation.

The problems with the use of so-called 'innovative' digital tools result from the complications and constraints of managing ICTs in the context of the VVC science-learning environment. VVC teachers believe 1:1 does not provide reliable affordances for their students. Chapters 5 to 8 describe scenarios where teachers perceive and experience these concerns: ongoing battles with student misuse of laptops; the difficulty of creating and finding student work on laptops; and the negative impact that 'ubiquitous computing' has on student learning and relationships. However, these negative experiences with laptops relate to assumptions behind science teacher pedagogy, where amidst the bling of technology is the hidden underbelly that nothing really changes.

**Teachers bolt laptops onto existing transmission pedagogy because of their alignment to traditional science.** A key finding of this study relates to science teachers' actions and beliefs about learning. The New Learning Ecology states that a condition for successful 1:1 is that "teachers must have highly developed capacities for facilitation, improvisation, coaching and consultation" (Spires, et al., 2009, p. 9). In science, this kind of teaching is linked to inquiry and social constructivism (Tytler, 2007a). VVC science teacher pedagogy, however, indicates they follow the traditional positivist science pipeline model, forsaking relevant science and inquiry learning for academic science and the consumption of fact (Aikenhead, 2010).

VVC science teachers could be the orchestrators of change if they moved away from the culturally accepted middle ground, which is the 'normal' positivist framework for reality. VVC science teachers do not teach using the 'science for all' philosophy, which the literature review stated is the framework underpinning contemporary science education. Chapter 5 presented data indicating that VVC science teachers are aware their students have different needs to 'average' students, yet they continue to teach for future scientists at the same time as believing there are few in the cohort.

Research suggests that innovative science teachers use cultural points of intersection to develop curriculum that is relevant and engaging for all of their students (Chigeza, 2011; Grimberg & Gummer, 2013). They push the boundaries of what, and how, to teach science, using the 'science for all' philosophy (Aikenhead, 2006; Tytler, 2007a). However, there is an expectation at VVC that students will assimilate into mainstream science. The failure of the school to address this social justice inequity during the study period echoes reform failure on a global scale. Such failure is blamed on a complex set of hidden Eurocentric cultural assumptions that have plagued science and education reform for at least 100 years (Aikenhead & Ogawa, 2007; Cuban, 2013a; Tytler, 2007a).

In the context of traditional science, the role of technology in science at VVC also becomes one of assimilation. Chapter 3 explained that pedagogical transformation is a key affordance of 1:1, however laptops at VVC are integrated into existing transmission pedagogy. This links back to teachers' notions of science. Constructivism is not the central tenet of science teaching and learning at VVC. Jeff's quote about constructivism being something that happens after rote learning, e.g. *"these are the facts, you need to know them"* (p. 138), highlights this philosophical disconnect, and explains why laptops are used for transmission rather than knowledge creation.

Newhouse's (2008) evaluation of 1:1 at VVC claimed that laptops at VVC shift the focus from teacher to student control of learning. Chapter 3 explained that transmission pedagogy can be difficult to eliminate in a 1:1 environment, and the only study of science in established 1:1 schools found that "prevailing pedagogical styles in a school, or even an individual teacher's classroom, will set the interactional patterns into which technology then fits" (Drayton, et al., 2010, p. 38). This study of science at VVC has found that ubiquitous computing hides a lack of transformation, by cloaking the traditional science classroom in 21$^{st}$ Century bling. It can look innovative, because of smart presentation tools (e.g. ComicLife), and is sometimes almost social constructionist in nature (e.g. internet research), but it feels like transmission (e.g. copy and paste posters, cookbook 'experiments', and 'interactives').

The literature review (see 'Cultural reform…failure?') explained that technology in schools could just be a case of 'new replacing old'. At VVC, during the study period teachers bolted laptops onto existing transmission pedagogy, as a new way to do old-school things. Next, the focus shifts to school leaders, and how they influence the way computers are used in science at VVC.

**Leadership supports existing school culture that does not provide opportunity for long-term innovative use of laptops.** Chapter 2 identifies good leadership as critical to contemporary science education, but leaders can end up "a victim of culture if the leader does not understand how to manage culture" (Schein, 2004, p. xii). A key finding of this research is that during the study period there was limited evidence of science leadership that worked toward managing, or reforming, the multiple dimensions of science culture at VVC.

Chapter 5 presented limited evidence of leadership that supports the ‘science for all’ philosophy, and the leadership vacuum of 2010 enabled teachers to continue working in the culturally accepted paradigm of traditional science. Chapter 2 explained that traditional school science is not good with reform. Melville, Hardy and Barkley (2011) found that science leaders and teachers give a “glacial” reception to new teaching models (Melville, et al., 2011, p. 2276). They found that staff need to align in the common goal of reform, and department heads must initiate such changes (Melville, et al., 2011). At VVC, Jeff talks about students’ negative perceptions of science, but he doesn’t attribute these perceptions to his science department (p. 174). At the time of the study, it appears school leaders were happy with the way things were, even though the majority of students were failing science, and their teachers, including Jeff as HOLA, believed that *“there’s nothing any of us can do”* (p. 136). Without being able to “perceive the limitations of one’s own culture and to evolve the culture adaptively” (Schein, 2004, p. 2) there is limited scope for reform at VVC. Another way of looking at this is to frame it in the context of whole-school culture, where the type of school environment is what Hopkins, Ainscow and West (1994) term ‘stuck’: failing students, low expectations, and teachers blaming others for poor achievement.

**Limited collegiality and collaboration reduce opportunities for change.** To progress from being a ‘stuck’ to a ‘moving’ school requires a blend of change and stability (Hopkins, et al., 1994). At VVC, the relatively new structure of the middle school, with its Sub-Schools, didn't change the isolation of the science department. The physical and philosophical isolation of VVC science acted as a barrier to successful collaboration between and within learning areas, with other stages of schooling and the community. Furthermore, during the study period, there was no professional learning to address contemporary teaching strategies, including the importance of making curriculum relevant to minority students. Therefore, VVC science teachers are not encouraged to change the way they teach science because there are no challenges to their worldviews, where limited collegiality and professional learning makes both understanding the need for change, and access to reform tools difficult. In this context, it is easy to see how and why laptops are inserted into existing pedagogy.

**The policy paradox tempers the impact of computers in science.** As reported through the literature in Chapter 3, successful 1:1 programs have a well-developed set of policies and procedures in place related to: "hardware delivery, support, upgrades, repair, servers, security, student authentication, usage policies, etc." (Tinker, et al., 2007, p. 2). The ACOT model states these changes to the physical environment occur in the initial phase of 1:1 (Dwyer, et al., 1990). But Drayton et al's (2010) study of three established 1:1 schools found that technical problems continued through the established phase and had "pedagogical consequences" that "in some cases have substantial impact on teachers' attitudes and actions about the innovation" (Drayton, et al., 2010, p. 40).

This study at VVC, set in an established 1:1 middle school, provides data supporting the assertion that established 1:1 schools continue to have technical problems that impact on the delivery of ubiquitous computing. A key finding is that glitches in the

VVC laptop program contribute to negative experiences with, and perceptions of, computers in science. These experiences are a contributor that leads teachers to ditch innovation in favour of old-school methods. This significant finding adds a new dimension to the literature, which to date has focused on initial phase 1:1 programs and the wiz-bang bling of potential affordances. The next section explains that the policies and procedures that form part of the laptop program at VVC contribute to 'catch-22 scenarios' that temper the transformative impact of computers in an established 1:1 setting.

***1:1 policies create catch-22 scenarios.*** Data through Chapters 5 to 8 present scenarios where VVC's 1:1 policies create paradoxical situations with positive intentions (bling) and negative outcomes (underbelly). One of the main issues relates to accountability and responsibility. For example, VVC policy requires laptops and chargers to be 'sighted' by teachers every day. While it enables the school to keep track of laptops, it causes strained teacher-student relationships. The irony of 'personalised laptops' is that ownership is a tokenistic gesture, where the school retains control over how and when laptops should be/are used.

The concept of 'ubiquitous' is also tokenistic. For example, school policy mandates students cannot get laptops and chargers during class time. This serves to minimise disruption, but creates an access issue, leaving students without laptops in science. It means science teachers must prepare two lessons to cater for students with, and without, laptops. Another 'ubiquitous' issue relates to the locker key. While it appears to promote student ownership and removes responsibility from staff, when students lose their key they can't access a laptop. This is similar to the end of term 'lockdown', which is designed to give the technician time to check and update laptops, but reduces the amount of time students can access laptops by at least eight weeks a year. 'Ubiquitous' is less about 'all the time' and more about meeting the operational needs of the organisation.

The purpose of these school policies and procedures is to smooth out 1:1 implementation, but as illustrated, they have an underbelly. Coupling these catch-22 policies with technical issues compounds the problem, reinforcing the negative perceptions of laptops in science, and contributing to the problem of students not bringing, or using, laptops in science.

***Unreliable technologies limit laptop use.*** The New Learning Ecology explains that one of the four conditions for successful 1:1 is "immediate and constant access to information" (Figure 1 and 2, pp. 52-53). This is an important failure in science at VVC, where during the study period two types of technical problems limited participant access to ICT affordances, particularly 'immediate and constant access to information'. Chapters 5 to 8 presented critical incidents where technical problems formed part of the scenario. First were the 'top end' issues beyond participants' control: poor/no internet connection; printer/server/software/hardware failure; lockdown. Then there were 'user failure' issues: lost work; lost programs; broken chargers; no key; smashed screens; and the most common user-fail of all, no laptop. The immediate impact is a reduction in user's 21st Century experiences, including the important 1:1 affordances of "communication, productivity and creativity tools" (Spires, et al., 2009, p. 6). One is left wondering about 'ubiquity', if it exists, and how these problems impact on equality of access, and the digital divide, which was raised as a social justice concern of 1:1 in Chapter 3.

**Where is the love? Power and control are core tenets of VVC science culture.** At VVC, 'us and them' is a common theme in interview and observation, situated mainly in students' negative talk and responses to structures imposed by their teachers, in particular related to laptops and science. In our normative education system, we supposedly work together to achieve student outcomes, yet there remain questions about how we deal with those who do not prescribe to the same set of beliefs about teaching and learning. At VVC, science teachers are apathetic to student disengagement. When VVC students complain about *"boring"* science, the dismissive response of VVC science teachers, as evidenced through their lack of pedagogical change in the face of mutinous, disengaged class behaviour, confirms the literature's complaint that science ignores/excludes those who don't fit its culture (Aikenhead, 2006; Noblit, 2013; Tytler, 2007a). This plays out on a global scale, where there's ambiguity and confusion over the perceived culture (what should be happening), and the actual culture of schooling (Cuban, 2013a). Questions remain about alignment between policy and practice. An example is the contemporary philosophy of science education being about constructivism, inquiry, and student-centred learning, when in reality kids sit at desks facing the front listening to lectures. This is happening at VVC, and across the world (Cuban, 2013a; Goodrum, et al., 2012).

At VVC, there is conflict about shared beliefs that stems from different perspectives about truth and reality. Part of the shared vision at VVC locates laptop use at the centre but data indicate that from a science teachers' perspective it's an enforced mandate from the ‘engineering’ and ‘executive’ cultures of school administrators and policy makers (Schein, 2004). It’s a hierarchical system where teachers and students feel they are part of a coercive organisation that forces them to use laptops.

In his commentary on science education, Noblit (2013) frames science education as bound by language, where modes of communication exclude participation in knowledge creation and, importantly good policy development. We see this in VVC science, where low achievement relates to students’ inability to access information because of their limited literacy skills. It’s a visioning failure at an engineer and executive culture level, because the message from these groups is not clearly filtering down to teachers, who sense no urgency for change. As a result, low expectations are a cultural feature of the VVC learning environment, where it’s ok for kids to get Ds, and it’s ok to keep teaching in traditional ways.

Noblit takes his assault on science to a multinational level, and compares science to colonisation. He posits that where language was once the vehicle for colonisation, it’s now science that is the “content” (Noblit, 2013, p. 243). So before pointing the finger at VVC science teachers as the powerful overlords of science (as students Cozza, Barry, Chris and Bill might believe), there is some finger pointing to be done ‘up there’ to the cultural artefacts dangling over us on a much bigger stage, orchestrated by the engineering and executive leadership groups. As explained in Chapter 2, teachers could be mere vehicles for cultural policy delivery, relaying their interpretations of science experienced through university, work and society. Chapter 2 introduced the idea that individuals develop and use cultural software tools to negotiate their interactions with the world of science around them (Wood, et al., 2013). The unconscious and unquestioning use of cultural tools makes VVC science teachers unknowingly complicit in contributing to a way of knowing that is about power and control. To play this conspiracy theory through further, we can relate the power of science to its role in the global economy, where it links to progress and economic growth: these are the tenets of modern(ist) society and serve to hold science to particular social outcomes, namely growth, assimilation and domination (Giroux, 1991; Noblit, 2013).

The resistance to change occurs at all levels of education for a range of different reasons (Giroux, 1991). Tytler (2010) believes that teachers are not so much resistant to reform as they are bound by the constraints of a society where literacy and numeracy dominate educational policy, and where their attempts to do good science relate to continuing the traditional science regime. Reform-oriented teachers, on the other hand, focus less on transmission and assessment, and more on inquiry, critical thinking and engagement. At VVC, the reformist, student-oriented, inquiry learning science teacher did not have a place in the context of science culture as present in 2010-11.

**VVC aligns to the where-not-how model of middle schooling and this constrains innovative practice.** Research suggests that middle school structure can enable teachers to adopt “cross-curricula and other progressive teaching strategies” to engage students (DoE, 2008, p. xvi). At VVC however, there is limited evidence of cross-curricular or progressive pedagogy. The Introduction identified that middle schools can be innovative, yet it’s common for them to be blinkered in the way they operate, which “exacerbates” the “cultural and curricula divide” with upper school (DoE, 2008, p. xviii). Data in this study support such an assertion, as there is limited evidence of connections between VVC middle school science, other learning areas, stages of schooling, and science in everyday life.

In the context of science, VVC fits the where-not-how model of middle-schooling: a criticism that claims they're just a "place" that doesn't change "how" students are schooled (DoE, 2008, p. xii). This is a significant factor in the culture of schooling at VVC. It contributes to the traditional approach to science, where laptops become part of this 'old-school' learning environment culture.

Culture experts claim there must be a balance between structural and cultural change (Hopkins, et al., 1994), otherwise reform is all just smoke and mirrors. At VVC, structural changes have done little to alter the culture of the learning environment. The executive culture, in the form of the Education Minister of the jurisdiction, set the tone for reform at VVC in 2003, predicting innovation and improved student outcomes resulting from middle schooling and ubiquitous computing (see quotes in Chapters 1 and 3). What failed to translate to staff, who were to be the 'operators' of this reform at ground zero, was that VVC needed to flip its theoretical assumptions about teaching and learning on its head for these structural changes to be successful. Underpinning the failure of the trickle down approach for middle schooling and 1:1 reform at VVC is something much bigger: the business of Eurocentric, westernised schooling. School reform has rarely been successful because of this industrialised process (Aikenhead & Ogawa, 2007; Christensen, et al., 2011), which includes a love of single-teacher, age-stratified classes (Cuban, 2013a). The ideological resistance of science staff sits within these cultural bonds (Melville, et al., 2011; Tytler, 2007a). In this context, we move into the answer to Research Question 2, which drills down into the factors related to VVC learner culture that continue to both sustain, and tear at, the status quo of 'normal' science education.

## The Culture of the Learners

If you imagine the learning environment as illustrated in Chapter 3 (p. 52), learners are right there in the middle of the mix, surrounded by an array of cultural pressures they must simultaneously understand, interpret, and negotiate their place in/with/between. This study reveals that the culture of the learners at VVC is a multi-dimensional set of responses to the extrinsic learning environment, and this hooks into a range of issues associated with age, gender, ethnicity, literacies and identities. It's in this context we examine the culture of the learners.

**Age and time impact on the use of computers in science.** The literature review explained that student attitudes toward science start to decline in early adolescence, and there is evidence that laptops are used less as time goes by in 1:1 schools. Findings from this study suggest VVC students' attitudes towards science and laptops decline because of their experiences in science in the 1:1 context of the VVC middle school.

***Students develop negative perceptions of science because of negative experiences in science.*** As VVC students become more familiar with high school subject cultures, they form opinions about the importance of science in their life. Chapters 6 and 7 capture these attitudes, where factors such as gender, ethnicity, identity and relationships play important roles in student participation and engagement in science. Changing perceptions over time also relates to students' age, and this study provides data about the development of personal epistemologies as students move from primary school into high school. In late childhood and early adolescence, children generally take an uncritical view of the world, accepting science as an objectivist factdriven discipline (Ricco, et al., 2010). Teenagers begin to take a more critical stance, where they "align strongly with their peers; are concerned with establishing their own identities; and often question accepted practice and other people's priorities" (XX Council, 1998, p. 235). Evidence from this study at VVC supports the assertion that teenagers are a critical bunch whose beliefs are influenced by their peers. At VVC, this pack mentality is obvious in lessons dominated by extreme behaviours, but also through conversations between students that involve negative talk about science, laptops, and teachers. A key finding, therefore, is that students work together to form opinions of science, and the desire to develop and maintain group identities subsumes individual students' agency. The notion of identity and agency continues in further findings.

Students' beliefs about the importance of science to their future develop over time at VVC. There are limited opportunities for students to connect science with their lives or their future, and poor self-efficacy enhances negative perceptions of science. Identity in school science research conducted by Shanahan and Neiswandt (2011) revealed four key aspects to teenagers perceptions of what it means to be 'good' at science: being smart, being able to do experiments, liking science, and good behaviour. Data from this study indicate that VVC students tend to reject the role of 'science student' because it identifies them as a geek, and this isn't a cool image. Chapter 2 identified that negative perceptions of science develop through an individual's interactions with the dominant culture. The agency of teenagers in science is known to be affected by the dominant discourse, which is usually set around the traditional view of science being for 'scientists' and 'future scientists' (Olitsky, 2006; Shanahan & Nieswandt, 2011). This subject positioning is crucial to understanding the culture of the science-learning environment at VVC, where traditional pipeline ideology forms the dominant discourse amidst a group of non-mainstream ‘students-at-educational-risk’ (SAER).

***Students use laptops less as the novelty wears off.*** Data from this study suggest that using laptops less is in part a function of the passage of time, and a student awakening as to the purpose and usefulness of laptops in the context of their needs. The literature review reported the Newhouse evaluation found VVC students did not develop negative perceptions of laptops over time. This study does not support such an assertion. The answer to Research Question 1 addressed the myriad of continual challenges thrown up by 1:1. These experiences mean that VVC students are less likely to engage with technology. Chapter 7 captured this in ‘Excess baggage’ and ‘Science with laptops’. One of the key issues relates to digital resources, and their appeal to teenagers in this age bracket. Although technology companies developing science resources try to provide high-end platforms similar to those students engage with out of school (Muehrer, et al., 2012), educational technologies have not evolved as quickly as the gaming industry (Christensen, et al., 2011).

**Student identities impact on the use of computers in science.** Southerland et al. (2011) found that science teachers believe learner characteristics, including “culture, economic class, primary language, ethnicity, self-efficacy, and interest” impact on teachers’ abilities to provide a science education for all (Southerland, et al., 2011, p. 2192). The answer to Research Question 1 explained that VVC science teachers do not embrace a science for all philosophy because they are indoctrinated into the pipeline science ideology. A key finding from this study is that they also struggle to deal with the needs of SAER in a 1:1 environment. Chapter 2 explained that most science teachers give the concept of identity no attention. Science as a discipline has long been criticised for this shortcoming, and it's a key contributor to the science education crisis (Tytler, 2007a). This contributes to student disengagement and creates social justice issues about access and equity. By not taking the identities of learners into account, VVC science limits the development of students' "cultural capital" (Noblit, 2013, p. 243). This links to scientific literacy, which Chapter 2 explained was an individuals' understanding of science that is relevant to them. VVC learners can only develop their cultural capital, and scientific literacy, if they can access mainstream ways of knowing. Vignettes in Chapters 5 to 8 capture critical incidents where 'students at educational risk' (SAER) struggle to engage in science, and the classroom discourse is dominated by oppositional behaviours that are a direct rebellion against the culture of mainstream science. These displays play a role in the culture of the learners and are a response to cultural assimilation pressures.

Wood et al. (2013) theorise that the barriers associated with creating and maintaining identities within the subject culture of science marginalises all students. At VVC, the concept of 'students-at-educational-risk' (SAER) stands out as a key identity factor, where learner dispositions, gender, ethnicity and literacies interact and impact on the way students engage with science, and the use of computers in science. The following sections present the findings related to these factors.

***Students' beliefs about science impact on the use of computers in science.*** Data in this study point to conflicting views between teachers and students on what 'good' science is. 'Conflict with science teachers' described incidents where students' perceptions of science are framed by the relationships and experiences they have with teachers, and whether they're having fun. 'Being cool, having fun' explained that students' perceptions of fun science are linked to social and practical experiences, but teachers don't have these same perceptions. The answer to Research Question 1 explained that teachers follow a traditional pipeline ideology, and therefore they put more emphasis on lectures and worksheets. Furthermore, teachers struggle to manage student behaviour when doing hands-on, out-of-seat activities.

Because of the teacher preference for a disengaging pedagogy, students develop negative perceptions about laptops too. The perception that laptops are heavy and associated with 'work' ('Excess baggage') compounds the issue. The problem here becomes how to change the way laptops are used in science, and how to use them for engaging students in science rather than supporting existing practice. This study points to gender-linked differences in the way students choose to engage with laptops in science, and this may have important implications for how technology is utilised in science.

***Gender-linked preferences for digital resources impact on the use of laptops in science.*** Research suggests that by Year 8, boys have already started to out-perform girls in science and have more positive perceptions (Fouad, et al., 2010). In this study, engaging both boys and girls in science was a problem. In Chapter 6, 'Gender' exposed gender-linked preferences for technology use in science, where girls prefer social media and boys prefer gaming. Teachers use this phenomenon as part of the 'dummy effect', allowing gender preferences for off-task activities on laptops to manage behaviour, e.g. allowing boys to play games, and girls on social media. Pacifiers are a useful tool in the context of VVC science, because it helps to create a calmer class environment. At VVC, much of the disruption comes from boys. The literature suggests that boys are more likely to engage in disruptive behaviours in science (Shanahan & Nieswandt, 2011), and at VVC, this finding is tied to ethnicity, because the most disruptive group were Indigenous boys.

***Ethnicity impacts on engagement and the use of computers in science.*** Chapter 2 explained that identity is especially important for students from minority groups who are already subject to hegemony in daily life. This study is unique in that it provides insight into the way Indigenous Australian boys manage their identities in science. These boys are the most concerning group in VVC science, whose behaviours imply their needs are not met, and data in Chapters 5 through 8 illustrate that smashing through hegemony with oppositional displays is a response to traditional science.

Research on minority students in science in other countries has uncovered a hidden world (B. A. Brown, 2004, 2006; B. A. Brown, et al., 2005; Olitsky, 2006; Yeo, 2009), with potential risks for minority students that relate to engaging, and/or not engaging, in science. Brown (2004) believes that identity in science is like a continuum, where at one end students are actively doing science (they're proficient), and at the other they are in opposition to the culture of science. Some students might choose not to engage in science and avoid science dialogue. Data from this study support the idea that Indigenous boys avoid engaging in science. At VVC, a majority of Indigenous boys are in opposition to science (e.g. 'Spectacular oppositional displays'). Others might attempt science talk, but try to work their own cultural identities into their behaviours. For example, 'Science proficiency' described how Cozza attempts to engage in a lesson on tides, but then 'A bunch of black boys?!' shows how Cozza can oppose his teacher when he wants to call out perceived racism. Bill is also an example of the way Indigenous boys balance their role as group leader while attempting to participate in science ('Bill's leadership').

In this context, the usefulness of laptops for Indigenous boys becomes an important consideration. The 1:1 environment provides potential affordances, such as better word processing and opportunities for research, but it doesn't mean that Indigenous boys can access them. This is evident through the case studies described in 'Indigenous boys using laptops in science'. Furthermore, even though VVC has so-called 'ubiquitous computing', Indigenous boys are often without a laptop by choice. This choice not to engage with learning through laptops increases the digital divide. It means they're not developing the learner dispositions, including digital literacies, required to be successful in a digital environment (Eshet, 2012; Spires, et al., 2009). In summary, a combination of issues associated with gender, ethnicity and access compounds factors that red-flag Indigenous boys at VVC as 'at-risk'.

The next section identifies low literacy as a significant finding with respect to how computers are used in science in the 1:1 middle school context. It acts as another barrier to learning with laptops in science at VVC, particularly for Indigenous boys.

***Low literacies limit student engagement in science in a 1:1 context.*** Data in Chapters 5 through 8 indicate that low literacies act as a barrier to the use of computers in science at VVC. Teachers believe that students do not have adequate scientific literacy to engage in constructivist teaching and learning activities ('The black cat in the black room'). Furthermore, as 'Research and critical literacies' explained, they are lacking in critical literacies for research and digital literacies to navigate technologies.

VVC students receive no support in learning how to use digital tools in science because science teachers do not believe it is their job. The only Australian study comparable to this one at VVC, by Ed Stolarchuk in 1997, concluded that the introduction of laptops in his school decreased the amount of time allocated to science teaching and increased the amount of time spent on learning digital literacies, none of which enhanced science outcomes (Stolarchuk, 1997). The findings from this study of 1:1 science at VVC support this, and such findings hold important implications for science teaching.

**Key affordances of technologies are not realised because of student (dis)engagement.** As explained by the jurisdictional Education Minister, the purpose of laptops at VVC is to improve/facilitate student outcomes (Removed, 2003). The literature review introduced the cognitive tools framework, which posits that students need to use technologies in science for four key things: higher-order thinking about science concepts, including real-life comparisons; evaluating and communicating; formulating knowledge from evidence; and gathering, analysing and interpreting information (Butler Songer, 2007). The literature review also explained there is evidence, particularly from teachers, that student attributes limit the success of these affordances.

A key finding from this study at VVC is that many of the potential affordances of ICTs described in the literature review (‘1:1 and learning science’) are not realised in the context of VVC science, and this is linked to student (dis)engagement. For example, authors argue that HLEs can improve students understanding of complex systems (higher-order thinking about science concepts), including the solar system (Freebody & Muspratt, 2007). In this study at VVC, student use of HLE learning objects for modelling and visualisation was perceived as *"boring"* ('They're only, like, for games'). Furthermore, 'students at educational risk' (SAER) did not engage with these resources, and failed to grasp the abstract concepts such resources are designed to facilitate (e.g. 'Cozza, laptops and power'). Another example of failure to realise the potential of ICTs because of student (dis)engagement is the affordance of 'evaluating and communicating'. Data in this study reveal VVC students are not given opportunities to collaborate online. Teachers perceive students are easily distracted in a digital sense by social networking, GoogleLand and games. The affordance of knowledge creation is also stymied by student (dis)engagement. When VVC teachers give students opportunities for online learning, characterised by scaffolded web-quests with set questions and websites (e.g. 'Research and HLEs' and 'Literacy'), their tendency to 'go feral' outweighs the perceived benefit of constructivist learning. Much of the research on student behaviour in online environments points to the need for 'highly developed learner dispositions' (Spires, et al., 2009). As the vignette 'Research and critical literacies' illustrates, not all VVC students are able to regulate their behaviour online, and this is a key issue related to the culture of the learners in science at VVC. Engaging SAER in science learning with technology is an important part of improving student outcomes at VVC, but there is limited evidence this was achieved during the study period.

## Conclusion

This chapter has distilled and discussed the culture of science at VVC. Understanding culture provides us with a means of identifying and solving conflict, and serves to illuminate and create pathways for positive reform (Schein, 2004). An important question stemming from the findings in this chapter relates to the role of technology in science and education reform. Data in this study suggest technology is not always useful in the context of science. Authors of the Digital Education Revolution (DER) review talk up evidence of 1:1 being the catalyst for the "transformation" of teachers from "sage on a stage" to "facilitator who supports learning" (DEEWR, 2013a, p. 28). To external observers, like those working on the 1:1 evaluation at VVC (Newhouse, 2008, 2011), established routines at VVC create the impression of seamless laptop integration, where teachers are likely to use laptops to transform their practice from teacher to student-centred. The actual reality I've exposed as an insider sheds light on the underbelly of VVC science. In the context of this study, 1:1 is an illusion that cloaks the traditional science classroom in 21st Century bling, where the underbelly of 1:1 science exists as a lack of transformation. The literature review gave warning from the grandfather of ubiquitous computing, Seymour Papert (1987), who feared this would happen when technology was let loose in schools in the 80s, and he argued the culture of schooling, including curriculum and pedagogy, must change before the true value of computers in schools could be realised.

Throughout this chapter, there has been reference to cultural artefacts that serve to maintain the status quo and constrain the development of new ways of doing things. At VVC, there is an ongoing paradox relating to policy and pedagogy, where 'students at educational risk' (SAER) struggle to participate in science in positive ways. Laptops form part of this problem. A concerning part of this is teachers' ignorance of student needs. VVC students, including those who should be engaged in science (e.g. the 'good' kids), have developed a culture of apathy toward science learning, in particular science learning with laptops. There were opportunities to engage Indigenous boys and 'students at educational risk' (SAER) in science, but this was difficult for classroom teachers because of their beliefs, and because traditional science does not accommodate identities or alternative cultures. One can conclude that the cultural assumptions of science and education are the real underbelly of 1:1 science at VVC. In summary, the culture of the learning environment is exposed as requiring a 're-imagining' to leverage potential affordances of ubiquitous computing. The next and final chapter draws out these ideas as implications of the research.

# CHAPTER 10—IMPLICATIONS OF THIS RESEARCH

Chapters 2 and 3 explained that cultural reform is an important part of 're-imagining' science and education. Tytler (2007a) frames re-imagining science in terms of change: "the changing practice of science; the changing nature of public engagement with science; the challenges of science; changes to the nature of schooling; the changing population of students; the changing nature of youth" (Tytler, 2007a, pp. 3-5). These many changing factors can frustrate attempts at reform, but none more so than the monolithic educational culture of western society (Christensen, et al., 2011; Schein, 2004).

The key implication drawn from the findings presented in Chapter 9 is that VVC science does not focus on reform: it's 'stuck' with a culture that blames external factors for lack of improvement (Hopkins, et al., 1994). This results from existing beliefs and practices that frame the learning environment and learner cultures. This chapter uses this implication to make recommendations for school improvement. The chapter also describes contributions this research makes to the field of science education, including the strengths and limitations of the research, with particular focus on my role as teacher-researcher and the notion of student voice. It offers suggestions for future research to improve our understanding of technology and science education, and then the chapter ends with my reflections in true critical educator style.

## Recommendations

The following recommendations focus on the idea that overcoming barriers to reform will enable ubiquitous computing to have a more transformative impact on education. These recommendations apply to: established 1:1 schools; schools considering 1:1; initial phase 1:1 schools, middle schools; high school science departments; and schools with ‘students at educational risk’, in particular those from minority groups.

**Recommendation: Remove catch-22 policies.** A first step toward transformation is to minimise limiting factors that sit within school-based 1:1 policy. The removal of restrictive policies, for example, those described in Chapter 9, such as limiting access to lockers, would ensure all users can access ubiquitous computing affordances.

**Recommendation: Minimise technical glitches.** This study recommends that infrastructure, hardware and software rollouts should be conducted in a planned and trialled manner without impacting on subject lesson time. This will have a positive impact on user perceptions of technology. Part of this issue relates to departmental level procedures, such as when and how to initiate system-wide technology upgrades. The other part of this issue relates to school-based decisions on how many ICT technicians staff and students can access, and the timeliness of this support.

**Recommendation: Create conditions for collaboration. Open the doors.** A recommendation is to create conditions for planned and spontaneous collaboration between science teachers and students, other areas of the middle school, stages of schooling, and the community. The notion of specialist subjects must be replaced with a more holistic view of education that focuses on cross-curricular learning and collaboration. Another part of creating conditions for collaboration is professional learning (PL) (Hattie, 2012) and collegiality. Furthermore, when there is a leadership vacuum, administrators must continue to provide support for staff.

**Recommendation: Embrace the science for all philosophy.** A recommendation is to overcome traditional ideas about who science is for. ‘Science for all’ would provide an ‘in’ for the Indigenous students who appear out of place in VVC science. Schools must adopt a ‘science for all’ approach, and teachers must be supported to develop their understanding of this, as well as provide appropriate curriculum.

**Recommendation: Use innovative pedagogies and digital tools to engage ‘at-risk’ Millennials in science.** Teachers need to adopt student-centred, constructivist pedagogy to meet the needs of SAER and all Millennials. For example, the ‘maker movement’ gives students ubiquitous access to technology rich ‘makerspaces’ (Martinez & Stager, 2014). Another innovative use of digital tools is collaboration through online networks, for example using a science blog to communicate with other schools, or collaborative online science investigations.

**Recommendation: Remove ownership of laptops.** This may be controversial, but I don’t recommend personalisation of devices, because this creates social justice concerns, such as those at VVC when students do not bring their laptop locker key. In 2015, students don't need to own devices at all. The prevalence of wireless cloud storage means student data does not require a hard drive, and the virtual desktop could be a solution to carrying laptops (DEEWR, 2013a). I recommend the use of laptop trolleys, or 'desktops' like Smurf requests (p. 200), in classrooms, where the teacher maintains the resource, and is therefore guaranteed each student will have access when they come to their class.

**Recommendation: Increase the 'sexiness' of digital science tools.** There are limited digital science resources that meet the needs of 21st Century learners. Software and website designers must create digital tools that engage Millennials who are looking for something different to what we currently have on offer in science.

**Recommendation: Support students' development of digital literacies in science.** This study recommends the explicit teaching of digital literacies in science. To do this, schools need to rethink the science curriculum, which has too much focus on science conceptual knowledge. Stolarchuk (1997) suggests reducing science curriculum to focus on depth over breadth. Furthermore, if science teachers were part of a more collaborative workspace, the problem of when to teach digital literacies would not be an issue.

## Contributions to the Field

The following sections explain the key strengths arising from this research: the unique opportunity to examine science in an established 1:1 school in Australia; and the power of the emic perspectives of teachers and students.

**The unique context.** This study contributes to the educational community by providing unique insight into the science classrooms of an established 1:1 school. There are no other Australian studies about the culture of the science-learning environment in an established 1:1 school. Most 1:1 research is set in the initial stage, influenced by issues that are specific to this phase of implementation (Drayton, et al., 2010; Richardson, et al., 2013). The only other 1:1 science study in an Australian context is set in private schools in the initial phase of 1:1 (Fisher & Stolarchuk, 1998; Stolarchuk, 1997; Stolarchuk & Fisher, 2001). Furthermore, the VVC middle school context grabs at that important phase of schooling: the transition between primary and high school, which the literature tells us is an important turning point for students and their perceptions of science.

Longitudinal research in established 1:1 schools, such as this study at VVC, is crucial to understanding the long-term impact of ubiquitous computing on education. The VVC setting provides data to inform us of the potential pitfalls arising in established 1:1 schools, where 1:1 is 'normal'. The myriad of research that exists in non-1:1 settings and initial phase 1:1 schools will continue to paint a rosy picture and more stories from established 1:1 schools, written by the people experiencing the phenomena, like this one, need to make it into the public domain.

**The powerful, rich qualitative data.** This research draws its strength from in-depth qualitative data, with a focus on depth versus breadth. There were no standardised surveys or observation schedules. Data were drawn from in-depth semi-structured and unstructured interviews and participant-observer fieldnotes over two years. There are very few, if any, published studies like this in a 1:1 middle school science context.

**The emic perspective of the teacher-researcher.** Chapter 4 dealt with the methodological strengths of working from an emic perspective. This study includes perspectives that historically have had limited voice in Australian science education research literature, and I believe it sits as close as possible to the truth for those inside the black box of VVC science classrooms. The relationships I have with the participants make this a very unusual study of 1:1 science. The "critical stance" I have "deployed" (Noblit, 2013, p. 238) appears to take aim at teachers and students, but this is a result of a pre-existing set of beliefs, where my understanding of science at VVC is "heavily contextual, historical, and interpenetrated with power" (Noblit, 2013, p. 238). As an individual, I cannot know anything "definitively": I build an understanding of VVC "relationally and partially" and my culture does the rest (Noblit, 2013, p. 248). My experiences as a science teacher at VVC infuse my views with a passionate perspective that is impossible for an outsider to replicate. It's possible I have made ambiguous interpretations of the artefacts in the culture I am describing (Schein, 2004), however I hope the narrative I deliver is powerful, and provides a view that is easy for outsiders to interpret.

**The emic perspective of students.** The power of this study lies not only in my emic perspective, but also the voice of students. Chapters 6 to 8 focus on disengaged youth, who are under-represented in science education research, and whose voice can illuminate factors involved in the science education crisis (Chigeza, 2011; Wilson & Alloway, 2013). It was a source of frustration, excitement, and then discomfort when I realised the scarcity of 1:1 science research that examines student voice. I trust student voice: survey and standardised interview questions that feature in other 1:1 science research cannot access such rich and authentic data. Giving children the freedom to take charge of conversations—giving them power—led to important disclosures, and the stories in this thesis are the result of a negotiated discursive, trusting process.

### New Beginnings: Re-imagining My Place in School Science.

When I started this EdD as a 'traditional' science teacher, I knew nothing of the science crisis. My reflections throughout this dissertation suggest that I was a part of the problem, unable to see that mainstream traditional science, even with sparkly-bling laptops, was putting 'at-risk' kids off science. I had no real understanding of the kind of change required, because my experiences sat within the cultural norms of traditional science.

Although all teachers work in a "monolithic" school system that is resistant to change (Christensen, et al., 2011, p. 111), it's more pronounced in science, where super-prescriptive pedagogies and curriculum are entrenched (Aikenhead, 2010; Bryce, 2010; Munby, Cunningham, & Lock, 2000; Noblit, 2013). My ongoing transformation is a crucial outcome of this study, which I'm hoping will result in good things for the teaching profession. It's been a bit shocking along the way, because I have had to embrace different ways of doing things in order to be able to see science, research and education in the way that I now see it. Exposing sticky situations in other people's classrooms is really also exposing myself, and my attempts at reconciling these events with my evolving beliefs. It's a journey of conscientisation, which I'll never finish, because "teaching and learning are never complete - we are constantly reflecting and revising within the classroom" (J. Goldberg & Welsh, 2009, p. 724).

In the quest for reincarnation as an enlightened science teacher, I have somehow morphed into a K-6 Principal/Teacher/Gardener/Everyone in a single-classroom rural school. This change is my own way of working towards science reform, however my ongoing struggle to communicate the need for 're-imagining' science is a new issue that I face as a school leader. I am often confronted with teacher resistance that I know so well through the literature and personal experience. The battle is now not just honed on science reform: I see the whole system requires 're-imagining', and the scale of the change is mind-blowing. The Australian Curriculum and NAPLAN are two hot topics on the education reform agenda, and in my school context, I see tell-tale signs that the needs of our learners are losing out to accountability for curriculum delivery. The ironic part is that I am questioning the role of technology, in particular online learning, in such a context, and struggling to provide student-centred learning experiences for my students. In addition, I have decided that teaching science in a middle school is far easier than being a curriculum octopus in a primary school. These experiences only serve to continue my growth as an educator, where in addition to being the teacher-agitator, I need to work on my leadership skills.

## Limitations

Emic perspectives can be seen as a weakness. Positivists who value objective reality do not consider the kind of study done here real research (Peca, 2000), but all researchers bring culture and power into their work, even positivists (Noblit, 2013). I believe my explanation of the strengths of qualitative research and the emic perspective in the Methodology chapter provides strong support for my theoretical framework(s).

Another potential limitation of this study is the very specific context of the setting. While the findings are not generalizable, it may be that my narrative and experiences resonate with other teachers. Any teacher who is experiencing frustration with their journey through technology integration will find these experiences are similar, even though they may be in a different context.

Another potential limitation of the study is student voice. Teenagers are renowned for their extreme and vacillating opinions, so their voices are sometimes labelled unreliable (Bassett, et al., 2008). Critics claim the use of children's voice in research is biased because of the power imbalance often acted out in adult-child relationships (Spyrou, 2011). Others support the validity of student voice if it reflects the complexity of their characters (Ryan, 2010). I addressed the strengths of student voice in the Methodology chapter. The most important facet of this study, making it unique in an Australian context, is the raw and colourful voice of teenagers. A more likely limitation is that the research could not address all facets of student discourse. This leads into options for future research.

## Future Research

A number of areas have emerged out of this research that deserve further investigating, and these are discussed in the following sections.

**Disruptive dialogue on 'risky' topics.** The limited number of naturalistic studies in 1:1 school contexts creates a great opportunity for future research. There is a lack of disruptive dialogue about school reform and science education in an Australian context. More conversations about the way we teach science, who we are teaching for, and what our students need would serve to close the gap for all students, particularly SAER. We need evidence that what we are doing with technology in science is ‘closing the gap’ between the ‘haves’ and the ‘have-nots’. Most importantly, we need to assess whether “student achievement in a range of outcomes” (that quote from the jurisdictional Education Minister) relates to technology.

**Longitudinal data on schooling outcomes.** Studying students as they come ‘out’ of 1:1 and ‘back to normal classrooms’ would provide a greater understanding of the impact that 1:1 interventions have on student outcomes. In addition, we need to understand why students drop out of science after compulsory years schooling. Examining the critical junctures between phases of schooling will provide a deeper understanding of this element of the science education crisis. Documenting the educational pathways of students who have participated in 1:1, and the impact 1:1 science has on career pathways will improve our understanding of the science education crisis, and if ubiquitous computing offers affordances for upper school science students, particularly SAER.

**Indigenous knowledge in school science.** The ‘science for all’ recommendation aims to address this idea of inclusivity of minority students and ‘alternative ways of knowing’ in science. Alarmingly, the 1:1 science classrooms at VVC hold social justice concerns for disadvantaged students. Future research needs to focus on minority groups, non-mainstream ways of doing things, and how we can use technology in science to ensure that disadvantaged students aren’t held in the social space that science and technology seems to keep them. Freedom from the constraints of a traditional learning environment is part of ‘re-imagining’ school science that needs to become a reality.

**Students at educational risk.** It cannot be understated that the students in this study, many of whom qualify as SAER, are those who suffer in mainstream science classes. I believe the conversation needs to focus on what the system demands of teachers. I am concerned by the apparent hypocrisy of our educational institutions at both state and national levels (the executive culture), who create school policy telling us to ‘cater to individual student needs’, yet also mandate policy in behaviour management, standards and curriculum, that are far removed from the needs of these same students. The role of technology in improving outcomes for SAER is not conclusive, and I would like to see more research in this space. Unfortunately, it is difficult to achieve balance in this area, as most published research focuses on an audience that is bound by traditional cultural norms.

**The role of families and communities in science education.** Due to the constraints of time and page limits, this dissertation was unable to cover the issue of community engagement in science education. Many of the students in this study did not have families that were engaged in their education. This was one of the key factors relating to their status of ‘students at educational risk’. The concept of community engagement wasn’t part of the dialogue in VVC science during the study period, even though it was one of the outcomes of 1:1. It’s also considered one of the key strategies for engaging students in science (Tytler, 2007a). Therefore, we need more research and support for schools to examine how parents/carers of ‘students at educational risk’ can help make science relevant to students’ lives.

## Parting Comments

The introduction of 1:1 at VVC was like a brave new world to me. There was so much to gain. However, this so-called transformative reform, borne from an election promise, didn't have a big impact on science. 8 years ago, I sought to use the science education crisis as an excuse for everything bad that was happening in my science classroom, and 1:1 as a bandaid to fix it. This research exposes my naivety as an educator, and it pinpoints the start of my transformative journey. As a teacher, I am the product of a top down cultural agenda, and science teachers in particular are often unable to extricate themselves from the cultural bonds that act as barriers to reform. I am therefore happy to declare that my study has moved me into a new phase of awareness, yet I feel these cultural bonds more than ever in my new role as a school leader. My challenge has shifted to change management leading to constructivist, student-centred learning environments. Yet there are a bunch of battle weary teachers out there, who don't want to listen to science evangelists like me. In my current experience, there's no room for disruptive dialogue because everyone is too busy maintaining the status quo, dealing with increasing burdens placed on our public schools. It's in this context that I understand why continual change rarely leads to reform (Cuban, 2013a).

Being part of a constantly changing, yet never evolving system leaves me cynical. No amount of high-tech bling will change the fact that teachers retain traditional beliefs about education that are influenced by their lived experience in a culturally 'strict' western domain. However, Cozza, a fabulous participant in this study, has faith that the stories told here will do some good, because if he's in it, *"it'll be boss."* This idea that sharing stories will impact on others gives me hope. In my world, even though some educators have been preaching it for years, the disruptive dialogue about science and schooling has only just begun.

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# APPENDICES

# A. Approvals

### Murdoch University.

Dear Dorit,

| | |
|---|---|
| **Project No.** | 2009/148 |
| **Project Title** | Exploring the interface between computers, science education and culture in a regional middle school with a one-laptop-per-student program |

Thank you for addressing the conditions placed on the above application by the Murdoch University Human Research Ethics Committee. On behalf of the Committee, I am pleased to advise the application now has:

**OUTRIGHT APPROVAL**

Approval is granted on the understanding that research will be conducted according the standards of the *National Statement on Ethical Conduct in Human Research* (2007), the *Australian Code for the Responsible Conduct of Research* (2007) and Murdoch University policies at all times. You must also abide by the Human Research Ethics Committee's standard conditions of approval (see attached). All reporting forms are available on the Research Ethics web-site.

I wish you every success for your research.

Please quote your ethics project number in all correspondence.

Kind Regards,

Dr. Erich von Dietze
Manager of Research Ethics

cc: Dr Lindy Norris; Ms Kristi-Lee Bejah

HREC Approval Letter 221107

CRICOS Provider Code: 00125J
ABN 61 616 369 313

**Department of Education.**

Removed for ethical reasons

## B. Sample Interview Questions

### Teacher

What does good science teaching look like?

How do you use your laptop as a teacher?

Do you think having laptops changes the way you teach?

How do you use laptops for assessment?

What kind of professional learning does the department offer relating to laptops and/or science?

How do you feel about admin and the way they support teaching with laptops?

What meetings have you guys been having?

Have you ever had any other adults in your lessons?

What are other teachers' perceptions of the laptop program?

What kinds of things do students use laptops for in your lessons?

How much time do student spend using laptops in your lessons?

Would you say that having the laptops there for students helps their understanding of science concepts?

Do some kids bring their laptops and not use them? How do you manage this?

Do you think the kids that start behind ever catch up? Explain.

Do you consider the laptop program to be successful in your class? Why/why not?

Do you think the laptop program helps to "turn students on to learning" as originally claimed by XX in 2003?

What percentage of students do think are disengaged from science?

What are the barriers you face using laptops in your lessons?

What happens when you can't use laptops as planned in your lessons?

What do you think of the behaviour of students in the class?

Do you see a change in student attitudes towards computers over time?

Why do you think students don't bring their laptop to science?

**Student**

What are some words you think of when I say "science"? Why?

What are some science jobs?

What do you like most about science lessons? Why?

What do you like least about science lessons? Why?

Do you like science? Experiments? Why/why not?

What do you think about laptops in science? Why/why not?

## C. Sample Journal Writing

Wednesday 25 May 2011, Block 1 and 2, Class 2

**The task.** When she starts giving instructions, Jill says, *"I'm going to get you to do the last set of questions in the book in Chapter 10."* There's a pause as she sets up her laptop, because Word takes time to load. I am again impressed with class behaviour. They are all calm and seated. This is the beauty of Block 1, but also the students have matured since last year, and Jill has made a few changes to her methods. In a new Word document, Jill types "Page 308 Blue Book Q 1-9" and we watch each keystroke as she does this. The teacher tells us, *"Page three-oh-eight, questions one to nine"*, and the questions are: *"Not to be done in your workbook, but to either be done on lined paper or on your laptop and you print it out. Now what that doesn't mean is that one person does all the work and everybody else copies it. And that's why we are currently in a seating plan."* There is some class noise as Keisha complains about sitting at the back near Phil. She is still moving from her Form class seat, where they don't have a seat allocation, to her science seat. I am sitting in her allocated chair so I move to the side of the room. The task today is an open book, end of chapter review of Geology: Rock Types. It's the set text at VVC, which is Heinemann Science for WA. It's Book 1, the Year 8 book, not the Year 9 book as would be expected. They didn't do this topic last year in Year 8. I need to get a pdf of the book chapter. Students have the option of writing their answers on paper or using Word and printing them out in the Lab Tech area, which is teacher access only. Either way Jill wants a printed copy at the end of the double block so she can mark it.

Jill uses her laptop to set up Question 1 on the whiteboard projector screen, and she tells us she doesn't mind filling in the answers, *"if you ask good questions."* The table below is what Jill types in on the laptop and this is projected to the class so they can copy it down. What are teacher expectations of students when she does this? Find out if everyone copied down the table with her answers. Who did their own instead?

| Type of rock | Features | How it's formed | Examples |
|---|---|---|---|
| Igneous | Crystals<br>May be glassy<br>Bubbles | | |
| Metamorphic | Layers<br>Dense<br>Sometimes crystals | | |
| Sedimentary | May have fossils,<br>layers<br>Conglomerate<br>weaker | | |

**What the students are doing.** Here I describe what students are doing through the double block. These are targeted cases, either 'typical', 'extreme', or doing something different with laptops to others.

**Chelsea.** (Recording 1. @9:10am 37min & Recording 6. @10:22am 4min). Chelsea should be an example of a typical case in this lesson. I sit next to Chelsea for nearly forty minutes while I am observing the class and talking with her. There is no one sitting near her due to the new seating plan. Chelsea has been moved to the front of the classroom, right in front of the teacher's desk. I ask her about this, and she says she doesn't know why. The teacher hears us and says *"You do talk a lot."* Chelsea is not happy that she has been moved away from her friend AK47. She tries to organise a desk swap with another student, yet AK47 isn't even here today! She is planning ahead so that for next lesson she can be next to her friend instead of sitting alone up the front.

Chelsea is confused about whether she can use her laptop or not for the task. She repeatedly calls out to the teacher to ask if it's ok to use her laptop to find answers. I see twelve other students have their laptops open, and I say that it must be ok to use them, but she still wants to confirm it with the teacher. The teacher is busy with other students and either doesn't hear Chelsea calling out, or is prioritising students in some way. We ask some students (Nigel and Jemima) who have their laptops out if they are allowed to, and they say "*Yes"*. Bill addresses Chelsea in a frustrated tone with *"YES!"* because they are sick of hearing her calling out *"Miss!"*, but also because he enjoys hassling her (they are quite flirty). After a couple of minutes, the teacher is able to talk with us, and confirms it is ok to use laptops to find answers.

Chelsea started her work on paper (she got out paper and a pen), but switches to her laptop once she realises it's ok to use it. Because it takes her a few minutes to realise laptops are allowed, other students have already started working and she is a bit behind. I ask her about why she's picked her laptop instead of paper. She says she likes to work on paper if it's for writing, but as this work has a table, and she doesn't have a ruler, she chose to work on her laptop. She copies the teacher's table example from the board. Last year the teacher didn't have a Mac, but this year she does. I need to ask the teacher about this.

Chelsea is trying to find the rest of the answers for Question 1 herself. She's looking for information on the three rock types: Igneous, Metamorphic, and Sedimentary. She doesn't know the difference off the top of her head, but she remembers doing a prac activity where they looked at the three rock types and samples of each. She goes back through some photos on PhotoBooth to show me the rocks she took photos of. Most of the photos are of her and her friends, and nothing to do with

Science. She has to scroll through all the photos to find the ones with rocks in them. There is no file name to indicate what they are, or notes to describe them. It's girls making smiley faces and holding a rock at the camera. Lots of photos, not much evidence of brain work.

When they did the prac the rocks were labelled, and that is how she knew at the time what they were. Now she's not so sure. She remembers marble because she liked the look of it. I ask if she did any additional work with the photos, and she says *"Yes"*. She says she has a PowerPoint of the prac, which has some writing, but we can't find it, and we then get side-tracked by a discussion with other students and the teacher.

Chelsea says she has a Science folder on her laptop but none of the photos from PhotoBooth that relate to her work are saved there. They are all in PhotoBooth, amidst the masses of non-science photos, and unlabelled. But just looking at the photos is enough to trigger her memory and she starts to recall the information about different rocks she looked at during the prac. She has a good memory and she can recall at least 3 of the rocks she saw.

Jill has just returned to the front of the room (next to us) and I make the comment that Chelsea has a good memory. Jill replies, *"She does, she's a clever girl"*. When the teacher moves away, I ask Chelsea "*Do you like science?",* and she says "*Some of it."* We talk about her favourite subjects, and they are: Sport; Outdoor Ed; SOSE; Science. She likes SOSE more than Science, but she got a C for both. The way she says this implies she does equally well in both subjects, just likes SOSE topics more. I can see that Chelsea is a student who gets her work done and hands her work in when she is supposed to. She is not a bad student. From what I have seen of her though, she does get distracted by the off task behaviour around her and perhaps the teacher placing her at the front is because she thinks Chelsea could improve.

*K* *Do you like it* [SOSE] *because the work is easier? Or because...?*

*C* *I dunno, I just sometimes find it more interesting.....but then other days it's boring in SOSE and that day Science is better*

*K* *So like when you do stuff out of your seat, or...?*

*C* [nods]

*K* *Do you like doing stuff where you can get up and play with stuff?*

*C* *Yep*

*K* *What about written work? Are you ok with that as well or is this* [implying the written research work we are doing now] *boring stuff to you?*

*C* *It's sorta boring, but then sometimes I already know it, so then it's easy, and then sometimes I don't and then...*

*K* *So if you don't know the answer it's not as good?*

*C* *No not really* [agreement with me]

*K* *Do you like the fact that she's already put all the answers up for that one* [Question 1 Table]*?*

*C* *Yep* [chortle, like, "yeah that makes it easy"]

We are working through questions and trying to find answers on the internet and the book. I am looking through the book, but then I wonder if that is what Chelsea would be doing if she were working alone. She hasn't had to work alone much this year as she has always sat near her friends. But with the new seating plan she is isolated from everyone else. I ask her how she would go about finding the answers, and she says *"Probably the internet…Google".* I ask, *"Do you reckon that books are harder to find the information or easier?"*, and Chelsea says, *"Sometimes the internet's harder. When you want that* [meaning the answer]*, it wont give you exactly that answer you want."*

Chelsea clicks on several websites before settling on Wikipedia. The information doesn't pop right out at her, and she can't find the answer. We end up talking it through to get to an answer. She then moves onto another question and we try using the book but can't find the the answer there either. Chelsea then wants to go back to Google, and she types the whole question into Google Images: "What are metamorphic rock types?"

Most of the images are banned when you click on them, but you can still see the thumbnail. We both squint to look at these, and the search comes up with a heap of rock samples whose names and pictures Chelsea hasn't seen before. She is quite happy to use these as examples of rock types. I suggest she only uses ones she knows, as not being able to open the website and read it might mean she could get the wrong answer. She takes my advice and only includes marble, which she knows from her prac work the other day to be a metamorphic rock. We find a website with some basic information and read through it. We get to a short section of text that has a relevant sentence about how metamorphic rocks are formed, and Chelsea explains, *"I would copy and paste it, but like, copy and paste some of it, and then just leave the rest....and then, like, change two or three of the words."* I'm intrigued by her plagiarism, which I thought would be sorted by now in Year 9. I ask, *"So you reckon that if you copy and paste it and change a couple of the words that she wont notice?"* Chelsea nods.

Towards the end of Block 1 the students are getting restless. The boys behind Chelsea have been constantly trying to get her attention all lesson. They have an AIEO with them. I ask Chelsea about how she feels about this lesson. She says she prefers doing this type of work because *“when Miss only talks, like she talks at the board, that’s when I get, like, bored, and don’t listen.”*

I tell Chelsea I’ll come back at the end of the double block and see how she’s going. When I go back to Chelsea at the end of Block 2, she tells me she’s been a bit side-tracked, but I see she has done more work and hasn’t been using her laptop to do off task stuff. She isn’t finished though. She’s up to Q2e and is using Answers.com to get the answers. She is typing in the exact question. I ask her to rate how hard the work is, she gives it 5/10. I ask her how interesting the work is, she rates it 6/10. She thinks it’s above average interesting – *“way better than the teacher talking”* to them.

**Nigel.** (Recording 2. Nigel = Nigel @9:52am 9min). Nigel is an extreme case example because he doesn’t know what he’s doing. He’s a ‘student at educational risk’ (SAER). This is the first time I have talked with Nigel. He has his laptop open at the back of the desk, and the textbook and paper are in front of him. He says he hasn’t really used his laptop much today, and he hasn’t been off task. But he says he only *“sometimes”* uses it for work.

*K* *So you haven’t used it for anything off task?*

*N* *Nuh*

*K* *Not at all. That’s good! Do you normally only use it for what you’re supposed to use it for?*

*N* *Sometimes.*

He has been isolated from Sammy and is a different boy to the one I saw last time (they were off the wall throwing things out the window, running around and calling out). I remind him of how he behaved and he smiles and says, *"Yeah that was fun."* He seems lost today, and is looking around a lot. He's been put in the front row, and his mate Sammy is in Row 3. Most of his seat squirming is to look at Sammy and what he is doing. There is some muck around behaviour starting at this point in the double lesson and Nigel is keen to know what's happening. Given his new position in the classroom, however, it is difficult for him to engage in off task behaviour with Sammy as they are not allowed to move. I feel like Nigel feels alone and scared. He says he usually asks the teacher for help and she usually gives him the answers.

*K* *So how are you feeling at the moment? What word would you use to describe how you're feeling?*

*N* *I dunno, umm...*

*K* *Sleepy....?*

*N* *Yeh, just real weird, coz I don't know what to do really*

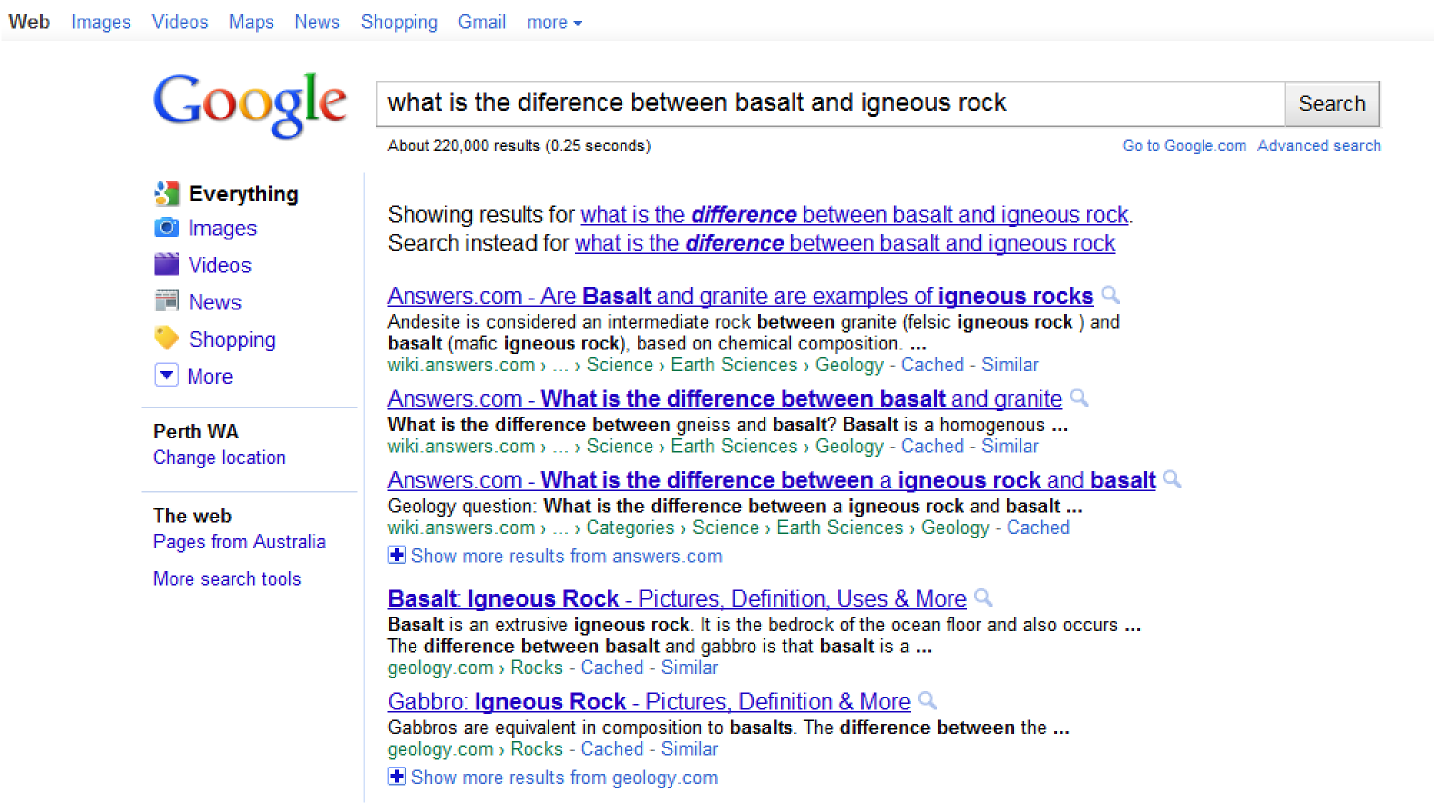
*K* *You don't know how to get the answers?*

*N* *Nah*

I have a look at the answers he's written down. The table has been copied from the board and the teacher gave him the last column too. None of the information in his table is his own work. It has all come straight from the teacher. He says he always gets the teacher to give him the answers.

| | |
|---|---|
| *K* | *Do you use, do you think the internet and the laptops are helping you today to do your work?* |
| *N* | *Not really, I don't really like the laptops.* |
| *K* | *Why not?* |
| *N* | *Well, they do help you out a bit, when, like, you write stories and stuff, but they're just like a pain in the butt to carry around and everything* |
| *K* | *So, for today, have you looked up your answers in the book? Or the laptop, or neither? Or both??* |
| *N* | *Mmm bit of both* |
| *K* | *So you've used them both?* |
| *N* | *Yeh.* |
| *K* | *What's been most helpful? The laptop, the book, or the teacher?* |
| *N* | *Teacher* |

I watch how Nigel uses the laptop to find answers. He goes onto the internet, and googles the entire sentence as is written in the book, then clicks on whatever link comes up first. For one question, he types it in with a spelling mistake and by chance clicks on the first link which is a correction for his spelling mistake (see screen shot below), but he doesn't even notice.




K *Ok. Do you always just click on the first one that comes up?*

N *Yeh*

We start looking for the answer to the question "What is the difference between the terms basalt and igneous rock?"

K *Alright, explain the difference between basalt and igneous rock*

N *I don't even know what it are, they are!*

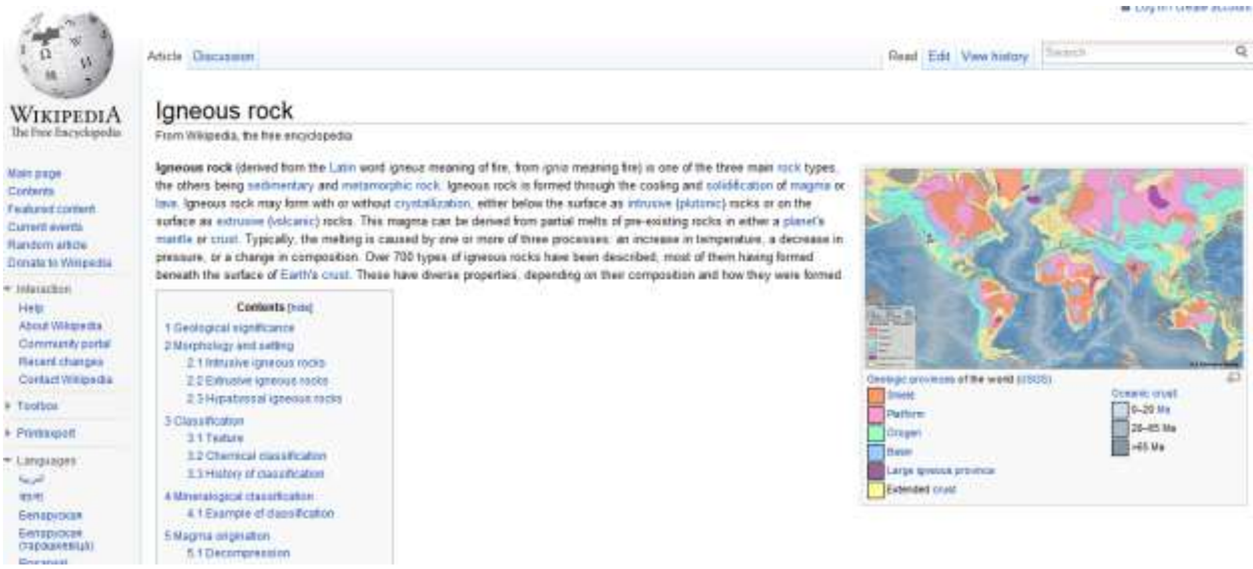
K *You don't even know what they are? Alright, so how on this page here, and you're on Wikipedia...*

N *Yeh*

K *How would you find those words? Are you looking for those two words? Or you just...? How would you normally get your answer? Would you guess it, or...*

N *I'd probably just write it out and then just read through it*

Nigel is referring to copying out the text after the word igneous in Wikipedia (see screenshot below).




K *Right, so you've already picked igneous rock*

N *Yeh*

K *Is the other word on there as well?*

N *Nuh*

K *So whaddayou do next?*

N *Umm...I'd probably pick that [points at next highlighted word], and then the next one...*

K *Yep, so would you keep going down, until the answer just pops out?*

N *No, I'd get frustrated and then I'd just ask the teacher*

K *Really? And she'd just tell you?*

N *Yeah*

K *So she always tells you the answer?*

N *Yeah*

After I stop recording he asks me if the teacher will know what he says to me and I say no, it is private, but it will be put in a book and I will use a fake name for him. When I started talking to him today he didn't have or want to use a fake name, but at the end, after we finish recording, he says in a shy voice *"I want to be called Nigel. That's what I call myself to other people."* It means Nigel No Friends. That is sad.

**April.** April is a typical case for this lesson. April is proud of the work she has done. She has been working hard all lesson (unlike the last lesson I saw her). She says it's because it's the morning. She is doing the questions on her laptop and writing out full sentence answers. She's going to print her work out when she's finished. I ask her how she's getting her answers and she says she's using the book and the internet, and there is one *"pacific"* website she has used – www.thinkquest.com. It's the first link that came up when she typed the whole question into Google: *"It's, I typed up 'main features on sedimentary rocks', and I clicked on another one, and then it came up, and then I just changed sedimentary to metamorphic and then, it was the same site, so..."* Towards the end of the double block April's work ethic is faltering, but she is not alone: most of the students seem to be getting restless by about 10:15am.

**Fairy.** Fairy is another typical case of what should be happening. Fairy sits next to April and is doing the questions on her laptop. She has been working well all lesson. Like April, she is using full sentence answers. She thinks today's work is *"boring!"* but she hasn't been using her laptop to go off task. She has been busy talking off task though, and throughout the lesson you can hear her voice – she is loud today. She's using the same website as April because it's the first one that came up in a Google search.

**Kelly.** Kelly is a typical case example. Kelly has her work folded on paper in front of her. She has chosen to work on paper. She says she didn't want to have to print her work out. She is a very quiet student, shy. I would imagine she doesn't like having people pay attention to her. She is four questions behind Mia. These two are the best students in the class: the teacher thinks Kelly is the best performing student. Kelly says she likes science, and rates it 5/10. It is in her top 4 subjects at school. She ranks it fourth after Maths. She likes finding out about stuff.

**Mia.** Mia should be a typical case, but there are some unusual phenomena I see today that I have questions about, e.g. why does she spend the last half hour drawing? At 10:10am, Mia has finished the nine questions. She didn't use the internet to find answers: *"I just used work we already did."* She used work saved in her science folder on the laptop. Like most other students, Mia used Word to type out her answers. I ask her, *"What about you, do you like typing?"*, and she replies *"I don't , not really, but it's easier."* Mia printed her work to the lab tech printer, the teacher went and got it, and now she has *"free time."* The teacher tells her where she can find drawing paper, and she is getting ready to spend the rest of the lesson drawing. She loves animae pictures and wants to be a cartoonist. She doesn't like science: *"it's boring"*, she likes to be *"creative"*, and she thinks she wont need science in her career as a cartoonist.

*K* *Have you enjoyed doing your work in science today?*

*M* *[shakes head makes face]*

*K* *On a scale of one to ten?*

*M* *Zero!*

When Mia finishes he work on the laptop, she closes it and puts it away in her bag. She doesn't want to do anything on her laptop. She wants to draw on paper. I ask her if there are any programs on the laptop for drawing, and she says, *"Oh, there's Sketchup, but that's* [trails off implying it's no good]". The school doesn't have any drawing software, and she doesn't *"know how to do that yet."* She ranks Science down the bottom, just before Sport. She doesn't see a connection between science and her real life. The topics in science are not interesting to her, and they wont help her get a job: *"I only care about stuff I'm gunna need in the future, like English."* For the rest of the lesson (25-30min) Mia draws and lets the crazy classroom noise move over her. She moves away from Kelly to get more room for her paper while Kelly continues working.

**The laptops.** Students used the laptops today as a word processor and textbook/research tool. Some students chose to use them because they make it easier to draw up a table. Some students prefer writing in Word rather than on paper. Laptops were used to access the internet and find information. I did work with anyone who was using laptops for any other purpose today, although some people were PhotoBoothing by the end. I was not sitting at the back of the room for long. I spent most of my time at the front and could only see the backs of the laptop screens.

I believe that because the teacher was very explicit about this being an assessment task for marking, and told students the work would be collected at the end, that students were hesitant to go off-task and waste time. They wanted to get their work done, or at least understood that the teacher would be strict today in making sure they remained on task. This was evident by the teacher walking around for the entire double block and reprimanding people for any off-task behaviour (such as talking, walking, taking photos, doing anything other than answer the questions).

**The end.** Because I stayed for a double block I could see the class enthusiasm/focus wane as the double lesson progressed (9am – 10:46am). Everyone works well in Block 1, but people get distracted in Block 2. At 10:25am, I leave the room for five minutes, and when I come back, it appears more people are off task than previously. Some are now moving around and the teacher is using their name to call them back to their seat.

At 10:30am there are still 13 laptops out, but now most people are off task. I don’t go around and see what they are doing, but most people are talking about non-science things. Earlier in Block 1, there wasn’t so much off-task calling out and talking.

At 10:40am most people have stopped working and have packed away. They are talking and waiting for the bell, which doesn’t go until 10:46am. I leave at this point because there is nothing science related left for me to see.

**Changes I notice today.** The teacher has a seating plan and is enforcing it. This is the second lesson I have observed this year, and again there is no chalk n talk. The teacher uses the projector as a whiteboard and explains how to draw up a table, but then spends her time working with individuals and small groups on the questions. Questions sent to the teacher via email: Today was the first day to have a seating plan. What made you use a seating plan today? Why aren’t students allowed to sit at the sides of the room anymore? Is it a behaviour management strategy? Are the desks in rows because it’s better than having them in groups? Is it related to laptops? Is Kate at the front because she talks too much? Do you think she’ll do more work away from AK47? Lots of students call out to get your attention – you’re a wanted woman! How do you decide which ones to go to first? I think that it’s great that they are confident enough with you to ask for help. Did you have a different laptop last year? Last year I recall you saying you didn’t have a Mac, but this year you do. Is there a reason for this? Students were asked to submit a hardcopy of the Geology end-of-chapter questions. Is this because you prefers marking hardcopy? If so, what makes marking easier this way? In this lesson students were able to choose to use the textbook or the internet to find their answers. Do you think there is a difference between the two, e.g. how easy is it to find the answers? Do you think students worked faster/better on paper or the laptop? What were your expectations of the students? Did you think they might know some of the answers already? How do you think students learn best? Can you provide a paragraph outlining the main teaching methods used today and why? It doesn’t have to be in fancy talk, just layman’s terms. General Question: What do you like doing most? What works and what doesn’t? Why?

| Critical incident 1: New seating plan | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? The teacher enforced new seating plan | Who was involved? Jill and students |
| | Causal | What made it happen? Bullying incident. Jill says "Some of the boys had started bullying Fairy over the way she speaks, if you have spoken to her recently she has started sucking the roof of her mouth when she speaks, I haven't asked her but I presume she is wearing a splint at night. I did not want them to know this was the reason why." | Who acted? Jill and students |
| | Effectual | What does it do? Physically separates students and limits social contact; Easier for teacher to control/monitor student behaviour | For whom? Jill |
| | Affectual | What does it feel like?<br>Teacher: more in control and /or confident<br>Students: isolation; weird; vulnerable<br>Chelsea: "I'm not sitting there!" | For whom? Jill and students |
| | Semantic | What does it mean? Teacher controls class | To whom? Jill and students |
| | Explanatory | Why did (does) it occur? Students are not showing respect for others | With whom? Jill and students |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? Yes<br>Is it a good thing? Yes<br>Why? Teacher more able to get on with lesson, students who are bullied feel more safe | Do others like it? Yes and no<br>For whom? Teacher can control class, students are bullied less |
| Critical | Classificatory | What is it an example of? Dominance | Whose classification? Mine |
| | Social | Is it just? Depends if you are the bully or victim | For whom? Victims win |

| **Critical incident 2: Desks are in rows not groups** | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Desks in rows | Who was involved? Jill and students |
| | Causal | What made it happen? Teacher says "Laptops, makes screens easily monitored form the back of the classroom…Also, makes it easy to use 'eyes forward' and everyone must face the front…In groups because desks are 2-wide, it is necessary for some of them to turn side on." | Who acted? Jill |
| | Effectual | What does it do? Allows teacher to see all laptops at once when at back; Allows teacher to see all eyes at once when at front | For whom? Jill |
| | Affectual | What does it feel like?<br>Control<br>Being watched | For whom?<br>Teacher<br>Students |
| | Semantic | What does it mean? Students can't go off-task on laptops as easily; Students need to look at teacher when asked | To whom? Students |
| | Explanatory | Why did (does) it occur? See above | With whom? Jill vs students |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? Yes<br>Is it a good thing? Yes<br>Why? Control for Jill | Do others like it? Yes<br>For whom? Jill |
| Critical | Classificatory | What is it an example of? Classroom management | Whose classification? Jill |
| | Social | Is it just? Depends | For whom? Students who want to listen to the teacher need to be able to hear her and not be distracted by other students or their laptop |

| Critical incident 3: Teacher uses projector and laptop instead of whiteboard and marker | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Technology replaces 'old school' delivery, no innovative pedagogy? | Who was involved? Jill |
| | Causal | What made it happen? New resources! | Who acted? WADoE and Jill |
| | Effectual | What does it do? Provides choices for curriculum delivery | For whom? Jill |
| | Affectual | What does it feel like? Ask Jill: When do you use the whiteboard? Why? When do you use the projector? Why?<br>Ask students: do you prefer the teacher using the whiteboard or the projector? Why? | For whom? Jill and students |
| | Semantic | What does it mean? Ease of delivery and more choice for delivery of curriculum | To whom? Jill and students |
| | Explanatory | Why did (does) it occur? Modern times (?) | With whom? WADoE is evolving |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? Sometimes<br>Is it a good thing? Maybe<br>Why? Method of delivery should be in tune with the times, but unless there is a change in traditional didactic pedagogy does it make a difference? | Do others like it? Ask them!<br>For whom? Kids and teacher |
| Critical | Classificatory | What is it an example of? Being forced to use particular technologies | Whose classification? Mine |
| | Social | Is it just?<br>Yes (but I am hesitant on this one)<br><br>No | For whom? Students need to keep up with the times and have curriculum delivered in a spiffy way to keep their brains in tune with the buzz of technology. Teachers shouldn't have to use something just |

| | | | |
|---|---|---|---|
| | | | because it comes into fashion or is deemed necessary by others (some teachers don't need any resources apart from themselves) |

| Critical incident 4: Teacher does not use "Notebook For Teachers" WADoE laptop | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Jill had an ACER laptop through the NFT program last year and replaced it this year with her own personal Mac laptop | Who was involved? Jill, WADoE |
| | Causal | What made it happen? NFT ACER was a *"dreadful machine"* | Who acted? Jill |
| | Effectual | What does it do? Empowerment. The Mac allowed Jill to demonstrate activities using same operating platform and model machine. Also enables Jill to use the same software programs the students have | For whom? Jill and students |
| | Affectual | What does it feel like? Equal access | For whom? Jill |
| | Semantic | What does it mean? WADoE are poverty stricken or don't care | To whom? Jill |
| | Explanatory | Why did (does) it occur? WADoE wouldn't pay for Mac laptop, makes it easier for planning and conducting lessons | With whom? Jill and WADoE |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? No<br>Is it a good thing? No<br>Why? Costs teacher lots of money. The teacher shouldn't have to purchase resources WADoE mandates as compulsory | Do others like it? Yes, saves WADoE $<br>For whom? Teacher |
| Critical | Classificatory | What is it an example of? Being ripped off | Whose classification? Mine |
| | Social | Is it just? NO! | For whom? The poor teacher who has to pay! |

| Critical incident 5: Students can choose to use laptops or books or both | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Choice of resources available | Who was involved? Students |
| | Causal | What made it happen? Permission | Who acted? Jill |
| | Effectual | What does it do? Increases resources available for research | For whom? Students |
| | Affectual | What does it feel like? Freedom to choose appropriate tools; Confusion due to lack of guidance in research methods | For whom? Students |
| | Semantic | What does it mean? Improved outcomes (?) | To whom? Students |
| | Explanatory | Why did (does) it occur? More technology resources are available through WADoE | With whom? WADoE, schools, teachers |
| Reflective | Personal Evaluative Justificatory | Do I like it? Sometimes<br>Is it a good thing? Yes, but only if student provided with appropriate critical inquiry skills<br>Why? Too many students go blindly off into GoogleLand and don’t take the time to think about what they are copy and pasting | Do others like it? Yes/No<br>For whom? Students and teacher |
| Critical | Classificatory | What is it an example of? Money (resources) being wasted (?) on technology implementation | Whose classification? Mine |
| | Social | Is it just? Yes=social justice=all students need to have access to the same resources | For whom? Students |

| Critical incident 6: Students use internet to find quick answers | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Internet used for "quick fix" | Who was involved? Students |
| | Causal | What made it happen? No direction given in how to search internet = free range | Who acted? Students |
| | Effectual | What does it do? Confusion | For whom? Students (Nigel) |
| | Affectual | What does it feel like? "weird" | For whom? Students (Nigel) |
| | Semantic | What does it mean? "I don't know what to do" | To whom? Students (Nigel) |
| | Explanatory | Why did (does) it occur? Lack of direction in research strategies (?) | With whom? Between teacher and Nigel |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? No<br>Is it a good thing? No<br>Why? Noone is learning, just copying and pasting facts | Do others like it? Yes, because it's an easy way to get an answer without having to think too hard<br>For whom? Students |
| Critical | Classificatory | What is it an example of? Low order thinking | Whose classification? Mine |
| | Social | Is it just? No – where is the real inquiry learning? | For whom? Students, particularly SAER |

| **Critical incident 7: The same task continues for 2 lessons** | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? It got boring because the same task continued for two lessons | Who was involved? Students, teacher, EA, AIEO |
| | Causal | What made it happen? Teacher lesson plan unsatisfactory due to failure to have backup lesson planned for students who finish early | Who acted? Teacher, students, EA, AIEO |
| | Effectual | What does it do? Promotes off-task behaviour | For whom? Students, researcher |
| | Affectual | What does it feel like? Boring and distracting | For whom? Students, researcher |
| | Semantic | What does it mean? Some students don't get as much work done | To whom? |
| | Explanatory | Why did (does) it occur? Teacher pedagogy | With whom? Teacher |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? No<br>Is it a good thing? No<br>Why? Don't learn as much/encourages slacknesss | Do others like it? Yes (free time)<br>For whom? Students |
| Critical | Classificatory | What is it an example of? Bad pedagogy | Whose classification? Mine |
| | Social | Is it just? Yes | For whom? Students – they think they deserve free time |

| **Critical incident 8: Student who doesn't like science finishes task first and spends 30 minutes drawing** | | | |
|---|---|---|---|
| Kind of Judgement | Kind of analysis | | |
| | Information required | Questions asked | People involved |
| Diagnostic | Descriptive | What happened? Task finished at 10:15am | Who was involved? Student and teacher |
| | Causal | What made it happen? Finished work early | Who acted? Teacher |
| | Effectual | What does it do? Allows free time; More teacher time can be invested in other students | For whom? Student, Teacher/other students |
| | Affectual | What does it feel like? Freedom | For whom? Student who finishes early |
| | Semantic | What does it mean? Teacher has less students to help; student thinks 'I am in control' | To whom? Teacher and Student |
| | Explanatory | Why did (does) it occur? Teacher philosophy | With whom? |
| Reflective | Personal<br>Evaluative<br>Justificatory | Do I like it? No<br>Is it a good thing? Yes<br>Why? Free to do something they like | Do others like it? Yes<br>For whom? Student |
| Critical | Classificatory | What is it an example of? Negotiated curriculum | Whose classification? Mine |
| | Social | Is it just? No | For whom? Student – does not promote good work ethic or engagement in science |

## D. Class 1 Recorded Interviews

| Student | Pseudonym (Gender) | Description | Year | Date | Duration (min.) | Others present | Total duration (min) |
|---|---|---|---|---|---|---|---|
| 1. | Simon (M) | SAER, SP (autism) | 2010 | NA | | | 0 |
| 2. | Kate (F) | Sem. 2 2010 only SAER (engagement) | 2010 | 20/9 | 5 | AK47 | 21 |
| | | | | 2/12 | 16 | Fairy | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3. | Jemima (F) | SAER, low literacy, in reading group | 2010 | 26/3 | 10 | April, AK47 & Mia | 30 |
| | | | | 20/9 | 3 | | |
| | | | 2011 | 25/11 | 17 | Sarah | |
| | | | | 16/11<br>16/11 | 1<br>9 | Sammy & Nigel | |
| 4. | Leo (M) | SAER, low literacy, in reading group, Indigenous | | 0 | | | 0 |
| 5. | Matt (M) | SAER, low literacy, in reading group, 2010 only, Indigenous | 2010 | 21/6 | 7 | | 23 |
| | | | | 24/6 | 12 | | |
| | | | | 19/8 | 4 | | |
| 6. | Luke (M) | Indigenous | | 0 | | | 0 |
| 7. | Jim (M) | SAER, SP, low literacy, in reading group, Indigenous | 2011 | 16/11 | 28 | April | 28 |
| 8. | Leandra (F) | SAER, low literacy, in reading group, 2010 only, Indigenous | 2010 | 0 | | | 0 |
| 9. | Mia (F) | Top science student | 2010 | 26/3 | 10 | April, AK47 & Jemima | 61 |
| | | | | 30/8 | 6 | Kelly | |
| | | | | 2/12 | 14 | Kelly | |
| | | | 2011 | 25/5 | 6 | Kelly | |
| | | | | 27/7 | 25 | Kelly | |
| 10. | Fairy (F) | SAER, processing disorder | 2010 | 23/8 | | Fairy | 65 |
| | | | | 2/12 | 16 | Kate | |
| | | | 2011 | 19/5 | 25 | April | |
| | | | | 25/5 | 3 | April | |
| | | | | 23/11 | 12 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11. | AK47 (F) | "very bright" but "too social" | 2010 | 26/3 | 10 | April, Jemima & Mia | 218 |
| | | | | 23/8 | 3 | Earthworm | |
| | | | | 20/9 | 5 | Kate | |
| | | | | 2/12 | 11 | Earthworm | |
| | | | 2011 | 3/8 | 93 | Chelsea & Nigel | |
| | | | | 24/8 | 65 | Nigel & Sammy | |
| | | | | 23/12 | 31 | Chelsea, Nigel & Sammy | |
| 12. | Kelly (F) | Top student, teacher suspects undiagnosed autism | 2010 | 30/8 | 6 | Mia | 51 |
| | | | | 2/12 | 14 | Mia | |
| | | | 2011 | 25/5 | 6 | Mia | |
| | | | | 27/7 | 25 | Mia | |
| 13. | Phil (M) | SAER (engagement) | 2010 | 24/5 | 2 | | 4 |
| | | | | 12/8 | 2 | | |
| 14. | Earthworm (F) | 2010 only | 2010 | 23/8 | 3 | AK47 | 14 |
| | | | | 2/12 | 11 | AK47 | |
| 15. | Keisha (F) | SAER, low literacy, in reading group, Indigenous | 2010 | 24/5 | 1 | | 60 |
| | | | | 12/8 | 2 | | |
| | | | | 29/11 | 18 | April | |
| | | | 2011 | 23/11 | 38 | April | |
| 16. | Anne (F) | Sem. 1 2010 only | 2010 | | | | 0 |
| 17. | Chelsea (F) | SAER, low literacy, 2011 only | 2011 | 12/5 | 1 | | 155 |
| | | | | 25/5 | 28 | | |
| | | | | 3/8 | 93 | AK47 & Nigel | |
| | | | | 16/11 | 2 | | |
| | | | | 23/11 | 31 | AK47, Nigel & Sammy | |
| 18. | Bill (M) | SAER, low | 2010 | 21/6 | 10 | | 12 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | literacy, in reading group, Indigenous | | 19/8 | 2 | | |
| 19. | Nigel (M) | SAER, low literacy, in reading group | 2011 | 25/5 | 9 | | 207 |
| | | | | 3/8 | 93 | AK47 & Chelsea | |
| | | | | 24/8 | 65 | AK47 & Sammy | |
| | | | | 16/11 | 9 | Jemima & Sammy | |
| | | | | 23/11 | 31 | AK47, Chelsea & Sammy | |
| 20. | April (F) | SAER, low literacy | 2010 | 26/3 | 10 | AK47, Jemima & Mia | 177 |
| | | | | 19/8 | 1 | | |
| | | | | 23/8 | 9 | Fairy | |
| | | | | 20/9 | 3 | | |
| | | | | 29/11 | 18 | Keisha | |
| | | | 2011 | 12/5 | 5 | | |
| | | | | 19/5 | 25 | Fairy | |
| | | | | 25/5 | 3 | Fairy | |
| | | | | 16/11 | 28 | Jim | |
| | | | | 23/11 | 38 | Keisha | |
| 21. | Sammy (M) | | 2011 | 24/8 | 65 | AK47 & Nigel | 105 |
| | | | | 16/11 | 9 | Jemima & Nigel | |
| | | | | 23/11 | 31 | AK47, Chelsea & Nigel | |
| 22. | Abbey (F) | | 2010 | 19/8 | 2 | | 19 |
| | | | | 25/11 | 17 | Jemima | |

## E. Class 2 Recorded Interviews

| Student | Pseudonym | Description | Year | Date | Duration (min) | Others present | Total duration (min) |
|---|---|---|---|---|---|---|---|
| 1. | Lion (F) | Term 1-3 2010 only | 2010 | 29/3 | 7 | Seal & Rukia | 10 |
| | | | | 17/6 | 3 | | |
| 2. | FluroGangsta (F) | | 2010 | 25/3 | 9 | Smurf & Butter | 43 |
| | | | | 17/6 | 5 | | |
| | | | | 9/9 | 9 | Butter | |
| | | | | 25/11 | 9 | MashCambella | |
| | | | | 6/12 | 11 | MashCambella & Butter | |
| 3. | Jemma (F) | SAER, engagement and attendance | 2010 | 24/5 | 23 | Smurf, Boi & MashCambella | 77 |
| | | | | 17/6 | 2 | | |
| | | | | 19/8 | 7 | Cement | |
| | | | | 6/12 | 20 | Nicole | |
| | | | 2011 | 26/8 | 25 | | |
| 4. | Lisa (F) | SAER, dyslexia | | | | | 0 |
| 5. | TimTam (F) | | 2010 | 26/3 | 5 | MashCambella | 20 |
| | | | | 17/6 | 5 | | |
| | | | | 16/9 | 5 | MashCambella | |
| 6. | Barry (M) | SAER, low literacy, in reading program, Indigenous | 2010 | 21/6 | 17 | Chris | 100 |
| | | | | 12/8 | 12 | | |
| | | | | 23/8 | 4 | Nicole | |
| | | | | 29/12 | 21 | Chris & Boi | |
| | | | 2011 | 5/8 | 46 | Cozza | |
| 7. | Nicole (F) | SAER, attendance | 2010 | 23/8 | 4 | Barry | 49 |
| | | | | 6/12 | 20 | Jemma | |
| | | | 2011 | 26/8 | 25 | Jemma | |
| 8. | Boi (M) | SAER, low literacy | 2010 | 24/5 | 23 | Smurf, MashCambella & Jemma | 46 |
| | | | | 19/8 | 2 | | |
| | | | | 29/12 | 21 | Barry & Chris | |
| 9. | Cozza (M) | SAER, Indigenous | 2010 | 17/6 | 2 | | 78 |
| | | | 2011 | 20/5 | 23 | | |
| | | | | 23/5 | 7 | | |
| | | | | 5/8 | 46 | Barry | |
| 10. | Daz (M) | SAER, low literacy, in reading group, Indigenous | | | | | 0 |
| 11. | Sam (M) | Semester 2 2010 onwards | | | | | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12. | Smurf (M) | Semester 1 2010 only | 2010 | 25/3 | 9 | FluroGangsta & Butter | 36 |
| | | | | 24/5 | 23 | Boi, MashCambella & Jemma | |
| | | | | 17/6 | 4 | | |
| 13. | Rukia (F) | Top science student | 2010 | 29/3 | 7 | Seal & Lion | 35 |
| | | | | 24/6 | 2 | | |
| | | | | 10/5 | 5 | | |
| | | | 2011 | 20/5 | 17 | Mouse | |
| | | | | 23/5 | 4 | | |
| 14. | Mouse (F) | SAER, low literacy, 2011 only | 2011 | 20/5 | 17 | Rukia | 23 |
| | | | | 23/5 | 6 | | |
| 15. | MashCambella (F) | SAER, engagement | 2010 | 26/3 | 5 | TimTam | 59 |
| | | | | 24/5 | 23 | Smurf, Boi & Jemma | |
| | | | | 19/8 | 6 | | |
| | | | | 16/9 | 5 | Teasy | |
| | | | | 25/11 | 9 | FluroGangsta | |
| | | | | 6/12 | 11 | FluroGangsta& Butter | |
| 16. | Brick (F) | | 2010 | 29/3 | 7 | Lion & Rukia | 18 |
| | | | | 19/8 | 3 | | |
| | | | | 16/9 | 8 | Cement | |
| 17. | Chris | SAER, low literacy, in reading group, Indigenous | 2010 | 21/6 | 17 | Barry | 48 |
| | | | | 9/9 | 10 | | |
| | | | | 29/12 | 21 | Barry & Boi | |
| 18. | Ben | Semester 2 2010 | | | | | 0 |
| 19. | Butter | | 2010 | 25/3 | 9 | Smurf & FluroGangsta | 36 |
| | | | | 24/6 | 7 | | |
| | | | | 9/9 | 9 | FluroGangsta | |
| | | | | 6/6 | 11 | FluroGangsta & MashCambella | |
| 20. | Cement | 2010 only | 2010 | 19/8 | 7 | Jemma | 15 |
| | | | | 16/9 | 8 | Brick | |
| 21. | Mandy | 2011 only | | | | | 0 |

## F. Observation and Interview Summary

| Type of data | Location/type | 2010 | | 2011 | | Total |
|---|---|---|---|---|---|---|
| | | Number | Duration | Number | Duration | |
| Observations | Form Class | 3 | 1 hr | 17 | 5 hr | 20 obs<br>6 hr |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Science Class | 40 | 45 hr | 14 | 28 hr | 54 obs 73 hr |
| Student interviews | | 50 | 7 hr 16min | 35 | 9 hr 21 min | 85 interviews 16 hr 16 min |
| Teacher interviews | In class | 4 | 12 min | 14 | 7 hr 23min | 18 interviews 7 hr 23min |
| EA interview | Out of class | 0 | 0 | 1 | 35 min | 35 min |

## G. Document Types and Purpose

| Type of documents | Purpose | Specific |
|---|---|---|
| WADoE Policy | To inform re: departmental culture and expectations; contribute to analysis of whole-school culture. Documents that describe philosophy of schooling were collected from the DoE public policy website: http://det.wa.edu.au/policies/detcms/portal/ | Strategic Plan<br>Curriculum Framework<br>CAR<br>AIEO Handbook<br>SAER<br>Behaviour Management<br>Aboriginal Education Plan<br>ICT Guide |
| School Policy | To aid in describing whole school and science department culture http://www.xxxx.wa.edu.au/ | School website<br>IBPs & BSC<br>ICT documents<br>Schools online data<br>School operational plan<br>2009 School Report<br>Science Plan 2010-2011 |
| Work samples | To showcase the type of work being done in science. Contains both student work samples and computer-based activities. | Class 1: 547 files<br>Class 2: 108 files |