Investigating Early Career Teachers’ Design of Technology-Integrated Learning in Context

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Lauren Jayne Knussen, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of International Studies and Education, Faculty of Arts and Social Sciences, at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Statement on format of thesis

This thesis is presented in the style of a conventional thesis.

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Abstract

The importance of preparing school students for a digitally-mediated future is widely acknowledged. Equally accepted is the role technology can play in supporting and enhancing contemporary teaching. The responsibility of designing and implementing technology-integrated learning (TIL) lies with schools, and by extension, with teachers. It is often assumed that early career teachers are well equipped to design TIL. However, the limited research on early career teachers (ECTs)' knowledge and skills in technology-integrated learning (TIL) indicates that ECTs struggle to design TIL which align with contemporary pedagogies. There is a need to better understand how recently qualified teachers are integrating technologies into their teaching practice. In particular, there is a need for more evidence-based knowledge about how early career teachers' individual and workplace contexts influence their thinking and practice as they design TIL programs.

The study investigated how ECTs engaged in the design of TIL in situ and the contextual factors which influenced them as they pursued their design work. Focusing ECTs' design work is a novel approach to investigating their practices and thinking about TIL as past research has relied extensively on reports of experience.

A multiple case study approach was used to provide rich description of seven early career teachers' practices of designing a TIL program for their students. The study was underpinned by activity theory, a framework that facilitated the analysis of internal and external contextual influences on each ECT's design process and thinking. Data was collected using interviews, researcher observations, think aloud protocols and program documents to provide a rich description of each early career teacher's process of designing a TIL program and the context within which they work. Data was analysed both inductively and deductively, guided by the activity theory framework.

The study found evidence of two different approaches to designing technology-integrated learning. The first was a redesign of an existing program. The second was the design of a new program. The redesign approach was found to result in limited creativity and innovation of TIL, whereas the design of a new program resulted in more creative and innovative TIL in the programs. Analysis of the participants' contexts revealed a that they were also influenced by a range of factors in their design environment. Influencing factors were their experiences in initial teacher education,

their skills and knowledge of TIL, school leadership and culture relating to TIL and access to technology in the school.

This study has shed new light on the contextual complexity of early career primary teachers' design work with TIL and the factors which influence this practice. Furthermore, the study provides insights into how these contextual factors interacted to support or limit ECTs in their design of TIL. The study identifies the value of fostering a positive culture of implementing TIL in schools, within which early career teachers are supported in their design of TIL programs. It also provides evidence that studying the complexities of digital pedagogies during initial teacher education can increase ECTs' capacity to innovate with technology when designing learning programs. Finally, the study proposes that future research focuses on exploring the social and operational activity systems in schools which influence technology integration. The potential development of learning design support systems for early career teachers designing TIL is also identified as a path for future research in this field.

Chapter 1: Introduction

1.1 Introduction

Education plays a critical role in supporting the development of school students, preparing them for a technology-mediated future work life and for participation in a technology-mediated society more generally. Developments in information and communication technologies (ICT) across all sectors of society have been a catalyst for changes to school education over the past two decades. Education research and policy advocate for the purposeful integration of technology in school education, citing an understanding that technology integration in teaching and learning (OECD, 2009) . In Australia, state and federal levels of government have supported initiatives to promote the use of technology in primary schools (DEAG, 2010). In New South Wales, this has led to syllabus updates which increase the prominence of technology integration across key learning areas.

Studies on teachers' work with technology integration have been undertaken from many perspectives; these include exploring teachers' work with specific technologies and analysing teachers' knowledge about technology integration (Mishra & Koehler, 2006). Understanding teacher knowledge of technology integration has increasingly been a focus in research due to concerns about teachers' capacity to integrate technology effectively (Koehler et al., 2007; Koehler & Mishra, 2009). However, early career teachers (ECTs), that is to say teachers in the first five years of their careers, are an under-researched group in terms of their skills and knowledge about technology-integrated learning (TIL) (Orlando & Attard, 2016). Research which has focused on ECTs has shown that despite often being personally technology-literate, they struggle to integrate technology in a way which supports student-centred learning (Bate, 2010; Tondeur, Roblin, et al., 2017). While a problem with ECTs' technology integration practices has been identified, what is still missing in the literature is an in-depth understanding of what these teachers think about and do when they design TIL programs and how their context might influence their practice.

The aim of the study was to explore how early career primary teachers engaged in the design of a technology-integrated learning program for their students. It also examined how they were influenced by factors from their internal and external contexts during their design process. The decision to focus on design as a way to explore ECTs' practices with TIL was purposeful and sought to provide insights into ECTs' development and implementation of TIL at a level of detail which has not previously been undertaken. The research used a case study approach to investigate the practices of the participants as they developed and implemented the programs. In doing so, it sought to shed light on ways in which contextual factors supported or inhibited their design of technology-integrated learning. By understanding more about these concepts, it was anticipated that the findings could inform how different stakeholders in ECTs' might develop support for early career teachers in their teaching with digital technologies.

1.2 Background

It is important that students graduate from school with the technological skills that will be required for future employment and participation in society more broadly (ACARA, 2012; ISTE, 2008). Both nationally and internationally, government bodies have also recognised the need for technology to be purposefully integrated into learning to engage and support students in achieving learning outcomes. The integration of technology into learning has presented challenges and opportunities across all sectors of education. In Australia, state and federal levels of government have supported initiatives to promote the use of technology in primary schools (DEAG, 2010). Following the Melbourne Declaration on Educational Goals for Young Australians (2008), the Ministerial Council of Education, Early Childhood Development and Youth Affairs (MCEECDYA) identified Information and Communication Technologies (ICT) as a key educational goal in schools, underpinning its commitment to strengthening the support of teachers and school leaders in this area (MCEEDYA, 2008).

The push towards technology integration in primary education is also evident in the curriculum. The Australian Curriculum and Reporting Agency (ACARA), on introducing their review of the technologies curriculum in 2012, identified and referred explicitly to opportunities for integrating technologies across all key learning areas (KLAs) for years K-6 (ACARA, 2012). In New South Wales, syllabus updates have increased the prominence of digital technologies, and have made the integration of digital technologies more explicit across key learning areas.

Schools, and more specifically teachers, are responsible for developing learning programs which deliver the content and skills outlined in the syllabus. The increased prominence of digital technologies in the syllabus means that teachers have an increasing responsibility to integrate technology in the programs they develop. The Australian Professional Teaching Standards (AITSL, 2015) "define the work of teachers and make explicit the elements of high-quality, effective teaching in 21st century schools that will improve educational outcomes for students" (AITSL, n.d., "*How the standards are organised*", para.1). The standards outline areas of expected performance for teachers within the domains of *Knowledge of Students*, *Professional Practice* and *Professional Engagement.* Teacher ICT skills and knowledge feature in both the domains of *Knowledge of Students* and *Professional Practice,* under the following descriptors:

- ***2.6*** *Information and Communication Technology (ICT):* Implement teaching strategies for using ICT to expand curriculum learning opportunities for students.
- ***3.4*** *Select and use resources:* Demonstrate knowledge of a range of resources, including ICT, that engage students in their learning.
- **4.5** Use ICT safely, responsibly and ethically: Demonstrate an understanding of the relevant issues and the strategies available to support the safe, responsible and ethical use of ICT in learning and teaching.

(AITSL, n.d.).

There is a clear impetus for teachers to integrate digital technologies in their teaching and learning, but there are discrepancies between the expectations of teacher practices with digital technologies and the day-to-day reality of teachers working to integrate technologies in their classrooms.

Multiple studies have identified that many teachers find it challenging to integrate technology into their teaching and learning (Lim & Chai, 2008; Ruggiero & Mong, 2015). Some such studies have highlighted a range of factors which act as barriers to technology integration (Ertmer, 2005). Barriers may exist within the school environment, such as difficulties with access to technology or a lack of technical support in schools. Factors such as teachers' own beliefs and attitudes have also been shown to impede their capacity to integrate technology in their teaching and learning (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010). For example, if teachers do not personally perceive a value in the integration of technology in teaching and learning, they are less likely to invest their time to learn about and integrate ICT (Bate, 2010; Starkey, 2010; Tondeur, Roblin, et al., 2017).

Although limited in number, some studies have shown that early career teachers also experience barriers to technology integration (Bate, 2010; Starkey, 2010; Tondeur, Roblin, et al., 2017). We know that the context of ECTs is further complicated by factors related to being a new, inexperienced member of staff in a school. Studies on the experiences of beginning teachers suggest that there are high rates of casual contracts for early career teachers, which may mean that the support they receive is limited (Kelly et al., 2018; Schuck et al., 2018). These factors might also be exacerbated by a high workload and a lack of agency within the school (Gallant & Riley, 2014, 2017). We know there are high attrition rates for early career teachers (Kelly et al., 2018) and therefore there is a need to better support teachers at this stage of their careers. These studies identify that contextual factors, both internal and external, create a complex environment within which early career teachers work to produce technology-integrated learning programs for their students.

There are few studies which focus on early career teachers integrating technology into their teaching practice. However, a key study in the field is Bate (2010) which found that technology integration presents an added pressure to the steep learning curve early career teachers already experience in their first years of teaching and it is identified as an area where they are especially lacking in knowledge and expertise. In Bate's (2010) study of 35 Australian early career primary teachers integrating technology into their teaching practice, he found that ECTs often express a positive attitude towards integrating technology in their teaching, but in practice their TIL is often teacher-centred and limited in innovation. This finding has been supported by more recent studies of early career teachers who have identified that both external contextual factors (e.g. limited experience of TIL in their initial teacher education, limited support for technology integration in schools) and internal contextual factors (e.g. teacher knowledge and beliefs about TIL) all contribute to creating a challenging environment for ECTs wishing to integrate technology (Orlando & Attard, 2016; Starkey, 2010; Tondeur, Roblin, et al., 2017). However, these studies have been limited in their capacity to understand the complexities of context. These studies have collected data over extended periods of time and have used interviews, group discussion and lesson observations to identify what the main challenges are for early career teachers integrating technology. What has not yet been identified is how the contextual factors create such challenges impact on specific aspects of ECTs' work, such as the design of learning programs. In order to understand how to better support ECTs in developing innovative TIL programs, we need to know what they do, what they understand, and what they think about when they are developing learning experiences for their students. This in-depth and holistic study of ECT thinking and practice as they engage in developing technology-integrated learning programs contributes new knowledge about how ECTs approach the design of TIL. It also informs our understanding of how support can be targeted specifically to their professional learning needs.

Researchers seeking to understand the complexities of teachers' practice and thinking as they develop learning programs have conceptualised such work as design (Conole, 2010; Goodyear, 2005; Goodyear & Dimitriadis, 2013; Laurillard, 2013). There is an extensive body of research dedicated to understanding teacher design in tertiary education, with the over-arching goal of improving the learning experiences and outcomes of students (Bennett et al., 2016). A salient feature of design work is that it seeks to solve a human-centred problem or concern. Professional designers, such as architects, work iteratively to solve the problem as they strive to meet a set of abstract specifications (Laurillard, 2013). Teachers are seen to follow design processes when developing learning programs. The concept of design thinking is integral to design work and is described as involving "creative thinking in generating solutions to problems." (Razzouk & Shute, 2012, p.331). The conceptualisation of teachers as designers thus encapsulates the cognitive processes as well as the operational processes of developing learning programs. This conceptualisation, along with previous research which explored teachers' design with a view to understanding how support and develop that practice, underpins the decision to focus on teacher design practice in this study.

Early career teachers frequently experience challenges in their attempts to implement technology-integrated learning. We know that the technology-mediated learning experiences they create are often limited and lack innovation. We also know that ECTs often report contextual factors as impacting on their practice with digital technologies. Technology-integrated learning is not implemented without background work; it is the result of planning and decision-making which is influenced by many factors. The nature of this work is complex and what is not yet fully understood is how contextual factors influence specific aspects of ECTs' work when they plan and develop technology-integrated learning. In order to address these gaps in our knowledge, research is needed which focuses on early career teachers' design practices with technology-integrated learning and how contextual factors influence their design process.

1.3 Significance of the study

A search of the literature published over the last 10 years identified only nine studies relating to early career teachers' integration of technology into teaching and learning. Research in the field has distinguished between pre-service and in-service teachers. The decision to focus on design is a novel one. Studies so far have not sought to identify what early career primary teachers do when designing technology-integrated learning, or what and how they think about and reflect on when designing technology-integrated units of learning in context. It is important to understand more about these influences and how they affect early career teachers' practice. This study seeks to contribute to our understanding of primary teachers' design thinking and practices with technology at this early stage of their careers.

This study proposed investigating early career primary teachers' design of a program from the initial conceptualisation phase of the unit to the post-implementation phase where teachers evaluate the unit after teaching. The design of this study allowed for the capture of contextual influences on the design process, changes in early career teachers' approaches and thinking throughout the design process and facilitated the identification of the ways in which teaching influences the design of the unit.

The study presents a rich picture of early career teachers' design practices with technology integration in context, which includes cognitive and reflective processes which are often tacit. This is an area which up to now has not been a focus of much research, yet it is important because it will add to our knowledge about how early career teachers approach the design of technology-integrated learning, and to our understanding of how we might effectively support teachers in designing for technology integration.

1.4 Research Questions

The overarching question of this study is:

> How do early career primary teachers engage in the design of technology-integrated learning in context in context?

Two sub-research questions guided this investigation. These are:

1. How do early career primary teachers approach the design of technology-integrated learning in context?
2. What influences early career primary teachers' design of technology-integrated learning in context?

The first question addresses the gap in the literature relating to early career teachers' design and their practices with TIL. The study focused on how ECTs think about and approach integrating technology into the programs they design prior to, during and after the design process. This aspect of the study captured design work undertaken before, during and after teaching a TIL program. Specifically, this question guided the consideration of which factors were considered by ECTs as they designed TIL and which steps they took as they worked on their TIL program design.

The second question sought to understand what influenced each ECT participant's practice as they designed TIL programs. By exploring the influences on practice, this research captured the various contextual factors which directly or indirectly impacted on the participants' thinking and actions as they engaged in their design work.

The findings relating to the research questions above enabled the development of rich case descriptions and an in-depth understanding of the contexts within which ECTs design technology-integrated learning programs. The study highlighted those contextual factors which supported, and those which inhibited, the participants' design practice; resulting in new knowledge about the complex interplay between ECTs' context and practice with TIL design.

1.5 Research Strategy

The study used a multiple case study approach with a qualitative methodology to investigate the complexities of context and how they influence early career primary teachers' broader practices when designing a TIL program. A case study approach was adopted as it facilitated an in-depth exploration of the cases to understand the subtle interplay between a phenomenon and its context (Yin, 2014). The study followed the development of ECTs' design practice and thinking from the initial conceptualisation of the program, through the teaching of the program to the post-implementation stage of program evaluation. By using multiple sources of data collection, the study captured both explicit and implicit details of the process. This range of data sources allowed an in-depth and holistic representation of early career teachers' thinking and practices to emerge. A case study approach was used because of its value in exploring and uncovering unknown perspectives of phenomena (Yin, 2014). This approach is also valued for its contribution to viewing phenomena through variety of lenses (Patton, 2015).

The study comprised seven cases where participants engaged in the process of designing TIL programs. The number of cases ensured that a range of contexts were represented in the data set in order to study the phenomenon (Stake, 2013), but it also ensured that the number of cases was manageable for the context of a doctoral study. The data collection process captured data from multiple sources at various points in the design process. Data sources included multiple interviews, observations of design practice and implementation (teaching), and program documents and resources. In the first stage of data collection, data was captured in real time as participants engaged in an initial design day. On the design day, participants were observed engaging in design, their thinking was captured through the use of a Think Aloud protocol (van Someren et al., 1994), and their practice was recorded on video to capture visual evidence of their practice. The collection of multiple sources of data was important to ensure rigour in the research design (Creswell, 2013).

The participants in this study were purposefully selected to represent different teaching contexts. By having such a range, it was anticipated that there would be the optimum opportunity to identify a broad range of contextual influences on the work of early career teachers engaging in the design of TIL. Selection criteria used for recruitment was:

1. Sector: the study included participants from three different school systems. These were government schools, Catholic schools and independent (private) schools.
2. Geography: the study included participants from schools in metropolitan, regional and rural areas of the state of New South Wales.
3. Demographic identification: the study included participants from a range of demographic contexts. These included variations in socio-economic identity and variations in students' cultural and linguistic backgrounds.
4. School size: the study included participants from schools of varying sizes. It also included schools who cater for students from grades K-12, as well as schools who were primary (K-6) only.

Activity theory framed this investigation and was selected because of its recognised value to studies which focus on the analysing factors impacting on work undertaken in context (Engeström, 2001). Chapter 2 presents evidence that external and internal contextual factors influence teacher practice with technologies. Activity theory allows for the exploration of both internal and external contextual influences on a work activity. The work activity and its associated internal and external contextual influences are viewed in activity theory as an activity system. Within the activity systems in this study, multiple contextual components were investigated, which allowed for the emergence of a complex picture of each participant's context and how these factors influenced the design process. Along with contextual factors from the participants' school environments, each participant's internal resources were analysed in terms of how they influenced the design activity. Each participant's knowledge about technology integration was analysed through the technological pedagogical content knowledge (TPACK) framework (Mishra & Koehler, 2006). This is a contribution to existing literature on early career teachers' work with TIL, as it allows for the analysis of TPACK as part of a complex network of competing influences, rather than in isolation.

1.6 Limitations of study

Two key limitations were identified in the research design:

1. The study was confined to the state of NSW, which has jurisdiction for the education of its citizens.
2. The study comprised a small number of cases. However, the value of case study research is the in-depth and holistic representation of phenomena in cases, resulting in "patterns" and "explanations" (Yin, 2014), which are not otherwise achievable. The depth of

exploration of each case and the comparison across the cases and contexts allowed important knowledge to emerge.

There was only one male participant in the study of seven early career teachers. According to the most recent data, males constitute 18.3% of the primary teaching population in Australia (ACARA, 2017). Therefore, the ratio of male to female teachers in this study is close to that of the broader teaching population and as such, does not constitute a limitation.

1.7 Definition of terms

Early career teacher: The definition of an early career teacher in this study is one who completed their initial teacher education studies within the past five years. Terms which are synonymous with 'early career teacher' in the literature are 'beginning teacher' and 'novice teacher'. In this study, the abbreviation 'ECT' is also used.

Program: A program is a learning sequence prepared by a teacher to meet a set of connected learning outcomes or to focus on a specific content area. In NSW, this is referred to as a 'unit of work'. A unit of work typically consists of between four and ten weeks of learning, which is usually consists of ten to twenty lessons, depending on the subject. For the purposes of this study, the term 'program' is used.

Technology: For the purposes of this study, the definition is broad and covers digital devices, applications, communications technology and processes embedded within these. Some studies refer to a type of technology (e.g. interactive whiteboards) and others leave it to study participants to define. Information communication technology (ICT) is often used interchangeably with the term *technology*.

Technology integrated learning (TIL): This term is used to describe learning activities that include technology-based tools and activities integrated throughout in a way which provides integral support for students in achieving their learning outcomes. An alternative term is technology-enhanced learning.

Key Learning Area (KLA): This term refers to subject disciplines which are taught in Australian primary schools.

Design: This term is used to describe the thinking and actions which together constitute the process of developing a program of learning.

Initial teacher education: This refers to the tertiary education course undertaken by students in order to qualify and be able to practice as teachers. This term is abbreviated to 'ITE' in this study.

1.8 Structure of thesis

This thesis consists of six chapters. This chapter presented an overview of the study, its rationale and approach. Chapter 2 provides a synthesis of research in the literature pertaining to early career teachers and technology-integrated learning design. Chapter 3 presents the research methodology, which includes the study's research paradigm, its theoretical basis and methods. It also details the ethics processes associated with the study and provides a consideration of researcher reflexivity. Chapter 4 details the findings of each individual case in depth. A theoretical conceptualisation of each case through the lens of activity theory is presented at the end of each section in this chapter. Chapter 5 presents a cross-case analysis of the cases and identifies a set of themes emerging from this analysis. Chapter 6 presents a discussion of the findings in view of each research question and considers the implications of the findings, the limitations of the study and suggestions for further research.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents a review of the literature conducted in preparation for this study. The literature covered in this chapter reviews studies published up to 2017. The data collection for this study was undertaken throughout 2017 and was informed by the literature I reviewed up to and including 2017. For that reason, this chapter focuses predominantly on the literature reviewed for the design of the study. In order to provide a more up-to-date synthesis of the literature in the field, Section 2.5 reviews literature published since 2017.The focus of this study was to gain an understanding of how early career primary teachers engage in the design of technology-integrated learning and the way in which contextual factors influence their thinking and decision-making as they design technology-integrated learning programs. This chapter presents a critical review of the literature on teachers implementing TIL in the school context, leading to a presentation of the literature on early career teachers and TIL.

This study focuses on ECT practices with TIL in context. This chapter presents literature which has focused on contextual factors which have been identified as influencing teacher practices. It is important to highlight two critical points which have shaped my presentation of literature on contextual factors in this chapter. Firstly, there is contention relating to how the concept of context is described and interpreted. There is little consensus in the literature of what constitutes teachers' context, and studies in this field have varied in the contextual factors they have included and those they have excluded. In their systematic review of literature on TPACK and context, Rosenberg & Koehler (2015) identified that the meaning of context has differed widely between studies. For example, they found that classroom factors featured in 84% of studies reviewed, whereas student factors only featured in 44% of studies. Societal factors only featured in 14% of studies reviewed. They concluded that this inconsistency was a significant challenge in researching TPACK in context.

Secondly, the way in which context is discussed in education research also varies. My study took an inductive approach to identifying contextual factors influencing ECTs' practice, allowing the factors which influence each case to emerge from the data. Some researchers have categorised individual contextual factors as micro-, meso-, and macro-level (e.g., Rosenberg & Koehler, 2015), especially in relation to teachers' TPACK. The depiction of context as micro-, meso- and macro-contextual factors has been specifically used in studies which have sought to investigate the influence of context on teachers' TPACK (Porres-

Hernández and Salinas-Amescua, 2013) and specifically considers teacher factors such as beliefs and motivation separately from TPACK, as an influence on it.

By contrast, studies relating to human activity in context more broadly, that is to say, including and beyond the education sector, have used categories of internal and external factors, indicating their relationship to the individual working in the context (Nardi, 2006). This design of this study is framed by activity theory, within which a key proposition is that:

> *"Context is both internal to people (..) and, at the same time, external to people (..). The crucial point is that in activity theory, external and internal are fused, unified."* (Nardi, 2016, p.76)

In line with this interpretation of context in activity theory, I have categorised the contextual factors emerging in this study as internal and external contextual factors. TPACK is conceptualised in this study as a conceptual *tool* in activity theory, which means [define conceptual took]. This is alongside factors such as teacher beliefs, motivation and attitudes. It is critical to acknowledge that while this study has context as a central focus of analysis, its analysis of ECTs' activity within that context requires that the participants in the study individually depict their context in a way which is unique to them and without categorisations prescribed by the researcher.

In order to situate this study of early career primary teachers' design influences and practice with TIL in existing literature, this chapter is organised into three sections. The first section (2.2) presents what is known about influences on teachers' practice with technology. It explores this field of evidence from the perspectives of both internal and external influences on teacher practice. The second section (2.3) narrows in on the literature on early career teachers' knowledge, skills and practices with TIL. The third section (2.4) explores the concept of teachers' work as design practice in the design of technology-integrated learning and why this is an important area of study. The chapter concludes with an evidence-based presentation of why this study is an important contribution to our knowledge of how to support teachers' TIL practices in the early years of their careers (section 2.5). Evidence is presented of a gap in the literature pertaining to how contextual factors influence early career teachers' practice of designing TIL-based programs.

2.2 Influences on teachers' practices with technology-integrated learning

The idea that there are factors within teachers' broader contexts which influence their capacity to integrate technology into their teaching and learning programs is not new. Since the early 1990s, researchers have focused on why teachers are resistant to using technology in their teaching. While the technologies in question have changed dramatically since that time, evidence continues to emerge which shows that teachers find integrating technology into teaching and learning challenging. Consequently, researchers continue to explore why this is the case and how this issue might be addressed. This section presents a summary of the key themes evident in research undertaken in this field over the past three decades. The themes are presented as factors influencing teachers' practices with technology integration in two contextual categories: internal factors address the beliefs, attitudes and knowledge teachers possess, and external contextual factors address factors within teachers' school environments.

Early research into the challenges associated with technology integration in teaching and learning led to the identification of factors which impeded access to technology. Ertmer's (1999) discussion paper on barriers to technology integration identified these factors as falling into two categories: first- and second-order barriers. First-order barriers were obstacles described as being "extrinsic to teachers" (Ertmer, 1999, p.50). These obstacles were part of the teachers' external context, occurring in the school environment and relating to issues such as time, access to technology, training to use technology and support for technology use. Ertmer (1999) described second-order barriers to technology integration as "typically rooted in teachers' underlying beliefs about teaching and learning" (p.51) and noted that as such they constituted hidden barriers, sometimes even proving difficult for teachers to identify in their own thinking. The distinction identified in Ertmer's (1999) paper has guided research in the field over the past two decades.

Later work focused more explicitly on internal contextual factors influencing teachers practices with technology integration. This was perceived by researchers to be appropriate as access to technological infrastructure in schools had significantly improved, and therefore was less of a limiting influence (Ertmer, 2005; Prestridge, 2012; Ruggiero & Mong, 2015). Investigating internal contextual factors was considered important because the resolution of many external contextual barriers was not shown to be resulting increased levels of technology integration in schools. However, this section argues that external factors should not be dismissed as influences on teachers' practice with technology. Key work on internal and external contextual factors which are considered influences on teachers integrating technology in schools is presented below.

2.2.1 Internal contextual factors

Multiple factors contribute to teachers' internal motivations and obstacles to integrating technology in their teaching and learning. Such factors are conceptualised as teacher beliefs, teacher knowledge, and risk-taking and risk aversion.

Teacher beliefs

There is now extensive empirical evidence that teacher beliefs are key to understanding their practices with technology integration (Tondeur, van Braak, et al., 2017). The formation of teachers' beliefs about technology integration are complex in their development and endurance. Beliefs are understood to often be resistant to change by persuasion, which is why negative beliefs about the value of technology in learning are not easily swayed (Ertmer, 2005). Teachers' views, beliefs and experiences of technology are formed both inside and outside of the education sector (Ertmer et al., 2006; Pegrum, 2009). Origins of teachers' beliefs about technology are understood to have a broader cultural and sociological origin (Ertmer et al., 2006). Pegrum (2009) describes a series of 'lenses' through which teachers view technology and through which their views of technology in education might be shaped. These lenses are *technology*, that is the understanding of technology and its affordances in the broader community. A *pedogogy* lens concerns the use of technology in education. The *social*, *socio-political* and *ecological* lenses described by Pegrum relate to broader concerns about the role of technology in society. Teachers' beliefs and perceptions of learning are known to have the potential to affect all aspects of their work (Clark & Yinger, 1977). These insights into the formation, maintenance and consequences of teacher beliefs provide a clear rationale for focusing on their influence on technology-integrated learning. Research in the field has explored the role of value beliefs and pedagogical beliefs in influencing teachers' practices with technology integration.

Value beliefs in technology are developed by teachers as they evaluate the extent to which technology benefits and supports their work as teachers, and their students learning (Ertmer et al., 2012; Kopcha, 2012; A. T. Ottenbreit-Leftwich et al., 2010). Studies have established that teachers will not devote time and resources to learning about and integrating TIL into their regular practice if they do not perceive there to be an associated value (Howard, 2013; A. T. Ottenbreit-Leftwich et al., 2010). Nevertheless, there are specific values perceived by teachers for integrating technology. Ottenbreit-Leftwich et al., (2010) found that teachers who held a positive value belief in technology integration perceived TIL as introducing critical ICT skills to students which would prepare them for their futures and benefit them throughout their lives. This study also found that teachers perceived a value in technology for motivating and engaging students in their learning. What is less of a focus in these studies, is whether these beliefs translate into student-centred TIL in practice.

Research on the influence of teachers' pedagogical beliefs on their propensity for integrating technology tells us that there is a link between TIL and beliefs in student-centred pedagogies (Ertmer et al., 2015). Tondeur, van Braak et al., (2017) found that teachers' pedagogical beliefs can be a barrier to technology integration because teachers who favour a more teacher-centred approach in the classroom are less likely to view technology as an integral part of the learning process. However, studies have also found that actively integrating technology in the classroom can potentially change the pedagogical beliefs of teachers who have a more didactic approach. That is to say that through integrating TIL, teachers can see more of a value in a constructivist, student-centred approach (Ertmer et al., 2015). However, when such beliefs are investigated as an influence on practice, the strength of that influence becomes less clear.

While the discussion around teacher beliefs and technology integration in earlier work suggested that negative views of technology in education could result in the teachers harbouring those views demonstrating a reluctance to use technology in their teaching (Ertmer, 2005), more recent studies have highlighted a nuance to that argument. That is, even when teachers express positive beliefs in the value of technology integration to support student-centred constructivist pedagogies, analysis of their practice reveals that that these beliefs are often not enacted (Ertmer et al., 2015). An Australian study carried out with 49 teachers in four primary schools identified that teachers in those schools expressed strongly positive beliefs in the value of technology integration as a result of a succession of government initiatives to promote the use of digital devices in schools. However, examination of their practice and the learning tasks they created showed that in practice, their use of technology was limited and mostly teacher-directed (Prestridge, 2012). This study highlighted that increasing competence with technologies led to increasing confidence to create technology-enhanced learning, however their increased confidence did not support them to develop the type of student-centred approaches they believed in. A typical example in Prestridge's study was Katherine, who was described as valuing the use of ICT in her classroom and being personally competent with ICT. Despite these characteristics, Katherine demonstrated "a limited understanding of the use of ICT to enhance learning as she focuses on basic skills, rote learning and the comprehension of information" (p.456). These findings suggest that even if we are able to overcome the internal 'barrier' of beliefs, there are further challenges for teachers who believe in student-centred approaches with technology.

The contrasting findings about the influence of beliefs on teachers' practice with technology suggest that this influence is complex and probably interacts with other influences in the context. An investigation of the influence of beliefs as part of a network of competing influences would be valuable in understanding this complexity more broadly.

Teacher knowledge

Research on teacher thinking has shown how teachers use their knowledge to plan lessons and units for their students, which knowledge they use and how these processes differ between various levels of expertise. Shulman (1986) developed the pedagogical content knowledge (PCK) model as a way to understand teacher cognition in relation to content-specific teaching:

> *"It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to diverse interests and abilities of learners, and presented for instruction."* (Shulman, 1987, p.8)

It is understood that teaching experience is critical to the development of a teacher's PCK (Gess-Newsome, 1999). Much of the theoretical discussion relating to the PCK framework is mirrored in that of the TPACK framework and is presented below. Shulman's (1986) pedagogical content knowledge (PCK) framework presented a categorisation of individual teacher knowledge components of pedagogical knowledge (PK) and content knowledge (CK) and how they interrelate to create PCK. Its aim was to understand the complexities of teaching knowledge by identifying features of teachers' knowledge which related to their understanding of the content they teach and their knowledge of how to teach. Their combined understanding of PCK relates to teachers' knowledge of how to teach specific content; a more complex concept. The TPACK model (Mishra & Koehler, 2006) integrates the layer of technological knowledge into Shulman's existing framework of PCK (Shulman, 1986) in order to identify the types of constituent knowledge which influences the integration of technology into classroom teaching and learning (see Figure 1).

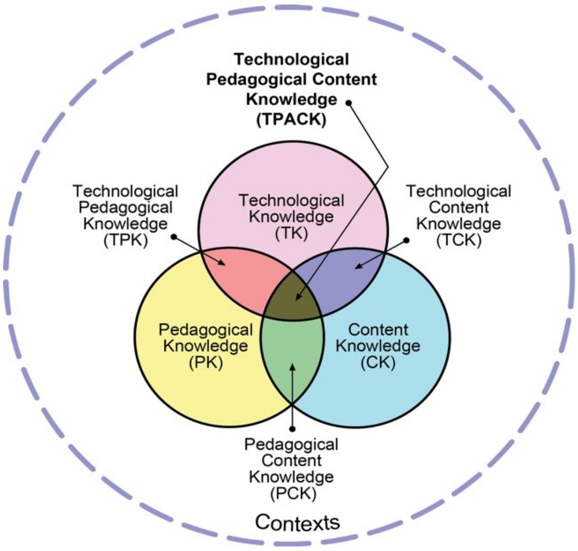

Figure 1: Technological Pedagogical Content Knowledge model (Mishra & Koehler, 2006)

TPACK continues to be relevant today in studies which investigate how teachers' knowledge influences the extent to which they integrate technology into learning experiences in a pedagogically principled way (Chai et al., 2014; Graham, 2011). For example, the study by Prestridge (2012) has established that teachers' competence with TIL has a positive flow on effect on their confidence and propensity to integrate technology in their teaching and learning. This reflects the value of improving technological knowledge (TK). However, within that study, teachers were unable to implement TIL which aligned with their pedagogical beliefs, thus highlighting the need for a level of knowledge where technological and pedagogical knowledge interact. An important critique of TPACK is that it is de-contextualised and therefore analysis of its components is not undertaken with the understanding of other contextual influences (Graham, 2011; Harris et al., 2017; Phillips, 2017).

Research on TPACK from a theoretical perspective has led to extensive interrogation of the structure of the framework and the depiction of its individual and integrated components. There has been some contention in the literature as to whether these components, such as content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK) should be seen as integrative, whereby each component is distinct, yet all integrate to create a complete form of TPACK, or whether in fact the components of TPACK are not distinct from each other and the TPACK framework itself is a holistic, transformative form of knowledge, which transcends its constituent parts (Rosenberg and Koelher, 2015; Angeli and Valanides, 2009; Graham, 2011). In this study, there has been an attempt to identify evidence for individual components of TPACK in each of the cases, such as technological knowledge (TK), as well as integrated components, such as technological pedagogical knowledge, and in doing so, the researcher accepts the argument for the depiction of TPACK as integrative. The rationale for this is underpinned by evidence in the literature on early career teachers' TPACK, which suggests that an imbalance between individual components of ECTs' TPACK contributes to challenges they experience in integrating technology effectively in their teaching (Bate, 2010; Orlando and Attard, 2016).

Researchers on TPACK have also argued for more focus on context in order to accurately reflect the complexity of technology integration in the classroom (Angeli and Valinides, 2009; Porras-Hernández and Salinas-Amescua, 2013). This understanding of the importance of context in TPACK studies has been extended by studies which identify the concept of distributed TPACK, which posits that knowledge about technology integration resides both internally to the teacher, but also within a complex contextual system. Studies have found evidence of distributed TPACK contextual systems, such as communication between colleagues, in the design of resources and documentation and the consultation of experts (Di Blas, 2014; Phillips, 2013). This study acknowledges the importance of investigating contextual influences on teacher knowledge and practices with technology and as such concurs with this argument. This aspect of TPACK is discussed further in Chapter 6 and is identified as a recommended focus of future research.

Risk-taking and risk-aversion

There is evidence in the literature that rather than generally holding a negative attitude towards technology, teachers who are reluctant to integrate technology into their teaching practice are influenced by a lack of perceived value of technology in teaching and a risk-averse disposition (Howard, 2013). This research indicates that teachers who do not perceive that technologies will positively impact on students' learning are less likely to take risks by integrating technologies in their teaching. Aside from value beliefs and pedagogical beliefs, teachers' aversion to risk-taking has been identified as a potential barrier to technology integration. Its importance is notable because such negative affective responses are stronger and more immediately impactful than more analytical responses. Howard (2013) argued that risk-taking is a key factor in technology integration because there are uncertainties about how to integrate technology and its value for learning. This research into risk-taking, when considered alongside the influence of teachers' beliefs on technology integration begins to build a picture of the complex interplay of internal influences on practice.

The consideration of risk-taking as an affective trait in teachers as they develop TIL also provides evidence of interplay between internal and external influences. A school's culture

which does not communicate strong support for TIL can further impact on a risk-averse teacher's capacity to integrate technology (Howard, 2013). A case study of teachers in two Australian schools identified that teachers can be reluctant to integrate technology based on anxiety and a perception that technology would not necessarily improve learning for the students. However, when that risk-averse response was not met with support or social pressure within the school community to take an element of risk with technology integration, the teachers' risk-averse approach was reinforced (Howard, 2013).
These findings indicate that the absence of an external factor, in this case the absence of explicit support in the schools, can construct a context which limits teachers' capacities to develop TIL. Conversely, schools can actively support teachers to develop their confidence and capacities to take risks with technology integration. Studies suggest that schools can decrease the perceived level of risk in experimenting with technology integration through increasing individual knowledge and skills, and also by aligning technology integration with a school vision which sets out aims and goals for TIL (Ertmer et al., 2015; Howard, 2013). These findings again indicate the complex inter-relationship of an internal influence on teachers' practice with external influences.

This section has summarised the research on factors which constitute teachers' internal context. The next section focuses on evidence in the literature relating to factors within teachers' external context which influence their practice.

2.2.2 External contextual factors

Factors from teachers' external context which are found to influence technology integration relate to elements existing within the school environment. Such factors might be physical (e.g. resources), regulatory (e.g. policies) or socio-cultural (e.g. influenced by colleagues). While there has been discussion in the literature expressing that the focus should be on internal contextual barriers to TIL because external contextual barriers have significantly diminished, this section identifies ways in which external factors influencing technology integration might have changed rather than diminished. This section summarises literature on key areas which have been found to influence teachers' practices with technology. These are access to technology, school vision, professional learning, time and attitudes and beliefs of colleagues.

Access to technology

In the early stages of research into barriers to technology integration in schools, access to technology was identified as an issue (Ertmer, 1999). Not all schools had internet access or computers on site and so this was naturally a significant restriction for teachers wanting to use technology in teaching. Some years later, researchers in the field identified that access to technology in US and Australian schools was no longer a barrier to integration as the technology infrastructure in schools had improved. (Ertmer, 2005; Prestridge, 2012). They noted that schools generally have access to internet and computers or other digital devices, which means access to technology is in place. While this is mostly true, there are great variations within this depiction of access to technology in Australian schools. While Australian secondary schools experienced the introduction of one-to-one laptops for students in years 9-12 from 2011 to 2014 (Parliament of Australia, n.d.), in Australian primary schools, the focus was put on the provision of interactive whiteboards (IWBs) in each classroom (Groundwater-Smith, 2010). Therefore, the provision of individual digital devices for learning has been the responsibility of individual schools and thus varies from school to school. While one-to-one devices are commonplace in independent primary schools (Pegrum et al., 2013), the situation for government schools is less clear, which indicates that there is a great variation in access to technology between primary schools in Australia.

Apart from physical access to technology in schools, there are other factors within the external context of schools which can obstruct the integration of digital technologies into teaching and learning. External contextual factors such as school vision, technology support, peer support and professional learning can negatively influence teacher beliefs about TIL . The role of school leadership and culture have the potential to be critical support structures or barriers to technology integration in learning (Divaharan & Ping, 2010; Laferrière et al., 2013; Tondeur et al., 2013). Such studies expose the broad range of contextual influences on successful technology integration by teachers. The next four sections summarise our understanding of external influences which can be identified as directly or indirectly related to school leadership and culture: school vision, professional learning, time and attitudes and beliefs of colleagues.

School vision

The importance of a whole school vision of principled technology integration was highlighted by Ertmer in her 1999 discussion paper. The concept of a school vision of technology integration continues to be identified in many studies as integral to the effective integration of technology in learning and teaching, despite these studies finding that such a vision is often missing in schools (Ertmer et al., 2012; Park & Ertmer, 2008; Tondeur, van Braak, et al., 2017). Tondeur et al. (2017), present the “desirability” of “the development of a vision of a ‘good’ education that incorporates the meaningful integration of technology” (Tondeur et al., 2017, p.17). Yet in many cases, the lack of such a shared pedagogical vision for TIL can negatively impact directly on teachers, causing uncertainty and disparity among staff members (Park & Ertmer, 2008). Park & Ertmer (2008) identified this barrier as the most significant for its participants. Their study also found that when developing policy around TIL, many schools focused on the technological aspects, such as choices of device and software, rather than on more pedagogical goals for TIL. Paradoxically, evidence in the literature from Indiana, USA, demonstrates the positive outcomes of staff being supported by administrators in their TIL practices (Ertmer et al., 2012).

Professional learning in TIL

Professional learning is identified as a way in which schools can support teachers to integrate technology effectively in their teaching and learning (Howard & Gigliotti, 2016). This has been shown in studies to be effective when the professional learning strategies engender some key characteristics. Firstly, professional learning is most effective when designed and demonstrated in the context within which those undertaking the professional learning work. This helps teachers to visualise and understand how specific TIL approaches might work in their classrooms and with their students (Kopcha, 2012; A. T. Ottenbreit-Leftwich et al., 2010). It is also shown to be important for schools to engage in long-term professional learning in TIL for it to successfully impact on teacher beliefs and practices (Kopcha, 2012; Tondeur et al., 2017). Without these factors, studies have found that professional learning might not be successful for some teachers, due to the complexity of their belief system (see section 2.2.1).

Mentors have been shown to support teachers in implementing TIL by acting as guides and supporters of practice. Kopcha's (2012) provided insights into the role of mentors in supporting teachers to integrate technology. In this study, it was found that communicating with mentors about TIL could be a valuable support mechanism for teachers, because mentors could "communicate the vision for using technology" and help teachers to "keep the technology working on a consistent basis." (p. 1118). While this study reported on the role of mentors as part of a professional learning approach for all teachers, this highlights an important concept for early career teachers designing TIL: ECTs often have mentors in the early stages of their careers, therefore it is possible that mentors can play a significant role in supporting teachers in their TIL practice. These studies provide evidence that in order for professional learning to be effective, it needs to be ongoing, contextualised and include guided practice.

Time

Time has been identified as a limiting factor in TIL design. In Kopcha's 2012 study of teachers' perceptions of barriers to TIL, time impacted on TIL in three significant ways: firstly, some teachers found it extremely time-consuming to create technology-mediated learning activities. Secondly, teacher participants found that significant time could be wasted in class as they attempted to resolve technical issues such as software updates and internet connectivity. Finally, teachers in this study found it time consuming to update their knowledge and skills for implementing TIL. This study of 18 primary teachers is interesting because it highlights that the responsibility for these areas of teaching with technology are perceived to be the individual responsibility of teachers. It raises the question how can teachers be supported in the design and implementation of TIL so that they are not carrying such time-consuming responsibilities?

Attitudes and beliefs of colleagues

In parallel with the understanding that an overarching school vision of technology-integrated learning shapes a positive culture of practice in schools, the influence of colleagues' attitudes and beliefs is understood to impact on individual teachers. Ertmer et al.'s (2012) study raises the issue of attitudes within the socio-cultural environment of schools to be a limiting factor for technology integration in schools. Teachers in this study who self-identified as having value beliefs which would facilitate technology integration, also identified the negative attitudes of their colleagues towards TIL as constraining to their practice. Participants in the study expressed their colleagues' attitudes using words such as "afraid", "fearful", "intimidated" and "reluctant" (p. 434). These findings again identify challenges which might be mitigated by a whole school or whole district approach to supporting teachers to integrate technology as shown in other studies (Tondeur et al., 2017). The evidence from these studies is interesting in their perspective of external and internal contextual barriers to technology integration. Section 2.2 identified that teachers' beliefs can be a barrier to their own capacity to integrate technology into their teaching. However, when we view this factor through the lens of a whole school community, it becomes apparent that the internal beliefs of individual teachers can impact on others and therefore their internal barriers can become the external barriers of their colleagues.

This section has summarised the research on factors which constitute teachers' external context. External factors which can influence teachers' practice are complex and demonstrably unique in each school. The findings of these studies on technology integration in learning programs add further support to the need to understand more about the complex interplay between contextual factors and their influences on teachers' design thinking and processes.

2.3 Early career teachers

There is limited literature about early career teachers integrating technology into their teaching and learning. Yet focusing on teachers at the beginning of their careers is important because they have years of teaching ahead of them. Their careers are likely to be impacted by a broader changing knowledge economy, in which they will face the need to manage the introduction of new technologies in schools (Finger et al., 2015). This section presents what is known about this sector of teachers and elaborates on why researchers in the field suggest further research, such as the focus of this doctoral study, is needed.

The section paints a holistic picture of current knowledge about the context within which ECTs are designing TIL and how this context influences their practice. It begins with an overview of what we know about the experiences of ECTs as they adjust from being students to becoming practitioners in the school context. There then follows a presentation of evidence in the literature about ECTs' practices with TIL. The section then proceeds to present the current understanding of the influences on their practice.

The literature relating to early career teachers' practices with TIL is limited to a small number of studies. For this reason, within the presentation of influences on practice, some studies are presented which relate to pre-service teachers. There is a broad range of literature on pre-service teachers' knowledge and skills with TIL, however for the purposes of this study, only those studies which present a connection between pre-service teacher education and the development of early career teachers in their careers have been selected.

2.3.1 Early career teachers in the school context

There is much evidence in the literature that context plays a critical role in teachers' development of skills and knowledge. A branch of this literature focuses on the issues facing ECTs when entering the profession. Such studies analyse the factors that can be a barrier to innovative practice impact specifically on ECTs. Many of these studies have focused on attrition rates of ECTs, which has become a significant issue in Australia in particular (Gallant & Riley, 2012), but is also a problem experienced in other countries, such as the USA (Hong, 2010). This section summarises the key issues in order to present an accurate picture of early career teachers' professional contexts and the influences which might impact their practice.

School culture and lack of support for ECTs in schools have been identified as significant issues for teachers starting out in their careers (Gallant & Riley, 2017). Aspects such as relationships between staff members, and between school leaders and staff, contribute to a school's culture. In Gallant and Riley's (2017) study, ECTs described experiencing exclusion in the staffroom, which contributed to them developing a sense of inadequacy. Participants in that study also described experiencing a lack of emotional support from leaders.

The impact of a negative school culture towards ECTs can have an impact on their self-confidence and their engagement with the profession. Such negative social experiences in schools have been found to lead to ECTs having a low sense of self-efficacy (Hong, 2010). ECTs experiencing low self-efficacy who work in schools which do not have structures in place for specifically fostering ECTs' growth as teachers were found to be at high risk of leaving the profession (Gallant & Riley, 2014). This highlights the severity of the potential impact of contextual factors on early career teachers.

In order to combat such emotional load for beginning teachers, Hong (2010) advocates for a program of mentorship in schools which focuses not only on the practical aspects of teaching, but also for supporting the development of ECTs' professional identities. As well as contributing to our understanding of the context specific to beginning and early career teachers, Hong's (2010) study also identifies how the support of ECTs in practice can be a more holistic process which supports all aspects of their professional development.

2.3.2 Early career teachers' capacity to design TIL

The area we know most about in the context of early career teachers and how they engage with educational technology is their internal influences: their knowledge and skills with TIL. Studies have found that ECTs often have strong beliefs in the value of TIL for students (Bate, 2010; Tondeur, Roblin et. al., 2017). However, researchers in both these studies identified that despite espousing positive attitudes towards the integration of technology in teaching and learning, their approaches meant that they used technology in a teacher-centred way, primarily to present content (Bate, 2010; Gao et al., 2011). Tondeur, Roblin et al. (2017) found that "There was no evidence indicating that beginning teachers were using technologies to facilitate collaboration, creativity or critical thinking" (p.172). Indeed, Bate (2010) noted that when asked about their use of technology, his participants' responses "tended to centre on the potential of ICT as a preparation and presentation tool" (p. 1052). This finding aligns with similar characteristics of teachers generally (see section 2.2), yet our understanding that there are additional external contextual pressures on early career teachers makes this an even important concern for teachers at this stage of their careers. The concept of early career teachers struggling to integrate technology in a way which supports student-centred pedagogies is recognised as an issue in the literature, and efforts have been made by researchers to identify the reason for this.

Research in the field has focused on two areas which are understood to impact on ECTs' capacity to integrate technology effectively in their teaching and learning. Over the past ten years, there have been studies which sought to investigate ECTs' knowledge about TIL. These have included, but are not limited to, studies which use interpretations of the TPACK framework (Mishra & Koehler, 2006) to investigate the levels of ECTs' technological pedagogical content knowledge. Bate's (2010) study of 38 beginning teachers is an example of one which used TPACK. In this work, he identified two critical factors. Firstly, he identified that "The quality of pedagogical reasoning processes tended to inhibit enactment of participants' beliefs" (Bate, 2010, p.1053), indicating that levels of pedagogical consideration of technology as a learning resource were low. Secondly, he found evidence that both a participant and her school leadership did not see a link between technology and improving learning outcomes, meaning that the school context did not support this ECT 's technological content knowledge (TCK). The evidence pertaining to ways in which the school context impacts on an ECT's capacity to design TIL is explored later in this section. However, it is important to note here that other empirical studies support the view that low levels of pedagogical knowledge about TIL are a barrier to ECTs wishing to incorporate TIL in their practice. Orlando & Attard's (2015) study on early career mathematics teachers identified that the student-centred technologies, such as tablet devices, demanded higher levels of TPACK from the participants than the teacher-centred use of the classroom IWB. They explained that "The difference in number of affordances between an IWB and a tablet required further development of the teacher's TPK when using tablets" In that study, despite espousing positive attitudes towards student-centred TIL and articulating their intention to use tablets for a student-centred approach, the participants' limited pedagogical knowledge "reduced their ability to do so" (p. 119).

The fact that ECTs often struggle to integrate technology in a pedagogically effective way might be surprising to more experienced practitioners who often view their junior colleagues as a source of professional knowledge of TIL. Tondeur et al.'s (2017) study found that participants reported that colleagues expected them "to be knowledgeable about technology" and "look to her for fresh ideas for the use of technology." (p. 163). This appears to put ECTs in an unusual position of being perceived as having experience in the field, yet not having the depth of pedagogical knowledge to support this experience. Orlando & Attard

(2015) found that ECTs often have more real-life experience with technology than their colleagues, yet struggle to move beyond their personal experience because "teaching brings with it the expectation for student learning" (p. 119), suggesting that they have limited knowledge of how to use technology to provide opportunities for students to learn effectively. Findings from many studies reviewed for this research support the view that higher levels of pedagogical knowledge are required of ECTs if they are able to effectively design student-centred TIL. The question, then, is how are ECTs to develop this knowledge?

Studies in this area have identified that ECTs begin their teaching careers with a myriad of different experiences with TIL in the pre-service education (Bate, 2010; Clausen, 2007b; Tondeur, Roblin, et al., 2017). However, an interesting aspect of these common findings is that when asked about how their pre-service teacher education could or did best support them in developing the skills to integrate technology in their learning programs, a common response was "While exposure to technological applications for education seems relevant, the respondents indicated that it was important to explore how new technologies can be used for educational opportunities" (Tondeur, Roblin, et al., 2017). The opportunity to have space to explore technology integration in a low risk environment was highly valued by ECTs who had experienced this (Clausen, 2007). Gao et al. (2011) found that this type of learning opportunity in pre-service teacher education allowed participants to reflect on practice in conjunction with their new knowledge of technology integration. This in turn afforded the teacher education students an important opportunity to construct personal meaning and pedagogical understanding of technology in the classroom: "Learning to teach with ICT is not only the accumulation of knowledge, skills and change of beliefs. Pre-service teachers continue to develop a better understanding of technology-based pedagogy from their own performance" (Gao et al., 2011, p.174). Clausen's (2007) research found that this practice allowed teacher education students to build their confidence and to be equipped with a sense of agency around technology integration when they started their professional careers. This is particularly significant in light of our understanding of ECTs' tendency to experience low self-efficacy in general.

2.3.3 Contextual influences on ECTs' practices with TIL

While the influence of teacher education in ECTs' capacity to integrate technology effectively is evident in the literature, this is not the only factor known to impact on ECTs' practice. The school context is understood by many researchers in the field as being a complex influence on teachers' design practice, as noted earlier in this chapter. However, researchers of early career teachers' technology integration practices have identified that the school context impacts more significantly on their practice in comparison to teachers with more experience. Bate (2010) noted a range of school-related factors which impacted on ECTs' technology use. He summarised these in his research: "At institutional level, two factors combined to limit ICT use. These were lack of access to ICT infrastructure and unenthusiastic school cultures" (p. 1054). Lack of access to technology has been widely discussed as a barrier to technology integration in schools, but these studies involving ECTs reveal a more nuanced view of inter-related factors in the school environment which work together to limit ECTs' creativity with TIL:

> *"The study, therefore, identified a vacuum in ICT leadership in schools. This leadership vacuum was filled to varying degrees by a range of individuals including teachers, teacher librarians, ICT coordinators and IT managers. This led to some variation in interpretation on how ICT should be dealt with in schools. (..). Many participants in the study felt that the policy was developed ad hoc and that school leaders were out of their depth"* (Bate, 2010)

The above quote from Bate's work demonstrates the roles all staff members can play in creating an 'unenthusiastic' or unsupportive environment for TIL. For ECTs who are negotiating a new socio-political context in which they often perceive themselves to have little power or agency, this complex barrier becomes greater. Along with the complexity of various staff member's interpretation of TIL policy, the problem of teacher colleagues' low levels of knowledge and understanding about TIL was identified by Gao et al. (2011) as another factor impacting on ECTs' capacity to implement TIL.

The issues outlined by studies presented in this section of the chapter provide some insight into the context in which ECTs are attempting to integrate technology. The evidence captured in these shows confirms that each ECTs' school context is complex. The studies referred to here are small in size but they go some way to providing insight into ECTs' practice and thinking with TIL. Starkey (2010) and Tondeur, Roblin, et al. (2017) acknowledge this and clarify that this complexity differs from school to school, with each school having its own unique complex context. It is in this contextual complexity that the difficulty lies for those wishing to identify how we can support ECTs to be able to confidently design TIL for their students. Both Starkey (2010) and Tondeur, Roblin, et al., (2017) state the need to further investigate the influence of ECTs' personal experience and knowledge gained during their initial teacher education and in their school context on their day-to-day work in practice: "..future research may examine these connections in relation to the complex realities of daily teaching with technology in a specific context" "..further studies might be needed to analyse the combined impact of school-level characteristics, beginning teacher characteristics and their pre-service experiences" (Tondeur, Roblin, et al., 2017, p. 174).

Studies in this field have been small in scale and have mostly relied on collecting data through interviews and observation of teaching practice. These studies have been valuable in developing our knowledge of ECTs' internal and external contextual influence on their technology integration. However, what is missing is a holistic understanding of how all contextual factors interact to influence ECTs' work as they conceptualise and develop TIL experiences for their students. By understanding in detail how these contextual factors impact on their thinking and processes as they develop TIL, there will be a more nuanced understanding of how to support ECTs to overcome barriers to the development of student-centred, innovative TIL.

This doctoral study is designed to extend our understanding of the context within which ECTs are working to design and engage in TIL for their students. It is anticipated that the study will provide valuable insights about initial teacher education and structures in schools which can best support ECTs' development of their pedagogical reasoning and capacity to engage in creative, student-centred TIL. So, how can we develop supports for ECTs integrating TIL when the context varies so much?

2.4 Teachers as designers of TIL programs

Characterising the work of teachers as design work has been increasingly prominent in education literature over the past ten years. This characterisation, described as design praxiology (Cross, 2006), has been advocated following the identification of stages of teacher work when planning and implementing learning experiences which correspond closely with stages of design practice in the design professions (Laurillard, 2012). Teacher design work has been contrasted with the work of planning learning in the following ways. Firstly, the idea of planning suggests an operational exercise, which establishes the parameters and requirements of a learning process and the skills and content which should be taught within specific lessons or courses. The idea of teaching as design work communicates the creative and iterative processes inherent in the work of developing learning experiences. Design involves an understanding of how to connect with students to engage them in the learning process and how to reach them on "both the pedagogic and affective planes" (Masterman, 2013, p.66). Secondly, it also carries with it the implication that the creative activity of design is never completed and can be adjusted throughout the implementation (teaching) process (Masterman, 2013).

Despite the increasing focus on teaching work as design work in tertiary education, this idea is relatively new to the compulsory education sector. The integration of technology into students' learning experiences adds further complexity to teachers' work when creating learning programs and reinforces the need to consider teacher planning as design work. The challenge of technology integration in learning is that the technologies used were not originally designed for education. Instead, teachers appropriate technologies for their teaching (Selwyn, 2017). Using digital tools which were not designed specifically for educational purposes presents a challenge to teachers to engage in creative thinking about how they can be used for learning (Laurillard, 2013). Laurillard explains that "the range of learning outcomes it is possible for their learners to achieve is being determined to a great extent by the range of teaching methods they employ" (Laurillard, 2013, p.3). This description outlines the connection between teachers' pedagogical thinking and their integration of technology. It also indicates that teachers need to engage in a new way of thinking about the learning activities they create when they integrate technology. The vast range of learning opportunities afforded by technology integration implies that a new level of thinking and conceptualisation of approach is necessary, one which can be characterised and conceptualised as design thinking (Svihla et al., 2015). This conceptualisation of teacher work as design work has significant merit because it can facilitate the deeper analysis of teachers' thinking and actions when creating learning experiences for their students.

Critical to understanding the characterisation of teacher work as design is the consideration of how design is different to teacher planning. Put simply, the idea of planning suggests the concept of planning a series of lessons which incorporate (in some cases existing) classroom activities and resources (McKenney et al., 2015), in which the dominant considerations of the teacher planners are practical issues (Boschman et al., 2015). However, factors present in design work reflect a more cognitive process. McKenney et al. (2015) identified the following common characteristics of design work:

- Problem-framing and formulation
- Working at many levels of detail in parallel
- Drawing on personal experiences and informal knowledge
- Creative ideas emerge from accumulated prior generated ideas and decisions

Design work demands an ability to visualise design outcomes and a predisposition to multifunctionality. In other words, design is a complex process the simultaneous consideration of multiple design considerations (Razzouk & Shute, 2012). These cognitive processes which are evident in the approaches of design professionals constitute what is often described as 'design thinking' (Cross, 1982; 2011). Researchers of teachers as designers identify design thinking within a broader design approach to creating learning experiences as a way to bridge the gap between planning for practical considerations and integrating pedagogical practice (McKenney et al., 2015). Indeed, they identify a design approach as critical for teachers designing new, innovative technology-integrated learning experiences (Svihla et al., 2014).

Analysing teacher practice from a design perspective helps us to understand the nature of teachers' work and the considerations they make when producing learning materials for their students. We know that when teachers develop learning programs to cover more than individual lessons or activities, there is an increased number of decisions which are made (Svihla et al., 2015). Decisions teachers make when developing new learning experiences are considered in response to multiple contextual considerations. These include the needs and preferences of others, access to resources and opportunities to try new out new resources (Matuk et al., 2015). As previously mentioned, teachers' own knowledge and experience can influence decisions made during the design process. Exploring teachers' design practice with TIL, provides the opportunity to identify at a granular level the way in which aspects of their complex individual contexts influence their practice.

Research on teachers as designers provide evidence from the higher education field about differences between novice and expert teacher design practice (Razzouk & Shute, 2012). From these studies we know that novice teacher designers tend to spend less time than experts focusing on understanding the design 'problem'. Instead they tend to begin working at a detailed level of design, and continue working at a detailed level, developing the learning design in a sequential way. They demonstrate limited capacity to view their design work from multiple levels. However, there is minimal evidence in the literature about the design approaches of early career teachers in the compulsory education fields.

Exploring early career teachers' approaches to developing TIL programs from a design perspective allows for an in-depth understanding of the contextual factors which influence their practice. Furthermore, such an exploratory research approach can provide significant insights into how these influences might interact to support or limit an ECT in designing a TIL program. We know a focus on design supports teachers to develop their understanding of pedagogy and we also know that a focus on design can support the development of professional identity (Svihla et al., 2014), therefore a focus on design for ECTs might support the development of their professional agency, especially in TIL design. This knowledge could provide fresh understanding of how to support and develop ECTs' capacity to design new technology-enhanced learning experiences in their immediate design practice and also to develop as reflective practitioners with TIL.

2.5 Literature from 2017 to 2020

From 2017 to 2020, research relating to this study has continued to pursue some of the key foci outlined in this chapter. This section presents an overview of recent research on early career- and pre-service teachers, and teachers as designers.

Empirical studies focusing on early career teachers explicitly depict the challenges experienced during the early years of a teaching career (den Brok et al., 2017; Harmsen et al., 2018; Voss and Kunter, 2020). A search of the literature on early career teachers and their practices with technology identified five publications, only one of which related to school-based education. This study was conducted in Morocco and specifically investigated the outcomes of education policy of the Moroccan government (Adil et al., 2019). Studies relating to early career teachers and their practices with technology predominantly characterise beginning teachers as pre-service teachers This means the focus of such studies is on beginning teachers before they are employed as teachers and as such, do not have a teaching context to work within. A summary of recent studies on pre-service teachers is presented below.

Pre-service teachers (PSTs) are the focus of numerous studies relating to education technology. A search of the literature on pre-service teachers and education technology from 2017 to 2020 resulted in 71 academic articles. These articles were from a range of perspective, including the development of PST's TPACK, their beliefs and attitudes towards TIL, but many also focused on small studies relating to specific technologies, such as digital storytelling, or were country-specific. The studies focusing on PST's skills and knowledge take varying perspectives of the PSTs' digital competences and how these competences might be developed during their teacher education. Studies have attempted to measure PSTs' TPACK over the duration of their teacher education with specific interventions (Baran et al., 2019; Chai et al., 2017; 2019; Howard et al., 2020). Investigations focusing on how affective factors influence PSTs' TPACK and digital competences have shown that attitudes towards technology and self-beliefs are positively related, however, there are differences between participants' attitudes towards general technology and their attitudes towards technology integrated learning (Scherer et al., 2018). The scope of this study allows for the exploration of both ECTs' attitudes towards technology generally and their attitudes towards TIL, thus allowing for the identification of these attitudes on their practice.

The concept of teachers as designers features in recent empirical work (Hrastinski, 2020), including a focus on pre-service teachers (Chai et al., 2019; Nguyen and Bower, 2018). One of the most interesting developments in literature in the field over recent years is the design of research which integrates TPACK and design (Koh, 2019). This study found that introducing design scaffolds in TIL education had a positive impact on PSTs' TPACK confidence. While this is a valuable development in the field, the lack of focus on early career teachers designing TIL in context is notable and constitutes a clear gap in the literature. Preparing teachers to enter the workforce with competences in integrating digital technologies is critical, however, we still need to better understand how their practices are influenced by their teaching context. The research undertaken in this study addresses this gap in our knowledge and sheds important light on ECTs' practice.

2.6 Summary

As the newest generation of teachers, ECTs will be the education professionals charged with taking our schools and teaching into the future and meeting society's expectations of how technology will continue to shape education. Empirical studies which focus on ECTs' practices with TIL specifically are limited and yet we need to better understand why this cohort of teachers is experiencing difficulties with technology integration. For this reason, it is considered critical to develop our understanding of the personal and professional contexts which influence ECTs' practice with technology integration in order to provide targeted support where it is most needed.

Studies which identify contextual barriers to technology integration in learning show significant variation between schools and reinforce the idea of the unique contextual environment of each teacher (Divaharan & Ping, 2010, Laferrière et al., 2013, Lim & Chai, 2008). In order to understand more about the practices of early career primary teachers, we need to identify which contextual factors most influence and impact on their practice, as well as how and to what extent these influences have an effect on practice.

We know ECTs struggle to integrate technology, we know there are contextual reasons for this. What has not been captured is an in-depth understanding of how these contextual factors impact ECTs' TIL specific work practices. We do not know how they influence ECTs' decision making when they are planning programs of learning for their students. Tondeur, Roblin, et al. (2017) identify that in order to fully understand contextual influences on ECTs' integration of technology, there is a need to investigate contextual influences on ECTs' thinking and decision-making about TIL in specific and authentic practice. The focus on design in this study allows this complexity and level of detail of ECTs' work to be analysed in depth. An understanding of this complexity is important if we are to support schools in developing the capacity best support ECTs in designing TIL.

Chapter 3: Methodology

This chapter presents the research methodology used in this study. The first section (3.1) outlines the aims of the study and the research questions which underpin the research. Section 3.2 presents the philosophical theoretical approach to the research. This is followed by a discussion of the design of the study and how this fits within the research approach in Section 3.3. Section 3.3 also sets out the ethical considerations which were taken for this study and the process of identifying and recruiting the participants. In Section 3.4, the process of collecting data and the data collection instruments are presented. A presentation of the process of analysing the various data sources for each participant, followed by the presentation of the process undertaken to analyse the data across cases, is given in Section 3.5. Finally, Section 3.6 presents the strategies undertaken in the study to ensure quality and trustworthiness.

This research was conducted as an examination of an activity in context which is framed by Engeström's activity theory. Chapter Two identified a need for empirical research to understand early career teacher (ECT) practices in designing technology-integrated learning (TIL). Activity theory views human activity as complex and socially-mediated (Engeström, 2001). Employing activity theory in this study has facilitated an in-depth understanding of the external and internal context within which they work: The external context relates to the school environment where they work and their interaction with other professionals with while engaging in this work. The internal context takes into consideration the ECTs' beliefs, knowledge and thinking. The role of activity theory in this study is as both a theoretical framing and an empirical analysis tool in this research.

3.1 Aims and research questions

Literature examined in Chapter Two identified that it cannot be assumed that early career teachers are able to integrate technology effectively into their design of learning experiences in a way which enhances the learning experience for students. The significance of this phenomenon is that as the next generation of teachers, they will increasingly be required to design technology-integrated learning which will in turn support their students to function and succeed in a rapidly changing, technology-afforded world.

Studies on teachers' work have identified that context can play a significant influential role in how teachers conduct their planning and teaching. Therefore, in order to better understand the experiences of early career teachers and the difficulties they may encounter as they design technology-integrated learning experiences, this study was designed as an examination of their design context. The central question of this research is:

> How do early career primary teachers engage in the design of technology-integrated learning in context?

The two sub-research questions which guided this investigation are:

3. How do early career primary teachers approach the design of technology-integrated learning in context?
4. What influences early career primary teachers' design of technology-integrated learning in context?

3.2 Philosophical approach

This qualitative study is situated within a social constructivist world view. As such, the research is designed to investigate ECTs' design thinking and work with technology-integrated learning through their personal viewpoints. This interpretive framework acknowledges that the ECT participants' perspectives have been created through their social interactions which have mediated their experiences and facilitated their learning in the field. Social constructivism supports the development of theory through the research process, which guides the design of this study.

Ontologically, this research acknowledges the existence of multiple realities; that the meaning created by each participant is a unique perspective which has evolved through their experience and interactions (Creswell, 2013). These perspectives are investigated in this study, as closely as possible to each participant's context, and by engaging with and understanding the context of their practice with TIL, through the lens of activity theory. In this way, the epistemological assumptions which frame qualitative research are reflected.

3.3 Research design

The research conducted in this study was designed as a qualitative multiple case study. This section presents the key features and considerations of the research design.

3.3.1 Case study

The design of this research was a multiple case study. Case studies are acknowledged for their value when seeking to understand complex social phenomena. A case study is defined by Punch (2009) as a study of one or more cases "in depth, in its natural setting, recognising its complexity and its context" (p. 119). In fact, the nature of case study inquiry, in that it "relies on multiple sources of evidence, with data needing to converge in a triangulating fashion" and "benefits from the prior development of theoretical propositions to guide data collection and analysis" (Yin, 2014, p. 17) allows for the investigation of a contemporary phenomenon "in-depth and within its real-world context" (Yin, 2014, p.16)

A case study approach was considered appropriate in a study of this kind where the aim was to discover and develop an understanding of the important features of a process (Punch, 2009). Punch (2009) also highlights the valuable contribution of case study research in areas where knowledge is "shallow, fragmentary, incomplete or non-existent" (p. 123). This could be said of early career teachers' design of technology-integrated learning because there is limited research which focuses on this field at this stage of the teaching career trajectory. It is important to note that the intention of this study was not to make generalizable findings from the data, but instead to identify key themes to gain a better understanding of these cases. By identifying key factors which influence ECTs' practice, this research can inform the development of strategies to support new teachers in their school environments, as well as providing a basis for future work in in this field.

Miles, Huberman & Saldaña (2014) note that researchers often have difficulty defining what their case is and the boundaries of their cases. In this study, the approach was to conduct a study of multiple cases of novice primary teachers' design of technology-integrated learning from the conceptualisation of the unit of work to the post-implementation reflection on the design process. The study was bound by the design context and by time, as no further data was collected after the final post-implementation reflection. A further boundary of this case study was that no other stakeholders apart from the novice teacher participants were interviewed.

The conceptual framework of activity theory was selected for this study because it allowed for the consideration of internal and external contextual factors which influence early career teachers' design of technology-integrated learning. The framework supported the investigation of the teachers' thinking and decision making when engaging in design (internal contextual factors), as well as the external contextual factors, such as the school environment, policies and colleagues which potentially influence the process. The concept of technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006) was included as an analytical lens which supported the investigation of early career teachers' internal contextual influences. TPACK has been used extensively in education technology research as a way to analyse educators' knowledge and skills in integrating technology into learning activities in a pedagogically-sound way (Phillips, 2016). In the next section, the activity theory framework is presented and discussed.

3.3.2 Activity Theory

Activity theory has been used in this study in three critical ways. Firstly, the activity theory framework was used to inform the design of the data collection instruments in a way which ensured data was gathered which met the criteria of the activity theory components. Secondly, the activity theory framework was used to inform the design of the analytical framework used to analyse all data collected for this study. This is discussed further in Section 3.5.3 of this chapter. Finally, activity theory was used to guide the interpretation of the study's findings. This work is presented in Chapter 6.

Activity theory originates from the work of cultural-historical psychologists in the Soviet Union in the early to mid-twentieth century. It allows for an examination of context through the lens of a specific activity, which itself has a clear objective. Activity theory conceptualises an activity and the context within which it takes place as an activity system. In this way, context is not perceived to exist outside of, or independent from, the person undertaking the activity. Instead, in activity theory, the activity is the context and the internal and external components of the activity system are "fused" (Nardi, 2006, p.73). The original conceptualisation of an activity system comprised three key components: the *subject*, which is the person undertaking the activity, the *tools*, which are physical and cognitive tools used by the subject to achieve a desired outcome, and the *object*, which is the desired outcome of the activity (Vygotsky, 1978). More recent work undertaken by Engeström (1999) and other activity theorists at the University of Helsinki produced a new version of activity theory to allow for the exploration of activity undertaken in teams. This model includes the added components of *rules*, which includes any policy or procedural documentation governing the activity, *community*, which includes stakeholders who might influence the activity, and *division of labour*, which describes how work for the activity is divided between multiple people (Engeström, 2001). It is this model (Figure 2) which is used to investigate the activity systems of early career teachers in this study as they engage in the design of TIL. As previously explained, the analysis of ECTs' activity systems includes the consideration of the context which is fused throughout the activity system.

Activity theory (AT) is a framework devised for the study of patterns in human activity and how they are influenced by, and in turn influence, a range of constituent components within an activity process. The original model of activity theory included the components of subject (the person doing the activity), the tools used (both internal and external) and the object of the activity (Vygotsky, 1978). During the early 1980s, Yrjö Engeström revisited Vygostky's model and added the components of rules, division of labour and community to the model in order to facilitate his work on the collaboration of people in teams. The rules component refers to any policies, procedural- or compliance-based processes within which the activity is bound to operate. Division of labour allows for the analysis of the team activity in terms of how the individual tasks are divided up between team members. Finally, the community component accounts for the influence of different groups on the activity at the centre of the study. Cole & Engeström (1991) illustrate in their work that the interaction of these components of the activity theory model ultimately influence the mental processes that develop for each individual (Figure 2).

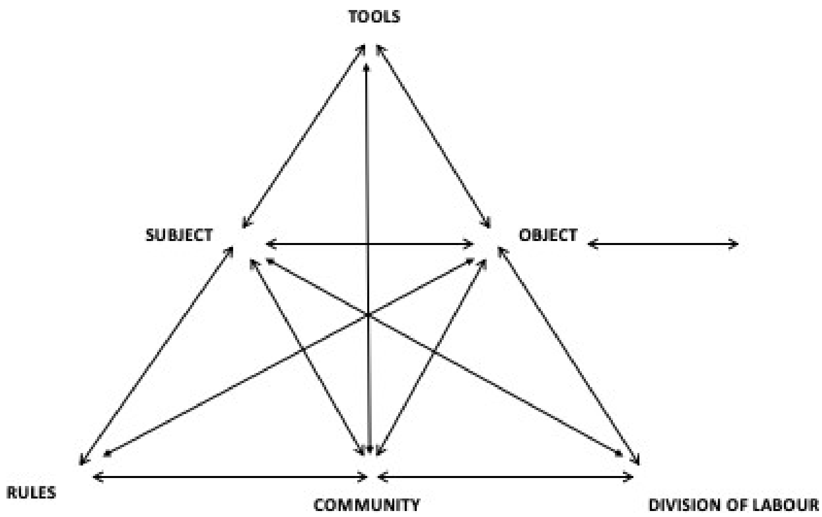

Figure 2: Engeström's Activity Theory Model (Engeström, 2001)

When viewing an activity through the activity theory lens, we are able to analyse each component to identify what constitutes the context of the activity and how the components influence each other. Engeström's research has focused on a broad range of work activities, including those within educational sectors. Because of its value in uncovering often hidden contextual barriers to achieving predetermined outcomes, activity theory has been found to be appropriate for research studies in education, particularly in contexts where technology plays a role (Bellamy, 1996; Scanlon & Issroff, 2005). Activity theory facilitates the analysis of the influence of artefacts within an activity system. Bellamy, (1996) identified a reciprocity between an activity system and a new artefact, such as a technology, which is introduced. That is that the artefact will affect the kind of processes that develop within an activity system and, conversely, the existing interactions within the activity system will influence how the artefact is used. This perspective is valuable to analysing the of the effect of technology integration in schools, because it facilitates the broader investigation of a community's response to new technologies, but also allows for that to focus on the level of individuals within the community.

The concept of tools in activity theory is complex. Tools are described as mediating artefacts in that they interact with the activity system in some way to guide the activity process. It is easier to understand how physical tools can determine the actions within an activity system. For example, a teacher's planning document, through its design and requirements, can guide a teacher's actions as they plan a lesson. More abstractly, researchers working with activity theory have identified systems of knowledge and beliefs as cognitive tools which can mediate an activity (Grossmann et al., 1999). It is widely accepted that a teacher's TPACK is an impactful influence on a teachers' capacity to design TIL. For that reason, in this study, TPACK is interpreted as a conceptual tool – one not explicitly identified and talked about by the participants, but rather an analytical lens the researcher has used to identify how such knowledge mediates ECTs' activity of designing TIL.

A primary concept within activity theory models which adds to the quality of the analysis in this study is that of disruptions, which are sometimes referred to in literature as contradictions. Engeström (2001) identified disruptions or contradictions as "structural tensions within or between activity systems" (p. 137). This means that there are times within an activity that different elements might clash and give rise to changes in the activity in order to overcome these disruptions. Engeström noted that activity systems are constantly working through contradictions. Much information can be gleaned from the study of disruptions in an activity system in the form of where problems lie for an individual teacher within the activity and how these problems are/are not resolved. An example for this study might be an early career teacher engaging their psychological tool of TPACK in working towards the outcome of designing a mobile technology-integrated unit of work, which encounters a tension with the contextual component of rules when the school technology policy allows for limited access to tablet devices. This contradiction might lead to a resolution involving an alternative approach to mobile learning, or it might result in the sequence of learning activities involving mobile technologies to be abandoned, thus the contradiction is not resolved. Identifying the contradictions contributing factors on conjunction provides important information about whether participants in an activity have the capacity to overcome an issue in an activity system, and if not why that might be. Such granular information about an activity system could inform the developments of supports for staff which are targeted towards building their capacity within the activity. Alternatively, such information would allow for adjustments to the activity system to avoid such a contradiction. In this study, the identification of such contradictions in ECTs' teaching context led to an in-depth understanding of the factors which impacted on their design of a TIL program.

For the purposes of this study, the activity theory model was interpreted to focus on the case of an early career teacher designing a program, with the design activity as the unit of analysis. Figure 3 illustrates the activity system in this study:

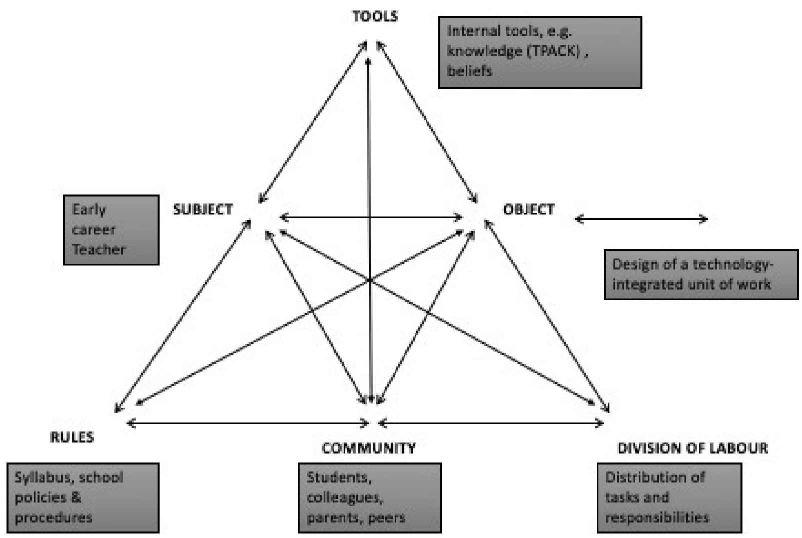

Figure 3: Conceptualisation of Activity Theory model for this study (based on Engeström, 2001)

This theoretical model of activity theory guided the collection of data on both internal and external contexts. This study explored design practice by considering both early career teacher perceptions of their design practice and actual design practice. Through such techniques, influences which teachers may not have recognised or referred to when describing their practice, were able to be identified. Examples of such tacit influences include personal beliefs and knowledge, which could be examined as psychological *tools* in the activity system, as well as their previous experiences with technology integration. By focusing attention on how ECT participants' thinking was influenced by other components of the activity system, the activity theory lens also facilitated the analysis of considerations they make when designing for technology integration, as well as how and why changes in the design are made.

More explicit analysis of other contextual influences was also undertaken; these included aspects such as the teachers' consideration of the students in their class, the wider school community and the knowledge and beliefs of colleagues. The role of colleagues was further analysed in terms of how planning work is distributed among staff members. These are some examples of areas which were identified through the data analysis process. It is not possible to predict which will be most influential on the design practice of early career teachers, as it is anticipated that each teacher's context will vary to some extent.

3.3.3 Key features of research design

The following features were integral to the research design in order to ensure a rigorous investigation of the phenomenon and trustworthiness in the findings:

1. Multiple data sources reducing the reliance on interview data alone.
2. Investigation of ECT practice as design work.
3. Production of rich descriptions of cross sector and demographic teaching contexts.
4. Analysis of contextual influences from physical and socio-cultural environment, as well as the internal influences.
5. Rich data to show ECT design perspectives and practices within their individual contexts.

An innovative aspect of this study is the exploration of the design process and of the influence of contextual factors within as the participants progress through their design process. The focus on ECT practice as design work allowed for the analysis of complex design activities and thinking, which in turn allowed for the practice to be explored at a granular level of detail. While literature in the field of teacher planning focuses on the internal cognitive processes and decision-making of teachers (Hall & Smith, 2006), we also know that there are external contextual factors which impact on teachers' work and that there are contextual factors which impact specifically on early career teachers (Gallant & Riley, 2012). For these reasons, this study was designed to capture both internal and external contextual factors which might influence ECTs' design activity. Patton (2015) notes that "firsthand experience with a setting and the people in the setting allows an inquirer to be open and discovery oriented and inductive because, by being on site, the observer has less need to rely on prior conceptualisations of the setting" (p. 333). The aim to understand, as fully as possible, the contextual influences on the ECTs' practice in the study, meant that there was a need to design a study which captured data from a range of instruments, including interviews, observations and diaries. This resulted in the development of a rich description of the cases which originated not only from the participants' own reports, but also on the observations of the researcher, thus adding to the analytical rigour of the research. The learning programs were also analysed as artefacts which themselves told a story of the design decisions and thinking conducted by the participants during their design activity.

The study was designed to follow early career teacher participants as they engaged in the design of a technology-integrated learning program for upper primary (Stage Three in NSW). The design process included the planning, implementation (teaching) of the program, and subsequent reflection on the design of the program and the design process. The focus on the design of a technology-integrated program allowed for the investigation of the participants' thinking as they engage in the planning and implementation of the design.

3.3.4 The researcher

The researcher in this study of primary teachers was not a trained primary school teacher. At the first interview, she explained to the participants that this was the case and that she was not there to make any judgements on their practice. This was explicitly done because consideration was given to the fact that the participants were in the early stages of their careers (in some cases in the first year of teaching) and so may have felt uncomfortable being observed. This meant that any sense of power imbalance in the relationship between researcher and participant could be minimised. The fact that the teacher did not have a background in primary teaching may have also been beneficial for retaining objectivity in the study.

3.3.5 Ethics, consent and confidentiality

This study received approval from the University of Technology Sydney Human Research Ethics Committee on 18th November 2016 (ETH16-0932: see Appendix 1). Following ethics approval from the university, the researcher applied for further research approval from two education sectors. The first was from the NSW State Education Research Approval Process, which is required for research taking place in NSW government schools. The researcher was notified of approval from SERAP on 3rd March 2017 (SERAP 2016636: see Appendix 2). The researcher also applied for research ethics approval from the Catholic Education Office, diocese of Wollongong. Approval was received from the CEO Diocese of Wollongong on 17th February 2017 (see Appendix 3). Ethics approval for research conducted at independent schools was considered by each school principal individually and permission was given prior to the commencement of the study in participating schools.

The following areas of ethical responsibility in research were considered in the design of the study:

Anonymity

The anonymity of participants has been ensured by the use of pseudonyms when referring to them in research writing. Additionally, steps have been taken to de-identify details relating to their school and locality. All participants were notified in advance that such steps would be taken to protect their anonymity.

Informed consent

Each participant received detailed information about the study and its aims in a Participant Information Sheet, which they signed to give their consent (see Appendix 4).

No harm

Every consideration was given to ensure that no harm was inflicted on participants in the study, or to students who were present during the lesson observations. No participant reported harm either to the researcher or to the university at any stage in the research process.

Privacy

The researcher contacted participants only after receiving confirmation from their principal that they were willing to participate in the study and to share their contact details. Contact details used in communication were their email address and their mobile phone numbers.

Voluntary participation

Participants were informed, in the Participant Information Sheet, that their participation was entirely voluntary and they had the option to withdraw from the study at any time.

3.3.6 Recruitment process

The recruitment process began with the researcher identifying prospective primary schools to approach regarding participation in the study, which would allow for the representation of a variety of contexts. Considerations factored into this process focused on having a range of government, catholic and independent schools represented in the study, a range of demographic variance in the student body of the participating schools, and also a range of geographical locations within NSW. When prospective schools had been identified, the researcher contacted the school principals by email (Appendix 5). The principals were sent an overview of the aims and design of the study, along with the criteria for prospective participant early career teachers. The researcher followed up the email with a telephone call to principals. Those who had early career teachers who met the criteria, and consented to their participation, introduced the study to those teachers and gave them the researcher's contact details for further information.

3.3.7 Participants

A purposeful sampling strategy of maximum variation was employed in order to describe a broad range of perspectives in this study (Creswell, 2013). Seven participants were recruited for this research; these participants were early career primary teachers in schools across New South Wales. As one of the principal foci for these participants was the design context, a key consideration of the recruitment process was to ensure the participants came from a broad range of contexts. This led to the recruitment process targeting schools from a range of geographical areas in NSW, and a range of educational sectors. As a result, those teachers taking part in the study were working in schools in both inner-city and regional areas, and were working in government schools, independent schools and the Catholic education sector. This range of contexts also meant that the students they taught were from different socio-economic backgrounds and were from a range of cultural contexts.

Additional participant criteria (see Table 1 below) were identified for the recruitment process. Early career primary teachers who were teaching a grade five or six class, which is a class of students in their final two years of primary education in NSW, were identified as potential recruits. The rationale for this criteria is presented below. The study was designed to collect data from participants as they designed a TIL program for their students. This meant that data was collected at various points in the design process, starting from the planning stage, during the teaching of the program and as they subsequently reflected on the program. For this reason, it was deemed necessary for the participant to be the principal teacher on the class and not teaching on a part-time or casual employment basis. The rationale for targeting participants teaching students in grades five and six (aged between ten and twelve years) was based on several factors. Firstly, the curriculum for students at this stage is more complex in terms of content and skills. It is also a stage which presents challenges for teachers in preparing students for high school. In essence, focusing on teachers of this stage meant that there would be a complex range of contextual influences originating with the students. Table 1 presents an overview of criteria for participation in this study:

Criteria for participation in the study	
Teacher/class	***School***
No. of years teaching (<5)	Sector (government, independent, Catholic)
Grade of class	Geographical area
Main teacher on class	Socio-economic demographic of catchment area

Table 1: Criteria for participation in study

The aim of this research was to conduct a holistic investigation into the participants' design context for TIL. To this end, whether they identified as 'good' integrators of technology or not was not considered important. What was important was that the participants could be identified as 'early career' teachers, and that they were willing to engage in the design of a TIL program as a design task. The focus of the research on identifying influencing factors from the teachers' context on how they design TIL meant that it was valuable to investigate ECTs with varying levels of experience with technology integration. The fact that principals were not asked to nominate teachers for the study because of their TIL skills resulted in a range of participants with differing experience and knowledge of technology-integrated learning. An overview of the participants and their context is presented in Table 2:

Name	Education sector	Geographical location	Number of years teaching
Jenny	Government	Urban	4
Simon	Government	Urban	4
Kiara	Government	Metropolitan suburb	<1
Catherine	Independent	Regional	<1
Shelly	Catholic	Regional	3
Emma	Catholic	Regional	<1
Elena	Independent	Inner city	2

Table 2: Overview of research participants

The decision on the number of participants considered for this study was influenced by competing factors. The aim was to ensure there was a broad enough range of contexts represented in the study. This would ensure that contextual factors commonly influencing early career primary teachers' design practice with TIL could be investigated. However, a number of participants needed to be limited in order to ensure that there would be a sufficient timeframe to collect and analyse a range of data sources from each participant within the boundaries of a doctoral study. In consultation with advisors, the decision was made to recruit six participants.

During the recruitment process, two early career teachers from one school expressed great interest in participating in the study. As the opportunity to investigate two teachers from the same school presented the potential for comparison between two 'like' cases, both teachers were accepted as participants, and the total number of participants at the end of the recruitment process was seven.

3.4 Data collection

In line with case study research protocols, a range of data collection instruments were designed for this study. These were implemented over the entire course of the participants' design process. Because data was captured from the design process from initial conceptualisation of the program, through the planning and teaching phases, and finally in the post-teaching reflection phase, the data collection process was a lengthy process. The logistical implications of conducting such a longitudinal study covering a wide geographical spread of almost 400km meant that there were implications for gathering data. For this reason, some interviews were conducted by telephone. Additionally, the use of diaries as a data collection tool allowed participants to record data individually on a regular basis without the intervention of the researcher.

All participants conducted their planning of the program in the term prior to teaching. The researcher maintained a data collection journal where she recorded reflections on the data collection process at all stages and for each participant. This journal later served as a reminder of the key data identified at critical points through the data collection and also informed the development of case summaries during the analysis phase.
The data collection timeframe was between 10 and 20 weeks for each participant. The next section presents an overview of the data collection process and follows this with a description of each stage.

3.4.1 Data collection procedure

The complete data collection phases and their associated instruments are presented in Table 3 (instruments are included as appendices):

Data collection stage and instrument	Purpose
Stage 1: Semi-structured pre-design interview (February-March 2017) ***See Appendix 6***	Discover the participants' process of incorporating technology into a unit of, identify considerations made when considering technology in the classroom discuss their specific design plans
Stage 2: Design task observation (video & field notes). (February – March 2017) ***See Appendix 7***	Capture design process synchronously. Use think aloud protocols to elicit tacit thinking processes.
Stage 3: Semi-structured end of day interview with participants. (February – March 2017) ***See Appendix 8***	Reflect on design process so far and explain design
Stage 4: Participant Planning diary ***See Appendix 9***	Capture work they do to complete the unit of work, as well as any thoughts/amendments prior to teaching
Stage 5: Pre-teaching interview ***See Appendix 10***	Capture reflection on design work and design process prior to teaching.
Stage 5: Teaching observation (field notes) (2 observations per teacher), followed by short post-implementation interview ***See Appendix 11***	Capture implementation process synchronously and to observe how the design is implemented. Interview will capture reflections on any changes in the design during implementation.
Stage 6: Participant Teaching diary ***See Appendix 12***	Capture thinking/amendments during teaching .
Stage 7: Reflection interview ***See Appendix 13***	Reflect on entire design process after the completed implementation of the unit of work.

Table 3: Overview of data collection phases

The first three stages of data collection were conducted over the course of a day. In the description of the research methods this is referred to as a 'design day'. The design day took place at each of the participant's schools. On the day, participants were introduced to the design task. This task was to design a technology-integrated unit of work to fit the Australian Curriculum for upper primary (Stage 3 in NSW). The unit design was required to include technology-integrated learning experiences for the students. The reason for conducting this part of the design process under these conditions was that it allows for the participants to be closely observed and questioned about their actions while they were engaged in the process in order to uncover their thinking and decision-making. This process has a precedent in other design protocol studies (Cross, 2006). The activities on the design day followed the procedure below:

1. A pre-design semi-structured interview (Stage 1), which contained questions on the participant's background and experience, their school context, and their usual approach to designing teaching programs. This stage allowed for the preliminary identification of contextual influences for each participant.
2. The participant undertook the design task (Stage 2), while the researcher observed the participant's practice. The researcher used the think-aloud protocol (van Someren et al., 1994) to prompt the participant to explain what they were thinking about and why they were making their design decisions. The researcher concurrently took field notes on an observation document to record how the participant approached the design. A video recording was also taken of the activity to capture dialogue and how participants created artefacts during the design process.
3. This final part of the design day consisted of an end of day interview (Stage 3), where the participant was asked to explain their program design in detail, including how they approached the task, how far they progressed with the design and what they anticipated doing to complete it. This interview served as a point of triangulation with the observed design activity and helped the researcher to identify and investigate actions within the design process.
4. The unit of work in its unfinished state was then collected along with any other artefacts used by the participants.

The next stage of data collection (Stage 4) consisted of data being collected on design work undertaken by each participant to prepare the unit for teaching. The data collection instrument used in this stage was a design diary. Participants were asked to keep a design diary, where they recorded information on how and when they added to the unit of work, and the reasons for any changes. The researcher suggested the use of Google Docs for ease of sharing information and so that the researcher can observe whether the diary is being completed by the participants. However, alternative methods were arranged to suit some participants. Reminder emails were sent by the researcher to prompt the participants to record their design work in their diaries. Prior to the unit being taught, the researcher conducted a telephone interview with the participant to discuss work completed on the program following the design day, and request the most recent version of the unit of work (stage 5). This stage allowed for additional data to be collected on teachers' thinking and actions during the design process.

The implementation part of the data collection (Stages 6 & 7) involved the participants teaching the unit of work they have designed. An arrangement was made for a lesson to be observed by the researcher and field notes were taken at this time. The specific lesson to be observed was agreed by the researcher and the participant as a lesson which presented TIL tasks from the program. A short pre-lesson interview was conducted with the participant prior to the lesson observation to discuss his/her aims and thinking about the lesson. A short post-teaching interview was also conducted to record the participant's reflections on the lesson. Throughout the teaching stage, participants were asked to complete a teaching diary where they recorded comments and evaluations they made on the program design, as well as information on any changes they make to the design. The aim of this stage was to continue collecting data on the teacher thinking and contextual influences throughout this stage of the design process.

Following the teaching stage of each participant's program, the researcher conducted a final interview (Stage 8) where each participant was asked to reflect on the design and implementation process in terms of what occurred and how they would improve the unit for the future. At this point a final version of the unit documentation was collected, along with any accompanying documentation relating to student assessment. Digital resources created by the teacher were also collected. This stage allows for the final iterations of the unit to be uncovered and the participants' thinking and actions at these final stages to be identified.

Data collection with all participants took place between March and October 2017. Table 4 presents a sample data collection timeframe for an individual participant:

Data collection stage	Data collection instrument	Date	Collection
Stage 1	Pre-design interview	31 March 2017	Face-to-face
Stage 2	Design observation	31 March 2017	Face-to-face
Stage 3	End of day interview	31 March 2017	Face-to-face
Stage 4	Planning diary	March – April 2017	Electronic document
Stage 5	Design progress interview	24 April 2017	Telephone
Stage 6	Pre-lesson interview	05 June 2017	Face-to-face
	Lesson observation	05 June 2017	Face-to-face
	Post lesson interview	05 June 2017	Face-to-face
Stage 7	Teaching diary	May- June 2017	Electronic document
Stage 8	Reflection interview	27 July 2017	Face-to-face

Table 4: Overview of data collection timeframe

3.4.2 Data collection instruments

This section presents in detail the data collection instruments used in the study. Each instrument is presented and described in the first instance. Table 5 summarises the data collection instruments in relation to the aims of each instrument and their alignment with the research questions and activity theory:

Data collection stage	Data collection instrument	Focus	Research question	Activity theory representation
Stage 1	Pre-design interview	ECT's background experience, knowledge, skills & beliefs; background information on school and students; school practices	RQ 2	*Tools, Community, Rules, Division of labour*
Stage 2	Design observation	Design activity; articulation of thinking during design day activity	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*
Stage 3	End of day interview	Design activity; articulation of thinking during design day activity	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*
Stage 4	Design diary	Design activity; articulation of thinking following design day activity	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*
Stage 5	Design progress interview	Design activity; articulation of thinking following design day activity	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*
Stage 6	Pre-lesson interview	Teacher's articulated aims for the lesson	RQ. 1 RQ. 2	*Tools, Community, Rules*
	Lesson observation	Teacher's interaction with technology while teaching class	RQ. 1	*Tools, Community, Rules*
	Post lesson interview	Teacher's reflections on lesson and decisions made during lesson	RQ. 1 RQ. 2	*Tools, Community, Rules*
Stage 7	Teaching diary	Design activity while teaching: articulation of design decisions while teaching	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*
Stage 8	Reflection interview	Teacher's reflections on design practice and TIL program designed	RQ. 1 RQ. 2	*Tools, Community, Rules, Division of labour*

Table 5: Data collection tools' alignment with research questions and activity theory

The construct validity of case study research is strengthened by the collection of data from multiple sources. This is because the triangulation of multiple sources of data provide "multiple measures of the same phenomenon" (Yin, 2014, p. 121). The analysis of data from multiple sources also allows for a richer depiction of a case. Multiple sources of evidence were collected as part of this case study research in order to conduct a study of strong trustworthiness.

Interviews

Seven interviews were designed and conducted with each participant in this study and spanned the process from before the design activity began through to the participants' reflection on the design process at the end of the design activity. Three participants were unable to complete a pre-lesson interview on the day of the lesson observation due to supervision duties in the school immediately before the lesson began. In an effort to capture some of this missing data, questions from the pre-lesson interview were incorporated into the post-lesson interview for these participants.

Interviews in qualitative case studies involve significant cognitive effort on the part of the interviewer to evaluate evidence that is provided and make immediate decisions about information to probe further with the interviewee (Yin, 2014; Creswell, 2013). The design of the interview protocols for this process requires consideration of the fact that the researcher will need to be adaptive during the interview and will have sufficient knowledge of the field in order to make informed decisions during the data collection process. The questions in the interviews for this study were designed to be semi-structured to allow the researcher to probe areas of import when noteworthy data was provided. This meant that interview protocols were prepared with questions which were designed to ensure critical data was collected, but it also gave the researcher flexibility to explore and probe themes in greater depth with the participants as they arose. The semi-structured design of the interviews also allowed the researcher to raise questions relating to information recorded in other data sources, e.g. diaries. Sample questions which demonstrate the semi-structured nature of the interviews are given below:

1. *As a teacher, what formal support is available in the school for designing technology-integrated learning?*
   (*Probe: level and type of support available for technology integration? I.e. is it systematic, ad hoc etc.?* (Pre-design interview)

2. *Please describe the activities using technology and explain your thinking behind those.*
   i. How are they used? [Prompt for specific examples]
   ii. How did you decide on that particular integration of technology? (Ask what they thought about when making those decisions.)
   iii. Did your initial idea of the plan change in any way because of the technology you chose to use? (End of day interview)

Design observations

Observations were a critical component of this study. As Yin (2014) notes "Observational evidence is often useful in providing additional information about the topic being studied" (p.114). Through the design observation, for example, the researcher was able to identify when in the process the participants appeared to be experiencing difficulties or confusion, even without any articulation of such feelings. This meant that the researcher could ask directed questions in real time to identify potential (AT) *disruptions* in the activity. Such occasions in the observation process allowed the researcher to gain an implicit understanding of the extent of the difficulties the participants were experiencing; an insight which might not have been articulated later during the end of day interview.

The design observation was conducted during the in-school design day and took place between the pre-design interview and the end of day interview. The object of the design observation was to capture the participants' design process and their design thinking in real time as they started working on the program. Prior to the observation, the researcher explained that she would like to ask questions during the observation to understand the participant's thinking and actions. It was also explained that the researcher would make judgements about the timing of questions so that the participant would not be disturbed too frequently through the process. Participants were also asked to explain their thinking at any time during the process, if they felt able to. This process followed a think aloud protocol (van Solensen et al., 2014) and its aim was to uncover the participants' thinking during the design process. In this way, it was anticipated that data could be collected on participants' design thinking which might not be recalled by the participants in a later interview about the design observation process. The researcher sat next to each participant throughout the observation and took field notes on an observation protocol prepared for this stage of data collection. In order to collect data from this stage as efficiently as possible, a video camera was set up to record each participant's work, their desk and computer screen over their shoulder. This way, participants' articulation of their thinking and explanations for their design decisions during the process could be captured on video, and audio from the video could be transcribed for analysis.

Lesson Observations

Lesson observations were incorporated into the data collection process for several reasons. The data collection phase is extended over several months and there is a lengthy period of time where contact between the researcher and the participant was limited to emails prompting the participant to complete the teaching diary with notes about changes they made to the unit as they taught it. When designing the research, it became apparent firstly that this stage of the research process was relying on teachers completing the diary in detail and secondly on the participants' reflections potentially being the only source of data from that stage. The observation during the planning day allowed the researcher to capture rich data which could be triangulated with the data from the interviews on that day, thus adding to the reliability of the findings (Creswell, 2013; Yin, 2014). As the only researcher in this doctoral study, it would have been impossible to observe every lesson taught in each participant's unit. However, it was felt that there was value in collecting lesson observation data which could be triangulated with the data from the diaries and the final reflection interview, and thus strengthen the quality of the research. In order to conduct a lesson observation in the study, the researcher considered a set of questions:

1. What type of data do I want to collect?
2. How am I going to collect that data?
3. How am I going to identify which lesson in the unit to observe?
4. What would my role be in the classroom?

The first question is critical to consider. Gillham (2008) notes the importance of developing a systematic approach to observations because of the nature of how and what we see when we observe a scene. He notes that we tend not to see what we do not personally understand or factors which are not in our own frames of reference. By specifying in advance what we are going to look for, and by reflecting on and seeking explanations, we can affect a change in our understanding (Gillham, 2008). The purpose of the lesson observation in this study would be to identify influences on the teachers' design process while teaching. Reflecting on this led the researcher to design an observation protocol which would collect the following critical data during the lesson observations:

- How the technology was set up for the lesson
- What the teacher did with technology during the lesson
- How students used and interacted with the technology
- How students responded to the activities
- Any changes from the lesson plan or overview (noting questions on possible reasons for this
- The influences of students' behaviour and responses to the design of the lesson (either affecting change made during the lesson, or reflected on as a change for future teaching of the unit)

Deciding which lesson would be observed required some consideration by the researcher and negotiation with the participants. Going into a school to observe a lesson meant that there might be school-related considerations which needed to be taken into account as well as the researcher's wish to observe a specific lesson in a unit. For each participant, the researcher sought to observe a lesson where not only did the technology feature strongly, but the aim of the technology integration was to improve the learning outcomes for the students. Identifying a lesson in a unit which met this criteria would increase the importance of the observation of student responses to the technology and their interaction with it. If, for example, technology was being used to engage students in understanding content, while arguably worthwhile, if students were not engaged in higher order thinking with the technology, there may be a limit to the value of collecting data from this lesson activity. By contrast, a lesson where technology is used to stimulate higher order thinking and students' production of work which reflects their learning, would mean the technology integrated through the lesson would be more complex in design, and would require more design thinking on the part of the teacher. This complexity would also increase the need for the teacher to be responsive to students throughout the activity and resolve issues which may impede their learning.

For each lesson observation, the researcher entered the classroom with the participant teacher, who made introductions to the students and briefly explained that the researcher was interested in watching what the students were doing in the lesson, but would not take part in the lesson. The researcher then found a place to sit at the side of the classroom and took field notes on a computer throughout the lesson. Occasionally, the researcher walked around the classroom to better observe students' interactions with the learning tasks and with each other. At these times, students would sometimes talk to the researcher, who would respond in a friendly way, but also ensured that such interactions were brief. In this way, the researcher approached the observation process as an observer as participant (Creswell, 2013). The field notes taken during the observation were guided by the observation protocol prepared prior to data collection.

Design diaries

Two journals were used in the data collection process: a design/planning diary and a teaching diary. The journals were designed to collect evidence of design work completed by participants in the absence of the researcher. The diary documents were emailed to participants following the design day and consisted of a table to complete when any further design work was done. Design work carried out after the design day, but prior to the teaching of the program, was recorded in the planning diary. When participants began teaching the program, they were asked to record reflections and changes to the program design in the teaching diaries. Email prompts were sent to participants weekly to remind them to complete diary entries where possible. It is important to note that two (?) teachers did not return their teaching diaries to the researcher.

Artefacts

Various artefacts were collected for each case. Program documentation was collected at the end of the design day, prior to teaching and at the reflection stages of data collection. Other artefacts which were collected include digital program resources, photograph images of students' work and of the classroom environment. No photograph images were taken of participants or their students. The rationale for collecting such artefacts was as contributing sources of evidence for the participants' design thinking and the use of technology to support student learning.

3.5 Data analysis

Data analysis in this study consisted of multiple phases from preparing the data for analysis through to the final stages of interpretation and representation of the data. Creswell (2013) represents the data analysis process as a spiral, a model which identifies the circular nature of analysis at each stage. Figure 4 presents the analysis spiral undertaken in this study and the nature of the analysis activity at each stage:

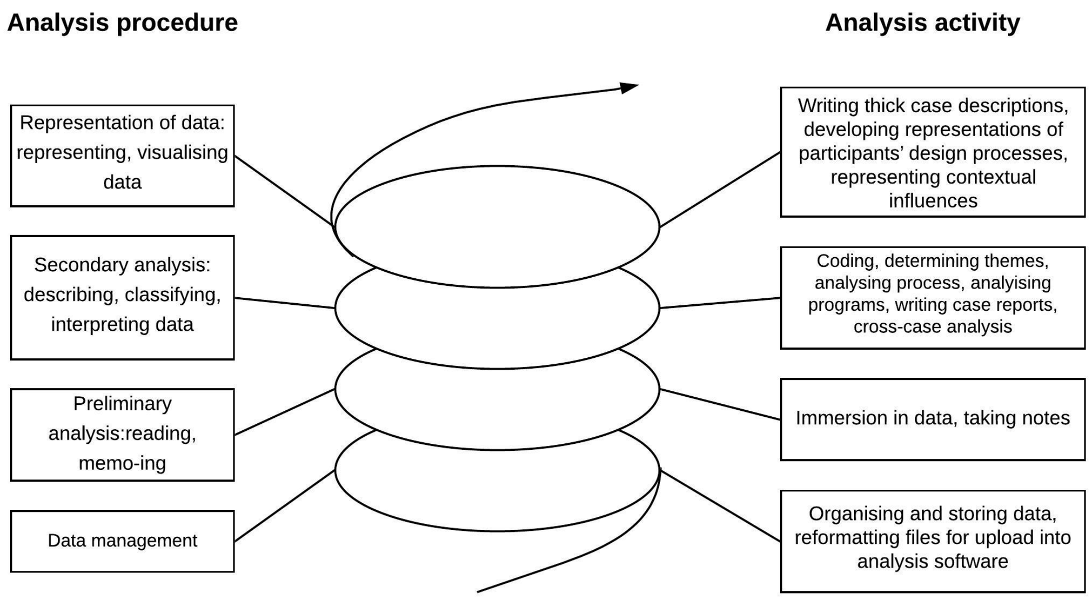

Figure 4: Spiral diagram of analysis process (Creswell, 2013)

As the analysis process progressed, it became apparent that multiple analytical activities would need to be undertaken in order to respond to each research question. These divergent processes emerged during Stage 3 of the analytical process. The analysis of the design process was conducted separately to the analysis of the contextual influences. The analysis of the levels of innovative integration of technology in the programs designed by each participant was a further separate process. These analytical processes resulted in separate representations of the data. However, in the final stage of analysis, they were all incorporated into thick descriptions of each case. These case descriptions are presented in chapter 4. Chapter 5 presents the interpretation of these analysis processes across all cases. The following sections present details of each stage of analysis undertaken for this study.

3.5.1 Data management

The data collection process in this study took place over a number of months, with data sources being returned to the researcher at various times throughout the process. This meant that the organisation and storage of the data sources for each participant was critical throughout the data collection stage. An online data folder was created for each case, and a naming protocol was developed for each data source. All interview, observation field notes and journal data were stored in these folders, along with artefacts collected for each case. The video data files were too large to be stored in an online repository. Therefore, two copies of each video file were stored on two external hard drives, which were kept in separate locations for safety.

In preparation for analysis, all interviews were transcribed and stored as text-based documents, as were any hand-written field notes. Data in the form of tables, such as the diaries, were re-formatted into text-only documents in preparation for computer-based coding. Design observation protocols were explored to identify time stamps on the video files where important audio could be located. This audio was then transcribed on to the observation protocol, before these documents were also reformatted to text-only files. Interview transcripts were sent to participants for them to read through and they were offered the opportunity to add comments or remove parts of the interview if they wanted to for any reason.

3.5.2 Preliminary analysis

The first stage of data analysis consisted of a process of familiarisation with the sources. This involved the researcher reading through data sources multiple times and making notes on themes and analytical thinking which arose. Each case contained extensive data from a range of sources and it was therefore necessary to consider ways to approach analysis in a manageable way. In order to analyse the data in a way which would facilitate the research questions being answered and the design context of each participant being analysed through the lens of activity theory, the researcher worked on the development of an analysis framework.

3.5.3 Secondary analysis

The secondary analysis stage consisted of multiple analytical processes. Firstly, an analysis framework was developed to guide the coding process. Secondly, coding was conducted through the use of analysis software. Coded case summaries were produced prior to thematic analysis taking place. The interpretation of the coded data into themes was the final secondary analytical stage relating to research question 2. However, two further analytical processes were conducted at this secondary stage of analysis in order to answer research question one, which was the analysis of the design process; and also to analyse the level of innovation in the programs designed by participants. All secondary analysis processes are presented below.

Data coding

The analysis of data through coding is a means of reducing and organising data, and is commonly used in qualitative studies (Creswell, 2013). For the purposes of this study, the researcher used an online analysis software system Dedoose[1] to code data. Interview transcripts, observation field notes and participant diaries were data sources uploaded to Dedoose, and the codes were added to the system from the analysis framework. Working through each data sources, codes were allocated to excerpts from the data as deemed appropriate.

Each participant's TPACK was analysed as part of this stage of data analysis. The process of analysing TPACK has been subjective, however excerpts from the data have been included in analysis to exemplify the 'level' of TPACK assigned to each participant. Inferences have been made regarding each participant's levels of TPACK through such engagement with the data.

Development of case summaries

On completion of the data coding, the next step was to use the coded data to begin to interpret the individual cases. To do this, the researcher developed a coded case summary for each participant. The coded case summaries consisted of description of the cases in categories using a combination of background information collected about the case through interviews and also through researcher case summary notes, and coded data from Dedoose. The coded data served to identify points and themes raised during data collection and provide evidence in the form of excerpts. Relevant excerpts were added to the coded case summaries. The structure of the case summaries is as follows:

[1] www.dedoose.com

1. list of data collected

2. Overall theme about design practice

3. Summary of participant's professional background

4. Code summary: Design context

5. Code summary: Design tools

6. Code summary: Technology

7. Code summary: Design influences

8. Code summary: Reflection on design process and product

After this process of data reduction, the researcher began to work on summarising the data. This was done as a process of writing up the coded case summaries as cases. Conceptualising each case in its writing up phase led to the identification by the researcher of thematic concepts (Creswell, 2013; Patton, 2015) and implications of the research, which guided the next stage of the analysis.

Thematic and theoretical analysis

The analysis framework for this study sought to align the contextual components viewed through activity theory with the analysis of the participants' design thinking and process. Iterations of the framework were trialled on data sources from two of the cases. These were adapted when it was evident that the current version of the framework did not allow for certain aspects which were critical to the aims of the research being sufficiently examined. Some of the key themes emerging from the data were given more prominence in the analytical framework, such as isolating information on university experience and identifying external support systems. When the framework was deemed satisfactory for the analysis process, a system of coding numbers was devised and added to the framework document. The final version of the analysis framework is in Appendix 12.

The analytical framework was designed to code data pertinent to two guiding factors in the research. The first factor was the research questions; namely how ECTs engage in the design of TIL and what their influences are throughout the design process. The second factor was the examination of the design context through the lens of activity theory. Table 5 highlighted how data collected through the various instruments related to these two factors. Following the coding and summarising phases of the analysis, the next stage of analysis was to consider how to progress from description of the data to interpretation of the data. Two key questions at this stage were how to approach theorising the significance of patterns identified in the data, and how to consider their broader meanings and implications for the field (Patton, 2015). Examining the design context for ECTs using Engeström's (2001) iteration of activity theory encourages the researcher to lean towards interpreting meaning from a more constructionist perspective because it facilitates the examination of socio-cultural contexts and socially created design activity. The examination of school policies and guidelines, for example, might shape or influence the articulated design thinking of the participants. The understanding of how this can occur can be gleaned from more latent-level thematic approaches to analysis (Braun & Clarke, 2006). Consideration of such epistemological aspects of the research design guided the following analytical approach.

The researcher had made initial notes about potential themes and ideas emerging from the data as each case was developed and written about from the coded data. These notes were kept in an analysis journal. The research design of this study placed value on both inductive and deductive approaches to reading and note-taking from the data. As previously described, the researcher's first stage of analysis was to read the data sources in depth for each case and to make notes on points and themes which arose at that time. That process was inductive, allowing ideas to emerge from the data. The development of the analysis framework served to create a tool for viewing and coding the data according to the components of context identified in activity theory. This theoretical approach required a level of understanding of activity theory and as such was a more deductive process. The benefit of using both inductive and deductive approaches to preliminary analysis meant that the researcher had a good understanding of the cases in depth and potential themes arising within each case.

The thematic analysis of data in this case was conducted after all individual case data had been coded and written up as first drafts of the cases. At this point, the researcher returned to the coding software and produced reports for each code which comprised data from all cases. By analysing the coded data across the cases, it was possible for the researcher to identify patterns and themes which were common to multiple participant data sets.

Themes were created on the basis of their relevance to the research questions and for their value in highlighting contextual aspects of cases through activity theory. There was no defined quantifiable minimum number of excerpts for each theme, rather the researcher made judgements as to the importance of the theme in the study (Braun & Clarke, 2006). As the themes were identified, they were noted in a separate document and corresponding references from the literature were added to each theme. Notes were also added at this time relating to possible interpretations of the themes through activity theory. This was an iterative process of reading through data excerpts for each code and reading through literature and theory texts.

The analysis of design process

In line with the research question *How do early career primary teachers engage in the design of technology-integrated learning in context?,* a further analysis protocol was developed to map the steps taken in the design process, the interpretation of these design steps through the literature on teachers as designers, the influences at various stages of the design process, how these might be viewed through the lens of activity theory. From this, a graphic representation of each participant's process was created and added to each case. The analysis protocol for the design processes in this study is presented in Appendix 13.

The analysis of learning programs

While writing up case summaries for each participant, the range of data sources for each participant was considered by the researcher, and this led in turn to thinking about the bigger picture of what each source was showing. Essentially, the interviews which were conducted over a period of time preceding, during and following the design and teaching of a unit of work, and also the observation protocols, showed the evolution of the design thinking of each participant. They also showed how the thinking was influenced by a range of contextual factors and how this thinking led to changes and shifts over time in the design of the unit of work. There then followed some consideration of the role of the program document collected as an artefact at separate stages of data collection. As an artefact, it sat separate to the other data sources. The researcher began to ask questions about what the program document evidenced. Was there an opportunity to look for evidence of design thinking in the program documents? If so, how should analysis of these artefacts be approached? In essence, what does this mean for analysis?

The learning program is an artefact used by teachers to document both the higher level information about the program, such as which learning objectives are being met; and the week-by-week breakdown of the teaching work to be done by teachers, the learning to be done by students and the assessment tasks to be set. So, could an artefact with such a practical purpose provide further evidence of how each teacher participant considered technology integration? In order to categorise data on the technology integrated in each program, the analysis focused on the degree of innovation of TIL evident in the program documentation. In this study, SAMR is used in a limited way to analyse the levels of sophistication of TIL evident in the programs designed by participants. Including such an evaluation allowed the researcher to interpret the contextualised design process of each participant in terms of how their design activity and influences resulted in the design of their individual level of sophisticated TIL. Chapter 4 provides an explanation of the interpretation of the level of sophistication of TIL in each case. This evaluation was done by comparing the TIL activities to the levels of technology integration represented in the SAMR model (Puentedura, 2013; Romrell et al., 2014) and then identifying features of the TIL in each program which correlated with the characteristics at specific levels of SAMR. SAMR depicts levels of technology integration in terms of the degree to which the TIL enhances the learning experience (see Figure 5):

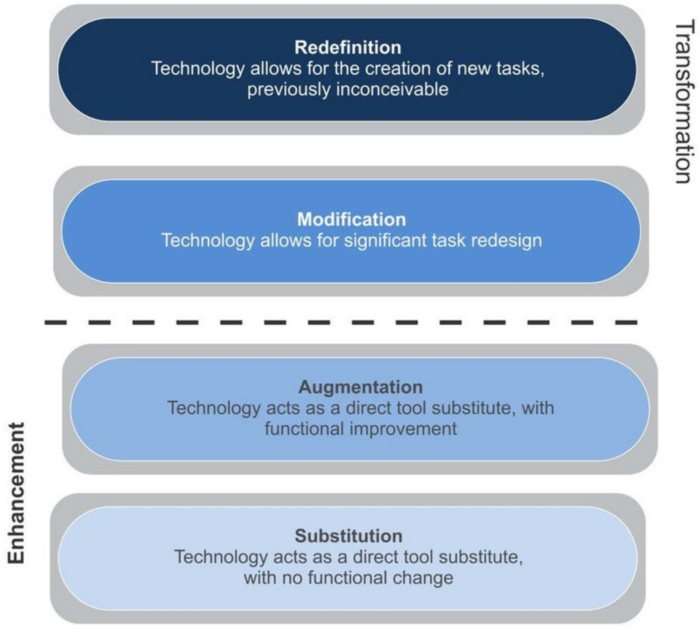

Figure 5: SAMR Model (Puentedura, 2014)

Cross case analysis

In line with Yin's (2014) description of cross case synthesis, the key contextual factors and influences on design practice were analysed across the cases to identify similarities and differences. The comparison of themes across cases is presented in Chapter 5.

3.5.4 Representation of data

Following primary and secondary data analysis, the final stage is the representation of data in the study. The overall representation of the data is presented as a thick description of each case. Each case description also includes representations of data which emerged from the various secondary analysis processes. For each participant, a diagram was created to represent the design process undertaken in this study. The influences on each participant's design process are represented by individual activity theory model representations (see Chapter 4). In the cross-case analysis tables depict the range of contexts identified across the cases. Patterns identified across the influences in each case are represented in the cross-case chapter in a matrix.

3.6 Quality of the study

In-depth qualitative studies such as this one cannot claim generalisability based on a large sample group of participants. Instead, Yin (2014) proposed the concept of naturalistic generalisability which is achieved through adherence to criteria which ensure rigour in research design. Agostinho (2005) identified three key factors in qualitative research design which indicate the trustworthiness of the findings: appropriateness of research design, rigour in the research process and usefulness of research outcomes. The quality of this study is presented below in light of these three factors.

3.6.1 Appropriateness of research design

This research was designed to explore the complex contexts within which ECTs design technology-integrated learning, to identify how ECTs engaged in the design of TIL programs and to explore the contextual influences on that practice. Activity theory was selected as an framework through which to identify the contextual influences in each case and to investigate how these influences interacted with each other to support or impede participants' practice with TIL design. Activity theory is accepted as a valuable tool for exploring complex activity systems in workplaces and as such was felt to be appropriate for this research. The research was designed to study ECTs' design practice over a period of time within which they would design and implement a TIL program. This extended timeframe of data collection allows for aspects of the design process and design thinking to be captured at multiple stages, thus adding to the understanding of the complete design process. Finally, multiple sources of data were collected throughout the duration of the investigation, therefore allowing for triangulation of data sources.

3.6.2 Rigour in research process

Explicit steps were taken to ensure the validity of this research. As previously mentioned, multiple sources of data were collected and triangulated in order to strengthen the evidence base for the findings of the study. Following the transcription of the interview audio files, the transcripts were sent to participants by email for member checking. They were offered the opportunity to amend and remove wording from these documents if they wished. No participants made changes to any of the transcripts. In addition to these measures, the researcher had regular debriefing meetings with supervisors where all aspects of data collection, analysis and interpretation were discussed, which served as a method of checking the researcher's conduct and execution of the research project. Finally, the researcher considered her own position in the research study and regularly questioned her own interpretations of the research in order to check researcher reflexivity. As the researcher was not a trained primary school teacher, it was possible to maintain reasonable objectivity from the participants' reported experiences.

3.6.3 Usefulness of research outcomes

The value of this research is its contribution to our understanding of a current pressing issue: why is it that early career teachers, despite espousing beliefs in the value of student-centred innovative approaches with technology-integrated learning, struggle to use those approaches in their teaching practice. Specifically, the research contributes to our understanding of contextual factors and how they impact on ECTs as they design TIL programs for their classes.

Chapter 4: Presentation of Cases

4.1 Introduction

This chapter presents the individual cases of participants in this doctoral study. Cases are presented in an order which is aligned to the level of innovation of TIL identified in the programs they designed. The order starts from the least sophisticated and ends with the most sophisticated. The level of sophistication of TIL in each case was determined through examination of the technology used and its contribution to learning in each case. The TIL in each case was allocated a sophistication level in alignment with the SAMR model (Puentedura, 2006). Table 6, on the following page, provides an overview of the levels of sophistication of TIL in this study and in doing so supports the order in which cases are presented in this chapter.

Case	Overview of TIL	SAMR level	Rationale for SAMR level determination
1. Kiara	Students' use of iPads to explore websites on topic; students conduct online research to answer questions in webquest and to identify features of planet in matching exercise;	**Substitution** (technology is used, but the tasks could be undertaken without technology, with no change to the learning outcomes)	Kiara's case demonstrates the use of technology for internet research in order to answer questions or find information about planets. This work could equally have been conducted using reference books from the library, which reflects the *Substitution* level. The learning outcomes for these activities are deeper understanding of the content.
2. Jenny	Teacher's use of video to present content; students conduct online research; students' engagement with interactive learning object.	**Substitution/ Augmentation**	Jenny's use of technology was primarily to support students' understanding of the content. These types of activity are defined as *Substitution* level because they could have been undertaken using analogue resources. The use of the interactive online tool extends the SAMR definition to A*ugmentation* because of the technology-mediated interactivity and student-centred nature of the engagement with the content.
3. Elena	Teacher's use of video to present content; students conduct online research; students' engagement with interactive learning object; use of iMovie to create videos	**Substitution/ Augmentation**	The use of video in this program and the students' use of internet-based research demonstrated a strong focus on understanding content through activities which could have been conducted without technology, resulting in the *Substitution* level in this case. The video-making task required students to interpret their learning of content into a technologically-mediated creative product, which aligns with the *Augmentation* level in SAMR.
4. Catherine	Students' use of mind-mapping app to share work samples with peers, students' use of movie-making software to film and present their slam poetry	**Augmentation**	The use of technology in this program aimed to develop students' poetry-writing skills and understanding of different genre of poetry. The apps supported peer-collaboration and feedback process, which reflects processes of analysis and application of skills. While some of the tasks could have been undertaken without technology, the use of technology enhanced the learning beyond that possible without it.
5. Simon	Students' use of mind-mapping app for collaborative planning, interactive learning object, jigsaw analysis and presentation task using Google Docs	**Augmentation**	The apps used in this program supported peer-collaboration and feedback process, which reflects processes of analysis and application of skills. The technology used in this program enhanced the learning beyond that which would have been possible without it.
6. Emma	Design of 3D cityscape in Minecraft, design process captured in iMovie	**Modification/ Redefinition**	This program used technology in a way which significantly altered and enhanced the way students engaged with the content and applied their new knowledge to their creative process.
7. Shelly	Entire program mediated by website and apps for design and interpretation of content	**Redefinition**	The learning facilitated by the technology applications in this program, and the pedagogical approaches embedded in the program, would not have been possible without the innovative integration of technology.

Table 6: Rationale for SAMR level attribution by case

4.2 Kiara's Science Program – 'Exploration of Earth and Space'

4.2.1 About Kiara

This section presents the case of Kiara. At the time of this research, which was 10 weeks from April to June 2017, Kiara was in her second school term of teaching at a large government school in a small suburb in the northern beaches of Sydney. This was her first full-time teaching role. The year before this study, Kiara graduated from a metropolitan university in New South Wales, with a Bachelor of Primary Education degree. Kiara was the teacher of a grade five class of 27 students at the school.

Kiara designed a 10-week program for the New South Wales Science syllabus titled 'Exploration of Earth and Space', based on the content areas of Earth and space.

4.2.2 Kiara's knowledge and experience of technology-integrated learning

Kiara articulated a belief in the value of technology to enhance learning for students. She explained her understanding of TIL as a means of going beyond traditional pedagogies to enhance learning:

> *I suppose for me it means integrating it meaningfully so that if you are using it, it's not necessarily just replacing a different form of media, whether that's a book or whatever it is – it's something that can offer the students more than that and something that's going to engage them and enhance their learning.* (Pre-design interview)

Kiara expressed her beliefs about the selective use of video in the classroom, saying that while useful to engage students in a topic initially, it "doesn't actually add anything or enhance anything to your teaching" (Pre-design interview). This is a belief that she expressed at different stages of the design day:

> *I tend to use them sparingly, only because I like the students to be able to construct the knowledge themselves rather than, yeah, just watching a video and getting told what they need to know. I like them to be involved in the process of what they're learning* (end of day interview)

In the pre-design interview, Kiara reflected on her university education. She described her university experience with technology-integrated learning as having "gaps". She said that lecturers often expressed the need to integrate technology to appeal to 21st century learners, but those lecturers appeared to lack in-depth familiarity with technology integration. Their approach was generally to recommend mobile applications (apps) and websites to use:

> *I think it could have been better integrated but I think a lot of the reason why... like they did mention technology a lot and that we really needed to implement technology in our classroom to be able to appeal to the needs of 21st century learners but I think some of the lecturers themselves weren't familiar with technology and kind of struggled with it. Yeah, like they would recommend apps to us and things like that and maybe recommend websites and things.* (Pre-design interview)

Kiara believed that teaching pre-service teachers about TIL at university should be compulsory:

> *..I think it would be good if at the university they had a good ICT program and that it was compulsory because I know that friends of mine that did ICT at university as their elective found that it wasn't taught well and that they weren't learning new skills from that subject so they really didn't get anything out of it and...(..) the teacher that was teaching it, (..) I think maybe her depth of knowledge... I think maybe the students had a better depth of knowledge of technology than her.* (Pre-design interview)

Kiara explained it would have been beneficial to learn more about technology integration at university in order to be able to navigate the volume of internet-based resources available to teachers online:

> *…I suppose it's maybe not so much about the apps but more about how to implement it and how to maybe use it as your assessment in a unit of work…* (Pre-design interview)

Kiara reported that she learned about technology integration at university through her observation of tutors and her fellow students, as well as by observing teachers while on practice teaching placements.

One website she was familiar with through exposure at university was Primary Connections[2], an Australian Academy of Science website designed to provide sample science programs for the Australian primary curriculum. Kiara used this website as inspiration for learning activities at several stages through the design day.

[2] https://primaryconnections.org.au/

Kiara created a professional learning network beyond the school context, through her participation in Facebook groups with her university friends who are also in teaching positions, and also through online groups for specific key learning areas (KLAs). She noted that these often provided inspiration for TIL:

> *..there's some maths and English ones that have really good links to resources and things like Pobble for English and the maths one has like different... you can download smart notebooks for a unit like angles and then a lot of them have interactive games and things that are embedded in the notebook so you can use that for the kids.* (Pre-design interview)

In sum, Kiara valued the role technology could play in teaching and learning, but reflected that her university education was the principal influence on her knowledge.

4.2.3 Kiara's school

Kiara taught at a government school in a small beachside suburb north of Sydney. With approximately 1200 students, the school was relatively large, and was above the average Index of Community Socio-Economic Advantage (1096; average ICSEA = 1000).

The school had a *bring your own device* (BYOD) policy for students in grades five and six, and most students chose to use an iPad. Kiara was unsure about the school's technology equipment, stating: "I probably don't know everything that is available" (pre-design interview). She reported that the support offered by the school for technology in the classroom related to technical aspects such as guidelines for connecting devices to the internet. Kiara described school support for implementing TIL as "just really informal things like chatting to other staff members about things that they've used in the classroom and what's worked well for them" (pre-design interview)

Kiara explained that it was important for students in her school to have digital literacy skills to prepare them for learning activities in high school:

> *..it is good for them to be using their devices more because I know that some of the parents said to me that some of their kids that are now in high school didn't do very much with their devices and didn't do much research or use them to make films or anything like that and now they're in high school and they're behind other kids because they weren't taught those skills.* (Post-lesson interview)

Kiara continued to explain that the level of exposure students in her school had to digital skills varied according to their teacher's use of technology in the classroom:

> *..and some of them (students) have gaps in their knowledge because I mean I think it's really dependent on the teacher as to how much they utilise technology. I know there are some teachers that don't really use it, then there's other teachers like for instance another teacher in Year 5, she uses it every day and she pretty much uses it for everything*. (Post-lesson interview)

As a new teacher in the school, Kiara had a teacher mentor, whom she met with once a week. The mentor was a teacher on a grade six class and offered Kiara support with day-to-day classroom issues and offered general advice on any issues that Kiara requested. She also had weekly team meetings with the other grade five teachers and the grade supervisor. At these meetings they discussed academic issues, such as comparing their reflections on teaching a program shared with all classes, as well as issues relating to students' well-being. An additional entitlement Kiara received as a new teacher was four hours' relief from face-to-face teaching each week. One hour of this time was spent with the mentor. Kiara used the other hours for various tasks such as marking assessments.

4.2.4 Kiara's class

Kiara taught a grade five class with 27 students aged between ten and eleven. She described her class as an enthusiastic and engaged group of students, with a wide range of academic needs, who required her to cater for broad differentiation in her learning programs.

Kiara found the BYOD policy raised challenges in her classroom because it relied on students remembering to bring the devices into school with them as there were no school sets of iPads to use in the situation where students forgot to bring them. This sometimes meant that, in instances where she had planned a technology-integrated lesson and a number of students have forgotten to bring their devices, she had to problem-solve under pressure to ensure all students had the access to the technology that they needed for the learning activities. Kiara reported that solving this problem could take up a lot of time in the class.

Kiara's post-qualification teaching experience was limited at the time of the study, but she reflected on her implementation of TIL in her classroom. She identified that she often underestimated the time allocation for TIL activities, due to the complexity of using technology with a large group of students and the different paces at which the students were able to work. She had clearly reflected on this issue and suggested possible solutions for similar activities in the future, such as group management, and learning to mirror her iPad on to the interactive whiteboard (IWB).

Kiara articulated her thinking about technology integration as a way of supporting constructivist approaches to teaching in her classroom, rather than as reinforcing more traditional didactic pedagogies:

> *I like them to be involved in the process of what they're learning because I think that that... I suppose that's just the style of teaching that I find is beneficial to them and based on constructivist principles as well because then they're also responsible for their own learning as well. They have the time to be able to test out ideas and see what works.* (Post-lesson interview)

Kiara had taken the initiative to integrate technology with her class by designing a digital storytelling task for a program during her first term at the school. She explained that she felt confident to implement this task due to her experience with teaching a digital storytelling class at a community college when she was at university:

> *Well, it was in the unit of work as an option that they could do a speech or they could do like a digital story and because I had experience teaching that at Rozelle, I kind of jumped on that and went for it because I already knew what the steps were and how to implement that..* (Pre-design interview)

However, this task presented difficulties for Kiara because of some students' lack of access to the technology:

> *I gave the students an assignment where they had to make their own digital story and because not all the students had their own devices, it made it really difficult for some of them because they had to use other students and some of them used my laptop as well and we don't actually have iPads on hand that we can hire out for the kids to use because it's a bring your own device school..* (Pre-design interview)

Kiara explained that she would like more guidance, to not only choose the appropriate applications, but also to better understand how to implement them in the classroom.

4.2.5 How Kiara designed her science program

The common approach to designing learning programs at Kiara's school was for individual teachers to amend a program which had been prepared by the stage supervisor to meet the needs of their class. For some KLAs, such as English, teachers had the opportunity to be more involved in program design, for example choosing a novel and designing an English program around it. Towards the end of each term, the teachers on each grade met to discuss the programs that would be taught in the next term and the associated learning outcomes and assessments which would be used. This information was used to underpin the programs which would be taught during the following term.

Kiara decided to use the opportunity of participating in this study to design a program that she had not designed before. This was a science program on Earth and the solar system. Kiara explained that, prior to the design day, she looked at the relevant syllabus outcomes for the program and had done some preliminary thinking, drawing on her university experience:

> *I have done a little bit on Earth and space at university so thinking about the resources I've already looked at for that and thinking about how I'll be able to integrate them into the unit. And just examine them again and make sure that they're something that will engage the kids and would be useful for what I'm going to be teaching them.* (Pre-design interview)

She explained that this design activity would also provide some developmental opportunities for her as an early career teacher:

> *Just like probably a better understanding of technology and just the time to really think about how I can really use it effectively, and to search for different resources as well, and just to have time to really plan.* (Pre-design interview)

Design day

Kiara used her laptop and sat in the library on the design day. At the beginning of the process, she spent twenty minutes thinking about and generating the overall design of the program. In these initial stages, she consulted the syllabus and considered resources she had used at university for the topic of Earth and space in order to understand the focus of the program. This was followed by a process of searching for inspiration for the learning activities and structure of the program, by looking at sample programs, including those on the Primary Connections website.

> *I like to gather information for units of work – I like to kind of read everything and then whittle it down, which sometimes just takes a lot of time, and probably isn't the best way.. I could probably just use that unit..* (Design observation)

This process lasted approximately nine minutes. The fact that she was searching for complete unit designs could have meant that this was a less abstract and more concretely defined search target, therefore limiting the range of search results on offer:

Kiara: *So I think what I'm going to do is look at what's on here and then try and just use that as my model, and then just expand, or alter what's there. Because I feel like what I have looked for on other websites, like on my Google search, has given me resources and ideas, but there hasn't really been as comprehensive a unit of work as this one, so this I think will just be easier for me to just go, at a glance, I can look at this and then use this to make my own, because it doesn't seem like…*

Researcher: *So when you say you're going to use it as a model, do you mean the order of the topics?*

Kiara: *Yeah I think the order.., the way the teaching and learning sequence, and maybe just change some of the tasks they have for that concept to something a bit more interactive..* (Design observation)

Kiara then spent thirty minutes documenting her initial plan for the program design in the school's program proforma document.

The next stage of searching for general teaching inspiration related to the topic lasted for 40 minutes and was less systematic, involving searches online and reading through various web-based sources of teaching materials related to the topic. At this stage, she made the point that there were so many resources online that it was an overwhelming process to identify the most useful for the program.

Kiara then spent 20 minutes integrating a Primary Connections program with the school's program from the previous year to form a basis for the program design. She considered the program at a higher level and wrote a new version of the overview during this phase. Following this, she began to search specifically for teaching strategies relating to the use of questioning techniques and Bloom's taxonomy of higher order thinking skills, which are areas of focus identified by the school principal. This search was reasonably short, lasting approximately eight minutes. The final 20 minutes of the design activity on the design day were spent creating assessment resources and making decisions on how to use a mobile app which she had identified earlier as a key resource for the program.

By the end of the design day, Kiara had documented the program overview, the learning objectives and the assessments. However, she not made detailed records of potential lesson activities. Figure 6 shows an example of the documentation of the program completed by Kiara at the end of the design day:

Content	Teaching, learning and assessment	Resources
Stage 3 - Working Scientifically Students question and predict by: • with guidance, posing questions to clarify practical problems or inform a scientific investigation (ACSIS231, ACSIS232) • predicting what the findings of an investigation might be (ACSIS231, ACSIS232) • applying experience from similar situations in the past to predict what might happen in a new situation	**Lesson 1:** Students	https://celestiaproject.net/ https://schoolsonline.britishcouncil.org/sites/so/files/epic_space_mission_primary_1.pdf **Scootle resources** **Primary Connections: Earth's place in space** TFL-ID S5683 http://www.scootle.edu.au/ec/resolve/view/S5683 **The wonders of our universe: space traveller** TFL-ID L3069

Figure 6: Excerpt from Kiara's program documentation at the end of the design day

For later lessons, she had only documented the intended content areas or some potential resources:

Content	Teaching, learning and assessment	Resources
		M018852 http://www.scootle.edu.au/ec/resolve/view/M018852 **Language central for science** TFL-ID M017189 http://www.scootle.edu.au/ec/resolve/view/M017189
Stage 3 - Working Technologically Students explore and define a task by: • developing a design brief individually and in collaboration with others • developing design criteria that considers, where relevant, function, aesthetics, social and environmental considerations • planning the process considering constraints where relevant, eg time, finance, resources and expertise Students generate and develop ideas by:		

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Figure 7: Excerpt from Kiara's program documentation at the end of the design day

Kiara spent more than a third of the design time searching for technology-based activities and then checking their potential alignment with learning outcomes from the syllabus. She had gathered a range of resources and reported that she would need to spend approximately four more hours on deciding on how to sequence the knowledge that students needed to acquire and the resources and tasks that she had found. In the end of day interview, Kiara explained that the syllabus had informed her program design so far:

> *..it gave me specific things that I needed to discuss with the students and it gave me specific tasks that I needed them to do as well because one of the dot points was about making the model so I knew that they had to do that to be able to meet the requirements of the syllabus (..) it also just guided me as to the direction of their learning and what I'm going to include in my lessons.* (End of day interview)

Kiara also explained that the syllabus did not directly support technology integration, but it did provide links to partner websites which did provide suggested technology-based learning activities:

> *It had in it that you needed to look at technology that scientists are using to be able to understand scientific concepts but it didn't really have anything specifically about... but I suppose like yeah, in the syllabus it didn't but on the resource builder which is provided by BOSTES[3] there was the link to be able to get Scootle[4] resources and all of them were ICT. Yeah, so in a way it did.* (End of day interview)

Kiara stated during the end of day interview that her process was typical of her usual design practice.

After Design Day

Following the design day, Kiara added to and modified the program design prior to and while teaching from it. Prior to teaching, she spent 1-2 hours at home adding to and refining the design by incorporating the *We Are Learning To (WALT)* strategy to support student learning, and by identifying a new online webquest for students to do in order to consolidate their understanding of key concepts in the program (design diary). This was in

[3] BOSTES: Board of Studies Teaching and Educational Standards NSW
[4] www.scootle.edu.au

replacement of a webquest which was in the previous year's program. Kiara summarised her design work following the design day:

> *I didn't talk to anyone, actually, I pretty much did my own independent work online. I had the unit of work that they had done for Earth and Space last year, and had a look at what was already there, and I just, like, changed it. And I actually found that Australia Post had a really good unit of work on Earth and Space, and it was quite comprehensive and had a lot of hands on activities and resources and things that I thought were quite good to use in the class, so that actually provided a lot of scaffolding for me as to how I was going to plan the lessons and then I went back to Primary Connections again and looked at what they had done and then compared that to the other resources I had found, and then figured out what of that I was going to take and how I was going to put it all together.* (Pre-teaching interview)

The final stage prior to teaching was the finalisation of the program description in the program document. At this point, Kiara explained that she felt more confident in the design of the unit, however she was still slightly apprehensive because she had never taught the content area before.

Kiara's individual design process can be illustrated in eight key stages. Table 7 presents each step of the design process in more detail:

Design step	Contextual detail	Observed by researcher/reported by participant	Time taken
Familiarisation with content	1. Viewed syllabus for specific skills and outcomes for the program, viewed university resources to review previously designed science task and to identify areas which might be more challenging for some students. Notes in program document (Word)	Observed and reported	20 minutes
Research	2. Searched online for sample programs for target content area. Identified useful content from *Primary Connections* and government syllabus support site (BOSTES *Program Builder*)	Observed and reported	9 minutes
Describe	3. Documented initial design in Word file	Observed	30 minutes
Research	4. Searched online for general inspiration and resources on teaching this topic area. She identified an iPad app to integrate into the program.	Reported	40 minutes
Describe	5. Worked on aligning sample program (sourced online) with the school's 'old' program to create a new program design, and wrote overview	Reported	20 minutes
Research	6. Searched for resources for specific teaching strategies	Observed	8 minutes
Think and describe	7. Designed assessment and considered its implementation	Reported and observed	20 minutes
Synthesize (integrate resources and strategies)	8. Refined resources by incorporating school's preferred learning strategy and integrated an online webquest.	Reported (design diary and Pre-teaching interview)	1-2 hours

Table 7: Detail of Kiara's design process stages

4.2.6 Summary of Kiara's science program

The program Kiara produced was from the New South Wales science and technology syllabus and focused on the content strands of Earth and space. It was designed to be taught as two 40-minute lessons per week over seven to eight weeks of a ten-week term. The program included opportunities for collaboration and investigation, which involved students using their own mobile devices.

Kiara explained her goals for the unit in her own words:

I want them to be able to have an in-depth knowledge of the solar system and to be able to identify where the planets are, obviously, and how to scale their model as well because when I was looking online before, it said that scaling is really important for them to be able to understand to make the model properly. (End of day interview)

The learning objectives of the program were:

1. Shows interest in and enthusiasm for science and technology, responding to their curiosity, questions and perceived needs, wants and opportunities.
2. Demonstrates a willingness to engage responsibly with local, national and global issues relevant to their lives, and to shaping sustainable futures
3. Investigates by posing questions, including testable questions, making predictions and gathering data to draw evidence-based conclusions and develop explanations.
4. Plans and implements a design process, selecting a range of tools, equipment, materials and techniques to produce solutions that address the design criteria and identified constraints
5. Describes how discoveries by people from different cultures and times have contributed to advancing scientific understanding of the solar system
6. Explains rapid change at the Earth's surface caused by natural events, using evidence provided by advances in technology and scientific understanding.
7. Describes systems in built environments and how social and environmental factors influence their design.

The TIL activities in Kiara's program were focused on research and understanding information on the solar system. The first two TIL tasks focused on students reading an introduction to the solar system and then using online research skills to answer their own questions about the planets and the solar system. The third TIL activity was a reading task which helped students deepen their knowledge of individual planets. The final TIL task focused on identifying the environmental conditions on each planet in a webquest-style activity. This final task appeared to go beyond the stated aims of the program, which were to identify where the planets are in relation to each other in the solar system. These activities could mostly have been implemented without the use of technology. This means that the implications for students' learning of these activities are that there is little additional benefit for students beyond slight elevation in engagement by introducing the content on devices rather than on paper. Despite Kiara's articulated belief in the value of technology in students' learning, the TIL activities she incorporated into this program did not reflect thatbelief.

Kiara created four main TIL activities for the program. The TIL activities in the program are broken down in terms of their technology classification and role in the program in Table 8 below:

TIL activity	**Technology classification**	**Role of the activity in program design**
1. On iPads, students explore website as introduction to topic of space	Education website (Scootle)	Introduced at beginning of program to engage learners
2. On iPads, students browse internet to find answers to self-identified questions	Internet browser, non-education specific	Follow up to TIL activity 1 – broaden knowledge, formative assessment
3. Group task – information matching activity using internet to research and identify planets in the solar system	Teacher-prescribed websites: education pages of non-education specific websites, e.g. NASA	Follow up to TIL activity 2 – deepen knowledge of planet characteristics, formative assessment
4. Group task based on internet resource: Identify a planet to relocate the human race (webquest)	Single webpage with overview and outline of task for students to follow. Handout with chart for students to complete with information on their planet. Some internet browsing	Application of knowledge gained in previous activities to a task, informal summative assessment: work sample

Table 8: Breakdown of TIL activities in Kiara's program

4.2.7 Teaching the science program

The teaching of the program broadly followed the outline that Kiara produced in her program document. Kiara said she was particularly satisfied with lessons seven and eight, where she described students as being "really engaged in the content" (teaching diary) and she reported that students produced work samples of a very high quality. Kiara explained that the technology used in the program had successfully enhanced student learning, especially through the jigsaw research and webquest activities. However, it is possible that it was the organisation of the learning activities (in groups, doing jigsaw-style research) which led to the high level of engagement and the quality of work produced, rather than the technology-based resources themselves (researcher reflection).

Issues which impacted on the teaching were timing, technology difficulties, the weather, and by teacher absence due to illness. Issues relating to timing were activities which took longer to complete than anticipated, such as the drawing of a learning reflection chart in lesson one. The result of this activity running over time was that the students had less time to conduct internet-based research. When Kiara was absent due to illness for lesson four, the relief teacher had difficulty in getting students to focus, which meant the content was not fully covered and had to continue into the following week's lesson. The result that was that lesson five did not take place at all. Issues pertaining to technology integration included links to websites which did not work (lesson 1) and students forgetting to bring their devices, which resulted in difficulties ensuring access for all students to the required technology (lesson 10):

> *This lesson students were really engaged and keen to research their planets. It went to plan even though it was hard because not all students had brought their devices so that made it slightly difficult for some groups, but I managed to allocate them to additional computers.* (Teaching diary)

The weather impacted on the plan in lesson three to create a to scale representation of the solar system outside of the classroom. The lesson was designed to take place outside because of the amount of space it required. Kiara reported that because of rain, the students had to squeeze together under a bus shelter to complete the task, which diminished the learning opportunity of the activity.

Kiara also reported that she believed her knowledge of the content could be improved "to be able to answer some of the hairier questions for the students." (Teaching diary)
During the ten weeks when the teaching of the program was taking place, Kiara, along with colleagues who were also teaching the program, amended the program by adding some scaffolding activities to support students understanding of some of the key concepts relating to the planets. Kiara reported that her colleagues informed her they had made changes to the program for their students and then Kiara decided to incorporate the changes for her students:

> *I think some of them took some of the aspects of it and they really liked the research task about the planet..(..) and then referred back to the Primary Connections unit and did more lessons in the lead up to some aspects of it which I actually incorporated into my programme as well because I thought that it would give the kids a greater understanding...* (Reflection interview)

She explained that her colleagues decided on the changes to make on the program from their own experience on teaching the program in the past:

> *...I think most of the time teachers kind of interpret different things and then look at the sequence and add things that they think work better or they can add in things from tasks that they've done in the past because some of us that were on Year 5 taught it before so they had things that they'd done with their classes that they knew worked well and then they recommended them to me and I just incorporated them into the unit.* (Reflection interview)

Figure 8 presents images from Kiara's classroom and the students' work from the program displayed on the classroom walls:

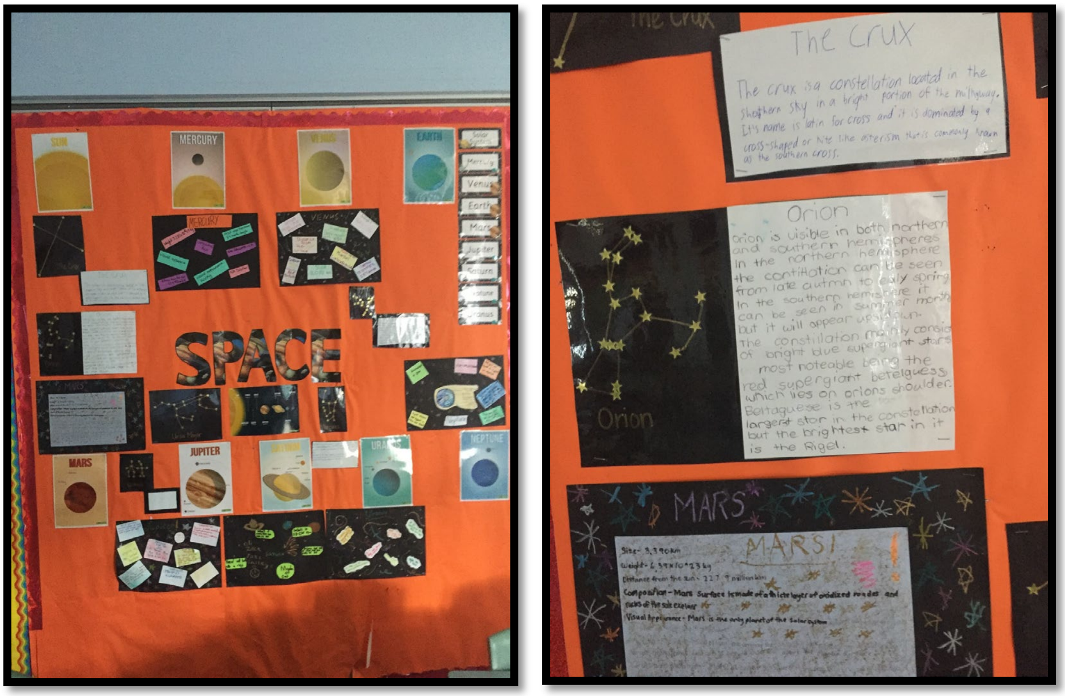


Figure 8: Images of the space display in Kiara's classroom

Observed lesson

The researcher observed a TIL lesson in week eight of the program, which was the final lesson of the program. The TIL activity in this lesson was a webquest activity. The researcher was unable to interview Kiara prior to the lesson observation, as she was on playground duty. However, the post-lesson interview captured her aims for the lesson and reflections on the lesson itself.

The main aim of the lesson was for students complete a webquest in groups, where they investigated which planet had the best conditions to accommodate human life. Kiara reported that her main concern prior to the lesson was that there would be difficulties connecting to the internet and that not enough students would remember to bring their devices. The lesson was hampered by the fact that only seven students brought their devices on the day, and time was spent (approximately ten minutes) at the beginning of the lesson organising for all students to have some access to a device. This involved some students working in the classroom next door which had two desktop computers available.

The webquest activity was provided to students as a worksheet and students had to search for answers to questions on their allocated planet. Students appeared to the researcher to enjoy searching for information on their chosen planet. Some students were extremely interested in the topic and were observed to be enthusiastically collaborating with each other to find answers to the webquest questions (researcher field notes). The teacher moved around the classroom giving support where needed.

Kiara's reflections on the lesson

The post lesson interview took place during the break immediately after the students had left the classroom. During this interview, Kiara reflected on the aspects of the lesson which she viewed to be successful and on those which she thought could have been improved. One of her main reflections was that students working in groups with more than one device between them were more engaged in the task and were completing the worksheet more efficiently.

> *I think as I was saying to you earlier about those students that only had one device that they weren't as on-task so then they were distracting other students. (..) But if you don't have the technology and they can't actually do the task and they need technology to do it, those are where the problems arise because they can't be as focused..* (Post-lesson interview)

Kiara was satisfied with the evidence of learning during the lesson:

There were some groups that were having really great discussions and talking; a few of them actually mentioned the atmosphere of the planets and how that's going to impact whether or not we can live there because you might have to wear a space suit if you live there all the time because there's no oxygen so we'd have to bring our own oxygen. So that's a really good thing that they're considering because that kind of says that they're beginning to understand about earth and things like that which they really need to know for high school. (Post-lesson interview)

Timing issues meant that was no time for students to present their findings on the day, as had been planned.

4.2.8 Kiara's reflections on the program

Kiara reflected on the program both in her teaching diary and in the final reflection interview. She had made 10 entries in her teaching diary, which amounted to approximately 950 words.

Kiara explained during the reflection interview that she felt her own content knowledge about Earth and space was lacking:

I think just getting my head around all the content and making sure that I was teaching it well and being able to address the depth and scale of the questions about space because it is such a big topic. So that was probably something – getting my own head around the content. (Reflection interview)

However, Kiara explained that the integration of technology in the program meant that her role in the classroom was not to impart content information. Instead the research and webquest activities meant that the students were more independent learners, which in turn enhanced their learning and increased their engagement with the content:

Researcher: *To what extent do you think the technology integration supported and fostered your students' learning in the unit?*

Kiara: *The technology (..)excited them and gave them a sense of wonder about space. I think it kind of brought the concept for them to life. It also gave them autonomy as a learner as well because they had to independently (think) and I think that was really good for them to have ownership of their own learning particularly for* *some that maybe need more support – I think that assisted them and supported them interpreting content.*

<u>Researcher:</u> *So they could just go off by themselves and do their research in their own time and figure it out by themselves you mean?*

<u>Kiara:</u> *Yeah, and just if they did have any questions or they needed direction to complete the task or interpreting information that they'd found, but guiding them with websites that.. that way you can kind of control the information that they were getting and have it at a level that was appropriate to them.* (Reflection interview)

Kiara wrote in her teaching diary that when teaching this program in the future, as technology-based tasks, she would facilitate students creating slideshows, videos, or posters with their devices:

> *Technology is excellent when it works. This improved throughout the unit, but access to technology really makes or breaks a lesson. As well as this, having students understand what kind of websites and search engines are quality will help them get more out of independent research tasks. I would implement it again in the unit and I would also add tasks where students made slideshows, videos, or posters with their devices.* (Teaching diary)

This indicates an awareness on Kiara's part that the TIL activities were heavily focused on research rather than creative production activities, which would lead to more higher order thinking skills.

4.2.9 Summary

The case of Kiara's design of a TIL science program highlighted some key findings. Firstly, Kiara approached the design of her TIL program as an amendment of an existing program. She changed some aspects of activities within the existing program, but the underlying structure of the program was unchanged. Kiara considered technology integration as part of the decisions about which tasks to add to the program. She took inspiration for these tasks from sample programs online. Kiara's TIL activities were limited to research-focused tasks. However, her in evaluation of the TIL activities she indicated an awareness of the potential to include more creative TIL tasks in the future.

Secondly, this case identified key contextual influences on Kiara's design process. These are discussed in the following section, which includes an interpretation of the case through activity theory. Table 9 presents an overview of this case through the activity theory framework:

Activity theory component	**Evidence in this case**
Tools	Kiara's lack of in-depth TPACK, School program proforma
Rules	BYOD policy is the only official communication on technology for learning; Syllabus provides the learning outcomes for the program; Accepted practice of adjusting a pre-designed program for use with a particular class
Community	Students bring their own devices for learning; Kiara's mentor to navigate day-to-day issues; Grade colleagues who offer informal support; No appointed ICT 'expert' on staff
Division of labour	Colleagues decide as a grade on learning outcomes and assessment tasks for each program; Colleagues contribute to development of scaffolding activities while teaching; No explicit communication or collective set of actions to support TIL

Table 9: Components of Kiara's activity system

Kiara had limited knowledge and experience of TIL

As the *subject* of the activity system, Kiara brought her internal *tools* which mediated the activity. These consisted of her technological pedagogical content knowledge (TPACK) and her experience with TIL. As a recent graduate, these internal *tools* were developed predominantly through her initial teacher education.

Kiara's pedagogical content knowledge was limited. Her content knowledge (CK) originated from the work she had done on this topic in her teacher education studies. When reflecting on her teaching of the unit, she commented that she had felt that her knowledge of space and the planets was inadequate at times and that she and the students had had to search for answers to some questions online. The pedagogical knowledge (PK) Kiara displayed in the program consisted of learning strategies which were prescribed by the school executive and which would have been familiar to students from other KLAs. Her pedagogical knowledge specific to this content area was limited, as she reported herself, and she relied heavily on sample programs and the school's old program for approaches to teaching this content (PCK). Having limited PCK in this area may have been a contributing factor to Kiara feeling overwhelmed by the resources available online and not being able to filter or refine her search to resources which would align with her knowledge.

Kiara's general technological knowledge was adequate. Kiara demonstrated some understanding and knowledge of the use of technology in her teaching context.
She reported being comfortable switching between devices and platforms when searching for inspiration for the program. She had a general understanding of the affordances of the devices students were using, and where potential difficulties in transferring activities from mobile devices to computers could arise. This was important because of the reliance on school computers in the classroom when students forgot to bring their devices. These factors mean that we can identify Kiara's technological knowledge (TK) as adequate in relation to her teaching context.

Kiara demonstrated some understanding of issues relating to the use of technology for certain pedagogical approaches in the classroom (TPK). Following the observed lesson, Kiara identified some strategies for managing activities and student engagement with a small number of devices available, for future lessons when students forgot to bring their devices. She also demonstrated knowledge of timing issues with TIL activities, due to added complexities associated with technology use.

Kiara demonstrated some knowledge of using technology for teaching specific content (TCK). She identified the potential value of designing a webquest so that student could apply learning and scientific thinking skills to solve a problem (TCK). She also articulated reflections on the use of video in the classroom, commenting that students were not likely to be actively engaged in learning when watching a video, but instead would be engaged in passive listening.

Kiara had a limited understanding of how to effectively integrate technology to enhance or transform learning beyond the level of engaging students' interest

Kiara lacked confidence in her technological pedagogical content knowledge (TPACK), despite expressing an understanding of the complexities involved in TIL activities which were familiar to her through her, such as digital storytelling. She articulated a belief in TIL for enhancing learning rather than simply using it a replacement for traditional teaching approaches, as in her reflections on the use of video in the classroom. She also demonstrated understanding of the role technology can play in inquiry-based learning. However, the technological solutions she selected for the learning activities did not reflect a high level of technological pedagogical content knowledge (TPACK), and only reflected her previously articulated beliefs in allowing students to construct their own learning in a limited way. The activities she chose sat in the lower to middle range on the scale of higher order thinking skills: helping students to understand concepts, but not going further; supporting them to construct new meaning and create or produce new work based on their understanding of the key concepts in the program, for example.

Kiara appeared to have gaps in her TPACK. At the same time, her confidence and skills in designing TIL for her students seems to be lacking. The consideration of TIL in Kiara's design was not explicit and occurred through the identification of activities in the previous year's program (webquest) and activities identified through an online search for inspiration. In line with much of the literature on ECTs, Kiara's beliefs in TIL were not followed by the systematic conceptualisation and design of principled TIL during the design process.

In the activity theory framework for this study, TPACK exists as a psychological design *tool,* which can mediate and influence the design of a technology-integrated learning program. The fact that Kiara's TPACK did not appear to be well developed can be seen to have had a constraining effect on her design practice of TIL.

Despite having a BYOD policy, access to technology for all students was often problematic

The *rules* influencing Kiara's activity theory constellation provided both guidelines for her design, but also had a constraining influence. Firstly, the whole school communication about technology in learning was restricted to an articulation of the BYOD policy. By limiting its official communication about technology in learning to a set of rules governing which devices are acceptable and an acceptable use policy, the school has shaped the school culture around technology for both parents and staff. A lack of strategies and goals which could guide teacher practice with technology effectively limited the involvement of the school leadership in TIL. Kiara reported that there was no identifiable support from school leadership for designing TIL.

Within the *rules* component, there were two factors in this case which related more specifically to teacher design practices with TIL. The first of these was the accepted practice of using a program pre-designed by a senior teacher for each subject and adjusting the tasks within the program to suit a particular group of students. This practice carries with it some implicit assumptions, which have particular implications for ECTs. Firstly, there is an assumption that the program is of a high quality and meets the learning outcomes identified in the syllabus. Secondly, that the content has been successfully used with students in the past and contributed to their learning of the specific content. These assumptions might imply to an ECT the idea that any changes to the program design should be minimal. In fact, Kiara's changes to the program were minimal, where she incorporated a slightly improved version of a webquest to replace the original one prescribed for that lesson.

The syllabus and the school's existing program were strong influences on Kiara's design practice

The analysis of the data in Kiara's case identified that the school's existing program and the syllabus for this topic were strong influences on her design practice. In activity theory, these contextual factors constitute two components of the activity theory model. Firstly, they are *tools* which mediate the design process. Secondly, they emanate from a system which governs teacher practice and as such can be identified as *rules*. The existing program was the basis of Kiara's design, as she made minor adjustments to its content in order to create the new program. The syllabus guided Kiara's understanding of the content area and the learning outcomes. She reported that she was not confident in her knowledge of the syllabus in this area and needed to spend some time understanding the key content points. However, while these components of *rules* and *tools* were significant in Kiara's practice, neither of these components provided support for thinking about technology integration in her design.

The school had limited support for teachers designing TIL

Members of Kiara's *community* impacted on her design thinking and practice with TIL in different ways. Kiara's teaching colleagues were her main source of support and mentorship as a new teacher. Kiara's mentor supported Kiara in navigating day-to-day issues. Her grade colleagues were a daily source of informal support to her and might offer suggestions relating to technology integration if asked. However, there was no requirement for communication between staff about TIL and no staff member who was a designated source of expertise in TIL. Within activity theory, it is understood that in order for an objective to be achieved, there is a need for a common understanding and communication which focuses on the achievement of that objective. These processes lead to a culture which produces a set of actions which will achieve the objective. This leads into discussion about the division of labour component of activity theory for this case.

The *division of labour* component of this case identifies some important features of cooperative work in Kiara's design context which impacted on her practice. Prior to working individually on her programs, Kiara worked with colleagues to decide as a grade on learning outcomes and assessment tasks for each program. This was accepted practice in the school. While teaching the program she designed, Kiara worked with her colleagues to develop scaffolding activities for the program where they identified that students needed extra support. This type of collaboration is an important source of support and taking of joint responsibility for the teaching and learning in a learning program. We also know such practices support professional learning in an authentic situation (Dreyfus et al., 2000). However, in order to achieve the objective of designing TIL, there needs to be an explicit organisation of activities within a group of colleagues who are jointly contributing to an activity (Bellamy, 1996). As identified previously, there were no explicit processes in place for designing TIL, there was no source of expertise in the teaching staff on TIL and there were no specific paths of communication which might have supported Kiara's design of TIL.

Contradictions in Kiara's activity system

From the analysis above there is evidence of several contradictions within and between components of the activity system which have impacted on Kiara's design of technology-integrated learning. Firstly, there was a contradiction between the internal *tools* that Kiara had at her disposal to guide the activity. Her TPACK was low for two main reasons: She had experienced little learning about TIL of any substance during her initial teaching education and she was in her first year of teaching and so had little professional experience with using technology in her classroom. This factor presented a contradiction with the BYOD policy of each student having access to a device in Kiara's classroom; a norm within the activity system which sits in the *rules* component.

Within the *rules* component itself, there was a contradiction between the BYOD policy in place in the school and the level of support available to teachers for designing TIL. No formal support for Kiara in integrating technology meant that the BYOD policy had limited impact on learning in her classroom. She did not have the level of internal tools (TPACK) to understand how to design effective TIL by herself in this case. An extension of this contradiction is that of the BYOD policy and the lack of leadership and support in the school for TIL. With no obvious high-level direction articulated for TIL in the school, Kiara identified that teachers choose themselves the extent to which they integrate technology in their classrooms. The indirect impact of this is that Kiara viewed the process as her individual responsibility and did not seek out support from colleagues.

4.2.10 Conclusion

Kiara was a teacher in her first year of teaching a grade five class at a large government school in an outer metropolitan suburb. She designed a program for the science syllabus focusing on the solar system. Technology was integrated in a minimally innovative way, with students using their 1:1 devices to research information on various characteristics of planets over several different tasks. Through activity theory, it was identified that despite the access to devices in her context, key limitations in Kiara's activity system were the combination of low TPACK and minimal support in the school for designing technology-integrated learning.

4.3 Jenny's History Program – 'Australia as a Nation'

4.3.1 About Jenny

This section presents Jenny. At the time of this research, which took place over 10 weeks from March to June 2017, Jenny was in her fourth year of teaching at a government school in the suburbs of a metropolitan city in New South Wales. This was Jenny's third year at the school; she had previously worked for six months at a school in the UK immediately after graduating from university. Jenny graduated from a regional university in NSW with a postgraduate diploma of primary education. Prior to her education qualification she completed an undergraduate degree in media and communications. Jenny was a teacher of a grade six class of 25 students.

Jenny designed a 10-week program for the New South Wales History syllabus titled 'Australia as a Nation', focusing on the history of migration to Australia and Aboriginal human rights in the history of Australia as an independent nation.

4.3.2 Jenny's knowledge and experience of technology-integrated learning

Jenny expressed a positive attitude towards TIL, saying that she enjoyed using the interactive whiteboard to incorporate multimedia into her programs. She explained this helped her students' understanding of key concepts in a program, as they would otherwise have difficulty understanding large amounts of text-based information. Jenny's most common technology practices were using video in class and internet-based research tasks in the computer laboratory. She explained that her choice to use the IWB as the main technology in the classroom originated from the school's preferred practice of creating presentation slides to accompany each program in order to ensure that there were visual aids available at all times to support students with literacy difficulties:

> *I mean I love technology. I use it all the time, obviously with the smartboard – that's where everyone accesses their programs and what you're going to teach so...* (Pre-design interview)

Jenny described her confidence with TIL as *"so-so"*, and explained that difficulties with accessing technology in the school limited her options with TIL:

> *Like I said, it's hard again with the resources – when you have limited resources it makes it hard to incorporate it into the program.* (Pre-design interview)

However, when asked about TIL she would like to incorporate if she had the possibility, she was unable to think of any examples.

In the pre-design interview, Jenny described her exposure to technology during her university teaching degree as limited to learning to use an interactive whiteboard (IWB), and her experience with technology at her UK school as being predominantly using the IWB for teaching.

4.3.3 Jenny's school

Jenny taught at a government school in a suburb of Sydney, NSW. Jenny's school had approximately 800 students, 97% of whom were from non-English speaking backgrounds; predominantly Arabic, Mandarin, and Vietnamese. The school was below the average Index of Community Socio-Educational Advantage (964; ICSEA average:1000), indicating the student demographic were of a lower than average socio-economic status.

The school did not have specific policies regarding technology integration in learning and teaching. Jenny explained that there were not many technology resources available to her at the school. She said that she used the IWB for every lesson and that there was a computer laboratory at the school. Classes had timetabled fortnightly access to the computer laboratory, which could affect the scheduling of TIL lessons in the program:

> *I guess it just depends on when you teach it really affects that because obviously it's too difficult to program it and take in account everybody's computer time because we all go in different weeks. Like I might go in even weeks where someone else goes in odd weeks so it's kind of too hard to program it that way.* (Pre-design interview)

She talked briefly about mobile technologies available for her class and reported that because the ratio of devices to students in the grade (multiple classes in each grade) was very low, teachers were not using them in class:

> *They had iPads but I found that people weren't using them because there was only six per class, or six per grade so you had to share them around basically once a week so it kind of didn't really become effective..* (Pre-design interview)

At the end of the year prior to this study, the school had sold the six iPads and purchased six laptop computers to replace them. At the time of the study, Jenny had not had the opportunity to use them. Jenny later reflected that she did not perceive technology integration to be a high priority at the school: “It’s not overly pushed” (Reflection interview).

Jenny stated that the assistant principals at the school did not help or support teachers with technology integration in learning programs. She explained that the level of autonomy to design programs depended on the KLA and clarified that some programs were pre-designed for teachers:

> *I guess it depends what unit you’re planning really because the science – we have a science program that we use that basically tells you what you need to teach every lesson so if you’re doing that, basically you just make the slides, like an interactive whiteboard notebook to go with it.* (Pre-design interview)

She continued to explain that it was preferred practice for teachers at the school to create a slide presentation to accompany every topic area in every program. These slides would be used by the teacher on the IWB in the classroom and would contain all teaching presentation materials, including links to online videos and other resources which would accompany the program.

The school had a system of teacher-led professional learning committees (PLCs). All staff met annually to decide on the focus of PLCs for the year. Jenny reported that in the previous year, some teachers at the school had formed a PLC on technology, which meant that some expertise in the field was accessible in the school. The committee identified and held professional learning on ways teachers could improve the use of technology in the classroom. However, Jenny did not think that the same committee would continue to be active as they did had not established further goals in the area. Jenny did not expand further on the subject of the technology PLC and when asked, she could not recall the goals or topics that the committee had focused on in the previous year. However, she mentioned that she had learned about Google Classroom from the PLC and had started to use the platform with her students.

Jenny reported that the school’s guidelines for technology integration were communicated through the ‘core programs’, which consisted of a scope and sequence for each program. She appeared to lack some clarity of detail on how the core programs specified technology integration practices:

> *I mean it's part of the program in our core programs that you use technology and I guess it's just teaching them the skills that they're going to need when they leave school – just basic computer skills.* (Pre-design interview)

4.3.4 Jenny's class

Jenny taught a grade six class (aged between eleven and twelve years old) of 25 students. She explained that the academic levels in her class ranged from grade two level upwards. Two of her students had mild intellectual disabilities, and their learning progress was described as being "slower than the other kids, so they're behind." (Pre-design interview). Jenny reported that her class did not have significant behavioural issues and described her students as being "a bit chatty, but other than that, it's a good class." (Pre-design interview). She explained that the majority of her students came from backgrounds where English was a second language and that this was a consideration for her in every aspect of her teaching. Her students had two hours a week (one hour on two different days) when they would leave the class to attend a community language program. At these times, Jenny had relief from face-to-face teaching time.

Jenny reported that she only did group work activities with students in guided reading and science lessons. For the science lessons, the pre-designed program outlined how groups should be organised:

> *Well basically the program that we're given tells you how to assign groups. One person has a role of being like the person that collects everything – one person as well, being the speaker, and then they have to do a science investigation as that group.* (Pre-design interview)

Jenny reported that her perception of her students' technology skills was that "they all seem pretty good." And that "most people would probably have a computer at home." (Pre-design interview).

Jenny used a collaborative learning platform with her students, which they enjoyed. She explained that she mainly used the platform to set assignments:

Basically just set an assignment for the students, like a research task, and then can answer it in the Google Classroom and submit it and then you can assess it that way. (Pre-design interview)

Jenny referred on several occasions to the fact that it was difficult to access the laptop computers available for her class, which meant she was generally reluctant to use them.

4.3.5 How Jenny designed her history program

At Jenny's school, the teachers were allocated time away from their classes towards the end of each term to meet and identify goals for the following term's programs. During these meetings, a significant amount of time was spent analysing data collected on students' literacy levels which would guide the English programming. For the other subjects, each teacher was allocated a program to design for all the teachers in the grade to use. Jenny explained that they would discuss ideas for assessments, but for teaching and learning activities, the teachers would be free to incorporate what they felt was appropriate. Jenny clarified that individual teachers were responsible for the design of the program with little input from the assistant principals. Regarding integrating technology, Jenny explained that this was an individual decision on the part of the teacher designing the program. At the beginning of the following term, the non-teaching day would be used partially for all teachers on the grade to meet and present their units to each other. The aim of this was mainly so teachers would be familiar with the lesson content:

"Print out the program and give everybody a copy of that and that's it really, and maybe just have a discussion on what each lesson is in like a team meeting, see what we need to do." (Pre-design interview)

Jenny's TIL program was for the history topic of 'Australia as a Nation'. She decided to do a history program as it was an area of interest for her and because she believed "it was probably the easiest topic to integrate technology into." Prior to the design activity, she identified her key considerations for the program, which were to incorporate research tasks and to ensure that students understand the historical context of the topic areas:

I guess with history, a lot of it is research, so incorporating research elements into it and just ensuring that the students get the background knowledge that they need. I think a lot of the time we skim over things and just not giving enough detail.. (Pre-design interview)

Design day

Jenny used the staff room computer in the school during the design day, so that she had easy access to the school network, and the previous year's program and resources. Jenny brought an assessment task to be incorporated into the program which had been created by the teacher who had designed the history program for the preceding term. This program was intended to be a continuation of the topic area from the earlier program. Jenny also articulated some improvements she wanted to make on the previous term's program, which focused on the design of the Powerpoint slides and the incorporation of more video resources:

> *I guess last term I found the program wasn't reflected in the slides that were made; a lot of people only access the slides so it's really important that all the slides have all the information that you need. So, I guess making explicit slides that include everything. I like to incorporate the videos like I said before so I'll be using more of those. (..) there was a lot of writing so I found a video from BTN that explained federation which made it more explicit I guess for the kids to understand, easier to understand than just reading a lot..* (Pre-design interview)

On the design day, Jenny's approach was to use an existing program for this same topic, and change sections to reflect recent curriculum changes introduced in a new syllabus. She initially started working on a new program document by copying the focus for each lesson from the previous year's program. She then spent five minutes identifying syllabus outcomes and vocabulary to be covered, in line with the school's policy to support students' high literacy needs. She then moved quickly on to allocating content areas, resources and assessment detail to the new program document from the previous year's program and accompanying Powerpoint slides. This took approximately twenty minutes. At this point, Jenny explained that she felt one content area (migration) was not covered sufficiently in the program last year, and so she wanted to build up the focus on this area in the new program. As a result of this, she spent 45 minutes searching online, eventually locating an education resource from the Australian Human Rights Commission (AHRC)[5] website. She then added the details of the activities to the program document. This resource was an interactive learning resource and constituted the first student-centred TIL activity in the program. When later asked about this resource and her reasons for choosing it, she

[5] https://humanrights.gov.au

explained that she had been thinking about technology integration, but this resource had prompted her to think about a possible activity:

> *Yes, I was thinking about it but the resources helped too because they kind of prompted research tasks or they gave me ideas to make a research task that the kids could do in the computer lab.* (End of day interview)

Her thinking when considering the integration of the interactive learning activities on the AHRC website was concerned with the students' understanding of the content and their technology skills to access the activities:

> *I liked obviously the videos because it gives you deeper insight and the website's really good too – they were quite interactive and they were kid-friendly as well so the kids would be able to use them easily.* (End of day interview)

The subsequent stages of the design process on the design day were an iterative process of searching for and identifying online resources, adding lesson and assessment detail to the program document and developing the accompanying IWB slides.

By the end of the design day, Jenny had completed details of each lesson in the program and included links to resources she had decided to include. The following excerpt from the program documentation from the design day presents the detail included for each lesson:

TERM 2, Unit 5: Migration stories & citizenship	Evaluation	Register
Lesson 3: Migration stories *L.I: We are learning about migration* *S.C: We can:* • *Explain what migration is and why people might migrate* • *Explain how WWII impacted migration* • *List the arrivals in Australia from WWII* Recap previous lesson on (Rights of Aboriginals). Introduce migration – brainstorm what is migration? Why might people migrate? Explain what migration is and why people migrate – push and pull factors. Discuss what might be some push factors and pull factors for people migrating. Discuss how World War II marked an important turning point in Australia's immigration history and the move away from the White Australia Policy. Activity 1: • Explore the link http://www.nma.gov.au/interactives/tlf/homes/index.html • Complete the worksheet to record how many people were displaced Discuss post world war II arrivals – children of the blitz, 10 pound poms and displaced persons. Activity 2: • Julia Gillard Migration Policies worksheet Activity 3: • Ask students to list 10 things that they would take with them if they had to flee their homes and travel to another country – can only take what they can fit in a backpack and carry. • Think about what they would have to leave behind and what non-physical things they could take. **Computer lab task**: Have students go to the link http://www.nma.gov.au/interactives/tlf/homes/index.html Students need to select either Petronella Wensing or Lilijia Brakmanis and explore their interactive timeline. Students need to create a personal profile on person selected. Students then to create an exhibition in the 'Create Exhibition' tool. This should include an exploration of any disadvantages or discrimination.		

Figure 9: Excerpt from Jenny's program document

After the design day

Following the design day, Jenny spent a further 6.5 hours working on the program. Her main design focus was on refining the slides to accompany the lessons, and to add detail to the lesson outlines. At each point in her design work captured in the diary, she referred to working on the Powerpoint slides to accompany the program. Her design diary captured the changes she made to the program:

> *I worked on creating the PowerPoint presentation which is presented to the class and used by all classes to deliver the lesson. I worked on lesson 1.* (First entry, design diary)

As I had already planned the basis of the unit, I used that as a guide to create the slides. I added more information in the slides and made it student friendly. The only thing I changed to the program was adding a video explaining children's rights. (First entry, design diary)

Subsequent entries in the diary showed the addition of a total of three video clips and further information added to the slides as she systematically worked through each lesson. She completed the program design at school before the holidays so that she would have a break when term ended.

Jenny confirmed in her planning progress interview that her design activity following the design day had focused on adding detail to the program slides:

I haven't really changed a lot, like it was good on the planning day because I got to basically set out the whole unit.. and since then I've just been making the slides that go with it, so I haven't really changed.. because I was pretty happy with what I'd planned when you were here. (design progress interview)

To summarise Jenny's design process, the key influences on Jenny's thinking were the school's existing program and the school's preferred practice for teachers to develop IWB slides to accompany the program. A large proportion of Jenny's design work was on the creation of slides to support teaching of the history content, both on the design day and over the weeks before teaching (design observation and planning diary). Jenny explained that she liked the slides to have all necessary information for the program, and to incorporate videos because "it explains a concept maybe that you can't explain as well in a kid-friendly way." (Pre-design interview). The needs of the students were implicitly considered through the requirement of the school to create IWB slides. Technology was integrated (also implicitly) in an ad hoc way, through the resources identified in an educational website. This means that there was little consideration of the design of principled TIL to support the teaching and learning of the unit at the beginning of the design activity, it was more the case that TIL activities were incorporated to enhance the teaching of content. A further influence for technology integration was access to the computer laboratory where students could conduct research for their assessment, as well as access interactive learning activities from a government website to support deeper understanding of content in this area.

Analysis of the design process undertaken showed that Jenny followed a process which comprised seven stages. Table 10 presents each step of Jenny's design process in more detail:

Design step	Contextual design detail	Observed by researcher/reported by participant	Time taken
Familiarisation with content	1. Viewed syllabus and previous year's program	Observed and reported	10 minutes
Describe	2. Amended part of the old program to align with new syllabus	Observed and reported	14 minutes
Research	3. Searched online for inspiration for migration content. Iteratively searched and added to lesson detail.	Observed and reported	2 hours
Familiarisation with content	4. Viewed and amended last year's assessment	Observed	15 minutes
Describe	5. Viewed key online source (for interactive activity on migration) and added further detail to lessons	Observed and reported	16 minutes
Describe	6. Added program overview and success criteria	Observed	6 minutes
Create resources	7. Created IWB slides for the program	Reported in design diary and Pre-teaching interview	16 minutes and 6.5 hours after the design day

Table 10: Jenny 's detailed design process

4.3.6 Summary of Jenny's history program

Jenny designed a program for the New South Wales history syllabus, covering the development of 'Australia as a Nation'. She was working from the new NSW history syllabus, which prompted her to consider the weighting of the content areas in the program she designed, as there was a shift in focus from the old syllabus to the new one.

The program was designed to cover eight lessons, to be taught over a ten-week term.

Learning objectives:

- Identifies change and continuity and describes the causes and effects of change on Australian society
- Describes and explains the struggles for rights and freedoms in Australia, including Aboriginal and Torres Strait Islander peoples
- Applies a variety of skills of historical inquiry and communication

  English:
- Composes, edits and presents well-structured and coherent texts
- Uses an integrated range of skills, strategies and knowledge to read, view and comprehend a wide range of texts in different media and technologies

- Thinks imaginatively, creatively, interpretively and critically about information and ideas and identifies connections between texts when responding to and composing texts

Assessable tasks:

1. Work samples from information reports, student presentations and reflections on events (formative)

2. Creative task: Students to propose a new exhibit for Madame Tussaud's, Sydney. Students select a significant figure in Australia's nation and design a scene for the wax museum. Students also present an information report about the significant Australian.

Program overview:

Lesson 1: Focus on human rights by revising key concepts and identifying human rights and freedoms by completing a worksheet. Introduce Universal Declaration of Human Rights (UDHR) and students read and reflect on an article from the UDHR. Students create a word bank for human rights and then a work cloud using Wordle[6]. Review of assessable task for term.

Lesson 2: Introduction to topic of Aboriginal and Torres Strait Islander and events which shaped the development of their rights. Students view historical source from 1888 and reflect on the attitudes it demonstrates before completing a comprehension worksheet. Discussion of more recent events in Aboriginal and Torres Strait Islander history and identification of when their rights were upheld or denied. Students complete a timeline of events. Computer research task: find historical sources to add to the timeline (e.g. images or posters).

Lesson 3: Migration stories: Students brainstorm migration and why people migrate. Teacher discusses why WWII was an important point in Australia's migration history. Students investigate migration stories using an interactive learning task from the National Museum of Australia. Students complete worksheet before exploring the personal stories on the website and using tools on the website to create a virtual museum exhibition.

Lesson 4: Teacher discusses Snowy Mountains Hydro scheme. Students read stories of migration and discuss in pairs, then discuss as class. Students complete worksheet on stories of migration. On computers, students investigate more migration stories on website (immigrationplace.com.au) and complete worksheet on the stories.

[6] http://www.wordle.net/

Lesson 5: Focus on Australian migration. Teacher leads discussion on migration and the contribution of migrants and students complete worksheet. Teacher then discusses refugees and asylum seekers with class.
Lesson 6: Focus on Eddie Mabo and the Mabo decision as a significant event in Australian history. Students watch video about his life and write information report in their HSIE books.
Lesson 7: Students continue to explore Eddie Mabo's life by watching two videos. They then continue writing their information reports. Computer lab task: students search for 5-10 facts about Eddie Mabo that they did not already know. Students include this information in their reports. (Teacher advised using .org and .gov websites).
Lesson 8: Focus on the freedom riders and the 1967 referendum as significant events in Australian history. Students watch video to explain the events and completed a worksheet. Teacher led discussion of referendum and its significance, and the Racial Discrimination Act.
Further work to complete for assessment: research a significant Australian who has impacted the development of Australia as a nation and justify choice. Students create a diorama of this person which could be placed in Madam Tussaud's. Students complete an information report to accompany diorama.

Technology integration in the program

The technology used for teaching in this program was predominantly the IWB in the classroom. This was accompanied by Powerpoint slides, some of which included videos, to illustrate the content points and to support the students' understanding of the content. Jenny planned for three lessons to be completed in the computer lab. Two of the three planned lessons were taught. These included one lesson where students accessed interactive learning materials on migration to Australia from a government website, and took notes on some personal migrant stories, and one lesson for internet-based research. Most of Jenny's TIL activities could have been implemented without technology. Table 11 presents an overview of the TIL activities in Jenny's program:

TIL activity	Technology classification	Role of the activity in program design
1. Creation of word cloud for vocabulary on human rights using Wordle	Non-education	Developing students' vocabulary to talk about human rights
2. Online research to find historical images to depict events on timeline	Non-educational	Familiarisation with topic
3. Students engaged with interactive learning object about migration	Educational resource	Deepen understanding of stakeholder perspectives on time/event
4. Students investigate more stories on migration from historical website	Educational resource	Deepen understanding of stakeholder perspectives on time/event
5. Students watch videos on Eddie Mabo's life	Educational resource	Students to understand this significant person
6. Students research online to find additional facts about Eddie Mabo	Non-educational resource	Students to understand this significant person
7. Students watch video on the 1967 referendum	Educational resource	Students to understand this significant event

Table 11: Breakdown of TIL activities in Jenny's program

4.3.7 Teaching of the history program

The implementation of the program encountered a few disruptions. In order to align the teaching of the content about Eddie Mabo with a connected aspect of the English program, the grade teachers decided to move the content to different weeks.

One of the three computer-based lessons was omitted due to time constraints, but Jenny did not identify this as an issue because the activities were supplementary and not core teaching components:

> *Well it was kind of an additional activity.. It didn't overly affect what had been taught..* (Reflection interview)

Observed lesson

The researcher observed lesson three of the program. The lesson took place in the computer laboratory and its aim was for students to go through a series of interactive activities on the website of the National Museum of Australia in order to develop an in-depth understanding of the stories of migrants to Australia. Jenny outlined her plan for the students' activity during the lesson:

> *Yes, so it's a computer lesson where they have to research.. where they have to pick one of two women from the website, and they have to like research or listen to her story, and then just take notes in their HSIE book. And then after that they can create, like, an exhibition that's on the website.. and it's like picking photos to go to different things. I think one's like leaving home, 'cos it's all about migration, and things like that.* (Pre-lesson interview)

Jenny explained that she had already shown the students the website, so they were familiar with its interface. Her main concern with the lesson was the computer audio equipment because she was anticipating that some sets of earphones might not work. She made sure she had headphone 'splitters', which allowed students to share the audio from one computer between two sets of headphones in case there were issues with the computers themselves.

At the beginning of the lesson, there was considerable difficulty in providing the students with earphones so that they could listen to the audio of the activities. Despite Jenny being prepared with split earphones for students sharing their computers, there were issues with students not being able to hear properly and with some computers not functioning for the activities. During this time, Jenny was calm and problem-solved effectively by moving students around in the lab. It was clear that she was confident and familiar with the 'typical' issues with computers in the lab, and so this did not affect her negatively. However, this issue did impact on the time students had to complete the activities. Jenny noted that there were routinely issues with the computers and so she was used to problem-solving:

> *Yeah, you're kind of used to one computer's not going to work, or the login won't work, so you just kind of get used to it.* (Post-lesson interview)

There were differences in the levels of engagement of the students with the interactive materials, with some students taking the initiative to overcome initial difficulties with the mode of audio only:

> *I guess the other challenge for them is that they did have to listen to the information, it wasn't written as well.. I saw one girl who had opened up a separate page on the browser and had researched the girl as well, that she was looking at (..) so she had opened up a separate tab, must have Googled her name and was finding extra information there.* (Post-lesson interview)

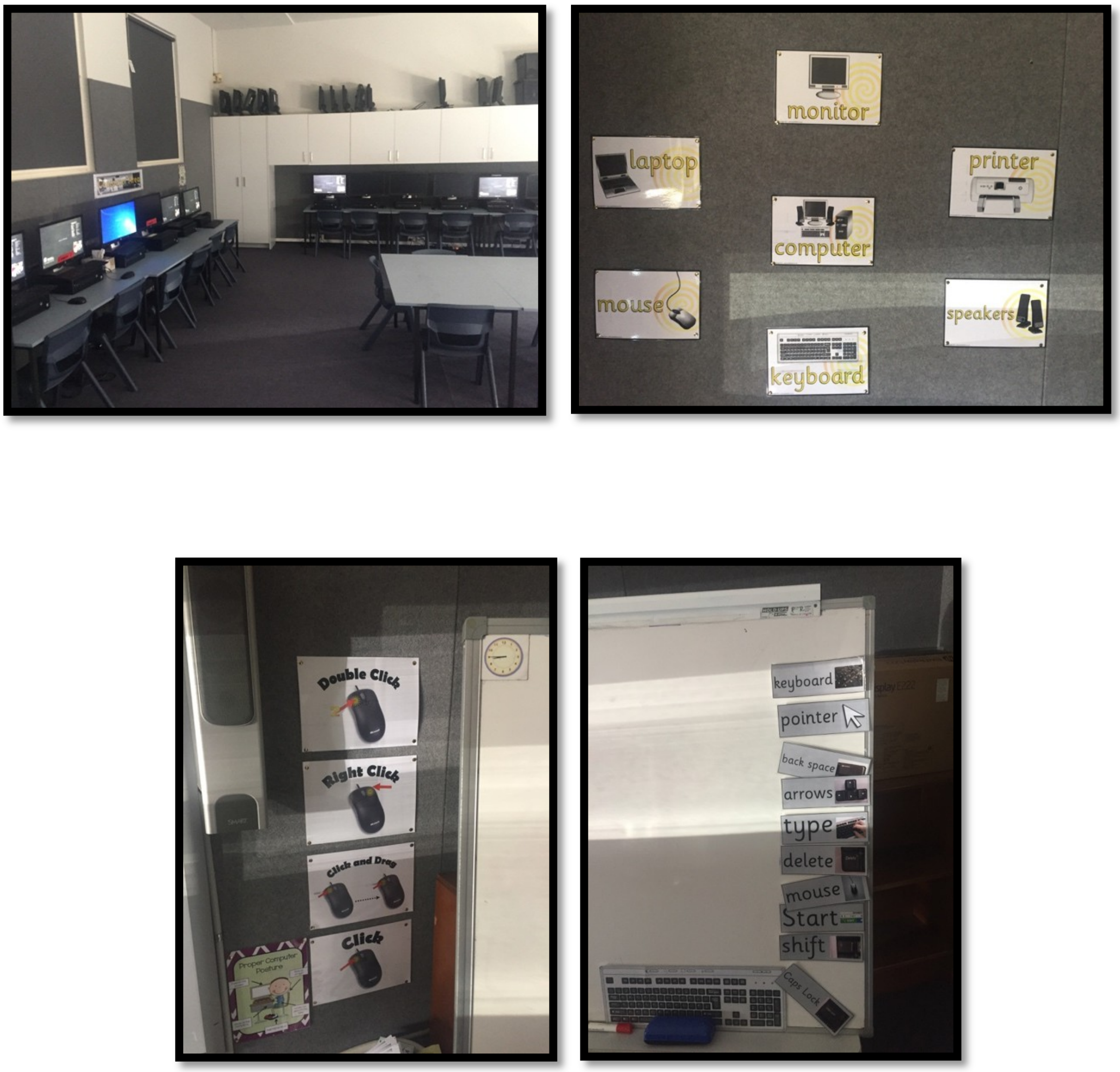


Figure 10: Images from the computer laboratory at Jenny's school

Jenny's reflection on the lesson

Jenny's reflection on the teaching of the unit was brief as she had to leave as she was rostered for playground duty. She reflected that the lesson had been more successful than she had anticipated:

> *Fairly satisfied – it went as I expected.. actually better than I expected – I didn't think they would make that many notes, to be honest.* (Post-lesson interview)

However, she did briefly mention that the students' knowledge and understanding had broadened:

> *You could see by the end when they shared all the things that they knew, so..* (Post-lesson interview)

When interviewed about the lesson at a later date, she recalled that the students had found the lesson engaging:

> *I think it was good because they got to research themselves, which is a good skill that they will need to have. And they did really enjoy the researching* (Reflection interview)

4.3.8 Jenny's reflection on the program

Jenny's initial reflections on the program centred on timing issues for the program and the changes made so that the lesson topics aligned better with the concurrent English program:

> *I didn't actually finish the whole thing due to time, so there's probably one lesson that I didn't get to teach. I also had to change the order as well, based on an assessment that we were doing in writing.. So they were writing about Eddie Mabo, and we were teaching that in HSIE, so we needed to change the order of the lessons, so they had the information.* (Reflection interview)

Jenny had planned to do three or four of the lessons in the computer laboratory, however access to the laboratory meant that she was only able to complete the technology-based tasks in two of those lessons:

> *..so I planned some computer lab lessons that were additional from my class lessons, and we didn't get to complete some of those just because of access to the computer labs.* (Reflection interview)

When reflecting on the students' responses to the program, she reported that most were engaged in the activities, but there were some students who did not show high levels of engagement. She identified these students as four or five boys in the class. She also explained that this was not unique to this particular program. Rather it was a general observation of these students:

> *.. I think most were engaged.. I mean, I feel like it gets harder, the older they get, they choose not to really learn. There's kids in there who just aren't interested in learning.* (Reflection interview)

Jenny reflected that the students enjoyed all of the computer-based research tasks they were assigned:

*I think it was good because they got to research themselves, which is a good skill that they will need to have. And they really did enjoy the researchin*g (Reflection interview)

However, she reiterated that access to technology was an issue for her teaching TIL:

> Jenny: *And.. I don't know about technology.. it's just hard here with access to computers..*
>
> Researcher: *You mean the access to the computer lab?*
>
> Jenny: *Yeah*
>
> Researcher: *And is there any technology you can take into the classroom? iPads?*
>
> Jenny: *We don't have iPads, we have laptops, but there's only six of them, and I think they're pretty hard to move around, they're in like a big…*
>
> Researcher: *Oh, like a big trolley? I think I saw them..*
>
> Jenny: *Yeah.. So you have to ask somebody to move them for you.. You have to ask the groundskeeper, but he's always busy doing stuff, so it's kind of like.. you plan a lesson and the laptops never come, and you're sitting there waiting for them..*
>
> Researcher: *Yes.. would you say that's your main issue around technology, the access?*
>
> Jenny: *Yeah, oh yes, for sure."* (Reflection interview)

When reflecting after teaching on how the TIL activities in her program supported student learning, her responses related to students' general technology skills development and engagement, rather than to any specific evaluation of how the integration of technology might have supported students in achieving their learning outcomes:

Jenny's reflections also explained that during the design and teaching process, she did not communicate with other teachers about the program, other than to change the order of the lessons. She explained that she made evaluation notes on the program document, but there was no further team communication about the program:

The only person who would see it is Dale, the AP, when he checks our programs, so he would read over it. But we don't come as a team together and reflect on it, no. (Reflection interview)

4.3.9 Summary

The case of Jenny's design of a TIL history program highlighted some key findings. Firstly, Jenny's approach to designing her TIL program was to amend an existing program. She improved the multimodality of the existing program by incorporating more videos, but the underlying structure of the program was unchanged. She identified TIL activities to add to the program when searching for engaging tasks online. When speaking about her TIL design, she reflected on the research task being useful for students in developing their ICT skills and the value of the interactive tasks and videos for supporting students' engagement and comprehension of the content.

Secondly, this case identified key contextual influences on Jenny's design process. These influences are discussed in this section, interpreted through the lens of activity theory. Table 12 presents an overview of this case through the activity theory framework:

Activity theory component	Evidence in this case
Tools	Low TPACK (higher level of CK, lower levels of TPK) and limited experience with TIL; Experience of teaching history program in previous academic year; Previous year's program and slides
Rules	Accepted design practice in school of creating IWB slides to support students' literacy needs; Limited access to technology; No leadership or support for teachers designing TIL
Community	Students: strengths and challenges; Colleagues' input on scheduling of lessons in program
Division of labour	Little/no feedback on program designed

Table 12: Components of Jenny's activity system

Jenny had limited knowledge and experience of TIL

Jenny's limited knowledge and experience with technology was a limiting factor in her design process. These factors are categorised as *tools* in activity theory. Jenny viewed technology as useful for helping students to understand content-related concepts and vocabulary related to lesson content. This belief is reflected in the dominant use of technology in the program to support students' vocabulary development and their understanding of key history-related concepts.

Jenny's teaching experience had been conducted at the same school, with the exception of a six-month placement at a school in the UK, where her main use of technology was the classroom IWB. Jenny's experience with TIL was limited to the use of the IWB. These two key facets of her experience could explain the strong influence of the school context on her design of a TIL program. The fact that her use of technology in the past has been predominantly through an IWB may have limited her TPACK development.

Jenny's knowledge (TPACK) and confidence about which technologies to use to enhance learning appeared to be limited to certain media and student tasks. When Jenny described ways in which she commonly used technology to enhance learning, apart from internet-based research tasks in the computer laboratory, she reported that her main approach was to use the IWB in the class, often incorporating video. This practice usually involved the presentation of content to the whole class. This is also influenced by the school's policy of creating slides to accompany each program (AT: *rules*).

Jenny demonstrated a sound knowledge of the content of the program (CK) and had reflected on aspects of the school's existing history program that she wanted to change. These changes centred on the communication of the content to her students, such as reducing the amount of text on IWB slides and incorporating video to explain the background to historical events. This shows that her pedagogical knowledge (PK) was focused on didactically delivering the content of the program so that her students could understand it. Jenny's strong focus on the slides also meant that many of the learning activities consisted of teacher-led discussion with the whole class; a predominantly didactic pedagogical approach. Despite talking about the range of learning needs and abilities in her class, Jenny did not report considering differentiation in any explicit way during her design activity. She expressed surprise when one of her students took the initiative to research the historical characters on websites other than the teacher-recommended site during the observed lesson.

Jenny' reflections on the role of technology in the program were limited to how the TIL activities supported students' general technology skills and not how they might have contributed to content-related learning outcomes appears to identify a gap in her understanding of how technology might be integrated into learning to support students' learning (TPK). Her design thinking and reflection appeared to focus strongly on students' understanding of content (TCK) and she did not articulate any thinking on innovative pedagogical approaches using technology which might transform students' learning experiences in the KLA.

An existing program at the school was used as the basis of Jenny's program design

Jenny used an existing history program as the basis for her program design in this study (AT: *tools*). She worked extensively with the document through the design activity, making changes that she reported to be necessary either to suit her students' literacy levels or to improve the mode of communicating some complex content, such as the political background to historical events. In this way, the existing program acted as an important tool for the design of her new program.

Accepted design practices in the school influenced Jenny's practice

The *rules* component of Jenny's design activity featured both the school's accepted practices and barriers to technology integration which impacted on Jenny's design of TIL. The school's accepted practice of designing IWB slides to accompany the program, which was implemented to ensure that students' difficulties with literacy could be addressed, proved to be a significant influence on Jenny's program design, with a substantial amount of her design time spent on the creation of the slides. This accepted practice appeared to stimulate Jenny to think about how to use the slides to support students' learning of the content. This practice led to Jenny incorporating several videos, which she used to stimulate whole class discussion of the content. The design of these activities meant that many of the lessons in the program were teacher-led.

Access to technology was problematic in the school

Jenny's prior experience of difficulties in accessing devices to use in the classroom at her school appeared to cause her to not consider their use in the program she designed. This negative experience originated in the school provision of technology devices and the system for using the devices in the classroom. As such, it is categorised as within the *rules* component of activity theory. These difficulties were the low numbers of mobile devices available for the number of students to use and the complications of arranging to share devices between classes; and the lack of reliability of having someone to assist with moving the heavy trolley of laptop computers to her classroom when she booked them. She at her explained at several points during the research that this specifically meant that she did not feel confident to use mobile devices in the classroom. Furthermore, Jenny had access to the computer laboratory once per fortnight, which made the scheduling of lessons within a program to coincide with the computer laboratory difficult to negotiate.

No leadership or support in the school for designing TIL

The *community* component of Jenny's activity system comprised her colleagues, her students and the school leadership team. Jenny perceived there to be no support from school leaders regarding TIL. Jenny did not identify her colleagues as having significant influence on the design of the program. The main influence of colleagues was the decision which was made to change the order of the lessons so that content aligned more effectively with the English program. Jenny reported that there was no input or contribution by colleagues to the technology-based learning activities. Jenny's students' needs were considered in her design work through the consideration of the language used in the IWB slides and the incorporation of internet-based research tasks which would support their general ICT skills.

The program was designed by Jenny with little input by her colleagues (AT: *division of labour*). As previously reported, the grade teachers made a decision to align the order of the lessons with the English program. However, Jenny reported no other discussion with colleagues on the subject of this program. Her assistant principal had the responsibility to approve programs, however he made no changes or recommendations to this program. For these reasons, *division of labour* is a component of Jenny's activity system which had the lowest level of influence on her design practice.

Contradictions in Jenny's activity system

Jenny's case raises several contradictions between the components of the activity theory framework in her case. Jenny articulated a belief in the value of TIL for the development of students' digital literacy. However, she did not have a level of knowledge or skills in in TIL from her initial teacher education or her previous teaching positions to support her capacity to design effective TIL for her students. This indicates a contradiction within the *tools* component, between her psychological *tools* of beliefs and knowledge/skills.

Jenny's beliefs about TIL are also in contradiction with several factors within the *rules* component of her activity system. The school's limited access to technology means that Jenny's beliefs are difficult for her to realise. The school leadership provided an implicit indication that technology should be integrated in teaching and learning through its program documentation, yet there was no clear leadership or support for teachers about how this should be achieved. Both factors identified here belong to the *rule*s component.

The school's accepted approach to designing programs (*rules*) which consisted of the revision of an 'old' program to suit the current cohort of students meant that Jenny had no opportunity to improve low level of TPACK and experience with TIL through the design activity. The 'old' program she redesigned had little TIL content. The school's policy of developing IWB slides for each program, while useful for teaching vocabulary and content, could have had the unintended effect of making the lessons very teacher-focused. However, this could also have been a result of the influenced of the students and therefore sit in the *community* component of activity theory.

4.3.10 Conclusion

Jenny was a teacher in her fourth year of teaching a grade six class at a large government school in a metropolitan suburb. She designed a program for the history syllabus focusing on Australian as a Nation. Technology was integrated in a minimally innovative way, using videos to present content and to explain key historical events, and students using computers in the school's computer laboratory to research information on migration to Australia and key figures in the fight for human rights in Australia over several different tasks. Activity theory identified that access to technology was a significant limitation for Jenny in designing TIL in her context. This barrier was exacerbated in Jenny's activity system by her low TPACK and minimal support in the school for designing technology-integrated learning.

4.4 Elena's History Program – 'Australia as a Nation'

4.4.1 About

This section presents the case of Elena. At the time of this research, which took place over 13 weeks during terms three and four in 2017, Elena was in her third year of teaching at an independent K-12 girls' school in a central metropolitan area. This was her first full-time teaching role. Elena graduated from a metropolitan university in New South Wales with an undergraduate degree in primary education in 2014. Elena was the teacher of a grade six class of 25 female students.

Elena designed a program for the new NSW history syllabus titled 'Australia as a Nation'. based on the content areas of government and the history of migration to Australia.

4.4.2 Elena's knowledge and experience of technology-integrated learning

Elena described herself as being very comfortable with technology, although she said she lacked confidence in her abilities to integrate technology into her programs in a pedagogically sound way:

> *I'm confident with the technology itself. Whether I'm using it to the best of its ability, I'm not sure. Like I'm sure there are apps on their iPad or there's apps other that would be really good that I don't know about. Whether I'm using Apple TV the best that I could – I don't know. Am I using my...? Do I need PowerPoints or are they for me, not for them? Like that sort of thing I'm still not sure about because I love having the PowerPoints because it kind of reminds me and my brain what I'm doing so am I thinking of them or am I thinking of me? So that's kind of my thing – am I actually using it the best that it could be used?* (Pre-design interview)

Elena took opportunities to develop her TIL skills, volunteering to undertake an external professional learning course in coding so that she could teach coding to her grade five class. Elena explained that she did this during the previous school year when she recognised that no other teachers were teaching coding because she believed it would be an important skill for the students to learn prior to their year six robotics tasks.

Elena did not undertake any TIL-based programs while at university. She explained that there had been an elective on the topic that she could have taken, but she was unable to due to a timetable clash. However, she reported that she learned some technological skills by observing her fellow students:

> *There was a – I think it was in third or fourth year – there was a prac option, like an optional extra subject where we got to pick a few and I remember (..) I didn't pick it because it didn't suit my timetable (..) but other than that one elective, there wasn't really a technology subject. It's kind of just something I've always enjoyed. I mean we used PowerPoint and things like that but there was no coding or anything like that involved. It was if you chose to do it. I mean I've learned, like Prezi, l learned that because someone else used it in an assignment and I watched them do (..) So there wasn't really a lesson or a subject on "This is how you could implement iPads or technology in the class", no."* (Pre-design interview)

Elena clarified that there was little exposure to TIL through other units at university:

> *So it wasn't really embedded in it, no, it was more we looked at like "How do you program it? How do you make a program? Perhaps you could use iPads if they have them or if they have laptops", but it wasn't really like hands-on, "Here's an iPad. This is what your students would do". It wasn't really that.* (Pre-design interview)

4.4.3 Elena's school

Elena taught at an independent girls' school in an inner metropolitan area and catered for students from Kindergarten to year 12. The junior and senior schools were located across the road from each other, in what had been an old residential area, but was now the location of many businesses and cafes. The junior school had approximately 300 students. Its student body was above the average Index of Community Socio-Economic Advantage (1168, average ICSEA = 1000).

Elena's school had a one-to-one BYOD iPad policy for grades five and six. She explained that the high school considered itself to have a strong focus on science, technology, engineering and maths (STEM), and the junior school had an understanding of the need to prepare its students for progression to high school in these areas specifically:

> *..so then they hit Year 7 and (..) what they do across the road is very STEM-focused so they love the concept of them being good at technology. So yeah, that's kind of how we've... we kind of saw a need and like a love of the kids – they love... like they all go on a coding holiday programs and they were*

> *loving it and we were like, "We should probably somehow involve them in that because they'll be engaged and they'll love it". So now, we kind of link it to the science technology curriculum."* (Pre-design interview)

A key component of the junior school's STEM program was that each grade had access to a different type of technology, with each grade aiming to scaffold students' knowledge for the STEM learning they would encounter in the following year. Younger years had access to virtual reality devices, for example, while grade five students learned about coding and grade six worked with robotics. For grade six robotics, there were several existing themed programs, which integrated the target technology in alignment with topics in their other subject areas. Meanwhile, as well as the student' devices, teachers had access to interactive whiteboards, iPads, Apple TV and laptops in their classrooms.

There was little internal support for teachers integrating technology at Elena's school. Elena explained that she was supported by her coordinator with any support she might need.

The school offered professional learning days which focused on areas which were integral to the teaching and learning priorities of the school. As well as this, teachers were asked to nominate their individual professional learning objectives. When they had done this, the school financially supported teachers to identify and undertake external professional learning to meet their objectives. Elena reported that she had identified technology as one of her learning objectives. This had allowed her to pursue external professional learning in coding and robotics. While Elena found the course to be valuable, she expressed a need for the skill to be contextualised in her school setting:

> *I think kind of the next step is to get the teachers confident with it because I said to Daniel (..), "I am loving robotics. I can't wait to teach it. Problem is what if I'm not on Year 6 next year" and someone else is on it and then they don't know about it. There needs to be like a system where like maybe I go to a course, I then come back, present on it and teach everybody and he's like "We're getting there"* (Pre-design interview)

Elena also reported that she believed there was a need for further support for teachers integrating technology into their teaching and learning:

> *..my long term goal here is to push to not have that and to have like a... I don't know if it's... it wouldn't be a deputy but some sort of head of technology within the junior school like a technology assistant or somebody that walks around and goes into classrooms and just helps teachers implement technology..* (Pre-design interview)

4.4.4 Elena's class

While participating in the study, Elena taught one of three grade six classes at the school. She reported that there was a range of differentiation needs in her class, from students who were learning at a grade three level maths to some students learning at grade eight level maths. She explained that there were often interruptions in her class as the structure of the timetable meant that some students left the classroom at different times to attend music classes.

Elena's students were very enthusiastic users of their devices in the classroom and they were very knowledgeable about the learning apps they were using. She explained that she liked offering them the choice in how to approach learning tasks:

> *..we've kind of throughout the years taught them which apps they have and what they're used for and they can kind of self-pick which ones they want to use which I think's quite good for them to know what they do and they're very good at knowing what works and what doesn't. They're very good at telling each other what works and what doesn't, (..) So they're quite good at teaching each other, yeah."* (Pre-design interview)

Elena explained that she purposefully spent time introducing her choice of apps to students so that they would be equipped with the technological knowledge and skills to independently choose the technologies they wanted to use. The apps Elena used in the classroom included mind-mapping tools, multimedia production apps and presentation tools. She had also introduced cloud-based storage and tools via Google Drive to overcome issues such as students forgetting their work, or their devices and not being able to continue working on their projects in the classroom.

Elena expressed the belief that technology integration was valuable for teaching and learning because it supported her students' preferred learning styles:

I mean I love using my Smartboard and I love having them come up and interact with it and I love that they get really engaged with it because some parts of teaching it is me having to stand and talk (..) but if there's a visual behind me I feel like they're more engaged in it and they can see, "Oh that's what she's talking about when she's saying that's how the circuit connects. There's a picture of it. Great. I get it. Here's a video of it".. (Pre-design interview)

Conversely, Elena also expressed a belief that there was a general tendency on her students' part to over-use technology. She explained that she thought she needed to be aware of this issue and to critique her use of technology in the classroom:

I think, for me personally, I think we've gone on a spectrum of we over-use and it's now kind of like making sure we're not using it for the sake of using it. (Pre-design interview)

Elena described her students as being very reliant on technology. On several occasions and in various interviews, she referred to the fact that students would use an app or take a photo of the IWB in preference to writing notes and working out problems on paper. Rather than use dictionary and thesaurus strategies for vocabulary development when writing, Elena reported that students would often use the thesaurus and dictionary shortcuts on their devices. She frequently reflected on whether this was detrimental to their general skills and noted that some students struggled to write well with a pen.

Elena explained that she applied a critical lens to her TIL activities in the classroom to ensure that the students considered non-technology-based resources as well as their technology-based resources:

Yeah, I try really hard to not just use it – like if they say "Oh, can I do my working out, my maths working out, on like Pages and then I can rub it out – or to Explain Everything" and I say "No, can you please use a piece of paper and write it down", "Oh, can I read a book on my iPad?" "No, can you please go to the library and borrow a book?" It's just making sure that they realise that there's other options, other than like using an iPad.. (Pre-design interview)

Another technology-related issue Elena encountered regularly was that of students messaging each other, or their parents messaging them during lessons using their iPads.

This meant that there would often be message notifications during lessons. She also expressed concern about the students' use of social media as they were under the legal age to do so. However, she said that when she mentioned this issue to parents, many parents did not consider it to be a concern for them. Elena explained her belief that because parents provided the devices for their children to use in school, that they felt comfortable messaging their children during lesson time. Because of some parents' lack of concern about their children's inappropriate use of social media, Elena reported that she felt that she lacked some authority over the students' use of their iPads in the classroom. She explained that students knew she could not confiscate devices overnight as a consequence for poor behaviour, and if she did confiscate devices during class, students would often retrieve their devices from her desk before they went home, sometimes without asking her permission. This gave the researcher the sense that she felt some loss of control of her classroom facilitated by the parents via the devices (Researcher field notes).

4.4.5 How Elena designed her history program

Elena explained that there the school had programs for all subjects which had been designed by senior staff members. These programs learning outcomes for each content area, but did not specify the learning activities or assessments. When teachers came to design a new program for their students, they added the learning activities, resources and assessment tasks to the pre-designed programs. These newly designed programs were saved on the school network and used by teachers the following year as the basis of their programs. Elena described the design process at the school as "tweaking" the program to suit the current cohort of students in the grade and to make changes in line with teachers' recommendations and reflections from the previous year.

Elena explained that all teachers on each grade met towards the end of a term to discuss the programs for the following term and how they might need to be changed to reflect the needs of the current grade cohort:

> *..it's grade programming – it's normally not individual class programming. So we sit down and we kind of say (..) What do they need to be able to know?" So, open up the syllabus, what do they need to be able to know, look at the outcome, "Okay, well what do we actually want them to be able to do by the end?* (Pre-design interview)

Elena described the design process as collaborative. However, the process she described was one of initial collaborative discussion followed by individual design work. After initial discussions with colleagues, each subject was allocated to an individual teacher who would design the program for the following term. Once completed, the programs were distributed to the other teachers for 'checking':

> *It is normally like I go off, do my own thing at the end of the term, come back and say, "This is what I've made. Are you happy with it?" I think a lot of the time, like I don't know how well people look at the program when I send it or when they sent it to me or anybody sends it to anybody – do they really scan through it and say they're happy with it or are they just like, "It's done. It's a tick".* (End of day interview)

Elena explained that the teachers liaised with the school's educational support staff and the gifted and talented support staff when planning differentiation in their programs. These support staff gave feedback on learning activities and assessment tasks in the programs.

The school had no allocated release from face-to-face (RFF) time for programming. Student-free days were dedicated to professional learning, which meant that teachers worked on programs in their own time. This could make it difficult to find an appropriate time to liaise with other teachers on the design of the unit, and Elena explained that adapting a unit designed by a colleague to meet the needs of her class was often done while she was teaching, due to a lack of time:

> *So there are things that I tweaked as I went just because I didn't do this at the beginning and I think it's just we don't have as much time to sit and like nut out a program as well as I would like because it takes all day to really read through it and I could do it in the holidays but then I know when I come back they've probably changed it so then I often don't get the term's program before the start of the term and then it's like which day I'll have to spend reading it. I have to teach it today and that's where it gets tricky."*
> (End of day interview)

When discussing her usual design process, Elena referred for the first time to her sense of deferring to senior colleagues:

> *..last term science, Term 1 and I was like a deer in headlights, Year 6, first time, and Dean goes, "Are you happy with the science program?" I was like, "Yeah" Like I'm not going to challenge it…"* (End of day interview)

Elena's sense of lacking agency was one which was raised at different points throughout the design process.

Design day

Elena explained prior to the design activity that the history syllabus contained a lot of content and she anticipated that integrating technology could help her manage the teaching of the content:

> *History is so information-dense so (I) to try and make it not just read from a textbook and interesting, I think technology is one of the biggest helpers in that.* (Pre-design interview)

Elena began the design process by reading through the school's program for her topic in order to understand the sequence of lessons and the content to be covered. She then viewed the syllabus and identified the learning outcomes to be covered in the program to ensure that the program addressed these outcomes. Elena created a set of slides for the IWB to accompany the program so that the delivery of the content could be achieved efficiently directly from the IWB in the classroom. Elena then considered the program she had taught in the previous term and whether there would be consistency or overlap of the content:

> *I opened up Term 2's which is this term and said, "Are we overlapping there? Is there something that we could maybe move to that term?" I kind of acknowledged that realistically, I won't finish Term 2 and so it will be bumped. Does that bumping still fit in and it looked like it still would make a lot of sense as it's government-related and then I just went through it week-by-week and said, "Does it make sense to me, the reader and then what can I make to link it?""* (End of day interview)

Elena spent much of her design time reviewing the old program and making small changes to it in her documentation. She expressed that she had some difficulty at some stages in understanding the learning activities and their objectives for the program. As a result of this confusion, she created new learning activities for content which she believed would meet the learning outcomes of the program for those areas.

> *..it goes into that and to have them research it and then come back and share and I found that – the way it was written, a little bit confusing, so I rewrote it and I turned it into a jigsaw activity where it involves them researching..* (End of day interview)

When considering individual learning experiences from the previous year's program, Elena critiqued the activities and asked herself questions about student engagement. This led to more technology-based design of activities which she felt would be more engaging: "How can I make this more interesting and just more fun for them to do?" (end of day interview, discussing green screen tv ad activity)

Elena voiced her consideration of a senior colleague's possible disapproval of her design work on this program during the design process. After lunch on the design day, she commented on her colleague's concern that she might make what he considered to be too many changes to the original program:

> *Even at lunch time I made a comment that I was doing history and Dean looked worried like I'd touched his program [laughing] very protective and (..) so I guess I'm very aware that people like things perhaps the way they were done and sort of not, almost make too many changes without checking.* (End of day interview)

By the end of the day, Elena had completed details of all lessons in her program document:

Week	Outcomes/Content	Teaching, Learning & *Assessment* Strategies	Resources (including Primary & Secondary Sources)	Register
3 - 4	HT3-3 Identifies change and continuity and describes the causes and effects of change on Australian society	• Discuss different methods of voting such as first-past-the-post, preferential. Students can create Venn Diagram showing similarities and differences between the two. See powerpoint in folder for typos of voting. • Review compulsory and non-compulsory voting. • Hold an election to demonstrate preferential voting based on the choice of breakfast cereals using the AEC website Ballot Paper Generator • Establish the number of votes needed to establish victory based on half the number of voters. Have students count the votes recorded on the ballot papers while recording and explaining the votes and how the lowest candidates are eliminated and their 2nd preference votes are redistributed and so on 5. How does an election work? • The students' political parties create posters for display to promote their parties • On the morning of the election, each leader gives a short election speech to include: o an introduction to their party and members' portfolios o an outline of their policy o any ideas they will introduce if elected o optional one-minute television advertisement. Green Screen can be used. • Students and Year 6 teachers vote and results tallied in accordance with the preferential voting method outlined earlier	Powerpoint- 2017-HSIE-History Class Voting: http://education.aec.gov.au/getvoting/ Ipad and Green Screen	

Figure 11: Excerpt from Elena's program document

Subsequent design activity

Following the initial design day, Elena spent three hours and 45 minutes working on the program. During this time, she met with colleagues to explain the changes she had made to the original program. Closer to the start of the next term, she met again with colleagues and they discussed and decided on logistical and timing aspects of the program, such as how they would organise the students' parliament and how long this activity would take. They decided together that because of the time required for this program, they would need to incorporate some outcomes from the English program.

After these decisions had been made with her colleagues, Elena worked on the resources for the program. She added to the teaching slides she had prepared, and she created resources to support the parliament teaching activity. Table 13 presents Elena's design process prior to teaching:

Design step	Contextual detail	Observed by researcher/reported by participant	Time taken
Familiarisation with content	1. Reviews previous year's program and its work samples to gain in-depth understanding.	Observed and reported	14 minutes
Familiarisation with content	2. Reviews syllabus and articulates her understanding of the content and whether this has been achieved in the previous year's program.	Observed and reported	2 minutes
Familiarisation with content	3. Returns to previous year's program	Observed and reported	10 minutes
Familiarisation with content	4. Reviews and critiques old program, commenting that some activities are difficult to understand and resources are missing.	Observed and reported	9 minutes
Describe and create	5. Adds to old program in a new document for this year. Additions include new links to digital resources and identifying alternative learning activities where some are missing or difficult to understand. She also starts creating slides to accompany the program. Locates an interactive online activity about migration to include.	Observed and reported	17 minutes
Think	6. Considers gaps in her own content knowledge and whether she needs to add different content to support alignment with previous term's program.	Observed and reported	7 minutes
Think	7. Considers colleagues' preferences and teaching approaches, and their possible response to technology integration, and how this might need to affect the design of the program.	Observed and reported	9 minutes
Describe	8. Adds to old program in a new document for this year. Additions include new links to resources and identifying alternative learning activities where some are missing or difficult to understand.	Observed and reported	10 minutes
Think	9. Considers assessment: reviews and critiques previous year's assessments.	Observed and reported	10 minutes
Describe	10. Adds to old program in a new document for this year.	Observed and reported	38 minutes
Collaborate, describe and create	11. (Subsequent design work) Elena spent 3 hours with colleagues discussing and adjusting the timing and approaches to teaching content in the program. She then spent 45 minutes adding slides to accompany the program.	Reported in planning diary	3 hours and 45 minutes

Table 13: Excerpt from Elena's program document

4.4.6 Summary of Elena's history program

Elena designed a 10-week program for the NSW history syllabus, which was taught in term three of the school year. The program was taught by all three year six teachers in their classes. The program focused on the history topics of the development of Australia as a nation and migration to Australia.

Learning objectives:

The learning objectives of the program intend for each student to achieve the following learning outcomes:

- Identifies change and continuity and describes the causes and effects of change on Australian society
- Describes and explains the struggles for rights and freedoms in Australia, including Aboriginal and Torres Strait Islander peoples
- Applies a variety of skills of historical inquiry and communication

Assessments:

- Topic test on Australian Government and Parliament including a reflection of their experiences and gained understanding.
- Students create a series of photographs/pictures/images/captions to portray the contributions of migrants to Australian society. During a group conference with the teacher, students explain the contributions of the people represented and why their contribution was significant.

Program overview:

Lessons 1 & 2: Students learn about the role of parliament and its responsibilities. Students work in groups to establish their own political parties and portfolios. They learn about parliamentary procedure and preferential voting. The key resource is the Australian government's parliamentary education website.

Lessons 3 & 4: Students learn about different types of voting systems and conduct a sample election on a choice of breakfast cereal using the preferential voting procedure to understand how the distribution of preferences works. Students also use their iPads and a green screen to make short political advertisements. After the election, students in the winning party form government and the other party forms the opposition and students decide who takes on parliamentary portfolios. Students use a voting system from the Australian Electoral Commission website.

Students learn about the role of the speaker of the house and other parliamentary jobs. Students then conduct a jigsaw research activity on levels of government, where each person in the group is assigned a level of government to research, which they then present to the group. Teacher provides links to appropriate websites to find this information. There is a topic test (assessment) on Australian government and parliament.

Over the following weeks, students maintain a weekly parliament, where they follow procedure to discuss topical questions following parliamentary procedure. They also establish parliamentary committees which will be used in term four to assist a cause linked to a topic in their geography program.

Lessons 4 - 6: Students learn about stories of migration to Australia through an introductory video and discussion. They then follow individual migrants' personal stories through interactive activities on a website of the Museum of Victoria. Students then identify where their own families came from and share on a world map. Students then work to create a digital timeline of migration to explore the main waves of migration to Australia and their impacts on the nation. The digital timeline is accessed from the National Museum of Australia website**.**

Students read the story of The Little Refugee and excerpts from The Happiest Refugee, by Anh Do to understand the story of a Vietnamese child refugee to Australia.

Lessons 6-9: Students research reasons for migration to Australia and add these to their digital timelines. In groups, they then research a particular group of migrants and research their contribution to Australia as a nation. Videos depict stories of Italian and British migrants and the migrant contribution to the Snowy Hydro scheme as examples.

Assessment: Students create and present a PowerPoint presentation of the story of their migrant group. They should include images, quotes and captions to help tell the story.

The final design of this program was that there would be two content areas taught side-by-side: Government and migration. The government component was taught as a grade, with students from all grade six classes working together to learn about parliamentary procedures, and to experience role-playing parliamentary processes throughout the term. In an additional weekly history lesson, students worked in their own classes to learn about migration to Australia.

Technology-integrated learning in the program

Elena's program contained several TIL activities. Table 14 outlines the technology used:

Activity	Technology classification	Contribution to learning
IWB slides	Non-education-based presentation software	Organisation of teaching for use with the IWB
Videos to introduce content	Education-based videos	Introduction and explanation of content
Interactive stories	Education-based online tool created by a museum	Students to engage with personalised versions of the history of migration
Timeline tool	Education-based online tool created by a museum	For students to visualise the timeline of various waves of migration to Australia
iPads	Non-education-based device	Students used to conduct online research and to create videos
iMovie	Non-education-based mobile application	Students used the iMovie app to create political videos for their mock elections.

Table 14: TIL in Elena's program

4.4.7 Teaching the history program

Elena taught the program in term three of the school year. Elena made 17 entries in her teaching diaries, one for each day the program was taught. The first four lessons of the program were devoted to learning about voting and parliament, with two of those lessons being taught as a whole grade: three classes of grade six students together. The following 13 lessons consisted of five whole-grade lessons on parliament, and eight lessons on migration, which were taught in individual classes. Elena taught the program as she had planned, with only minor changes to add explanations about voting when she identified some gaps in students' knowledge or understanding. She reflected that she would add further scaffolding at this point in the program if she was teaching it again. She noted in the diary that students successfully created political advertisements, which they viewed as a class.

Design while teaching

Elena made some adjustments to the program while she was teaching it. The reasons for changes were mainly to add in some supplementary scaffolding for students so that they were able to complete the learning activities:

> *As the unit went on, I did find myself I guess making a PowerPoint or two here or there as well to go along with some of the activities I was doing, which I put in my teaching journal diary, (..) because I either saw a need that the students didn't quite get it..* (Reflection interview)

Elena made some further adjustments to the program due to the timing of activities in the program. On two occasions, the students needed significantly more time than allocated to complete their projects or key activities. This meant that time was allocated in later lessons for these activities to be completed.

Observed lesson

The lesson observed by the researcher was lesson nine in the program, which focused on migration and the timeline of significant waves of migration to Australia. Elena was unable to attend a pre-lesson interview, as she was on student supervision duty prior to the lesson. However, she explained in her post-lesson interview that her main aim for the lesson was for students to understand the timing and the reasons for migration from particular regions of the world. She explained that she intended to use the slides on the IWB to support the presentation of content, but that students would have a choice of tools to use to create timelines, including their iPads and their choice of app.

In the previous lesson, the students had presented their families' migration history, which had activated their existing knowledge about migration.

In the observed lesson, Elena introduced the concept of migrant stories by reading the personal story of a child refugee from Vietnam to the class. Students chose whether they wanted to sit on the floor or stay at their desks while they listened. After the story, Elena showed a sample timeline diagram on the IWB as a model for the activity that the students would be doing in the lesson. Elena anticipated that some students would experience difficulties working completely independently to research migration to Australia and interpret their information using a timeline diagram, so she explained that she allowed them to work in groups. She also reported that she remained close to those students during the activity so that she could offer support when needed. The researcher noticed that students chose to work on this activity using a wide range of tools. Some students used various apps on their iPads and some chose to use A3 paper and coloured pens. Elena explained that this was common practice for the students and that they were confident in choosing the tools which worked for them:

> *There are certain subjects where I'll say, "We're doing a mind map. Can you take up Popplet? That's the mind map" but I'll still have girls saying, "Can I just do it in my book?" I kind of like to think by Year 6 they're pretty good at knowing what they like and what each one can do. I think one group started on PicCollage, realised, "This is going to look really messy"*

> *and then changed and a couple of girls did it A4 and then said, "No, I need A3" and changed.*
> *They're pretty good at knowing what works for them.* (Post-lesson interview)

Elena reported that the timeline activity took much longer than she had anticipated and so she allocated time the following day for them to complete it. After the lesson she explained that this was important to do because there were gaps in students' knowledge of migration history which were important to address:

> *I observed that they probably know less... some of them know less history than I expected in that they got very mixed up with events. (..) But yeah, I think they learned quite a lot historically, like when things happened and why that affected Australia but I think they have a lot more to go. I think they were a little bit more confused than I expected which is why I think it took longer. So I thought they'd read it and kind of get it.. and that tells me, "Okay, we need to go back and do this again. We haven't quite got our historical timeline quite right".* (Post-lesson interview)

Elena also reported that the students were engaged and interested during the activity, although there had been some interruptions as three students had to leave to go to music lessons and returned in the middle of the timeline activity. This meant that Elena had to help them start the activity as quickly as efficiently as possible.

4.4.8 Elena's reflection on the program

Elena reflected extensively on the success of the program in supporting students to meet the learning outcomes. She explained that she was satisfied that at the end of the program, the students had a good level of knowledge of how the federal government worked and the roles played by other levels of government. She was particularly happy with the students' learning in this area because she explained that their knowledge at the beginning of the program was extremely limited. Elena was also satisfied with the students' learning in the content area of migration. She explained that because the school was located in an inner-city area, students were used to seeing people from a wide range of ethnicities. However, she reported that the students had increased their understanding of the reasons people have migrated to Australia from different countries over the years, and how they have impacted on the development of Australia as a nation.

When discussing the technology integration in the program, Elena reflected primarily on the logistics and organisation of technology in the classroom. She reported that her use of PowerPoint to organise the delivery of learning content was a valuable teaching tool for her and the students had enjoyed watching videos rather than listening to the teacher delivering content:

> *..and then for me in my teaching I think that they just... and they told me that they really like that I don't kind of just stand out the front and talk – that there are videos and images and things for them to look at – that it's kind of a combination because it's just... to keep them engaged is tricky and that is a big way to keep them engaged as well.* (Reflection interview)

Elena reflected generally on the value of using Google Docs to save students' work and the use of iPads for research. She reported that in the event of students' devices not working, they were able to access students' work on a borrowed device through Google Docs, which helped to minimise disruption to the learning activities. She also reflected that researching online was a useful skill for students and an activity that they enjoyed.

Elena's reflection on the design process

Elena reflected that she spent too much time reviewing the previous year's program and that she used the program to guide her design more than she wanted to. This resulted in an extensive focus on government in the program, whereas in the new history syllabus, the focus on government has been reduced. She commented that this was a result of her senior colleague's influence:

> *When you look at the new syllabus it's not as big an outcome as it was in the old, however, one of my grade partners is very passionate about it so that was almost a barrier in that I wanted to instil a little bit of change; not do it so often, but then I faced the whole... he didn't want to and then we're a team and so finding a sort of compromise there.. So I guess that would be the one challenge and the one thing I would then change for next year as well.* (Reflection interview)

Elena commented that she would like to change this for the next year as she knew she would probably be teaching the same grade. She explained that she would like to approach the design of the program by identifying the significant outcomes in the syllabus for that content area and "backwards map" to ensure all the learning activities supported the students' successful achievement of the learning outcomes. She commented that this might be conditional on the other teachers on the grade and she intimated that she regretted not being more assertive:

> *It'll just depend, I guess, on who's on the grade and how things go, but that was kind of the big thing – I walked away..* (Reflection interview)

Elena reflected that there were some technological problems as the program progressed, but these did not significantly impact on the learning:

> *A lot of my plans were to use a PowerPoint. There were a few times when we tried to use in our common (..) room – we tried to use the airplay on the television or PowerPoint on there and we were having some pretty big technical problems with that which wasn't ideal but in terms of me and my classroom, the screen was really good, PowerPoints were good. I also got the girls using their iPads for quite a lot and there were probably one or two girls who had iPad issues – either their iPads were really old or it wasn't charged so there were little things like that which were quite frustrating at times where they'd say, "Oh, it's not working. That app's not working" – they can't print anything, little things like that but as a whole, it worked pretty well.* (Reflection interview)

Elena reflected that because of her good knowledge of the history syllabus, she did not feel reliant on the technology:

> *I learned a bit about how to overcome if there are any issues with it that it's not a big obstacle, so kind of saying to the girls, "If you don't have it... you know, either you don't have it today and we do something else" or if there's no internet, "Okay, we change the lesson or get your laptop" – I think I found that at times I still rely on it a little bit but history is a topic for me that I'm quite comfortable with and I enjoy teaching and I know a little bit about it so I didn't tend to need it as much out the front but I still liked having kind of the support behind me, knowing that it's there.* (Reflection interview)

Elena commented on the students' research skills in the program, which surprised her because many of them preferred to research using books rather than navigate the complexities of researching online:

> *I think the big thing as well is that I often will say to the girls, "Okay, start – you can go research this" but teaching them the skills of research and that it's a big web out there and trying to narrow down their search, say for kids, you can get a book as well and I guess the one thing is when I actually got books, a lot of them preferred the books because it was easier to navigate. So that was also quite interesting to see."* (Reflection interview)

Elena reflected on different aspects of her students' learning with TIL. Firstly, she reported that the technology integrated in the program supported their learner independence:

> *I think the big thing is that it allows them to do a lot of inquiry and independent research which I really enjoy. For example, that migration group, they were able to look up like, "What was the Vietnam War? How many Vietnamese migrants came here? Why did they come here?" It's information that I know a little bit about but I don't know as much as what technology can give them..* (Reflection interview)

She continued to reflect on how the use of collaboration tools in the program supported students to produce work in groups more effectively and efficiently than they would otherwise have been able to. She also reflected that these tools had resulted in the students being more explicitly responsible for the work they produced:

> *.. and then the way they presented it as well so they were able to collaborate on Google Slides so if somebody was away, it didn't impact them because one girl could be at home and one girl could be at school and could be working on it at the exact same time. I even had girls Skyping each other if one was at home sick to talk about what needed doing. (..) I could have four girls on the same document at the same time which is something that in a book you just can't really do and the amount of times somebody said to me, "Oh it's in her book. She's away". I'm like, "That's not..". it doesn't fly anymore..* (Reflection interview)

Elena's final comment on the students' TIL-based learning was that the multi-modality which was facilitated by technology increased the students' engagement in the content:

.. and then for me in my teaching I think that they just... and they told me that they really like that I don't kind of just stand out the front and talk – that there are videos and images and things for them to look at – that it's kind of a combination because it's just... to keep them engaged is tricky and that is a big way to keep them engaged as well." (Reflection interview)

4.4.9 Summary

The case of Elena's design of a TIL history program highlighted some key findings. Firstly, Elena engaged in a process of refining an existing program as her main design process. She made minimal changes to the lessons and activities in the existing program. Elena reviewed the existing TIL in the program and made minimal changes. She discussed technology as being engaging for the students and as facilitating collaboration. Elena's students used iPad and Google apps seamlessly in their classes, however these were not a consideration in her design process.

Secondly, this case identified key contextual influences on Elena's design process. These influences are discussed in this section, interpreted through activity theory. Table 15 presents an overview of this case through the activity theory framework:

Activity theory component	**Evidence in this case**
Tools	Belief in value of TIL; Good TK, but low TPK and TCK, lacking confidence in these areas; Existing program
Rules	Accepted design practice; BYOD policy; No identified support for TIL design in school
Community	(Agency) colleagues; Students
Division of labour	Logistical contributions

Table 15: Components of Elena's activity system

Elena had limited in-depth knowledge about TIL

Elena's knowledge about TIL was variable. Elena demonstrated comprehensive knowledge of some specific areas of technology use in education, while her knowledge of other areas was shown to be less thorough. She had strong technological knowledge in coding because of professional learning she had undertaken supported by the school. However, gaps in other components of her TPACK knowledge meant that her overall understanding of designing TIL was limited. Elena had not been able to undertake learning about TIL during her initial teacher education at university. Because of this, there were noticeable gaps in her knowledge, which may have led to her lack of confidence in implementing TIL.

Elena's knowledge in the individual components of TPACK was variable. Elena's case presented evidence of variable knowledge in the individual components of TPACK. She reported that she felt confident in her knowledge of the history syllabus (CK) and the content areas she addressed in the program. This meant that when she was teaching and encountered technological difficulties, she was able to flexibly change to a low-technology approach and therefore minimise the disruption to the lesson. Elena reflected extensively on issues related to teaching her group of students (PK) and that she was mindful of using different teaching approaches which would engage her students. Elena's technological knowledge (TK) was strong in some areas. She said that she enjoyed working with technology and was interested in learning more about its potential use in the classroom. She had undertaken professional learning in teaching coding because she recognised its importance to the teaching of robotics, which was part of the grade six technology program at the school. However, she expressed a general lack of confidence and knowledge about implementing TIL in the classroom. She reported that she would like to have a deeper understanding of its potential value for students and how she should best approach its use in the classroom.

Elena expressed confidence and knowledge about how to use technology for specific areas of teaching (TPK) and explained that this knowledge came from her experience in her teaching. She was confident about the use of Google Docs for students to create and share documents, because it eliminated the problems associated with individual storage devices such as USBs, which could be left at home and accessing group work when a member of the group was absent. She was confident that online research was an important skill for students to learn and practice, and she also reported that she valued supporting students' independence with technology by allowing them to choose the apps they wanted to use to complete certain learning tasks. Beyond these three areas, Elena was unclear about how she should approach the integration of technology, thus showing the limitations of her TPK.

Elena demonstrated and expressed the least knowledge about the use of technology for teaching specific content (TCK). When talking about integrating technology to teach specific content areas, she relied on existing content in the program or conducted general online searches for resources which were aligned with a particular content area. This strategy resulted in her finding the interactive timeline tool and the interactive migrant stories, however this occurred through general searching rather any strategic search for particular types of activity, such as interactive resources to enhance understanding. She did not approach the search for resources with any clear targeted type of resource.

In sum, Elena appeared to have a good knowledge of the apps that she had recommended to students to use independently. She also had good knowledge of iMovie, which she used to enhance the creative learning aspect of the program dedicated to political parties' communications with the public, although this activity was part of the existing program and so cannot be identified as a TIL task created by Elena. This indicates that her knowledge is strong in some areas of TCK, but limited beyond the use of iPad apps.

Elena's belief in the value of TIL did not translate into innovative TIL design

Elena was strongly influenced by her internal context. Internal *tools* which influenced the design activity in this case include beliefs and knowledge. The accepted design practice in the school and the use of the previous year's program in the design of a program in this study was so significant that it was less obvious how Elena's beliefs and knowledge influenced the design. However, evidence of these influences could be found in the data when focusing on details of the design process.

Elena articulated her beliefs in the value and importance of integrating technology into her teaching and her students' learning activities. However, she also expressed concern about the effects of possible over-use of devices in the classroom. This concern was expressed in recognition of the fact that her students were highly dependent on their devices for most types of classroom work and the fact that they were highly skilled in their use of apps for learning heuristics. This belief led to Elena's in-depth evaluation of each TIL activity in the program to identify the validity of its inclusion in the program. In activity theory, we can identify the influence of the *community* component of the framework, i.e. the students, on Elena's psychological *tool*, her beliefs.

Elena's design approach was to amend an existing program

The previous year's program was a significant tool in the design process. Elena consistently viewed, evaluated, accepted and/or replaced elements of the old program in order to design the new program. This use of the existing program constitutes its categorisation as a design *tool* in activity theory. This approach was directly influenced by the school's accepted practice of adapting the previous year's program for the current year's cohort of students. Accepted practice in activity theory can be categorised in the *rules* component of the framework, thus identifying the influence of a *rule* on this *tool* in this activity system.

The school's accepted approach to design influenced Elena's practice

There were two aspects of the rules component of activity theory which were key influences on Elena's design practice. Firstly, the accepted practice of redesigning the previous year's program for the current year's cohort of students. This practice was at the forefront of Elena's mind during her design activity. She referred briefly to the syllabus to check that the program's content aligned with learning outcomes prescribed in the syllabus, but this action was limited to a two-minute reading of the syllabus. This accepted practice was also indirectly influenced by senior members of staff who expressed concern to Elena about her potentially changing too much of the content. This indicates a connection between the *rule* of accepted practice and the *community* of colleagues.

Elena's colleagues indirectly influenced her design decisions

Elena's colleagues (AT: *community*) were an important influence on her design practice. During the initial design day, she talked aloud about considering her colleagues who would also be teaching the program and what they might think about the TIL activities she was considering. More significantly, Elena mentioned on multiple occasions that her colleague who had written the original program had spoken to her about his concern that she would change parts of the program. She talked about how this made her reluctant to make any big changes to the program and to keep it as close as possible to the program's original design. In the reflection interview, she commented that she had kept to the original weighting of the content in the program despite the fact that the new syllabus had reduced the amount of content on government.

The students were also an important influence on Elena's design practice. She talked about being aware of their need for engagement and their enjoyment of multimedia presentations of content and this influenced her when searching for resources to replace missing sections of the old program.

No support was identified in the school context for designing TIL

Significantly in this case, Elena did not identify any sources of support in her school *community* for designing TIL. This was not an area which she received feedback on from her colleagues or from the school leadership. The design of TIL was the duty of Elena alone.

There was little *division of labour* in this design activity. Elena was individually responsible for the design of the program which was then shared with colleagues who would be teaching it in the coming term. Elena's colleagues provided some feedback on the practicalities of teaching the program, comprising mainly the amount of content which could realistically be covered in one program and the order of the lessons, which needed to align with events, such as an excursion, and other aspects of school scheduling.

Contradictions

Contradictions in Elena's activity system originated predominantly from the *rules* and *community* components of the system. The school's accepted practice (*rules*) of minimally adapting existing programs in order to create new programs meant that Elena felt there were limitations in the design work she was able to do. Additionally, pressure from her colleague (*community*) to change the existing program as little as possible lent additional weight to the limitations which Elena perceived during her design work. These factors represent contradictions between the *rules* and the *object* and also between the *community* and the *object*.

Through the activity theory lens, Elena's design activity is strongly influenced by the *rules* and the *community* aspects of the framework. Her school's accepted practice for program design meant that she was limited in her capacity to creatively design a new program (*rules*). One senior colleague influenced her to limit her integration of new learning ideas and activities (*community*). Perhaps more indirectly, she was hampered by her lack of knowledge and skills in TIL (*tools*) and by her concern about her students' overuse of technology in the classroom (*community*).

4.4.10 Conclusion

Elena was a teacher in her third year of teaching a grade six class at an independent girls' school in a metropolitan suburb. She designed a program for the history syllabus focusing on Australian as a Nation. Technology was integrated in multiple ways; using videos to present content and to explain key historical events, students using their BYOD devices to research significant events in Australian history, and students using their devices to explore interactive learning objects available on museum websites. Activity theory identified that school program design practices were a limitation for Elena in her capacity to be creative in her TIL design. The analysis of her activity system also highlighted a lack of agency on her part in designing programs generally, and a lack of confidence in designing programs for her students who were extremely confident in using technology and who she felt had an over-reliance on their devices.

4.5 Catherine's English Program – 'Poetry lights up our world'

4.5.1 About Catherine

This section presents the case of Catherine. At time of this research, which took place over 26 weeks from March to October 2017, Catherine was in her first year of teaching at a small Anglican independent school in central New South Wales. In the year prior to this study, Catherine graduated from an undergraduate degree in education (K-12) at a metropolitan university in NSW. Catherine was the teacher of a composite class of 19 grade five and six students.

Catherine designed a program for the NSW English syllabus focusing on poetry, entitled 'Poetry lights up our world', which was taught over two terms for a total of 17 weeks.

4.5.2 Catherine's knowledge and experience of technology-integrated learning

Catherine expressed a belief that digital literacy should be an integral part of most learning tasks.:

> *I think is important, so, "Yes, you've written this up. Okay, let's type it up, let's pop it on the Word document. Oh, let's have a go at the formatting too while you're there" – just learning those quick skills when they're younger so when they get older, yes, they've got the word processing, yes, they know how to open this and this but then building on that further and adding in their internet, so, "Where do I search for things too" when they're not given a specific website, "Where do I go?"* (Pre-design interview)

Catherine also believed that the thinking behind the execution of some technology-based tasks should be explicitly demonstrated to students:

> *.. I think as teachers, we think often that they know how to do it all and we need to revise that and think, "Actually, I need to explicitly be talking through my thinking process when I'm going onto a website and explaining what I'm doing rather than just doing it all the time on the internet and using apps. I think we need to explain our learning intention behind technology."* (Pre-design interview)

Catherine had personal technological knowledge from high school, where she studied a computer science subject in year 12. This experience meant that she had some skills in coding. Catherine's experience with technology-integrated learning (TIL) at university was reasonably broad, from planning a program of work for science with technology integration, to completing a program on ICT, which she described as "quite basic":

> *I think it was ICT, something, but I found that quite basic for what technologies used because we just created an interactive notebook.(..) Yeah. That was one of the assessments and I sort of did that in half an hour and sort of thought "Okay, come on guys! Give me something more" but I mean that's what you use in school. You do use your interactive notebooks but it's not the be all and end all now..* (Pre-design interview).

Catherine commented that the ICT unit she studied at university was useful for identifying apps for teaching mathematics. The experience of designing a technology-integrated program for science led to her becoming familiar with the application Padlet[7], a mobile application, which allows students to contribute their ideas through text on to the IWB, and which she noted she used frequently in the classroom, especially as a way for students to demonstrate their learning (formative assessment). Catherine reported that she had used a wide range of technologies in the design of the program for the university assignment:

> *We had a website so we used Wix as our website based and we also had a Padlet which was a live blog so ideally the kids – which were the uni students – all had iPads and they were recording what they were doing and then we had a QR code which they'd scan for the activity and then they would post that up to Padlet at the same time.* (Pre-design interview)

Catherine explained that she identified a difference between designing TIL at university and for her teaching work because at university their programs had focused on teaching younger years, whereas in her work she was able to challenge her students more because they were in higher grades:

> *..a lot of my uni, I was planning for the younger levels where now I'm on Stage 3, I can actually really challenge them to use actual websites. We have a thing called "Canvas" which I've started using with my maths class as well where they can log in, they can do activities online which is really, really good because it's basically like a website and you can design it yourself.* (Pre-design interview)

[7] https://padlet.com

Catherine also identified the difference in time available to design TIL between university and her current role as a full-time teacher:

> *I think so too because at uni, you have more time to put it together but in reality, you're sort of pulling resources because the internet has so many resources, you're pulling resources from everywhere and working out what's the best one to use.* (Pre-design interview)

Catherine explained that while she had seen TIL during her teaching practicum, she was not able to experience teaching with technology first-hand due to the way in which technology was organised at the school:

> *And also as a prac student, you don't get access to it (technology) unless you access it through the teacher that you're with. (..) Which is quite challenging as well; because I guess you don't have your own online access to put it all on there and they're sharing files with you from the server, whereas I feel like if you were to experience the whole server as a prac student it would be just a little bit more experience which I think is important.* (Pre-design interview)

4.5.3 Catherine's school

Catherine taught at an independent school in central NSW, which had approximately 500 students from Kindergarten to year 12. The school's Index of Community Socio- Educational Advantage (ICSEA) value was slightly above the national average at 1063 (ICSEA average: 1000). The school was located in a regional city and many students travelled from surrounding towns to attend, with some travelling up to an hour and a half every morning and afternoon. Most of the students from the junior school continued to the high school program.

Catherine's school had a bring your own device (BYOD) policy, and students in grades five and six brought their own laptops to class. Students signed a BYOD contract at the beginning of the year which pertained to expected behaviour and usage with technology in the school. There was no school recommendation for a brand of laptop and so Catherine's students had a range of brands in the class. Teachers and students had access to the school drive, the repository Google Drive and the learning management system Canvas[8]. All classrooms had interactive whiteboards (IWBs) with a computer connected to it at the teachers' desk. There

[8] https://www.instructure.com/canvas

was IT support available at the school four days a week. Catherine reported that there was no prescribed practice or guidance for teachers designing technology-integrated learning at the school: any support in that area has been informal. An example of such informal support was when a colleague, who had taught grades five and six the previous year and used the Canvas platform, explained to Catherine the main functions of Canvas and its benefits for students of that age range:

> *I had one of the teachers who use... because they all swapped around stages at the start of this year and another teacher had been on this stage last year and she used Canvas a lot and she talked me through the way that she used it for homework..* (Pre-design interview)

Teachers at the school were able to decide how they would use Google Drive with their students. Catherine set up Google Drive for her class herself. She stated she had intentions to use more functions of Google Drive, such as Google Chatroom, with her students. When talking about using technology at school, she commented that she was able to edit HTML code on the Canvas platform, through her high school coding experience and by using online guidance.

Catherine reported her reflection on the ICT integration at the school in terms of the SAMR model (Puentedura, 2010) which she had worked with at university. She explained that she found most TIL activities used by teachers were not transformational:

> *.. a lot of the apps we use, we're just using it for enhancement, rather than transformation all the time, so we don't get beyond there.* (Design observation)

Catherine also identified that some technology-focused knowledge was expected of all teachers:

> *I was lucky because while I was studying I was also working at a school and I was using the school database all the time but I think if you were never to use a huge database like that and coming into teaching, it's very different. (..) you don't talk about that at uni or anything like that. It's just sort of expected when you come in you know how it works...* (Pre-design interview)

Catherine had a teacher mentor at the school, who was the head of teaching and learning. This support was in place for Catherine as she was going through her initial teacher accreditation process. The support she received through this mentorship was with day-to-day issues, such as behaviour management. On a daily basis, Catherine found her grade five and six colleagues to be a valuable support. They had regular fortnightly meetings to discuss how various programs were progressing.

Along with other staff member in the Junior School, Catherine was in the middle of an online professional learning course on Visible Thinking learning routines, a set of approaches for students to experience deep thinking and learning of concepts, through Harvard University. This training was delivered through the Canvas platform, which gave Catherine the opportunity to experience Canvas as a student.

4.5.4 Catherine's class

Catherine described her students as "the lower end of Stage 3" (Pre-design interview), which meant that she had a wide range of academic levels in her class. She commented that while the range of students' abilities in English was broad, the range in maths was not so large. There were two other classes on the stage, both composite grade five/six, one of which was an enrichment class for student who were identified as needing a higher level of academic challenge. Catherine's class had 19 students, and the other classes had 23 and 24 students respectively.

When talking about integrating technology into learning experiences for her students, Catherine was very mindful of extending her students' technology literacy. She identified that many of her students felt confident in technology because they spend a lot of time outside of the classroom on gaming platforms. However, she reported that this did not mean they had skills which were necessarily useful for learning:

> *I know quite a lot of them get on at home and they're on the X-Boxes on the weekends so they thought technology will be fine, but it actually took them a long time to understand Google Drive, to understand how their internet's working and when it doesn't work, "Actually I need to go to IT"..* (Pre-design interview)

This lack of general knowledge about ICT among her students meant that the initial setup of students' laptops at the beginning of term was quite laborious and time-consuming, which Catherine had not expected:

> *"Oh they must be so good with technology because they've had all this exposure" but they've had exposure in a different context completely which was challenging at the start.* (Pre-design interview)

Her realisation that students struggled to navigate file sharing platforms like Google Drive meant that she sought out opportunities for students to develop these skills through learning tasks. For example, in order to help year five students to develop their skills in line with the year six students, she introduced a research project where year five and six students worked together to produce work using Google Slides and Google Docs. She also frequently used opportunities to extend free writing activities by requiring students to type up and edit their writing on their laptops.

Catherine also refers to the need for her to model good ICT practice; a concept which she had developed through the professional development work on visible thinking:

> *And also using it appropriately too in front of them as well so they can see and be more explicit. We're doing visible thinking as well so I need to be more explicit in why I'm using this site in front of them so they know, "Oh yes, that's a good site because..." rather than just clicking on sites from Google and being like, "Oh, that's okay", sort of thing.* (Pre-design interview)

4.5.5 How Catherine designed her English program

Programs in stage three at the school were each allocated to a teacher to design, and while they might have had input from other teachers if they requested it, design was generally a solitary process. Google Docs was used so that teachers could share the documents, but "but mostly we were dividing it up so we just did one program ourselves" (Pre-design interview). There was occasionally more input from other staff members if they had a particular skillset or experience in a key learning area (KLA). Prior to teaching, there was a planning day before the start of term where the programs designed by individual teachers were reviewed by all teachers on the stage, and adjustments were made if needed. Completed programs were checked for alignment with the compliance requirements for the Association of Independent Schools (AIS).

Catherine explained that she felt she had more autonomy and agency in designing programs at this school in comparison to her previous experience in a school:

> *I don't know whether it was just the school I was at – it's probably different for every school and because you're working too with a teacher supervising you all the time and trying to get you on the program so perhaps that's a different environment too.. whereas I feel like when you're teaching, you could be like, "Oh I can see everyone's interested in that. Okay, we'll just go down that track for a little while and see how we go" because there's not someone, I guess, over your shoulder all the time being like, "Go back to here, go back to here". I feel like you have a little bit more moving space in a way which is nice.* (Pre-design interview).

Before the initial design day, Catherine had discussed the parameters of the English program she was going to design with colleagues who would also be teaching the program. These discussions helped her establish that there would be a strong focus on poetry which would align with a planned incursion by a local indigenous poet. The discussions also influenced her to focus on film as a mode of assessment:

> *Yes, definitely what we discussed together. I think it was also to bring out different outcomes. For the poetry slam they have to perform it, they have to record it, they have to use the film techniques themselves rather than just seeing it and analysing it all the time.* (End of day interview)

Catherine had also spent time thinking about the assessment(s) for the program, but commented that she felt she was initially being over-enthusiastic with her ideas:

> *Because I got a bit carried away with the assessment. I was like "Oh, this'll be really great. They can do this or this or this" but I had to think back through and I was like "Actually, what structures of poems do I want them to know? What am I going to have to explicitly teach.* (Pre-design interview)

Catherine explained that prior to the design day she had found a sample program on poetry online which broke down the explicit skills that the students would need to develop through the study of poetry.

Design day process

On the design day, Catherine brought her Visible Thinking [9] materials, both book-based and online resources. She worked solely on her laptop throughout the day.

Catherine began the design process by creating a new document in Google Drive to document the program. She then opened the sample program on poetry that she had identified in preparation for the design activity. She scanned the program for components that she liked for about five minutes, before opening the syllabus document. In the syllabus, she focused on the learning outcomes, copying them into her program document on Google Drive, because she felt that the learning outcomes would help her to define the assessment. After scanning another sample online program, Catherine returned to the syllabus document to review it in more depth for two specific reasons: Firstly, she wanted to ensure that the technology-supported assessments she was planning would cover the learning outcomes in the syllabus, and secondly, she wanted to check the alignment of the content with students' knowledge and skills, and learning outcomes in the syllabus (Design observation). After spending approximately 30 minutes viewing the syllabus in depth, Catherine began documenting the assessment tasks in the program document. She spent approximately 14 minutes making detailed notes on the assessment tasks.

Following this focus on assessment for the program, Catherine spent five minutes reading through her notes from university on the Substitution Augmentation Modification Redefinition (SAMR) and Technological Pedagogical Content Knowledge (TPACK) theoretical models for education technology integration. She commented that she wanted to identify components of these models and highlight them in her program design:

> <u>Researcher:</u> *So you want to bring that image of the model (SAMR) into the unit so that you can refer back to it, or so that the other teachers know..Or..?*
>
> <u>Catherine:</u> *so that I can refer back to it and so that the other teachers know too.. On my PDHPE unit, I colour-coded it according to the inquiry.. (..) but what I think I'm going to do is, I'm going to type up the stages, and then I'm going to colour-code it according to where we're at with this model. Because I think that the technology, we use throughout it, so it will be interesting to see where we get to.. Are we just using it to*

[9] https://pz.harvard.edu/projects/visible-thinking

redefine, or are we actually.. (types into unit document)
(Design observation)

<u>Catherine:</u> *I guess this (TPACK) will be good for reflecting on what we've done, so I might use it more for the reflection and use it to reflect on every part according to the TPACK model.."*

<u>Researcher:</u> *So you might use it for reflection on teaching?"*

<u>Catherine:</u> *Yeah, on our teaching… but also the students' engagement. Are they mostly just engaged with the content that I'm teaching, or do they purely just base themselves on the technology and haven't got the content and the pedagogy behind it? Because the pedagogy will sort of come from that enquiry cycle.. Are they actually at that stage of the enquiry cycle or are we still here? That will be quite interesting. I haven't done that before.* (Design observation)

After considering technology integration, Catherine moved on to considering her professional learning on visible thinking strategies and how she could integrate these through the program in the lesson activities. While considering this, she began to add some detail to individual lessons in the program and create slides to accompany the lessons using Google Slides. This part of the design activity lasted for 10 minutes before Catherine took a break to coincide with the morning break at school.

After the break, Catherine explained that she had taken the opportunity of meeting her colleagues at break time to discuss her thinking on the program so far. When she returned, she had made some decisions regarding the extent to which text was going to be incorporated through the program (in comparison to other media such as video and audio), and also that the program would be taught over two terms rather than one.

Catherine then began to work iteratively on adding detail to lesson structures and content, while also searching for supporting resources. She also referred at this point to email correspondence from colleagues about ideas on how to use text in the program. This stage lasted for 13 minutes before she returned to thinking about technology integration. By this time, Catherine had identified two main ICT tools that she wanted to incorporate into the program. She had given significant consideration to the affordances of these technologies and how they might be used to meet the needs of students in her class:

> <u>*Catherine:*</u> *So what we might get them to do is, as much as they can post their ideas to Padlet, having that ongoing reflective journal, which will be their Storybird, when they go back and pop it.. it will be a simple copy and paste onto a different platform. And that will be a good skill for them to see and then they can come back to their Storybird and see where they are going with all their techniques, as well as going back to their English Toolshed.*
>
> <u>*Researcher:*</u> *So at this point the technology is to show their learning?*
>
> <u>*Catherine:*</u> *Yes, and we'll start to use it as a reflective tool with the class.*
>
> <u>*Researcher:*</u> *What lesson is that in?*
>
> <u>*Catherine:*</u> *That's from the 'tuning in' session, so we'll start right from the start.* (Design observation)

There then followed a 13 minutes stage where Catherine viewed resources and added detail to the program document, before spending a further 10 minutes thinking about visible thinking strategies and technology integration. She commented that Padlet could be used to support the visible thinking activities and could be used to stimulate students' thinking prior to, or during, the incursion by the poet.

At the end of the design day, Catherine commented that she had not finalised the learning outcomes as they could change as the program progresses.

When reflecting on her approach to designing TIL during the design day, Catherine explained that she considered technology at the level of the learning activities, thinking about how it could support students' learning:

> *I guess the skills and the content came first and then the technology acted as a tool behind it rather than being the technology first and then how do I implement it. I think it was more based on the learning and then how the technology supports it rather than using the technology itself by itself.*
> (End of day interview)

While Catherine used the syllabus repeatedly throughout the design activity, she reported that she used it to check that she was covering required content, rather than as a source of inspiration for TIL:

I guess it does lend itself to what you should do with the technology but I think we came up with more the ideas first, then went back to the syllabus rather than going to the syllabus first, then the ideas because I was sort of as I was going through the syllabus, I was thinking, "Oh, you know, like that's the main idea for this assessment. Yes, I will tick this one off" sort of thing rather than going, "Okay, this is my syllabus. What should I do now?" (End of day interview)

Catherine reported that her decisions about which technologies to integrate into the program were made with colleagues, based on what might interest and engage students:

Well I guess we were bouncing ideas off one another for a couple of weeks and the story bird, my class has been really keen to use it for a while. We introduced it earlier just as a narrative, creating a book more than anything. (End of design interview)

She also explained that the technologies would work together to support efficient feedback to students on their work prior to their assessment:

The Storybird is going to be more individualised so it's more their work sample. It would be equivalent of their book but then I had to rethink the way I was thinking about that because as much as it's their book, how are we also sharing it so we're all seeing it all the time. Rather than having to pull up one individual book, I decided actually for some activities it would be good if they just quickly typed something up on a Google Doc and then posted it to the Padlet so they can see that live feed of learning happening between all of them (..) Yeah, and it's a lot easier as a teacher when it's coming up on one stream rather than all the different platforms to go in – it makes it hard, so ideally the Padlet, if they were to make a quick mistake, the teacher could just quickly comment on it and say, "Quickly change this" and giving them that time before they add it to their story bird rather than having to go into the story bird individually and edit it out of there. (End of day interview)

By the end of the design day, Catherine had identified learning outcomes from the syllabus to underpin the program. She had also added detail of the assessments to the program documentation. She had also added significant detail to the first lesson in the program, but had not documented detail of any further lessons. Figure 12 depicts the level of detail captured in her program documentation at the end of the design day:

Syllabus outcomes	Preparation	Learning activities	Feedback and notes	Sign off
Term 2 Week 3				
	English Slides Individual class padlet Individual storybird accounts and poetry book	Pre assessment • MR: Vampyre by Margaret Wild and Andrew Yeo • Students read Vampyre by Margaret Wild and Andrew Yeo and write out their ideas behind See, Think and Wonder or Observe, Understand and Question. Tuning in **Rhyming couplets** • SR: Jan Dean chooses Silver by Walter de la Mare with focus on rhyming couplets • MW: Rhyming couplets • Add to english toolshed rhyming couplets • IW: Rhyming couplets and post rhyming couplets to Padlet to share with the class. Students choose four rhyming couplets they created to add to their story bird poetry book. **Shape poems** • Add to english toolshed (see slides) • MW: Shape poem • IW: Students type up shape poem on google doc and then copy and paste it to Padlet and their story bird poetry book. **Modelled reading** • Brown Girl Dreaming by Jacqueline Wilson **Shared reading** During shared reading focus on the film techniques. Put out he close-up and the medium close up. Discuss the importance of using the medium close-up for filming yourself in documentaries and for the news. • Three little pigs by Roald Dahl followed by video clip of the story • Little red riding hood and the wolf by Roald Dahl followed by video clip of the story **Connect, Extend and Challenge** • TD and IW: Print out Jan Dean chooses Silver by Walter de la Mare for the class and model how to annotate the poem and then let the class annotate the rest and post final product to the class padlet. • TD: Model the connect, extend and challenge routine to class using the poem Jan Dean chooses Silver by Walter de la Mare and the picture book Vampyre. Students then have a go at the thinking routine on their whiteboard desks using both texts. The class then comes together to share responses on a google doc created by the teacher. **See, Think and Wonder** • Read four news articles about Riverbank Frank. See CANVAS for the news articles. • Student record a see, think and wonder in the english books about the message/s that he might include in his poems when he comes to school.		
Week 4 Term 2				
		Tuning in Incursion • Students participate in an incursion with Riverbank Frank. Students bring in wonder questions from previous week to ask Riverbank Frank during the incursion.		

Figure 12: Excerpt from Catherine's program

Subsequent design activity

Following the design day, Catherine recorded in her design diary that she spent approximately 12 hours at home, on five separate occasions, adding to the learning activities for weeks 1-5 of the program and taking time to consider the associated learning outcomes. This was done in consultation with some colleagues. She also worked on creating slides to accompany these lessons.

Following the work on the lessons, Catherine wrote in her journal that she was confident that she knew "where this program is going" and so was able to write the rationale, which she spent 30 minutes doing. Her final stage of working on the program focused on developing lessons for weeks 5-10 of the program, and formatting the document using the school framework. The school framework for documenting the program was unfamiliar to Catherine and she took about an hour to familiarise herself with its structure and to re-document the program in this format:

> *This allowed me to use the UBD framework which I do not fully understand at this stage. It also allowed me to map out the formative and summative assessments throughout both term 2 and 3. I think this format makes the unit flow easier and will also be clear to follow as I teach week by week.*
> (Planning diary)

Catherine added additional elements to the program prompted by the format of the document:

> *I've got to go through and have a look at that tonight. I did also have to add the UBD elements which included transferable skills and essential questions. Rachel's added modified core enrich questions as well, as well as what the students will be able to... and there's something missing there – so what they'll understand and what they'll know.* (Design progress interview)

Catherine reflected that the document was useful in making explicit elements of the program which would otherwise remain tacit in her thinking:

> *It actually makes it also flow through because you can see, "Oh, you know, these are the questions I want them to ask throughout the unit, this is essentially what I want them to be able to do" and how they actually apply it to other areas of learning rather than just KLAs. I quite liked that – the transferable skills because that's not really covered in any curriculum necessarily. It's just a given that it happened sometime.* (Design progress interview)

During a student-free planning day, prior to teaching the program, Catherine spent a few hours with her grade colleague, who added differentiation activities to the program. This was so that the program could be taught in the gifted and talented class and also so that the program met the criteria of the school program format.

Prior to teaching this program, Catherine made some significant changes to the technology tools integrated in the program. She made a decision to remove Storybird, one of the main technologies she had incorporated in the program. This decision was based on her experience trialling Storybird with students at the end of the previous term, where she found the students' interaction with the tool to be too disruptive of the learning activity:

> *I think over... it was in the last couple of weeks, I started using Padlet with the Year 6s when the Year 5s were practising for NAPLAN and the Padlet worked really well and then I got my class to use Story Bird and that didn't work so well just because they kept on forgetting their log-ins and I thought, "Well, you're actually probably learning...", like if you're trying to get them to compose a text and actually put it up, it's taking too long for them to log-in and waste that time but that could be used for learning so I think I got rid of Story Bird because it wasn't effective.* (Design progress interview)

Catherine identified that there were opportunities for TIL which were afforded by the school's learning platform (Canvas LMS for her Visible Thinking resources):

> *And then I've worked out through Canvas which is I guess our online learning platform – each class can have their own Padlet but then I think through the unit, we actually composed a poem together as a class and then we swapped poems amongst ourselves so we can just go onto each other's Padlets and look at the learning.* (Design progress interview)

> *I think that's going to be where we start to have those really good conversations about technology when it's used for a learning tool that you need to be respectful of people online so hopefully that'll all come into play using that.* (Design progress interview)

Catherine explained that there were some potential difficulties originating from the fact that the students used laptops with various operating systems. This meant that she had to spend time researching technology tools which would work well on most systems.

> *..because the kids are all on different laptops which makes it quite tricky – it's not like with Apple we can just go straight and use iMovie because that's the platform that works for all the laptops – I had to research like a video editing software which would work across all their laptops. So that*

implementation is going to be tricky and I'm going to have to talk to IT about that one but I did find a programme called "Short Cut" which doesn't look too bad. (Design progress interview)

So that was sort of looking in advance but I thought if I get it organised this term rather than waiting to Term 3 and getting them then to install it. I'm going to have to talk to IT about them installing it.. (Design progress interview)

Table 16 presents an in-depth view of Catherine's design process prior to teaching:

Design step	Contextual design work	Observed by researcher/reported by participant	Time taken
Prior thinking	0. After discussions with colleagues and own research, had ideas for using video and book creation app as assessment tools in program	Reported	
Familiarisation with content and Describe	1. Opened syllabus and two sample programs on poetry. Added learning outcomes from syllabus to Google Doc files she used to document the program.	Observed and reported	10 minutes
Familiarisation with content	2. Iteratively viewed teaching activities in sample programs and content in syllabus. She checked technology outcomes and how they would align with her idea for the assessment.	Observed and reported	32 minutes
Describe	3. Documented the pre-assessment, formative assessments and some activity ideas.	Observed and reported	14 minutes
Think	4. Considered how she might use TPACK and SAMR models as reflection tools on the technology integration in the program.	Observed and reported	6 minutes
Describe	5. Started documenting learning activities in each lesson and created slides to accompany the program. This continued until the lunch break.	Observed	10 minutes
Collaborate	6. During lunch break, discussed with colleagues on grade which text to use and that she can run the program over two terms.	Reported	N/A
Describe	7. Added to structure of lessons, incorporating sample poems from online search to illustrate poetry features. Considered differentiation after referring to email from colleague.	Reported and observed	15 minutes
Think	8. Considered her plans for TIL and how to use the platform Padlet in the most efficient way in the classroom.	Reported and observed	5 minutes
Research	9. Searched for and evaluated resources and teaching activities for English skills. Incorporated visible thinking routines into activities.	Reported and observed	34 minutes
Describe	10. Added detail to learning activities, slides and learning outcomes	Reported in design diary and design progress interview	12 hours

Table 16: Catherine's design process in detail

4.5.6 Summary of Catherine's English program

Catherine designed a program for the NSW English syllabus focusing on poetry. The program incorporated cross-curricular links to the science and visual arts syllabuses. The program was designed to be taught over 17 weeks and two terms. This schedule allowed for flexibility for interruptions over the two terms and included the visit by a local indigenous poet.

The learning objectives of the program were:

- For students to recognise features of poetry
- For students to experience writing poetry

The assessable tasks were:

1. Weekly formative assessment tasks on students creating sample lines of poetry containing target poetic features.
2. Students write and film a slam poetry performance.

Program overview:

Lesson 1: **Visible Thinking Routine: 'Observe, Understand and Question' a Poem**

Without any context students read through a poem and use the poem to complete the table observe, understand and question. This will be gaining information on students visual literacy skills and their ability to recognise the text as poetry.

Lesson 2: **Formative Poem Assessment**

Write a short poem using rhyming couplets, shape poetry and including a message behind your poem.

Lesson 3: **Formative Poem Assessment**

Create a poem using imagery, personification and rhyming couplets. Don't forget that your poem needs to have a message behind it.

Lesson 4: **Formative Brainstorm Assessment**

Students start to brainstorm ideas for their poem in english books using interviews with Riverbank Frank as inspiration. This poem will be also for the Dorothea Mackellar Poetry Competition 2017.

Lesson 5: **Formative Poem Draft Assessment**

Student refer to brainstorm to write a draft for their poem this will go in portfolio with lots of feedback to help the students with the next stage of their assessment

Summative Poem Assessment

Students complete poem using feedback from their draft and this will also go in their portfolio

Lesson 6: **Formative brainstorm assessment**

Investigate Visual Literacy Techniques

Students complete brainstorm of 3D illustration of their poem, employing at least three visual literacy techniques.

Lesson 7:

Work on visual literacy techniques/poem and diorama.

Lesson 8: **Summative diorama-visual literacy synthesis with poem text**

Second term:

Lesson 1: Formative Bush Ballard Assessment

Students write their own bush ballad from the perspective of an Australian that lived in the bush during the 1900s. This will go in their portfolios.

Lesson 2: **Formative analysis of Dawn by Dorothea Mackellar Assessment**

Students use their knowledge of poems to analyse the poetic techniques within the poem Dawn.

Lesson 3: **Formative Connect, Extend and Challenge on Paper people by Harry Baker**

Students apply their knowledge of poetry to the poetry slam poem Paper people using a known visible thinking routine.

Lesson 4: **Formative Observe, Understand and Question on Touchscreen by Marshall Jones**

Students apply their knowledge of poetry to the poetry slam poem

Lesson 5: **Brainstorm on main theme behind individual poem for poetry slam**

Students write a brainstorm of their ideas they have about their own poem for a poetry slam

Lesson 6: **Draft poem for poetry slam**

Students write a draft poem for their poetry slam

Lesson 7: **Summative Assessment on final poem for poetry slam**

Students use feedback from their draft to complete their final poem for their poetry slam

Lesson 8: **Formative Assessment on progress filming poem on poetry slam**

Students start filming their poetry slam

Lesson 9: **Summative Assessment final film of poem for poetry slam**

Students complete filming of poetry slam

Catherine developed a set of IWB slides to guide the teaching and learning in the program. Her slides included links to a Prezi presentation on features of poetry (see Figure 13) and many videos of poetry performances exemplifying different poetry styles:

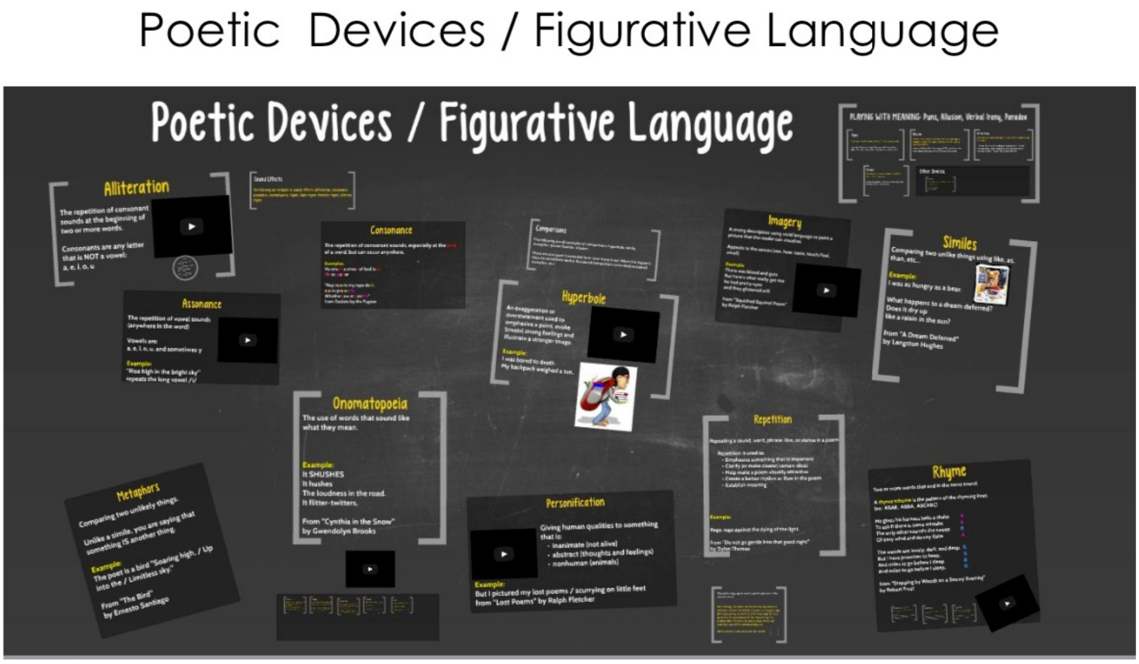


Figure 13: Examples slide from Catherine's program

Technology integration in the program

Table 17 below presents an overview of the technology-integrated learning experiences in the final version of Catherine's program:

TIL activity	Technology classification	Role of the activity in program design
1. On laptops, students contribute ideas and writing samples to the class IWB using Padlet	Education website (Padlet)	Used throughout the program to share students' work and for students to review and give feedback on the work of their peers.
2. Students film their performance of a slam poem and complete editing of film	Film-making software, non-education specific (Shortcut)	Assessment task to demonstrate learning of poetry features and film-making skills

Table 17: Breakdown of TIL activities in Catherine's program

Catherine's main TIL activities were sharing poetry writing with peers via the app Padlet on the IWB and using laptops to video and edit their performances of slam poetry. The activity of creating an e-book using the online tool Storybird[10] was cut from the program after the design day, as Catherine realised that her students' ICT skills might not be developed enough to be able to achieve the e-book task.

[10] https://storybird.com/

4.5.7 Teaching the English program

The teaching of the program went according to the scheduled program of lessons. However, the main cause of some design changes was timing. Several factors occurring during the term influenced the timing difficulties: The class were required to undertake testing of a new government system for testing literacy, reading and numeracy, which was unexpected. There was also a lot of illness among the students, which meant that some planned work was not able to be carried out. The unexpected timing issues resulted in the head of learning and teaching (a colleague on another stage three class) making the decision to change the format of the summative assessment: Instead of writing a piece of slam poetry, the students were assessed on their performance of a slam poetry piece written by a slam poetry performer.

As the program progressed, small changes were made in order to ensure that sufficient progress was being made through the program. The decisions about changes were made following stage meetings between Catherine and her colleague who was teaching the extension class. Some key changes made to Catherine's program were the omission of a diorama activity in the first term of teaching, and the omission of the light display task, which was an integration of the science syllabus.

Observed teaching

The researcher visited the school to observe a class where technology was a significant feature of the lesson. Unfortunately, there was no opportunity to interview Catherine prior to the lesson as she was on playground duty and the lesson was the first of the day. In the interview following the lesson, Catherine explained that her aim for the lesson had been to show examples of poetry features on video which would stimulate students' thinking about the poems they were writing, and would allow them to reflect and add some more poetic features to their work. She explained in the Post-lesson interview that it was important for her students to be reminded of poetry techniques and to experience writing and re-writing drafts of their work:

> *I guess because I've got a lower end class, we are continually going back like "What are the techniques? What can I add into my poem?" And we're sort of starting to discuss what it means by different drafts, like "This is my first draft. How do I build on that for my second draft" sort of thing. This is the first time they've really started drafting out their writing more than anything. I can't just say to them, "Go do the draft" – I have to actually give them something..* (Post-lesson interview)

The lesson started by having students focus on the IWB to view the presentation Catherine had prepared for the lesson. The students were supposed to watch videos of poetry as songs so that they could identify poetic features used in the lyrics. Unfortunately, the internet connection was slow, which meant that the videos in the presentation did not load and could not be shown. Catherine managed to find an audio version of the song she had chosen for the lesson, which did play and so the main aim of the activity was achieved. The next activity was for students to work on their own poetry samples on their laptops. While they were doing this, Catherine was able to ensure that Padlet was working on the IWB. She then circulated around students, offering feedback and support on their poetry writing. The final part of the lesson was a stage where students copied their writing to their Padlet accounts and shared them on the IWB. It was very interesting to see how students quickly became very engaged in viewing their fellow students' work on the board and that they made positive responses to each other.

Catherine's reflection on the lesson

Catherine reflected that although the internet connection problems had led to her making some changes, it was something that she was prepared to deal with:

> *...there was no point – I guess when you know the technology's down, there's no point just waiting that five minutes, them getting frustrated and getting reckless and you just working yourself up so I just moved on pretty quickly and I was like, "Okay, well part of it's working so let's go onto the next technique".* (Post-lesson interview)

She reported that despite the videos she had planned to show not being accessible, the Padlet application had worked and had had a very positive effect on students' engagement with the writing task:

> *..they love watching their work come live on the screen which is really nice to see. It was also nice to see the two boys down the back which I hadn't anticipated happening because it hasn't really happened much apart from with the rhyming words – they're actually scrolling through other people's poems which were coming up live and trying to work out what everyone else was doing which is quite nice; even though you're in the same classroom, they're interacting in a different way to what they have before.* (Post-lesson interview)

The way this activity led to students engaging with each other's work surprised Catherine:

> *Yeah, I was quite surprised because normally they're sort of, I guess a bit egocentric about work they're doing. It's all about me, sort of thing.*
> (Post-lesson interview)

Catherine reported that she underestimated the time it would take for students to complete the writing task. The result of that was that she had to make a decision in the class to continue with the task rather than moving on to the next activity she had planned. She explained that she decided to continue with the activity because the students were engaged in the task:

> *l think their writing is a lot slower than I always... like I always think, "Oh, you know, Stage 3, they'll get this writing task done in 20 minutes" but I always look at the time and I'm like, "Actually, when I think back on it, that took an hour to get that writing done" and I think I don't know whether that's just me as a new teacher; maybe I have such high expectations of them because they're in the higher primary years and I just think they'll be able to get it straight away all the time so I'm constantly... and I think maybe it will take more practice too, just having to say, "Okay, it's okay to give them more time on this because they're engaged in it now and it's getting done" rather than being so picky about the time with all the time I'm having to now pick when I choose the time limit to use.* (Post-lesson interview)

Catherine summarised that despite the internet connection resulting in changes to the lesson design, she was satisfied with the outcomes of the lesson for the students. She added that the unanticipated positive effect of using Padlet as a feedback tool had made her consider using it in a different way in future lessons:

> *I mean I'm pretty pleased with their poems. I think they've come a long way. I was a bit frustrated with the technology but that happens when it doesn't work. I was really, really happy with the way the Padlets started working at the end and that made me think, "Actually, I really need to start giving them time to post their work and perhaps to try using Padlet where they can have a go at posting that positive peer feedback. Maybe that would be really good for the boost up lesson for them all and their confidence. I think too because I have the lower class and they read it out to each other they're always like... they enjoy it and they enjoy reading it to their peers but they don't get the same level of feedback as they do when*

they went online and had a look at it. That was a different level. (Post-lesson interview)

4.5.8 Catherine's reflection on the program

Catherine reflected on the program and her design decisions mainly in her reflection interview. Unfortunately, her teaching diary was not returned to the researcher.

Catherine reported that she was "definitely happy with how it went" (Reflection interview). Her main reflections centred on changes made to the program design while teaching because of needing to provide additional support for students who were experiencing difficulties with the academic work. She also reflected on the technology components and how technological disruptions led to her changing her pedagogical approach.

In terms of differentiation, Catherine found that she needed to spend more time with individual students who were struggling to turn their ideas into poetry. She commented that when designing her programs she hadn't considered these possibilities because "you don't often write about that in the program which I think it should be in there.." She continued this reflection, commenting further on her lack of consideration for students who might experience difficulties:

> *And also I guess I knew the students too before I started, but I didn't think about designing it keeping them in mind; (..) keeping in mind the student so design it for them in a way rather than trying to hit sort of like a medium to high level.* (Reflection interview)

Catherine made a more positive reflection when considering the learning activities and how students who had previous not really engaged with English tasks had had a very different experience in this program:

> *..in the Year 5s some of the ones who previously in their writing had lacked interest, structure, just very all over the place, actually turned around and were really, like one of them almost topped my class in her end assessment for poetry. (..) Yeah, it was really nice to see. I think it sort of engaged students who weren't previously engaged so that was nice too because it turned their opinion around about English and it actually gave them something I think, because the poetry for my class it wasn't as heavy in writing. It was like a little phrase and then a little phrase underneath so*

that was more motivating than "Okay, sit down and write a narrative". (Reflection interview)

Catherine reported that when designing the program, she had considered TIL at a higher end of the academic capabilities of her class:

> *Obviously I said it needs to cater for the low end more. Even though I have them in my class I was more thinking about technology in the middle and high end.* (Reflection interview)

However, Catherine's students who were experiencing some difficulties with the techniques of poetry found the use of Padlet particularly valuable:

> *I think it definitely helped my lower ones when initially we started the poetry writing – they had to find rhyming words, they could go back to the Padlet so that was really helpful.* (Reflection interview)

Some students also identified a website which could support their learning and Catherine acknowledged that she could allow her students more independence in identifying technology-based resources to support their learning:

> *I guess too to trust the students too in finding resources along the way, like sometimes you think the teacher, "Oh I'll find it all on the internet" but they came up with that rhyming website resource so that was cool. That was probably a big thing – probably giving the students more initiative to research different poems and to find out what they were interested in guess we often threw the examples of poems at them rather than getting then to find their own style.* (Reflection interview)

Catherine reflected that the use of Google Slides to deliver content on the IWB was a significant support to her in the classroom. Catherine's reflections on the teaching show that she was satisfied that Padlet supported the students' learning well, as it gave them the opportunity to view writing samples from their class peers and find inspiration for their own writing. This was noted as being particularly useful for the students who struggled more with writing.

For three weeks during the program's implementation, the classroom IWB was out of order and under repair, and Catherine described how she relied more on the Canvas platform through students' devices to present content and teach the program. On reflection, she found this to be a positive experience in one way, because her teaching had to be less teacher-centric:

> *I had to stop and was like, "Okay, a week without technology. Okay, how do I teach?" So that was I guess a bit challenging for me because I actually had to think back to how I taught without it. Yeah, so I think, yes, the unit did heavily rely on technology but in a way necessarily I didn't necessarily need it all the time. Also relying on you don't have to have a screen – they can actually work off all their individual laptops so I had to change my thinking and work on... I used the Canvas platform instead of using my board so they had access to it rather than me showing it at the front. So I guess the reverse style was sort of forced on me in a way which... there's nothing wrong with that.* (Reflection interview)

There is little evidence in the program document to show that Catherine identified aspects of the SAMR and/or TPACK models as she had indicated she would during the design phase.

4.5.9 Summary

Catherine approached the design of her English program as a new program, which was guided by sample programs she had identified while searching online. She considered technology integration when she was designing the detail of the lessons, after she had identified the skills and content she was going to focus on in each lesson. When describing technology integration in her program, she identified specific ways in which students would benefit from its integration. These included receiving immediate peer and teacher feedback on their work, developing their technology skills and engaging in creative collaborative work for assessment.

The case of Catherine identified key contextual influences on Catherine's process. These are discussed in the following section using the lens of activity theory. Table 18 presents an overview of Catherine's case through the lens of activity theory:

Activity theory component	Evidence in this case
Tools	Understanding of TPACK and SAMR models; University experience of TIL; Sample programs found online
Rules	BYOD policy; Use of school program proforma; Syllabus
Community	Grade colleagues Mentor to navigate day-to-day issues, No appointed ICT 'expert' on staff
Division of labour	Colleagues decide as a grade on learning outcomes and assessment tasks for each program; Colleagues contribute to development of content and timing of learning activities; Some colleagues relied on Catherine for technology support

Table 18: Components of Catherine's activity system

Catherine had some knowledge and experience of TIL

Catherine referred to her university experience of TIL as having some awareness of TIL design models, experience of designing a TIL program of work, and having TIL resources, such as apps, recommended for classroom use.

Catherine's teaching experience following her graduation from university had provided some insights into students' actual skills and knowledge of ICT in the classroom. She had become aware that while they were used to using technology at home, this did not necessarily prepare the students well for using technology in their learning:

Catherine also found after graduation that the search for and selection of available resources for technology-integrated learning was difficult because of the volume of resources available online. However, she valued the opportunity to learn about new technologies available at the school.

Catherine acknowledged that her knowledge of poetry (CK) and how to teach it (PCK) was limited. For that reason, one of the first steps in her design work, prior to the design day, was to seek out sample programs online which could support her understanding of the content and how to teach it. Catherine demonstrated that she had good understanding of her students' needs and how she could address them pedagogically as a group (PK). After teaching the program, however, she reflected that she could have done more to meet the specific needs of individual students in the class who had struggled with some of the learning activities.

Catherine's technological knowledge was strong. Catherine reported and demonstrated broad knowledge of technology and its value in education. She completed computer programming courses at a high level, towards the end of her secondary education. At university, she undertook courses in education technology. However, Catherine perceived that her knowledge of educational technology was more limited that she would like. She expressed her wish to learn more in this field, coupled with frustration that her university education did not provide her with more in-depth TIL knowledge. Decisions about the use of technology to teach specific content had been made by colleagues before the design activity. Catherine often relied on her colleagues for input to the program about content, because she did not feel confident in her knowledge of this part of the English curriculum.

A sample program was a key influence on Catherine's program design

On the design day, Catherine was also guided by sample programs that she found online, and by her professional learning resources on visible thinking strategies. Her reliance on these resources stemmed from her need to understand the topic area and content to a greater degree.

There was limited support for designing TIL at Catherine's school

Catherine made some adjustments to her program to accommodate the range of laptop systems owned by the students in her class. In this way, the BYOD policy (AT: *rules*) influenced the activity system. In terms of explicit support for TIL in the school, there were IT personnel, but no staff member who was nominated to support TIL design from a pedagogical rather than a technological perspective. This meant that Catherine relied on her own knowledge only (AT: *tool*) during the design activity. She also perceived that she was viewed informally by colleagues as a source of support for TIL design.

Catherine's design process was directly influenced by her colleagues

Catherine was strongly influenced by her stage colleagues (AT: *community*) in the design of this program and made several design decisions after some in-depth consultation with them, including on the integration of technology (AT: *division of labour*). While teaching, Catherine consulted with her colleagues regularly, and they helped her make decisions to overcome the problem of timing. The head of learning and teaching also made the decision to change the summative assessment from one based on writing slam poetry, to one where the students performed a prepared poem, videoed it and edited the video for final submission. This shows again, that the *community* component of activity theory is very strong in Catherine's design context.

Catherine's students influenced her program design

Following the design day, but prior to teaching, Catherine made a key design decision about one of the TIL activities. Following close observation of her students' ICT skills, where she identified gaps in their knowledge, she decided to remove the Storybird e-book creation activity from the program. In activity theory, we can identify that this decision was influenced by firstly her students (*community),* and secondly by her understanding that persisting with the activity would probably not result in a positive learning experience for her students. This can also be attributed to her technological pedagogical knowledge (TPK), which in activity theory is a psychological *tool*.

Contradictions

The main contradiction in Catherine's activity system originates in the *community* component. Catherine identified, through recent prior experiences with a platform which she wanted to integrate into the program, that her students would struggle to navigate the login process of the platform, which in turn would reduce the time available for them to work on the platform. This issue shows the *community* in contradiction with the *object* of the activity system. It also presents a practical example of an obstruction to TIL in Catherine's classroom which she identified in the Pre-design interview: that of the students' limited technology skills.

Contradictions in Catherine's activity system do not appear to significantly disrupt the activity in a way which results in TIL not happening. Instead, Catherine works to find solutions to the contradiction which results in an alternative TIL design for the program.

4.5.10 Conclusion

Catherine was a teacher in her first year of teaching a composite grade five/six class at an independent K-12 school in regional NSW. She designed a program for the English syllabus focusing on poetry. Technology was integrated in a varied way, with students using their BYOD laptops to contribute commentary on videos of slam poetry on the IWB. They also shared their poetry writing on the IWB using apps and were able to critique each other's work. Their final assessment task was the creation of their own slam poetry videos. Activity theory identified that Catherine's TPACK supported her to be innovative with her use of technology despite having little support at the school for designing TIL. Her knowledge and skills led to her visualising how her students would use digital tools in the classroom and how these might support their learning needs.

4.6 Simon's History Program – 'The Australian Colonies'

4.6.1 About Simon

This section presents Simon who, at the time of this research, was in his fourth year of teaching in a government school located in the western suburbs of Sydney. This was his second full-time teaching role. Three years prior to the study, Simon had graduated from a metropolitan university in NSW with a Bachelor of Education (Primary) degree. Simon was the teacher of a grade five class of 23.

Simon designed an eight-week program for the NSW History syllabus entitled 'The Australian colonies'. The program was based on the content area of significant events and people which shaped the Australian colonies.

4.6.2 Simon's knowledge and experience of technology-integrated learning

Simon described himself as confident with technology in the classroom:

I feel comfortable using it and yeah, I sort of think critically when I do, "Is this going to take away from the learning experience or will it add to it" and then I use it as such. (Pre-design interview)

Simon was exposed to education technology theory and practice at university. During his degree, he completed two subjects about education technology, including one which focused on learning design. He also reported having lecturers in other units who required the students to integrate technology in their work. Simon explained that these experiences influenced his pedagogical thinking and his current practice:

> *.. we sort of focused on something which I always think about(..) I think about the TPACK model in terms of technology, content and pedagogy. It's something I always had in the back of my mind – don't put technology into a learning experience if it's going to take away from the learning experience.* (Pre-design interview)

In Simon's first teaching position following graduation, he was employed on a temporary basis, and was allocated programs to teach, rather than having input into the design of programs for his students. He was given a role of ICT coordinator and encouraged to take leadership in this field among his fellow teachers. As a younger teacher, he felt that this role was expected of him. During this time, he described having the opportunity to experiment and "play around" with technology, a process through which he learned a lot.

> *.. there was a lot more older teachers, (..) and I was on the ICT committee and you know, just sort of… because you're younger, you get sort of pushed to that side and you can sort of really explore it and have a bit of fun with it.* (Pre-design interview)

The principal at the school was personally involved in teacher development in TIL and encouraged staff to go to Simon for technology support and so he was able to develop a level of expertise and problem-solving skills with technology. The school had laptops in the classroom and teachers were actively encouraged to use them in their teaching.

4.6.3 Simon's school

Simon taught at a government school located in the western suburbs of Sydney. The school was reasonably large, with approximately 800 students, and had many classes at each grade. Simon's class was one of five grade five classes. 97% of the school's students came from homes where English was a second language. The school was below the average Index of Community Socio-Educational Advantage value (964; ICSEA average:1000), indicating the student demographic were of a lower than average socio-economic status. The school's policy was for each teacher to stay with a class for two years so that they could build a significant rapport with the students, many of whom had moved from other countries and spoke different languages at home.

There was no identified policy about TIL at Simon's school. Staff had access to a computer laboratory at the school, which had approximately fifteen desktop computers. The computer laboratory could be booked by teachers wishing to use the computers in their teaching. Additionally, each grade in upper primary had access to a set of six laptop computers for use in class. As there were five to six classes in each grade, this was potentially a factor which could limit opportunities to integrate technology using the laptops. Simon acknowledged the difficulty of access to technology hardware for his teaching:

> *I find here with the ICT, resources would probably be the hardest part – getting your hand on those, like we have a computer lab but trying to book it once a week, trying to get it and then trying to incorporate that into the actual design process as well..* (Pre-design interview)

Simon made no reference to colleagues providing support for technology integration. Overall, Simon did not perceive there to be a strong focus on technology within the school: *"It's not a big driver as such"* (Pre-design interview). He explained that the impetus for integrating technology into learning programs at the school came from individual teachers, describing it as *"more of a personal thing"* (Pre-design interview). He hypothesized that if individual teachers had an interest in TIL they could volunteer to participate in a professional learning committee at the school:

> *I suppose if ICT was an area where you're interested, you'd put your hand up to be in that professional learning committee for the next year and then that's when you'll do those professional readings about ICT and how it can be integrated in the design process..* (Pre-design interview)

Technology integration was outlined as a requirement in the core program documents for each subject at the school. This technology requirement was presented in the program documents as an additional section at the end of each document: *"an ICT part in the back, with curriculum links"* (Pre-design interview). The core programs formed the basis of any program design.

The teaching staff had regular professional development opportunities provided by fellow staff members. In the year preceding this study, a school ICT committee had formed to provide training in areas related to technology integration and had presented Google Classrooms to teachers, who then had the opportunity to use it with their students if they wanted to. The ICT committee was no longer in existence at the time of the study.

While Simon did not have an official mentor, he reported that there was a fellow member of staff who acted informally in the role of mentor:

> *My team leader this year was sort of my neighbour last year in terms of the classrooms and he sort of took me under his wing last year and through that, we stayed on the same year group together and I sort of bounce ideas off him and stuff like that and I suppose in an unofficial capacity definitely..* (Pre-design interview)

4.6.4 Simon's class

Simon taught an upper primary, grade five class, with 23 students aged between ten and eleven years old. This was the second year he had taught a grade five class at this school. He explained that he had requested to teach this grade again to have the opportunity to improve the programs he had created in the previous year in line with his reflections on each program.

Simon described his class as “chatty” and enthusiastic about TIL experiences. Many students in the class spoke English as a second language. Simon outlined some social difficulties his students experienced, and considerations he made when designing learning activities for them:

> *..the kids in my class, at the moment I have about 23 so it’s smaller but that’s obviously a few... one overseas, one left the other day, another one, I don't think he’s coming back. I have a range of different sort of... I look at socio-emotion needs so in terms of one child, I’m not a doctor but he’s showing trace that he’s on the spectrum. Some other children, just relationship friendships they find quite difficult to maintain so that sort of is a trouble shoot when you’re sort of looking at small group work; I’ve got to be mindful of who I pair students up with and stuff like that.* (Pre-design interview)

Simon reflected in detail about his students’ negative attitudes and motivations to learning, and that there was evidence that certain pedagogical approaches were effective in helping them change their attitudes:

> *We started a maths program in our school and it started last year and it’s been going through again this year but a lot of it does with sort of deep inquiry and really getting the kids to sort of challenge themselves , (..) So there’s just that where I found the way we teach maths now has encouraged kids to persevere and to give it a go and sort of I know in my classroom I sort of talk about failure being the first attempt in learning so, you know, making a mistake isn’t a problem; it’s just a matter of learning and thinking how we can improve on that.* (Pre-design interview)

More generally, Simon reported that he purposefully approached his teaching with a positive attitude and articulated high expectations for his students. He explained that this approach was intended to build students’ confidence in their academic abilities and capacity to succeed at school:

And in terms of job projection and growth, I believe in high expectations and I try to every day tell my kids to not only meet them but exceed them and I think it's really important because, you know, you look at the research, it shows they will sort of work to that, you know. Pygmalion Golem effect, you know; if you think the kids are going to do really well and you put those expectations there, they will perform better than if you had that other perspective of, you know, they're low, these kids can't do it. (Pre-design interview)

Simon explained that he considered the integration of technology in his students' learning in terms of how it would support their learning:

I just think we've got to be sort of realistic and think technology shouldn't be the driving factor of the planning; it should be there to support the learning process. The outcomes, what I want the children to achieve, how can technology support that. (..) I wouldn't just put the unit on Google Classroom for the sake of doing it, ticking that box; I'd think "How did that benefit the learning experience for the children and can it assist them in achieving what I want them to achieve by the end of that unit or by the end of that lesson?" That's my personal view on technology. (Pre-design interview)

4.6.5 How Simon designed his history program

Teachers at the school were allocated a day out of the classroom near the end of term when they worked with colleagues who were teaching the same grade to discuss and plan the programs for the following term.

When planning programs, teachers discussed ideas as a grade, then individual teachers were allocated a program to develop for a subject. Student data collected during the previous term on students' English language skills was analysed at this time to identify goals for the English programs. This was the most significant consideration for teachers when preparing for the design of new programs. On a student free day at the beginning of each term, teachers presented the programs they had designed to each other for feedback and to make any recommended changes.

Design process

Simon used one of the computers in the staff room during the design day, which gave him access to the school server and previous year's programs.

Simon began the design activity by referring to the previous year's program designed by a colleague. He explained that he wanted to change the approach to teaching some of the content to make it more engaging for the students and to deepen their understanding. He intended to do this by introducing a technology-mediated collaborative inquiry task over three of the lessons in the program:

> *I remember that when we taught the gold rush last year, we had it really knowledge-driven, in terms of they must know this, this and this because they were building up to one of their unaided writing assessments, and it was to write an information report around the gold rush. And what I found was, looking at that assessment, kids didn't get much from the gold rush, they didn't.. so I'm hoping what I can do this time, I can try looking at the gold rush but I can do sort of an inquiry based (task) over three lessons, where the kids are doing a bit of the research, and a bit of the learning themselves..* (Design observation)

Simon took his time in the initial stages to formulate his thinking about the program in terms of pedagogical approach. He conducted a 20-minute online search for inspiration in the form of sample units and resources. He then created a Smart Notebook file (IWB software) to begin documenting his design. A key influence on Simon's design process was his decision prior to the design day to use an inquiry approach to the learning. After creating the Smart Notebook file, Simon began his design of TIL activities which accounted for differentiation in reading levels.

> *We were going to do that throughout in terms of showing the content in different ways whether it was through videos, whether it was through online websites or interactive learning objects – the hope was to have students familiar with it and obviously because we've got students who read at a various range of abilities, that's also in mind too as well that they can read what they're reading..* (End of day interview)

The first activity he designed was one which would scaffold students' collaborative learning using Padlet, an online sticky note tool. This technology was identified as an efficient way to also administer formative assessment:

> *I'm thinking now that by next term we'll have the laptops and I could give the kids each a historical resource from that time, and (..) I'm going to get the Padlet up on there (IWB) and they can type in and it will come up on*

> *the board, and we'll have this sort of 'Think, Pair, Share', but it'll have joint information about the massacre, and give them maybe different statistics about the massacre, when it happened (..). instead of reading out to the whole class, I can give it to small groups of maybe three, and then have the Padlet up on the interactive whiteboard, and when they research and read, they can type it in and it'll pop up and appear.. and then I can get a screenshot of that and that can be my assessment of.. how did that group go? What did they Padlet up?..* (Design observation)

Following his design of the Padlet activity, Simon began adding resources to Google Classroom. His intention in adding website links to Google Classroom was to scaffold the students' development of online research skills:

> *I'll give them the links, then I sort of want, ok, when did it happen, they'll have to research.. so hopefully, by giving them these skills, it's sort of teaching them to do that inquiry process, so when we do come down to the Gold Rush, they can be a bit more independent – we're gradually building on those skills..* (Design Observation)

At various stages of the process, Simon referred to visualising how the lessons might play out in his classroom, and this appeared to lead to more careful consideration of how he would structure the activities to support deeper learning for his students:

> *And I'm thinking, as that information's up, ok, what would this actually look like? Right now, about 15 minutes into my lesson, are my kids going to be settled if I'm just talking at them the whole time? I'm just thinking if they have to read all that information, or watch a video, what's their mood going to be like? Especially in my classroom context, with the children I've got in my classroom, how would they engage in this lesson?* (design observation).

Simon's reflections on some of the online resources he identified during the design activity highlighted his awareness of the students' activity during TIL tasks:

Yeah, there were some that were just websites that weren't interactive and there were some where they had videos so that's pretty passive for students. (Researcher: So you don't like to use videos as much?)

No, not as much. I tend to use them sparingly, only because I like the students to be able to construct the knowledge themselves rather than, yeah, just watching a video and getting told what they need to know (..) I suppose that's just the style of teaching that I find is beneficial to them and based on constructivist principles as well because then they're also responsible for their own learning as well. They have the time to be able to test out ideas and see what works. (End of day interview)

At the end of the design day, Simon reported that he would show the program to his team leader for his feedback:

..as I said, my team leader has sort of been a mentor role with myself – I would share it with him first because I value his feedback and I'd be like "Look, this is what I've done so far"... (End of day interview)

By the end of the design day, Simon had completed an overview for each lesson (see Figure 14):

Lesson 7 & 8: European and Asian Immigrations	**Evaluation**	**Register**
Resources: Laptops/Computer Labs, research checklist, websites		
L.I. to describe and explain different experiences of people living in Australia over time. o Watch the videos about immigration and discuss the European and Asian countries from which people migrated to Australia during the 19th and 20th century and the reasons for their migration. o Create a class definition of migrant and immigrations. o In small groups students will examine the life of a post-world war II migrant using the links provided http://mimjaeger.wixsite.com/history/post-war-migration o Using the 'jig-saw' method, each group will research a particular period/type of immigration. ▪ Post WWII ▪ Post Vietnam War ▪ Muslim Journeys - http://naa.gov.au/collection/snapshots/uncommon-lives/muslim-journeys/index.aspx o Student will be required to design a poster/powerpoint about their topic, with an insight into the experiences and contributions of migrants to Australia. This will be presented to the class.		

Figure 14: Excerpt from Simon's program document on design day

Subsequent design

Following the design day, Simon came into the school on two separate days during the holidays to continue working on the staff computers. He also worked on the program at home on two days over the school holiday. He stated that working at school was more productive because the environment helped him to better concentrate. Simon continued to work reflectively on adding detail to the lesson description. Simon incorporated technology-based activities based on their value to the learning process. He discarded an online information poster activity on the grounds that *"it might have taken away from the actual learning activity and outcomes"* (Design progress interview).

> *'Cause my idea of the lesson, obviously I wanted them to research a significant event, but I did want them to be able to state the cause and effect and that was the main purpose of the lesson. (..) I wasn't sure by using Glogster if I was going to have to do a bit of troubleshooting, (..) and I wasn't sure if it was going to take away from the actual learning.. activity and the learning outcomes. And that was where technology, I thought, you know what? I'd like to put it in there, but I can't justify that it would sort of add to the learning.* (Design progress interview)

Simon searched for inspiration for the design of an activity which would make the learning more meaningful for students and help build their collaborative skills:

> *..for Asian and European immigration, how can I teach it in a way that is meaningful, in terms of all that content to get across, so.. And then I thought of, also, if you think of 21st century learning, in terms of the four Cs, I was going to do like a jigsaw method, where the kids work in small groups, and they get designated different, you know.. post World War II, post-Vietnam war.. And then there was another one around Muslim journeys, and I found a really (..) website that looked at that, and I thought that given the school context, given the background, I thought that would be one that the kids would enjoy.* (Design progress interview)

Simon also gave extensive consideration to the design of TIL activities using Google Classroom, a learning management system, to scaffold students' learning to meet the learning objectives of the program, while becoming increasingly independent learners. He continued to work on his idea to accommodate these aims through the design of a big task that would run over two to three lessons:

> *I know it's sort of, Powerpoint or poster, it's a bit cliché, but the benefit from it that they.. not only have to make it, but they have to present it to the class and they've got to, (..) can explain to the class how it all worked.' So I think that's, sort of, you know, using ICT not only to research, but to synthesise and present as well, would be a neat way to do it.* (Design progress interview)

Simon explained that he would have the opportunity for extensive feedback from his colleagues prior to teaching:

> *The time I actually share it with my colleagues probably won't be till next term on the Monday when it's sort of at a point where 90% complete and that will be, as I said earlier, getting their feedback, what their thoughts were, and then tweaking it as I go based on that feedback and then as I teach it as well..* (End of day interview)

During the planning day at the beginning of the term when the program would be taught, Simon made the decision, in collaboration with his colleagues, to reduce the first two lessons on the Gold Rush to one lesson. He elaborated on the potential issues of access to technology for all classes who would be teaching the lessons, and explained how the issue was approached as a team:

> *I gave them an overview of what I was doing in my unit, and I said "these are my thoughts, and this is what I wanted to do.." and I just sort of trouble-shooted it out there, and brainstormed, like, "what were your thoughts? Do you think this would be beneficial? Do you think it's accessible, for like, 130 kids to get to a computer lab, can we book it" sort of thing, so that was the chat around that.* (Design progress interview)

The feedback on the program which Simon received from his colleagues was that they were impressed with the innovation of the program he had designed:

> *The majority of feedback, you know, in terms of the learning objects that I showed them that we would be using in it was actually really positive, and they were like "oh wow, that's really interesting" and, yeah, I think they were surprised at what and how we could sort of use those resources, I guess.* (Design progress interview)

Simon’s program design and articulated thinking demonstrated that he was not negatively influenced by the difficulty of accessing the laptop computers and did not allow them to become barriers to technology integration. He reported that access to the technology was one area the teaching team for this program had to negotiate in order to ensure all students had the opportunity to do the TIL task:

> *..we’ve just got to work out.. We’re given a trolley for each year group, so in year six, we’ve got six laptops for the whole year, so it’ll pretty much be a matter of in your team or stage meeting: “who’s planning to teach a stage HSIE lesson this day? Or what time?” (..). And then on top of that, in my classroom, I’ve got two computers as well (..) But when we get to the Google Classrooms one, that’s when we need to have the computer lab booked. So that might be in a school of 800 or something kids, that might be one where we need to jump in early..* (Design progress interview)

Simon’s individual design process can be illustrated in seven key stages. These stages are presented in Table 19 below:

Design step	**Contextual design work**	**Observed by researcher/reported by participant**	**Time taken**
Prior thinking	0. Overarching idea of including a technology-mediated inquiry task	Reported	
Think	1. Reflected on syllabus and experience of teaching previous year’s program	Observed and reported	8 minutes
Describe	2. Identified content areas and pedagogical approach	Observed and reported	24 minutes
Research	3. Searched for sample programs and resources for inspiration	Observed and reported	20 minutes
Create resources	4. Created Smart Notebook slides for interactive whiteboard (IWB) to accompany each lesson and added resources.	Observed and reported	20 minutes
Create and describe	5. Designed TIL activities, using Google Classroom and the mind-mapping application Padlet	Observed and reported	35 minutes
Describe	6. Added detail to lesson level program design in Google Classroom	Observed and reported in design diary	20 minutes (+ 9 hours following design day)
Think, refine and document	7. Re-evaluated pedagogical approach	Reported in design diary and Pre-teaching interview	20 minutes

Table 19: Simon ’s detailed design process

4.6.6 Summary of Simon's history program

Simon designed program for the New South Wales History syllabus, covering the significant events and significant people that shaped Australia as a nation. It was designed to be taught as one lesson per week over eight weeks of a ten-week term.

Simon explained that his pedagogical approach for this program was influenced by his personal belief in the importance of students learning History to identify their own sense of self and future prospects:

> *When we're looking at these kids for the future, I think developing young Australians to think about, "Okay, you have ability to make an impact" and that's where I think as a teacher you've got a bit of scope with your history and geography units to actually do that with the inquiry process.* (Pre-design interview)

The learning objectives of the program were:

- describes and explains the significance of people, groups, places and events to the development of Australia
- describes and explains different experiences of people living in Australia over time
- applies a variety of skills of historical inquiry and communication

The assessable tasks were:

1. Summative assessment task: group jigsaw research task on migration to Australia.

Program overview

Lesson 1: Students brainstorm idea of 'thinking like an historian', view video of frontier conflict and research Myall Creek massacre, posting findings on IWB via Padlet.

Lesson 2: Students research information about the Coniston massacre. They answer inquiry questions about cause and effect, and the events impact on Australian history. Using websites and information sheets.

Lesson 3: Students' prior knowledge about the Gold Rush activated through brainstorm activity. Then they participate in "Can you strike it rich" a whole class learning object on computers to consolidate understanding and show different perspectives at the times. 3 views of the gold rush are introduced: Political, Social and Economic.

Lesson 4: (In the computer laboratory) Students access Google Classrooms and investigate two different primary sources on the Gold Rush to deepen their understanding of the topic.

Lesson 5: Students view a Behind The News (BTN) video on the IWB on the topic of the Eureka Stockade. They then read further information on this event and create 'T-charts' which allow them to present its causes and effects.
Lesson 6: Incursion about the Gold Rush.
Lessons 7 & 8: (Using laptops/computer lab) Students watched videos on migration to Australia and then work together to create a definition of immigration and a migrant. They then examined the story of a post WWII migrant by accessing a teacher-designated website (https://mimjaeger.wixsite.com/history/post-war-migration). Following this background work, students worked in groups on a jigsaw reading activity, based on researching three key periods of immigration: post WWII, Post-Vietnam war and Muslim migration. In groups, students work together to create a presentation on their findings, which they perform in class.

Technology integration in the program

Simon created six main TIL activities for the program. The TIL activities in the program are broken down in terms of their technology classification and role in the program in Table 20:

TIL activity	Technology classification	Role of the activity in program design
1. Use of *Padlet* by students to share research findings and opinions with class on IWB	Non-education	Develop understanding of topic
2. Online research using teacher-designated websites	Educational websites	Further explore different stakeholder perspectives on time/event
3. Students engaged with interactive learning object about the Gold Rush	Educational resource	Deepen understanding of different perspectives on time/event
4. Students explored primary historical sources posted on Google Classroom.	Educational resource	Experience thinking like an historian (learning objective)
5. Video from *Behind the News* on Eureka Stockade	Educational resource	Students to understand what happened during this event
6. Jigsaw research & presentation task	Educational websites, non-educational software	Students to collaborate to build understanding about 1 migration event and present their findings

Table 20: Breakdown of TIL activities in Simon's program

The program included a series of student-centred, collaborative activities using the laptops, which supported students in "using ICT not only to research, but to synthesize and present as well" (design progress interview). One example of such an activity was an investigation task where groups of students investigated various primary sources of historical evidence presented on Google Classroom, made interpretations from the evidence and then created an oral presentation of their learning. This task served as a model for a more in-depth jigsaw investigation task on different periods of immigration later in the program.

At this school, Simon acknowledged the difficulty of access to technology hardware for his students, but this did not limit his integration of laptops into his program design. Instead he paid particular attention to the design of technology-integrated activities for small groups of students using one device. One example was a jigsaw activity with each group *"reading a* *different primary source, and then sharing their information with the class"* (Design observation), which would scaffold their learning towards their achievement of the learning outcomes. Using Google Classroom as a learning support tool allowed Simon to design learning activities to support students in achieving an increasing level of independence in their learning.

Simon's approach to integrating technology centred on classroom-based activities using laptop computers. He designed activities using tools such as Padlet to support students in their initial thinking about the content. Following consideration of how to scaffold students to become more independent with their learning, he designed jigsaw research and presentation activities, which were first modelled in class, where students would initially be supported in groups to begin researching content area. Subsequent activities were designed in Google Classroom which supported more independent work.

Simon considered technology to enhance his students' learning in terms of structured support activities to help students visualise and use higher order thinking skills when working with the content. Furthermore, he designed the technology-based activities to scaffold students in becoming more independent in their learning strategies.

4.6.7 Teaching the history program

Simon reported in his teaching diary that he was generally satisfied with the program and he made no significant changes to it while teaching. He did find that he needed to offer more direct support to students than he had anticipated. This support was required in order for them to be able to understand the content and to be able to use the technologies. Reflecting on these points, he made notes about changes he would make for the following year, which included creating more explicit guides for students when using the Google suite and identifying texts which are more accessible for his students.

Observed lesson

The researcher observed the penultimate lesson in the program, in which students began to work on their inquiry task; the jigsaw research and presentation project.
Before the lesson, Simon explained that the lesson would have two objectives. The first part of the lesson was dedicated to providing background information to prepare them for the inquiry task. This was done through video on the IWB and discussion, with clarification of key vocabulary. The second part of the lesson was aimed at students beginning their research tasks in six groups, using the new laptops, as Simon explained in the pre-lesson interview:

> *The kids love the laptops; they're new, they're touch screen and we did one of the Google Classrooms lessons on it and the kids are familiar.. the students are familiar with how to log on and how to access the information and that, and it, pedagogically, it worked better than taking them to the computer lab. You take them to the computer lab, and then you've got to try to log kids on and that.. Whereas this is more, I think it's more dynamic, and the kids enjoy it more – it's sort of like that coffee shop feel, where they're on their laptops, they're spread out, and learning's happening, but they don't know they're learning, sort of thing.."* (Pre-lesson interview)

Simon reflected on the students' digital literacy skills through the preceding lessons in the program and these led him to focus on scaffolding their learning in areas where he found they struggled:

> *Well, sort of reflecting on how the unit's gone, I found students with their ability to research has been a lot of 'ok, first information is the best information, copy and paste'. So, I've chosen a good website for each of the kids to get started on, and my main thing would be, obviously, ESL- English as a Second Language for a lot of these kids. Is the content accessible, like reading it. So that will be an idea when I'm pairing the groups up to make sure there's a strong ability student, just for that research and that reading too. So that would be my concern and my caveat, and then also with any student-directed learning, you know, I put a checklist to have a sort of scaffold to make sure they have what I'm looking for, but I'm always worried: will they get to the end point of what I want the lesson to be?* (Pre-lesson interview)

At the time of this lesson, many students were fasting for Ramadan, which Simon felt could have impacted on their ability to concentrate.

The researcher observed that in the first half of the lesson, Simon was very structured in his teaching approach, clearly showing students their learning objectives, explaining how they would achieve the objective and conducting concept- and vocabulary- checking questions to ensure students were understanding the content as the lesson progressed. The students responded well and were comfortable to give their responses to his questions. The TIL in the first half of the lesson was focused on the use of video to support understanding of the key concepts of migration and its associated language. Students copied definitions of key vocabulary into their books from the IWB.

The second half of the lesson was more student-centred, as Simon put students in their groups for the jigsaw research activity. There were eight groups in total in the classroom. The researcher observed that initially students responded positively and enthusiastically to working in groups. Simon then distributed a checklist for students to understand the steps they would be working through to complete the task. Students then collected their laptops or sat at a desktop computer. There were six laptops in the classroom, the remaining two groups worked on the desktop computers. When they had logged into the computers, Simon used the IWB to show students the websites they would be using. Students then used the remaining 10 minutes of the lesson to explore the websites. Some opened presentation software and began to write titles on individual slides. However, there were two groups in the class who struggled for most of the remaining lesson time to log into their computers.

Overall, the lesson was clearly structured with explicit steps to support students in their understanding and in identifying their approach to a less controlled activity in the final inquiry task.

4.6.8 Simon's reflection on the program

Simon reflected extensively on the teaching of the program. He reported that overall, he had underestimated the students' technology skills to work with online tools. However, he also reported that he had overestimated their capacity to synthesize the information they had researched and to organise it for presentation. He explained that they needed more scaffolding in this area:

> *..the research side of things the students struggled where I think the technology side of things, I could have given the kids a bit more credit; they were pretty switched on with how to do the research but when it came to putting information into their own words – the sort of surface level skill that they still need to develop, I think that's something I'll definitely need to adapt.* (Reflection interview)

In terms of the flow of the program, Simon was pleased that he had put the self-directed activity at the end of the program, as this allowed for a more relaxed, yet engaging laptops-based class to complete the program. He also felt less pressure to rush students to complete and could allow them more time to enjoy their learning:

..like that lesson, I think I said would be two lessons but in fact, I gave my kids about three and a little bit over, just to do that student-directed learning a bit more and I think if I had put it at the beginning of the unit, I'd be time-poor and I'd be like, "Oh well, we can't. We've got to move on" where this had a bit more freedom. The feedback I got from the children was they really enjoyed the student-directed side of it. (Reflection interview)

Simon explained that when originally planning the final two lessons, he was anticipating that its success would depend on whether the teaching of the program allowed enough time for the activities and ultimately how the students responded:

When I was planning, I thought, "You know what, I'll put it at the end of the unit" and usually, you always have that risk when you put something at the end of the unit – is it going to be covered? (..) I told the teachers when I was planning it, I said, "Look, the last lesson, it says, the last part of the programme it says two lessons. You can stretch it over depending how your kids go with it". So it was always in the back of my mind but it ultimately depended on if the children would be engaged with it and if they would see a purpose in it, (..) They actually really took that ownership of the learning, worked in those small groups and really took a bit of pride in it and I think they really enjoyed it, especially at the end of the term when they're all sort of brain dead and exhausted. (Reflection interview)

Simon explained that the student-directed activity at the end of the program allowed more time for students to work independently than if it had been scheduled for earlier in the program. This meant that the students' learning was more meaningful. The 'coffee shop'-style inquiry activity being completed on laptops also was a positive way to complete the program:

I personally felt when they did it self-directed and in small groups I could have a chat to them and just like that observational teacher judgement through formative assessment, I found they were getting those "Aha" moments and it felt more fluid where the other ones were like, "This is the success criteria. Okay, what does this mean"(..) and I know if I probably, you know, first day back I asked someone to refresh about it, they would definitely remember it because it was sort of that like something they enjoyed and their learning was still occurring. (Reflection interview)

Simon was not satisfied with the Padlet-based activity when he taught that lesson. He felt that the process of setting up the class to do the activity was quite involved and detracted from the learning. The students' lack of familiarity with the tool meant that they were distracted by its affordances and were therefore not focused on the task:

> *I just found the whole concept kids weren't getting was that, "Okay, well this is what I want you to actually find" and then also seeing it up there was a bit of a distraction. (..) So if I was to implement it, like the Padlet side of the learning again, I would possibly maybe take it off the board so it's not up there for people to see or work on maybe a different resource...* (Reflection interview)

However, Simon's reflections on other aspects of technology integration in the program were positive. He reflected on his thinking during his design process as considering how technology could support his ideas for learning activities:

> *Technology – it wasn't the main focus of the lesson but it sat nicely side-by-side; it supported the... it wasn't one, like with one you didn't have the other sort of thing. It was like I think they both supported each other and I didn't go into that lesson, thinking, "How can I put technology into it?" It just happened like, "Okay, this is what I want to do. What sort of technologies will afford that learning to happen".* (Reflection interview)

He made a distinction between activities such as the Padlet-based task, which he found was "*too clunky*" (Reflection interview) and those where the technology fitted more easily into the learning activity, which he described as *" a bit more streamed, a bit more fluid*" (Reflection interview). To summarise his TIL in the program, he made a distinction between these two types of activity:

> *There weren't those, what I call like distractors or those off-task opportunities were limited. I honestly believe the technology afforded that ownership and (..) "How does this relate to what we're trying to do".* (Reflection interview)

The other key TIL activity was the interactive learning activity from a museum website, where students spent the day as a gold miner making decisions and experiencing the consequences of their decisions. Simon reported that this activity was extremely engaging for students and as a teacher found that it led to deeper learning than he originally anticipated:

..they really enjoyed... and I could hear like well justifying "Well why do you want to do that? What's that" (..) and it's like, "Well, why was it a bad choice?" And it gives you a little blurb underneath and the kids were like, "Yeah, I told you. That's because of..." (..) and I said, "Oh wow, I didn't think you were listening but you were" so yeah. (Reflection interview)

Simon reflected that in future programs he would extend this activity to more explicitly engage higher order thinking skills.

Simon reported in the reflection interview that he made some changes to the presentation of some information for his students while teaching the program. This was in cases where he found the language to be too dense and complex. The changes he made were because he found his students were copying and pasting information without really understanding what they were reading. In order to overcome this, he explicitly stated which essential information he wanted them to look for in the text, thereby supporting their scanning reading skills. In terms of supporting his students, Simon also reflected that his checklist, which he designed as an alternative to a rubric, served very well for students as a scaffold which guided them through the independent group research task. He reported that its simple structure and limited number of words reduced the cognitive load for students.

Simon also reflected on his intended role as a facilitator of learning in the classroom and how successful a strategy this was for him:

I was that guide on the side, you know, I wasn't in their face, "Okay, do this, yeah, now, use this website. There's your information" and by doing that, they were able to troubleshoot and challenge themselves and were, "Get all of... this is where we've got to go" and it was, when they were presenting they all had different bits of information, they all didn't have the same thing four different times, you know. So yeah, I definitely felt like it let me free myself up and be a bit confident with "Hey stepping back". (Reflection interview)

4.6.9 Summary

Simon approached the design of his history program as the development of a new program, which was centred around an extended collaborative task facilitated by collaborative online tools. He considered technology integration from the initial stages of the design process when he was thinking about how he would develop the extended task. When describing technology integration in his program, Simon first considered the pedagogical approaches to the learning experiences he was designing before considering how technology could support those activities.

The case of Simon identified key contextual influences on Simon's process. These are discussed in the following section using the lens of activity theory. Table 21 presents an overview of Simon's case through the lens of activity theory:

Activity theory component	Evidence in this case
Tools	Strong TPACK and experience with TIL, experience of teaching program in previous academic year, beliefs in setting high expectation for students
Rules	Limited access to technology, accepted design practice in school, syllabus, previous year's program,
Community	Students: strengths and challenges,
Division of labour	Feedback on program designed, guidance from mentor relating to content, not technology integration

Table 21: Components of Simon's activity system

Simon had comprehensive knowledge and experience of TIL

The analysis of Simon's case found that his TPACK was an important influence on his design process (AT: *tool*). Simon's knowledge in the individual components of TPACK were strong. Simon reported and demonstrated an in-depth understanding of the individual components of the TPACK. He demonstrated an awareness of different technologies and was comfortable using them for personal use and in his teaching (TK). He stated that he felt personally confident in using technology. Simon also demonstrated a solid knowledge of the content in the program he designed (CK). He reported that he had taught the program for a grade five class the previous year and that in this design task he was focused on investigating how he could improve on the teaching approaches in making the content relevant for his students. Simon demonstrated knowledge of a range of pedagogical approaches (PK) and reported that he regularly read teaching blogs and newsletters to improve his pedagogical knowledge. He referred to his chosen pedagogical approaches throughout the duration of the study, indicating that this was a strong influence on his design process.

Simon's understanding of the complexities of TIL was evident in the analysis of combined components of his TPACK. Simon carefully considered the types of technology he would include in the program to present content to students (TCK). Simon reported considering the ways in which technology could be used for more active and innovative pedagogical approaches in the program (TPK). In this area, he frequently reflected on his teaching practice. Simon demonstrated many ways in which his technological pedagogical content knowledge was used to evaluate the learning activities he designed for his students. He was aware of some difficulties associated with teaching a syllabus which contained high amount of content and considered ways in which he could approach the teaching of the content, using technology as a learning tool, to support the students as they developed their understanding of the history of Australia as a nation. To do this he integrated technology-mediated scaffolding tasks such as sharing research findings and perspectives on the IWB using *Padlet* and perspectives on the Gold Rush using an interactive learning object. His final assessment task of an inquiry task which students completed in groups using the laptops in the classroom was an efficient and engaging way for students to work independently to research, collate and present data on migrant journeys.

Simon developed his knowledge of TIL through his experience of education technology prior to starting his current teaching role. At university, he had studied two units on education technology, including one on designing education technology. In addition to his university experience, Simon had also experience of being an ICT coordinator at the school he taught at after graduating from his teaching degree. This position afforded him the opportunity to learn about and experiment with technology in a primary education setting. While Simon did not refer explicitly to these experiences during his design activity, he expressed a high level of confidence in designing TIL, to which these experiences had contributed.

Minimal policies for integrating TIL in the school were a limiting factor in Simon's design of TIL

The *rules* component of Simon's activity system featured a number of factors which were influences in Simon's design process. However, few of them had any significant guidelines or policies regarding technology in learning and teaching. While the school had facilitated the establishment of a professional learning committee for ICT, this had been identified as an area of need and had been established by teachers for the school teaching staff. The committee was discontinued by the time this study took place. The school communicated the need to integrate technology through documentation in the overarching progam documents (scope and sequence) for each KLA. Simon did not refer to these documents during his design process.

Simon identified the difficulty of accessing technology at the school. It is important to note that these constraints did not appear to constrain his design of TIL. Instead, he designed activities in a way which would allow for these difficulties to be overcome, resulting in meaningful learning experiences for the students. However, it is impossible to understand whether his program design would have differed if he and his students had access to one-to-one devices at all times.

There was no evidence of leadership of TIL in Simon's school

Simon's grade colleagues (AT: *community*), including the grade supervisor, were influential in Simon's context prior to the design day. In an extended meeting about program design prior to the design day, the grade teachers discussed the overall goals and areas of focus for the students in the coming term. In the meeting, Simon discussed the content for the program with colleagues who would also be using the program. Simon and his colleagues did not specifically refer to learning activities within the program when they discussed content and there was not mention of TIL.

While Simon's colleagues were impressed and supportive of Simon's TIL activities after he had designed them, they did not contribute to Simon's design of TIL at the beginning of the design process. This indicates that the main sources of design expertise with TIL came from Simon himself, through his learning at university, his experience at his first school and his own interest to seek out inspiration online.

Simon's students were a significant influence on his design process

Simon frequently referred to his students (AT: *community*) throughout the design process. He reported visualising how the activities he was designing would be received by his students and the extent to which they would support their deeper learning of the content and their 'thinking like an historian' skills. This was particularly true of the TIL activities, as Simon explained that he wanted to use technology purposefully and not for the sake of it. He eventually discarded one TIL activity he originally designed because he decided it did not contribute directly to students' learning.

Simon's colleagues were involved at the beginning of the design process as they discussed at a high-level programs to be designed for the coming term. Prior to teaching the program, they also discussed access to technology for the TIL activities that Simon was considering for the program as the program would be taught by all teachers across all grade six classes (approximately 130 students). The staff were supportive of the TIL activities and helped Simon trouble-shoot the potential issues with access to devices. Throughout colleagues were impressed with the TIL activities Simon integrated in the program, such as the interactive learning object.

Contradictions in Simon's activity system

The analysis of Simon's case highlighted some contradictions in his activity system. Firstly, within the *rules* component, there was a contradiction between the school's prescription of technology integration in their program overview documents and the lack of support available for teachers wanting to integrate technology. A professional learning committee on TIL had been established by teachers in the school, but was no longer in existence. Furthermore, there was no evidence of formal leadership of TIL in the school.

Access to technology was difficult at the school. Access to technology sits in the *rules* component of activity theory. This difficulty with access to technology is in contradiction to the school's prescription of technology use when designing programs, which also sits within the *rules* component of the activity theory framework. The difficulties associated with technology access also create a contradiction with Simon's internal tool; his TPACK, which is highly developed. The results of this contradiction might have been the limitation of his capacity to design TIL which could have significantly enhanced learning experiences for his students.

4.6.10 Conclusion

Simon was a teacher in his fourth year of teaching a grade five class at a large government school in a metropolitan suburb. He designed a program for the history syllabus focusing on Australia as a colony. Technology was integrated in a varied way; Simon used apps for students to share their ideas about primary and secondary history resources on the IWB. They also viewed videos and engaged with online interactive learning objects. Simon designed a summative extended task where students collaborated to investigated various sources of data and created presentations of a significant event. Such a task was identified as being innovative in the context. Activity theory identified that Simon's strong TPACK and prior experience with TIL supported him to overcome significant barriers such as access and lack of institutional support for TIL to design technology-mediated learning which was innovative for his context.

4.7 Emma's mathematics program – '3D Shapes'

4.7.1 About Emma

This section presents Emma who, at the time of this research, was in her first year of teaching at a Catholic primary school in a small suburb of a regional city in NSW. This was Emma's first full-time teaching role. The year before the study, Emma graduated from a university in a regional city with a Bachelor of Education (Primary). Emma was the teacher of a grade six class of 30 students.

Emma designed a 10-lesson program for the NSW syllabus for mathematics on the topic of 3D shapes.

4.7.2 Emma's knowledge and experience of technology-integrated learning

Emma stated her belief that the value of mobile devices such as iPads is greater in the upper primary years when students are able to manage the operation of the devices, for example in logging on to apps which require a password or in accessing the internet. She perceived there to be many opportunities for TIL using iPads:

> *I think that's quite difficult for the younger years but I think what they're exposed to in Year 5 and 6 with one-to-one iPads is fantastic and what you can do with them and the apps that are out there and what they can research and stuff, it's great. At the moment, when I first came on, I looked into Google Classroom and we used that all the time.* (Pre-design interview)

Emma explained that she had learned about TIL early in her university degree course. During that time, she learned about the affordances of IWBs and the use of some apps for mobile devices, such as iMovie. Emma reported that her initial teaching education had linked teaching competencies to the Quality Teaching Framework (QTF), but that ICT competencies within the QTF had not been referenced:

Researcher: But I mean obviously part of that quality teaching framework is use of ICT but was that referred to at uni as much in terms of quality teaching?

Emma: No. I remember the three columns in the thing. I suppose that would come into the part where you... like your hands-on experiences I guess and I think that they didn't make emphasis on the technology in that part but I'm assuming that that would be in that element of it.

(End of day interview)

Emma believed that there was an assumption on the part of her university tutors that because education students were mostly young, they would be confident users of technology already and therefore would not need explicit guidance in using technology for educational purposes:

> *..there probably wasn't enough exposure to technology at uni. I probably think that they just assume that you have the technology knowledge because you're young and fresh and you're using your laptop and your iPad, you know, so "Oh yeah, you're fine. You don't need to know that sort of stuff".* (End of day interview*)*

Emma reflected that she would have liked more specific guidance during her university studies in using TIL with gifted and talented students. Emma had gifted and talented students in her class and she felt that the unit she studied on gifted and talented education during her degree would have been an opportunity to focus on TIL:

> *I wish they did explain STEM units to us and stuff like that about robotics and coding and all those types of things because that really... and that should have come under (..)our gifted and talented unit that we did at uni. That was never (..) ever shown or discussed, like "Oh these are the things that you can use when you have gifted kids" because I'm in this situation and I'm like, "What part of that subject that we did at uni is going to help me right now?" Because I have eight different kids that need me to help them. I suppose research-based assignments and stuff were always emphasised but I don't think that you can always do that.* (End of day interview)

Emma explained that she spent a lot of time researching various teaching online and that she was a member of several teaching groups on Facebook and followed blogs relating to teaching advice. She reported that she found out about Google Classroom from a blog post and then researched and trialled the platform for herself. She did this before she had a secure teaching position:

> *I think that one day, just something about Google Classroom came up, like a blog-type article and I was just reading it and I thought, "Oh that's fantastic" and I think it was very early on, before I even started this position and I thought, "That'll be great" and I looked into it. I don't have an iPad myself; I have a school one now but when I started, I didn't have an iPad so I just downloaded it on my phone and flicked through and just kind of posted things on there to see how it would work.* (Pre-design interview)

4.7.3 Emma's school

Emma taught at a small Catholic school in a suburb of a regional city in NSW. There were approximately 240 students in the school at the time of the study. Emma's school was in an area with an above average score Index of Community Socio-Educational Advantage (ICSEA) (1106; average ICSEA= 1000).

The school had a BYOD policy for students in grades five and six, which specified a preference for iPads to be bought by parents. Emma explained that students knew what the school's expectations were regarding usage of devices because these expectations were communicated regularly by teachers and were articulated in posters around the school corridors, in classrooms and in the common areas such as the library:

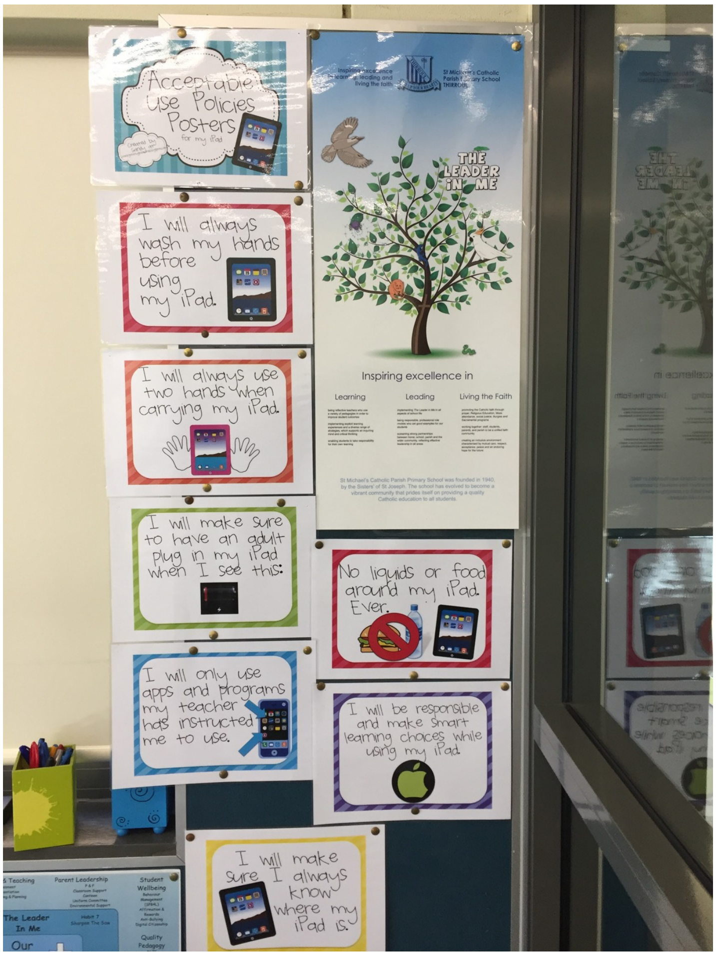


Figure 15: Student rules for using iPads at Emma's school

The school had also recently required all teachers to use Google Drive as a repository for their programs.

As an early career teacher at a Catholic school, Emma received support from the local Catholic Education Office (CEO). She explained that she often attended professional development days for new teachers provided by the CEO. She also had a nominated liaison officer from the CEO who she could ask for advice and support with any teaching-related matters. At the school, Emma's colleague on the grade five class was her nominated mentor. However, she also explained that she talked to other supportive staff at the school, including her assistant principal and her colleague who taught Emma's class the previous year, who Emma often asked for advice regarding learning activities for her class. She reflected that all her colleagues were particularly supportive of her as a new teacher:

> *So it's really good, especially when things like reports come along or I've had a really busy week and I come out and I'm doing all these things, they're always like, "Come into the staffroom. Are you okay? You look really tired. Make sure*

you go to bed early". So yeah, that's fantastic. It's really good. (Pre-design interview)

Emma reported that no CEO professional development days had been offered on the topic of TIL so far in her first year of teaching. She related an interesting occurrence at a recent development day which offered the opportunity for new teachers to become familiar with an app for parent communication:

> *When I was at a behaviour management day a couple of weeks ago, they actually brought someone in to show how See Saw works and I think out of the whole 20-30 people that were there, I was the only one that sat there; everybody else left because you could go. You could go or you could sit and watch this young early career teacher – she'd been like two or three years out – show you how to use See Saw and everybody just left and then it was me. So I thought that was kind of sad because what she showed me was really interesting and how I can set it up and everything.* (Pre-design interview)

Emma was the only teacher who attended this professional learning workshop. She hypothesized that if teachers did not currently have access to appropriate technology in the classroom, they were reluctant to attend a learning event which might provide skills for a future teaching position:

> *I think speaking to the woman that organised this young girl to come in, a lot of them were younger teachers and because they don't have one-to-one or even four iPads in their room and not much technology in their room, they just thought, "Oh well I can't use that so I'm just going to go". Instead of sitting there and just listening to it because you might use it in the future, they thought, "Well I can't use it now because I don't have the technology", they left.* (Pre-design interview)

Emma reported that she had to request permission from the school leadership team to implement a new technology which would support the overall organisation of learning. She described how the process of ensuring all teachers took the time in their busy schedules to learn about a new digital tool was challenging:

So, we're thinking of doing the next numeracy activity on See Saw but first we have to get Year 5 and 6 teachers to come together and talk about how we're going to do that. Amazing things like that take time and energy and thought, and when you have things like reporting and all that sort of stuff, that goes down your list. (Pre-design interview)

4.7.4 Emma's class

At the time of the study, Emma was in her second term of teaching her grade six class. She explained that she was reluctant to teach a grade six class as her first teaching appointment as she lacked the confidence in her own knowledge. However, the principal had persuaded her, saying that she would be approaching the teaching in a different way to the younger grades:

> *Yes, and I didn't think I would be good for them. I thought, "I'm not intelligent enough for this class". Like because I was first year out – I would just have finished in November (..) and then Karen rang me, the principal, and was like, "No, you can do it" and Karen was explaining her experience on Stage 3, like, "It's not really... you don't have to teach them – it's much more facilitating their learning".* (Pre-design interview)

It was a large class with 30 students. All students in Emma's grade six class and the grade five class had BYOD iPads. Her first comment about her students was that they were "really bright" (Pre-design interview) and explained that she had some students whose spelling was equivalent to that of a grade nine student, and some whose mathematics level was similar to that of the spelling. She explained that due to their family backgrounds being in a relatively wealthy socio-demographic, many students were exposed to learning opportunities outside of the classroom, through discussions at home and travel experiences. Emma reported that this meant the discussions which arose in the classroom were very interesting, however she had a personal concern about being able to continue to keep them engaged in their learning as the year progressed:

> *So, the conversations are fantastic but I'm constantly, constantly thinking of things that will keep them engaged and (..) they're a lovely class and I don't think that I'll have that much problem but I'm very worried about how we progress in terms of Term 3 and Term 4 and how engaged they'll be because really, they probably need to move on to Year 7 some of them.* (Pre-design interview)

Emma explained that eight of her students who were identified as needing academic extension were participating in a year-long project for gifted and talented students through the Catholic Education Office (CEO). She explained that this program was demanding for the students and meant that they were absent from the class to attend workshops occasionally. It was also a requirement for Emma to allocate class time for the group to work on their projects and for herself to be available to support them in doing this. She reported that she found this to be "quite difficult and stressful" (Pre-design interview).

Emma also reported that she had four students in the class who needed extra support with their learning and she explained that their positive attitude to learning meant that they were not reluctant to attempt the learning tasks:

> *I have about three to four kids working in English in cluster 11, some of them, but because they're so enthusiastic they still give everything a go (..) I don't have any behaviour issues where they say, "I can't do this. I need help". They don't give up so everybody is just give everything a go. It's fantastic, so when I plan things that are harder, they'll still approach it the best way that they can so I'm blessed in terms of that.* (Pre-design interview)

Emma attributed the attitude of these students to the opportunities to gain real world experience outside of the classroom through overseas travel.

Emma reported that she had a strong channel of communication with the parents of her students, who were very interested in their children's work at school. She explained that she often received emails relating to students' mood and welfare from the parents and that she would respond with communication about the students' performance and achievements in the classroom.

Emma had a teacher's aid working in the classroom for 40 minutes per day, three days per week. She explained that the TA would support a range of activities, including extra literacy support for students who needed it and supervising the work of those students working on the gifted and talented academic project.

Emma talked at length about the use of technology in her classroom. She reflected that although she had learned a lot about the use of IWBs while she was at university, much of that knowledge was no longer relevant as the school was transitioning from IWBs in each classroom to the use of Apple television sets. These were compatible with the iPad devices that students had because of the one-to-one BYOD iPad policy in the school and allowed students to give presentations by linking their iPads with the Apple TV.

Emma reported that her students' behaviour with the devices was generally very good. However, she had implemented behaviour management systems for students who had a tendency to be distracted by other websites on the iPads when they were supposed to be focused on a learning task:

> *Some do but by now I know who gets distracted by the iPad and does the wrong thing on the iPad so they are seated near my desk (..) So the kids that get distracted by the iPads are seated strategically, front-on, so when I'm behind, I can see what they're doing. It's very thought-out and it works well because I can say, "You're on something else. You shouldn't be. First warning" and then if they get the second warning their iPad goes on my desk and then they have to work with the person next to them (..) they hate that..* (Pre-design interview)

Emma reported that she believed it was important for use the iPads regularly in the classroom because the parents had made the financial investment to provide them for their children. She spent a lot of her spare time researching ways to use TIL to engage students in their learning:

> *Yeah, I think (..) spending late nights on the computer thinking how to keep them engaged because, as I said, a lot of them, if you're not prepared and the lesson is not engaging enough, they will switch off and that's because of what they're exposed to and their intelligence level and those types of things. You've always got to think about Plan B if it doesn't work and those things.* (Pre-design interview)

Emma also reported that she was grateful to have iPads in the classroom because of the opportunities to provide academic extension for those students who required it in her class:

> *I often think I don't know what I'd do with the gifted kids if there wasn't one-to-one iPads because how would you further their learning? You would have to have more of a knowledge base for them and I think that's where I would struggle..* (Pre-design interview)

Emma also reported that she had seen improvements in the quality of students' writing when they typed their work on the iPads:

> *I'm finding actually with my Year 6 class that they can actually produce a longer, more structured text by typing it on their iPad rather than writing it out. Some of them have very poor handwriting so, for them, when they're going back to proofread it, because I'm very, very big on them self-proofreading things, they can't actually read what they've written and then they say, "How can I assess myself if I can't even remember what I wrote in my introduction?"* (Pre-design interview)

She continued to explain that this was an important digital skill for her students to have because when they went to high school, their assignments would have to be typed.

Emma reflected on the issue of having limited time to spend on researching and developing new TIL tasks. She gave an example of an in-depth mathematics-based TIL learning experience she created with her colleague, which they demonstrated to parents who gave extremely positive feedback. She then explained that limitations on her time meant that TIL activities were usually not as well-developed as that example, instead they were often small scale and limited in their scope:

> *But I mean, there's limited I think things out there like that. Like if you don't come up with that with your stage partner and you don't have the time, you're just constantly doing – I'm finding – you're constantly doing basic things. Do you know what I mean? You're always going back to, "Oh well that'll do. We'll just do a multiplication lesson and we'll do number sense on multiplication facts and then we'll go in and I'll write some examples on the board..* (Pre-design interview)

She summarised her reflection on the impact of time limitations on her design of TIL activities:

> *..if you don't have the time to sit down and collaborate with someone or research something, then you constantly are going back and using it for basic things or not using it at all.* (Pre-design interview)

She explained that she liked to use Google Classroom to manage learning tasks for all subject areas**:**

Simple things like art even works really well because I love art so I'll do a sample for them, take a picture of it, upload it to Google Classroom with the steps and like, "This is want you to do" and they can look at my example with the steps and have it in front of them and then be working where it's not like me writing up the steps on the whiteboard and sketching it out on the whiteboard. (Pre-design interview)

Emma said that her students chose the technologies they wanted to use for these assessment tasks from a range of presentation and movie-making apps. She reflected that the students were good independent learners about and with technology. She also related an event from her practicum which influenced the way she supported students' independence. She explained that when she went from a practicum with a kindergarten class to a practicum on a grade six class, the supervising teacher told her that she was giving the students too much support in the classroom:

I just remember my prac teacher saying, "You need to leave them. You need to stop babying them. You're babying them, you're giving them too much help". So, from then on, I have never forgotten that and I think I brought that into my class this year and just to let them go and then they'll let you know if they're struggling – and they do. I don't think I have one child that I can't notice that's having trouble or that will tell me. (Pre-design interview)

4.7.5 How Emma designed her mathematics program

Emma chose to design a program for the NSW mathematics syllabus on the topic of 3D shapes. She explained that the students did not have as much opportunity to use technology as in other subjects and she wanted to use the design day to investigate how she could integrate technology into the program. She also wanted to design a "hands-on" program because the previous few maths programs had involved students watching modelled examples of calculations and then doing their own practice calculations.

Emma explained that she usually designed maths programs which covered one concept and lasted five days, with one lesson each day. She also explained that when designing mathematics programs, her usual practice was to incorporate a proficiency matrix using age-appropriate language so students could assess their own proficiency in each mathematical concept. Students would then also use these to set themselves learning goals.

Emma reported that she had spent approximately one hour prior to the design day thinking about the program. She had also shared some preliminary ideas with her grade partner on the morning of the design day. Her initial ideas were for students to design and build a city-scape and her thinking about this was stimulated by the syllabus outcomes for this topic:

> *..that idea came from wanting to do three-dimensional space, looking at the outcome. Without looking at the content, just the outcome, I thought about the city scape. First I thought about "Can they build something" and then once I thought more into it, I thought, "What do you want them to build?" And then I thought of the city scape idea so that came from knowing what I wanted the topic and then looking at the outcome and then having a little brainstorm to myself and then once I looked at the content, then the ideas, more of the ideas, came out of like what they're actually going to do with that city scape and what I wanted them to learn and all that sort of stuff.* (End of day interview)

She thought that they could film and photograph the construction of the cityscape and create a time-lapse video. This was a process the students had used previously during an art task and Emma recalled that they had found it very enjoyable. She also explained that she would like students to use technology to design the cityscape prior to building it, but that she did not know exactly how she might achieve that.

Design day process

Emma worked on her laptop during the design activity. She began with the syllabus displayed on her screen along with some images of students working on building a cityscape which she had found online.

Design process

Emma began the design process by viewing the syllabus document and talking about her design ideas. She spent five minutes explaining the content and learning objectives she intended to use from the syllabus. Emma had already decided to try to use the application Sketchup as a tool for students to design their cityscapes on their devices. She spent three minutes taking language from the syllabus to use in the program which she had started documenting in a syllabus document. Emma then began to work on the matrix to guide students' understanding of the proficiency levels they were aiming for in the program. This led her to consider differentiation for those students who needed extension. The use of the matrix in the design process and in the program was important for Emma as she designed:

> *And then I put it together in a matrix in a table with basic, proficient and extending and kind of broke down the content areas into each area so like what they need to be doing to be proficient, what they would be doing if they're showing an extending response or what they would show if they're just showing a basic response basically.* (End of day interview)

Emma explained that the matrix was critical in her understanding of how the students would achieve the learning outcomes:

> *I think it really helps me understand the outcome and breaking down the outcome into kid language and actually, the student language actually helps me understand what I need to teach them really, because I've never taught any of this stuff before and never really broken down an outcome and thought about how you're going to teach this (..) So I suppose sitting down to create that matrix and splitting it up into the three sections and stuff really helps me to help them learn.* (End of day interview)

Emma included the matrix, written in age-appropriate language, in her program document (see Figure 16):

3D Space Matrix

		
I can draw the net and construct at least one example of a 3D model. I have difficulty with drawing a net of a 3D model. I have difficulty with constructing a 3D model.	I can construct simple prisms and pyramids using drawn examples and 3D models.	I can construct complex prisms and pyramids using drawn examples of nets and 3D models.
I have difficulty with sketching and forming a 3D model.		
I have difficulty with explaining my 3D sketch and constructed object.	I can describe to another student how I sketched and constructed a three-dimensional object.	I can describe to another students how I sketched and constructed two or more three-dimensional objects.
I can draw my three- dimensional models from different view points, but I have difficulty with constructing the model. I have difficulty with drawing my three- dimensional object from different viewpoints and constructing the model.	I can draw a three- dimensional object from different viewpoints and construct the model.	I can draw three or more three-dimensional models including an abstract model from different view points and then construct those models.

My 3D space goal is:

Figure 16: Excerpt of matrix from Emma's program document

Emma worked on resources and visualising the content and learning tasks for those higher end students for five minutes before returning to add age-appropriate language to the matrix. Emma then began adding detail to the matrix by including references to the Sketchup application in the learning outcomes section. Emma spent 30 minutes working on the wording of level descriptors of the matrix. Emma then began to consider extension activities for those academically stronger students in the class. She worked on these extension activities for 20 minutes. Emma then began to work on the sequence of lessons for the program. She spent eight minutes to documenting her learning, teaching and assessment experiences for the program using a document given to her by a colleague. Emma's final design work for the day was to make notes about a possible assessment task. She ended when she explained she needed to do a basic pre-assessment with the students before she could add any further detail to the program.

At the end of the design day, Emma explained that she would spend time before teaching the program refining the matrix and making some decisions about the design of the pre-assessment. She also wanted to discuss her program design with her grade colleague:

I also need to make it more concise and less repetitive because some of the activities are quite repetitive in the matrix and then I need to have a space for their goal and I also need to think about how the pre-assessment is going to look and I would like to run it by James before – hopefully he'll come back to school this week. (End of day interview)

Emma also explained that she had left some decisions about the design of the program to make after the students had done the pre-assessment task:

Yeah, so if I think that they have enough knowledge and there's no need for me to teach them how to draw a net of a shape or naming 3D prisms and pyramids and stuff and just things like that – if I think that they're good to go, then we can start looking at how to use Sketchup and we could then, the next lesson, be underway with Sketchup and constructing. So yeah, within two days we should be underway I'm hoping. (End of day interview)

Emma reported that her design process on the design day had followed her usual process, which she usually undertook together with her grade partner. She explained that this was a process she learned from her grade partner and was different process to the one she had learned at university. She explained that she preferred this process because of the flexibility it gave her to design for the differentiation needs of her students:

It's what I'd normally do now because working along with James, he's brought these new ideas in because no-one else programs like this so it's kind of like a different way and I suppose I've stuck with it because it allows me to differentiate the lessons, (..) So I suppose that's why I've stuck with it because when I program for mathematics on prac, it was just a very structured template that I got given and you would do like a challenging maths task with levelled questions and like a number sense to end the lesson and everybody did it like that and it was very structured where now it's like very flexible so you have your own say. (End of day interview)

By the end of the design day, Emma had created an extensive rubric for the program, guided by the matrix (see Figure 16 above). In addition to this, she had created a brief overview of the learning tasks in the program document:

	Introduction of new concept or strategy	Consolidation of concept or strategy	Specific notes: differentiation, adjustments
1	**Assessment OF learning** -hand on experience, constructing 3D objects, justifying their purpose and applying the objects to real life situations -Challenging task Create one prism and one pyramid. Draw a net of a 3D object/s, construct it (form), name the object/s, apply it to a real-life situation (where would you see this object) and justify its use.		
2	Drawing nets of shapes		
3	Names of shapes		
4	Applying 3D shapes to real life situations		
5	Learning about sketch up. (youtube clips).		

Figure 17:Emma's program overview from the design day

Emma's subsequent design work

Following the design day, Emma spent one hour finalising the lesson sequence for the program and refining the matrix for the students. She then created slides to accompany the program and guide the lesson sequence. Emma explained that the slides would be used at the beginning of each lesson to review learning covered in the previous lesson:

> *Yeah, like a structure kind of thing, so they can see where we're up to and every time we start a lesson, I'll bring the Powerpoint up and I'll say, "ok, yesterday we did this.." and we'd have a talk about it it, like what they learned, what they did, and everything like that, and then, erm, we'll move on to the next task and.. I'll remind them about the learning intent and what we're learning about and everything like that.. from the syllabus outcomes* (Planning progress interview)

Emma explained during the planning progress interview that she had decided to change the application for the design of the cityscape from SketchUp to Minecraft after talking to her students about the program before it was going to be taught. She explained that she been prepared to take students to the computer lab in the school because all the desktop computers had SketchUp already installed. However, when she had talked to students about the program, one of them suggested using Minecraft because it was already installed on the students' iPads. As Emma was not familiar with Minecraft, the student linked his iPad to the classroom tv screen and demonstrated how they could design and construct buildings on the platform:

> *..I talked to the kids about it.. I decided to, you know, talk to them and like tell them about what we've been doing and if they had any ideas. And a couple of them suggested Minecraft, because they said, well, we all have the app on our iPads, so we don't have to download it (..) And one of the boys is quite good with Minecraft and he reflected his iPad up on to the Apple TV and showed me what you could do on it..* (Planning progress interview)

After class that day, Emma reported that she had conducted her own research on using Minecraft in the classroom, along with another app a student had recommended. She decided to use Minecraft in the program because it appeared to be easy to use and most students would already be familiar with it:

> *So, I then, on Friday afternoon, I researched it a bit more, like watched some tutorials on it, like how to construct buildings and all that sort of stuff, so I knew what to do and I knew, like, what the kids were going to be doing.. And I decided to go with that. So communicating with them was like the key thing in changing my mind because they told me about an app called '1-2-3 Design', which I also researched, but they said they used it last year, in year 5, and it took a really long time to construct 1 or 2 3-D objects in that application. So I went away and I watched tutorials on them and stuff, and Minecraft seemed like the easiest one, and I wouldn't have had to spend too much time explaining how to use the application and all that..* (Planning progress interview)

Initially, Emma reported that she was reluctant to use Minecraft, but when spoke to her assistant principal about the possibility of using Minecraft, her assistant principal encouraged her to take a risk and pursue it:

> *When he first said it, I was like, "I don't really want to go down that path" and we stopped that conversation there. I shared it with our Assistant Principal and she said, "Do you know what? Let's just have a go because no-one's ever done that before. Let's just have a go".* (Reflection interview)

Following this decision, Emma explained that she worked with her assistant principal to develop a list of expectations for working on the platform:

> *..we sat together and we wrote out those expectations; what she expected from me and what I expected from the kids, incorporated that together and made these expectations, made it clear to them and seriously, Minecraft worked amazingly.* (Reflection interview)

Her stage colleague was on sick leave when the change was made to the program, so Emma was not able to discuss it with him. However, she communicated with him about it so that he was fully informed of the change. Table 22 presents each step of the design process in more detail:

Design step	Contextual design detail	Observed by researcher/reported by participant	Time taken
Prior thinking	0. Idea of a 3D design project of cityscape using 3D software	Reported	
Familiarisation with content	1.Brief review of syllabus, focusing on content and learning objectives	Observed and reported	5 minutes
Think	2.Thought about what students will do in the program and creates a proficiency matrix to guide the learning activities	Observed and reported	4 minutes
Think	3. Considered differentiation and how it would be represented on the matrix. Continues to add detail to the matrix using content language from the syllabus.	Observed	2 minutes
Plan	4. Considered resources that would be needed for building the cityscape.	Reported	4 minutes
Describe	5. Returned to adding detail to the matrix while considering differentiation.	Reported	2 minutes
Describe	6. Added detail to design of task involving students making 3D shapes and added this information to the matrix.	Observed	5 minutes
Describe	7. Continued adding detail to the matrix, reporting that it was stimulating her thinking about the assessment and extension activities for her stronger students.	Reported and observed	30 minutes
Read	8. Thought about the lesson sequence in the program. Viewed previous maths program to see scheduling of assessment task.	Reported	6 minutes
Describe	9. Used a template provided by a colleague to begin documenting the program. Added information on pre-assessment and general ideas.	Reported and observed	8 minutes
Describe	10. Completed lesson sequence and matrix. Designed assessment task and created slides to accompany the program. This was done after discussions with colleagues.	Reported (planning diary)	1 hour

Table 22: Emma's design process

4.7.6 Summary of Emma's mathematics program

Emma's mathematics program on the content area of 3D shapes was a series of six lessons taught over the course of one week.

Program title: Three-Dimensional Space 2

Learning outcomes:

- Describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions.
- Identifies three-dimensional objects, including prisms and pyramids, on the basis of their properties, and visualises, sketches and constructs them given drawings of different views.

Lesson 1:

Pre-assessment task where students construct a net of a prism and a pyramid using paper. Students then apply shapes to real life situations, e.g. identifying where rectangular prisms might be seen.

Lesson 2:

Students work in groups of 2-4 to plan their city scapes in Minecraft. At end of lesson, students link iPad to television to explain the progress of their city construction.

Lesson 3:

Students continue to plan their city scapes in Minecraft. At end of lesson, students link iPad to television to explain the progress of their city construction.

Lesson 4:

Students use their planned Minecraft cityscape to construct their 3D model using cardboard, paper and other materials. Students use time lapse on their iPad to film the constructing process.

Lesson 5:

Students continue to use their planned Minecraft cityscape to construct their 3D model using cardboard, paper and other materials. Students use time lapse on their iPad to film the constructing process.

Lesson 6:

Each group presents final product placing all components (Minecraft pictures, constructed cityscape pictures and time lapse).

Students complete challenging maths task as assessment.

Assessments:

1. Pre-assessment to identify students' existing knowledge on 3D shapes.
2. Main project: constructing a city scape (group mark and individual mark)
3.Summative assessment: challenging maths task on 3D shapes from school program folder.

Emma created four main TIL activities for the program. The TIL activities in the program are broken down in terms of their technology classification and role in the program in Table 23:

TIL activity	Technology classification	Role of the activity in program design
1. On iPads, students work in groups to plan a city scape using their knowledge of 3D shapes in Minecraft	Education version of online game (Minecraft)	For students to think about how 3D shapes are present in towns and cities
2. Using iPads and iMovie, students film, take time-lapse footage of their design process and incorporate still images of the construction of their city scapes in real life to create a movie depicting their design process.	iPads and iMovie app (non-education-specific)	For students to record and present their city scape design process

Table 23: Breakdown of TIL activities in Emma's program

The technology integrated learning tasks in Emma's program design were creative and their design emerged in collaboration with the students in the class. The incorporation of Minecraft as a design tool allowed for the designs to be conceived and worked on from 360 degrees, a process which would not have been possible had they designed their city scapes on paper. This attribute means that in SAMR terms, the task can be identified as at the higher end of the model's classifications, at the *modification* level. Collaborative, problem-solving work was evident as students translated the design from online to in the physical space.

The second TIL task originally involved students creating a time-lapse video of their design and construction process, capturing evidence of their individual and group work. However, the students requested the opportunity to build on this idea and they created iMovies which incorporated their time-lapse videos, screenshots of their Minecraft designs and photograph images of their cityscapes. This final product allowed them to fully represent their work over the entirety of the program. This in turn allowed for evidence to be captured of their work and knowledge gained through the learning tasks. Allowing the students to take further ownership of their creative work in this way also increased their engagement and personal investment in the work. This TIL activity was multi-faceted and could also be placed on the *modification* level of the SAMR model, as the technology allowed for the synchronous capture of learning data which would not have otherwise been captured.

4.7.7 Teaching the mathematics program

Emma made five entries in her teaching diary and reflected on her teaching, the students' activities and her analysis of the students' learning in each entry. The teaching went mostly to plan, although the time allowed for the program was extended so that it lasted eight days in total, over two weeks.

On the first day of the program, the first step was a pre-assessment, where students created a prism and a pyramid using paper. Students then viewed the matrix and reflected on their knowledge of the concepts of 3D shapes. They then set themselves a learning goal for the week. Emma introduce the Minecraft task after a short pre-assessment on 3D shapes. She demonstrated how to use it by linking her iPad with the television in the classroom. She offered students the chance to review some tutorials on Minecraft, which some did, and some students demonstrated some Minecraft design techniques for students who were less familiar with the platform:

> *..so we watched a few tutorials and one of the boys in here actually taught a few little things on how to build certain things and how put the coding in and stuff like that.* (Planning progress interview)

Students then free to worked in groups of two, three or four to create their cityscapes. They were given two lessons to work in Minecraft before they had to begin to construct their cities using craft materials brought in from home. Emma decided to implement this restriction in order to focus the students and to discourage them from wasting time playing on the Minecraft app. At the end of each of the Minecraft lessons, students linked their iPads to the television and gave a brief summary of the work they had completed on their cityscapes for that day. This allowed students to see each other's work.

Observed lesson

The researcher observed a lesson towards the end of the program when students were in the process of constructing their city scapes in real life using their Minecraft designs to work from. This was an interesting lesson to observe because there were some valuable observations on the students' process as they translated their online designs into real life city scapes.

Prior to the observed lesson, Emma explained that it would be a hands-on session, where students would be engaged in constructing their city scapes in real life from craft materials. She had identified that some students found the process of translating their Minecraft-based designs into real-life constructions challenging and she anticipated that she would need to be prepared to offer support to help them to start:

> *..the kids actually find that quite hard to get started, right. So I had to sit with a lot of them and like say, Okay, look at this part of your Minecraft, this is probably where you should start. Because some of them the Minecraft is so overwhelming. They're built so much. Right. Okay. And some of the things are quite impossible to make. Yeah. So I said to them, just pick one section of the Minecraft plan that is a bit simple that you can kind of build. It's kind of simple to build, rather than building something more complex a bit later.* (Pre-lesson interview)

She explained that there was a broad range of complexity in the groups' designs and because of this she would be prepared to support the groups in different ways.

During the lesson, the researcher observed that two critical processes were occurring. Firstly, students were working iteratively to construct and reinforce their physical structures. They were recognising the differences between constructing their designs online and constructing them in real life, where they needed to add to the structures in order to make them stable. Some groups were using their knowledge of electrical circuits to add lighting to their city scapes, which was taking the design beyond the one they had created online. A secondary learning experience was taking place as students were taking time lapse video stills of their working process. They were experimenting with the angles of the device to take the images, and also checking the steps of construction they had captured, occasionally re-doing some steps so that they could be properly captured on the video.

Emma maintained a role of learning support where she observed intervention or prompting might be needed by some groups. Otherwise she monitored the activity in the classroom while allowing students to make their own decisions about how they approached the construction of their designs. At the end of the lesson, Emma requested that some groups link their devices to the television so that they could present the work they had completed during the lesson and invite feedback from fellow students.

Following the lesson, Emma reflected that it had been difficult for her to relax and allow the students to work independently in a "messy" fashion:

> *What I get a little bit flustered with is the noise and with the mess and I was talking to some of my colleagues on the staff about this – once you step back and think about what they got from it; they're using technology and they're experimenting with technology and then they're collaborating in groups as well as thinking mathematically as well and learning a mathematical concept all in one so they are getting a lot out of it and I think that I need to step back and let them have their time.* (Post-lesson interview)

She reported that the construction activity had been a valuable way of understanding the extent of students' knowledge of 3D shapes:

> *I think that the construction part has shown me whether they know whether they have a kind of in-depth understanding of 3D shapes and how they're incorporated into a real-life situation. You would have seen some of them – it's all realistic and it's to scale and then some other ones... the girls, some of their buildings aren't to scale, they're not really mathematically to scale but some are bigger than others. That, in real-life is not the case. So, I think that it's really allowed me to see who has an in-depth understanding as to how 3D shapes are seen in real life and who doesn't. And then I could see who can build an abstract shape and then who is just sticking with the cubes and rectangular prisms and square pyramid. So, I think that it gives me a wide range of understanding with where they're at.* (Post-lesson interview)

Emma reflected that there was a broad range in the complexity of city scapes the groups had produced and reported that she should have incorporated some scaffolding activities for some students who were experiencing some difficulties with their constructions. She also reported that she would have liked to allow time for students to reflect more deeply on their work and their designs, but time constraints did not allow for it.

4.7.8 Emma's reflection on the program

Emma's program was perceived to be a positive learning experience for her and for her students. Furthermore, the program was acknowledged and promoted by the school. Emma explained that her colleagues had been very impressed when she showed them some of the students' iMovies and the assistant principal and principal decided the projects were such a high standard that they should be presented in the hall for other students, parents and other members of the community to see. The school sent out invitations to families to come to the exhibition, which many did, and students presented their projects on individual tables, with the iMovie accompanying the presentations. Emma reported that when she heard the students talking to visitors about their projects, she realised the full extent of their learning on the topic.

Emma also reported further impacts of the program on the broader school community. Firstly, her colleagues were enthusiastic about using similar approaches with technology in their classrooms, which meant that Emma became a source of TIL support for her colleagues. Secondly, younger students in the school approached Emma to say that they were excited about the work they had seen and hoped they would be able to do the same thing when they reached grade six. Finally, the impact on parents and grandparents was felt by Emma in this small community following the exhibition. She reported that parents' confidence in the use of technology in school was reinforced:

> *Parents in this class are quite good but they, last year when the iPads were starting to be integrated in, they were worried about homework and how homework was going to be used for technology as well (..) they're so worried because they have three or four kids or they have a job and they can't monitor the kids and their homework with their iPad. Everyone is going to have worries but I mean the fact that they could come in, the parents and the teachers and the kids and see what's going on, they can see that technology's being used effectively.* (Reflection interview)

For Emma, as a new teacher, the value of taking a risk with technology to design an innovative learning experience, without the support of her grade colleague, was evident:

> *I think that doing this on my own has given me a lot more confidence to go out and do more things on my own and not always having to run it by James because I find every time I create something, I'm always like, "Better run this by James to see if it's going to work". And I think it's given me more confidence because I didn't have time to show him this because it had to be done really quickly.* (Reflection interview)

Emma's overarching reflection on this program was that she was surprised how successful it was in terms of students' engagement in learning and their achievement in the summative assessment task. Emma attributed the success of the program to the level of independence the students were given in the process:

I think the biggest thing for them is they had absolutely 100% control of that project. I facilitated, I gave them ideas, "What if you did this? What if you did that? What if you put that over there and then had this there? What if you built this", you know, gave them ideas along the way and helped them build stuff along the way but they had 100% control, they did the Minecraft, they did the filming, they did the constructing, they did the putting together the iMovie, they did the exhibition with talking about the whole thing, they completely had 100% control of that and I don't think that there's enough of that. (Reflection interview)

Emma reflected in her teaching diary that the TIL components of the program worked well to support students' engagement and learning in the content area:

The technology used within this unit (Minecraft, time lapse, iMovie) worked perfectly and was a great fit for this unit. It allowed students' knowledge to extend and for the unit to be more engaging and hands on. The technology also allowed everyone to see what every group had done and the whole process. It also made it easier for me to assess due to me being able to watch the iMovie to see where everyone contributed. (Teaching diary)

4.7.9 Summary

Emma approached the design of her mathematics program as the development of a new program, which was centred around an extended creative and collaborative cityscape design task facilitated by online world creation software. She considered technology integration from the initial stages of the design process when she was thinking about how she wanted students to approach their design. When describing technology integration in her program, Emma wanted to design a learning experience which was engaging and allowed students to use technology creatively. She integrated technology seamlessly as part of the extended task.

The case of Emma identified key contextual influences on her design process. These are discussed in the following section using the lens of activity theory. Table 24 presents an overview of Emma's case through the lens of activity theory:

Activity theory component	Evidence in this case
Tools	Teaching and Learning matrix; TPACK, especially
Rules	BYOD policy
Community	Students - differentiation, colleagues as support, parents interested and supportive of learning
Division of labour	Colleagues and supervisors as design advisors

Table 24: components of Emma's activity system

Emma had sound knowledge, but limited experience of TIL

Emma expressed a lack of confidence in her content knowledge (CK), often in relation to the academic abilities of the students in her class, as some of them were identified as academically gifted and talented. Emma had some technological pedagogical knowledge gleaned during her university education. However, as a recent graduate, she had limited professional experience of implementing TIL. Emma reported that she had confidence in using technology in the classroom, but that time constraints for planning meant that it was often used only in a basic way. This indicates a possible contradiction between the *tools* and *rules* components in activity theory.

As a support to her pedagogical knowledge (PK), Emma used a teaching and learning matrix throughout the design process to guide her wording and task design in the program in order to ensure that the differentiation needs of the class were catered for. This shows a strong connection between the *tools* component and the *community* component in activity theory.

Technology policies in the school did not guide the design of TIL

The school had a BYOD policy (AT: *rules*) for students in upper primary (grades five and six). While there were rules highlighted on posters in the classroom and around the school governing students' practice with the devices, there was little explicit guidance for teachers in identifying how to integrate technology. Emma's mentor teacher was a nominated ICT support person and was available to help teachers who wanted to use technology in their programs, but this staff member had a full-time class and so had a limited capacity for support. There was no identified professional learning about technology integration in the school.

Emma identified the fact that time constraints when planning usually meant that technology was integrated in a superficial way because there was no time for in-depth research and design of TIL.

There was some support for TIL in the broader education community, but little expertise in the school context

Emma had the support of a dedicated mentor through the local catholic education office (AT: *community*), whose role was to support teachers in their first teaching role. This meant that Emma participated in many professional learning opportunities for new teachers. However, professional learning focused on TIL was limited.

The teaching staff at the school (AT: *community*) was very collegial and Emma reported that she had shown her students' iMovies to her colleagues in the classroom, receiving valuable feedback. Emma's grade colleague was the ICT coordinator at the school. However, Emma reported that she was responsible for approaching him for support with her ideas for TIL, which she had not previously done due to time constraints. Other colleagues were supportive, but Emma did not perceive them to be a source of support for TIL design.

Emma usually worked on designing programs with her colleague who taught the grade five class (AT: *division of labour*). During this study, her colleague was on extended sick leave, therefore Emma discussed her program design with her assistant principal after the initial design day. Her assistant principal encouraged her to take a risk and pursue the idea of using Minecraft in the program. The AP supported Emma by working with her to write expectations for her and her students.

Emma's students (AT: *community*) were a key influence in her initial design conceptualisation because she wanted to be able to cater for the differentiation needs of her class while running a practical maths program. She consulted the students directly about the program and accepted their suggestion to use Minecraft after allowing them time to explain an demonstrate why it would be an appropriate tool to use to design a city scape. In doing this, Emma showed she respected their academic abilities and technological knowledge, and accepted them as partners in the program design process.

Contradictions

Viewing this case through activity theory, we can see that the *community* and *division of labour* components work well together to support the design activity in this case study. Contradictions are evident in the broader design context which might affect other design activity systems. These are a contradiction between the *rule*s and *tools*, in that having limited time to investigate TIL options result in minimal integration at superficial levels. This situation could be further exacerbated by the fact that there were no formal opportunities for Emma to engage in professional learning about TIL. There was an ICT support teacher in the school, but this support was offered on an informal basis with teachers approaching him when they identified a need or opportunity to design TIL. There was no formal leadership for TIL in the school. This indicates the existence of a contradiction between the *rules* (leadership) and Emma's psychological *tools* (experience and knowledge).

4.7.10 Conclusion

Emma was a teacher in her first year of teaching a grade six class at Catholic primary school a small suburb of a regional city in NSW. She designed a program for the mathematics syllabus focusing on 3D shapes. Technology was integrated in an innovative way, with students using their BYOD iPads to design a 3D cityscape in Minecraft, which they then recreated in class using craft and recycled materials. They created digital reports of their projects as videos, by using stop-motion presentation of their design processes and incorporating other images, video and audio. Activity theory identified that Emma's TPACK was strong and supported her to be innovative with her use of technology. She had confidence in her students' capacity to work with digital tools in this project. Her knowledge and skills led to her visualising how her students could use represent a 3D design digitally and how that process could support their learning.

4.8 Shelly's science program – 'Hollywood Blockbuster'

4.8.1 About Shelly

This case presents Shelly, a teacher of a grade five class at a Catholic primary school in a small beachside town in New South Wales. The data collection took place in terms two and three of the school year. Shelly was in her third year of teaching following graduation from a regional university with a Bachelor of Primary Education. At the time of the research, Shelly had been working at the school, for eighteen months.

Shelly designed an integrated project-based learning (PBL) program for the study, from the NSW syllabus for science and English. The impetus for its design came from school involvement in PBL introduction project from the catholic education office (CEO).

4.8.2 Shelly's knowledge and experience of technology-integrated learning

Shelly explained that she is very comfortable with technology generally and enjoys "tinkering" around with it outside of school. Shelly lives at home with her parents and acknowledged that this meant she had more free time and fewer responsibilities outside of school than many of her colleagues, which in turn allowed her time to investigate and seek out new resources and ideas for teaching. She also compared herself to her colleagues in terms of seeking out technology-based resources:

> *I think I'm very internet and technology-based, whereas some of the more experienced teachers will go to the library and use the resources but I seem to find that they're quite outdated and the most up-to-date information and resources you can find are on the internet.* (Pre-design interview)

Shelly reported that she had built an extensive professional learning network through social media, predominantly using Facebook (including being member of groups dedicated to teaching) and Pinterest. However, while she attended many professional learning events through the Catholic Education Office, she felt that these did not meet her professional development needs:

> *And they (CEO) sort of give us information so they'll send us emails and they'll say "We've got this planning day" or "We've got this PD day that you're welcome to attend". I find that the professional learning days are great but often I'm already at that stage anyway because the way that I learn how to do things is I just sit there and fiddle with it.* (Pre-design interview)

Shelly explained that she wanted to understand how to extend her knowledge and experience with TIL beyond her current level. Shelly's current knowledge and experience had led to her being appointed the leader of the school TIL learning committee. At the time of the study, she had also led some TIL professional learning events for the CEO. In these instances, while Shelly's own TPACK was strong, others were drawing on that for their own development. While she appeared to be pleased to do this, she was keen to extend her own TIL knowledge:

> *I feel comfortable with it. It's not something I find scary. I think the thing I'm finding the most is "Okay, well what can I do now? What can I build upon? What can I change" because I feel like I've used Explain Everything, we've used Book Creator, we've used iMovie, we've done this, we've done that but then I kind of think as well "Well, it's not really changing that". It's about "Is that improving the learning" I guess. So, I don't know (..) I can't seem to find that next step because everyone seems to be stuck at this level almost.* (Pre-design interview)

Shelly explained her belief that technology was an integral learning and teaching tool which had practical benefits for her students:

> *To me it just means it's another learning tool that we use alongside everything else that we have. I think that students need to learn it. I mean I don't use anything other than a laptop. (..) but I think it's also good because we're teaching them the skills to participate in social media and online forums, especially with our use of See Saw and Google Classroom. It's all monitored and we sort of weave those into our digital citizenship lessons.* (Pre-design interview)

She also reported the need to balance her strong beliefs in its value for students' education with the attitudes of some colleagues who were less enthusiastic:

> *Yeah, lots of conflicting perspectives but I definitely think it's a worthwhile addition to the learning just because of the engagement factor and the different possibilities and, you know, kids are going to have jobs in the future that require them to have these skills and to use technology and to create things (..) So yeah, I think that's where I come from with it but sometimes I have to take a step back because of the expectations of others.* (Pre-design interview)

During her initial teacher education, Shelly had completed subjects on technology-integrated learning. One subject was a theory-based unit in the first year of her degree. The second was a practice-based subject which gave her practical experience of integrating technology into learning experiences and designing technology-based programs. Both of these were underpinned by the theoretical SAMR model. She explained that this was a very enjoyable and useful subject, taught by a practising teacher, which made it more meaningful:

> *I found that a lot more practical and I could go into the classroom and analyse my use of technology and whether it was impacting on student learning but I also had ideas of what was possible..* (Pre-design interview)

Shelly reported that no other subjects she studied in her initial teacher education degree included technology integration.

4.8.3 Shelly's school

The school catered for students from Kindergarten to year six and had approximately 360 students. The socio-economic demographic of the students was slightly above the average Index of Community Socio-Economic Advantage (1040; average ICSEA= 1000). The school was located very close to the beach, which was used by teachers and students for sport (cross-country running) and for outdoor learning experiences such as science.

At the time the research took place, the school had been undergoing a period of professional learning and development, especially in the field of technology-integrated learning. They had introduced a 1-to-1 iPad program for students in grades five and six, as part of a trial by the Catholic Education Office. A new principal had also been appointed and had begun a comprehensive process of reviewing policies and procedures across a range of areas. While there had previously been attempts to help teachers develop their knowledge and skills with technology integration, Shelly explained that this was not successful due to factors relating to leadership and staff motivation:

> *I think it was a one-man show at the time when it was implemented and that person was driving it (..) and they had all the skills but it didn't necessarily go out towards all of the other teachers and they were older teachers on the stage at the time. It was to Stage 3 and there were four teachers and they were all sort of heading towards retirement and they've all retired since. I think there was definitely an attitude from some of them that it was too hard and "I'm just going to keep doing what I've been doing because I'm going soon" (..) whereas now it's very stable and there's a lot more happening so there's a lot more success.* (Pre-design interview)

The policy review process had included a survey of parents' views of technology-integrated learning (TIL) at the school. In the survey, parents had reported little knowledge and understanding of the 1-t-1 iPad system, even six months after implementation. In response to this feedback, the school moved to engage more with parents on the learning goals for TIL. As a direct result of this, the school introduced the Google Classroom platform and the use of the *SeeSaw* app to facilitate communication about students' work with their parents. Shelly explained that engagement with parents and the broader community about TIL was important to the school and they held information evenings to demonstrate and explain the technologies in more detail:

> *Yeah. We run an information night beforehand and last year I ran a couple of nights for Year 5 parents and I actually brought them in and did a lesson as if they were the students and they brought their student's iPad with their passwords and took them through... we went through Google Classroom, they used Ed Puzzle, (..) Yep, they loved it because they knew exactly how it was being used. It wasn't a foreign thing – because they haven't grown up in classrooms that are using it so they don't know the capabilities.* (Pre-design interview)

Under the leadership of the new principal, and in close liaison with the Catholic Education Office, the school embarked on a professional learning program which included a professional learning committee for TIL. Prior to establishing the structure and protocols of the learning community, the teachers worked together to better understand the concept of learning communities and the benefits of such communities being data-driven. This committee undertook a series of scaffolded learning events for teachers and included opportunities for team teaching. The principal had also secured a connection with a learning technologist from Apple to work with teachers, if they needed extra support. The school held regular technology staff meetings where they practiced using some of the technologies they aimed to integrate into the classrooms during the meetings:

> *Our view behind it is when we have a technology staff meeting, we try to incorporate Padlet or something that we're using in the classroom because then it exposes and we're then teaching and sharing and collaborating the way we want the students to. Yeah, and that's exactly what's happening now; we're all collaborating the same way we want them to in the classroom.* (Pre-design interview)

Shelly was appointed leader of the technology-focused learning team. She identified that while there were some more experienced teachers who were reluctant integrators of technology in the classroom, this was not always the case because some more experienced teachers were able to integrate technology more effectively than some of the early career teachers at the school:

> *I don't think it is because then we have some really experienced teachers (..) who would definitely integrate technology more effectively than some of the other early career teachers (..) the people that I was working with didn't really have too many skills – the iPads were basically in use as research tools; they weren't being used for content creation. I was the first one to sort of start doing that...* (Pre-design interview)

Shelly had a nominated mentor in the school, although she commented that she would not go to her for advice on planning her learning programs. She said that she often requested support from the school literacy coordinator in planning her programs. Shelly also commented that her mentor in previous years had "a lot of responsibility in her role" (Pre-design interview) and indicated that this meant the mentoring she received was variable. The Catholic Education Office for Shelly's region had a staff member who was responsible for early career teacher support and Shelly maintained contact with her. This person had asked Shelly to speak to new teachers about TIL on several occasions.

4.8.4 Shelly's class

Shelly taught a grade five class while participating in this study. She had been a teacher on grade five since beginning at the school. Shelly explained that her students had experienced some disruption in the previous year. A small group of students in the class had developed behavioural issues and so at the start of this year, she had to be mindful of setting clear boundaries and catering to their need for hands-on learning. She also reported that she had a wide range of learning needs in her class, catering for some student who were learning at a grade one to two level and others who are *"borderline gifted"* (Pre-design interview). She also had one student with a learning disability in the class.

Shelly described the students as being very engaged and creative in their use of technology for learning. However, she noted that they needed explicit direction in and reminders about working with iPads in the classroom. This was in relation to setting up technology for learning activities and familiarisation with some aspects of iPad use and design. Shelly also reported that she had to remind students of the expectations for behaviour and use of the iPads. Shelly explained that giving her students independence in choosing technology to work with in the classroom was a positive influence on the standard of work they produced:

> *I find that they've got more scope to show me what they know and show me their skills because if they just have pen and paper then they can only demonstrate in one way whereas with the iPads we've got students recording, they're videoing, they're pulling things from the internet, from other apps and I find it's more integrated and more students are able to express themselves whereas when I have work on pen and paper from some of the students, you sort of get a couple of sentences.* (Pre-design interview)

Shelly explained that her thinking about TIL was an integrated part of her design process:

> *I think of, you know, "How would I do it without the technology and then how could I use the technology to improve that or adapt it or is that really boring with the technology and can I just use technology to replace it and make it a little more exciting". So like our number sense at the moment is just NAPLAN questions but we're using Kahoot and obviously just for engagement but also it's focusing on the time – they've only got that certain amount of time to answer a question..* (Pre-design interview)

The TIL tools Shelly used in the classroom reflect her fluid approach to integrating technology. She reported that she commonly used a wide range of applications (apps) for mobile devices in the classroom, after consideration of their affordances how they might support her pedagogical approach. As a result, the students were comfortable with using a range of apps to plan and present their work.

4.8.5 How Shelly designed her science program

Shelly reported that she had a lot of independence to make decisions on content and learning activities when designing learning programs for her students. She explained that assessments were usually agreed as a stage team and she usually checked her programs with the school's literacy coordinator and the PBL coordinator:

> *Yeah, sort of as a year group but we try and split up the planning between us. There's two of us, to sort of share the load. We sort of catch up and have a chat about what we're going to do and then we'll go off and do something then we'll come back and, "This is what I've got. What do you suggest?" But then I also speak to other people in the school, like I was saying, I speak to Vanessa about incorporating, yeah, literacy and I'll speak to, I don't know, the PBL teacher – we'll just bounce ideas off, "This is what I'm thinking. What do you suggest?"* (Pre-design interview)

Shelly explained that there were several resources that she typically considered when planning a new program for her students. She reiterated that she tended to look for internet- and technology-based resources rather than paper-based resources in the school:

> *It depends on the unit. I obviously look at the syllabus. I look at the unit that I had the year before and I think about what worked well and what didn't and then I think about the students in the class and what resources we have as well. I think I'm very internet and technology-based, whereas some of the more experienced teachers will go to the library and use the resources but I seem to find that they're quite outdated and the most up-to-date information and resources you can find are on the internet.* (Pre-design interview)

Shelly reported that when designing TIL, she considered technology integration at different stages, depending on whether the technology would be used in the assessment task or not:

> *So you'd look at technology as sort of the final layer if you like?*
> *P Yeah, sort of the final layer but then it sort of changes depending on the unit that I'm planning because if I'm planning a unit where they need to produce some sort of project, then I need to think about how they're going to present that project. So, you know, doing like a backwards model type thing.* (Pre-design interview)

Shelly's design process

At the time of the study, the school was participating in a trial of project-based learning (PBL) by the Catholic Education Office, and so participation in this study offered Shelly the opportunity to design a PBL unit. The unit was designed and taught in conjunction with a PBL coordinator from the CEO. Shelly's overall aim was to design an integrated project-based learning (PBL) for an integrated unit on English and science. Her rationale was to create a program which engaged students in more higher order thinking skills:

> *I guess I want to create a unit that's more engaging and it's real-world and students are actually producing something and they're not just being fed information; they're applying it and they're using creativity, collaboration, all those skills that they would actually need in the real world. They're not just sitting there and learning what an adaptation is for the sake of it. And also, I guess to develop my skills in integrating different subjects. My focus isn't on the technology part. That's just going to be part of it.* (Pre-design interview)

Shelly commented that she always started to think about units at the beginning of the year, and so done some preliminary research for this unit. She had identified a sample unit online which followed the PBL structure and contained a similar assessment task to the one she wanted to design for this unit. This unit directly influenced Shelly's decisions to focus on a fantasy concept for the English component and the task would be a movie production. Prior to the design day, Shelly had spoken to her grade colleagues, the PBL coordinator and the technology consultant to discuss these ideas. In describing her aims for the unit, Shelly explained that she wanted a unit in which students would be able to employ real world skills of collaboration and creativity to apply what they have learned. She decided that technology would play a significant role in the summative assessment:

> *The one I'm going to do, they need to produce a presentation to movie producers so I kind of thought, "Well, if they're presenting to movie producers, how would they like the presentation to be presented and what will they need to include in the presentation?" So I'm kind of thinking iMovie will be the best option but then I need to look at what limitations that has; iMovie is not a collaborative program so if the person with iMovie on that iPad isn't there one day then the rest of the group aren't going to have access to the iMovie for that day.* (Pre-design interview)

Design context

Shelly used her laptop for the design process, and during implementation to record the reflections on the unit and also to add to a website to accompany and lead the learning in this unit, which was constructed using the platform *Weebly*. Google Drive was used to access previously designed PBL units in lower grades. Resources for PBL were also accessed on Google Drive. Before the design day, Shelly had given thought to the 'problem' for the PBL program and had also discussed some initial ideas with the technology consultant and the PBL coordinator:

> *Yeah and the problem is that they've been hired as the youngest cinema designer for the next Hollywood blockbuster movie and it involves visiting fantasy planets and they want to make realistic plants and animals for the scenes so they have to create animals and life cycles and adaptations that would suit that environment and then they've got different planets here (..) so then when I was thinking about our concept for English next term, I thought maybe we could incorporate a fantasy concept so we'd look at fantasy texts so with their movie, it's all books or video games because then that's incorporating STEM to a certain level. I haven't done a whole lot of research but this is just how my mind works; I'll see something and then I'll just... and I've spoken to our technology consultant on the Monday we just had just to run a couple of ideas by him and I've run a couple of ideas by Emma, our PBL and I've run a couple of ideas by Vanessa – just to give you that background that I've had that support.* (Pre-design interview)

Shelly's design process

She explained that her principal considerations were to create a program which was engaging and which had clear real-world connections, while emphasising key skills of creativity and collaboration. She clarified that technology integration was not a focus for her, but would naturally be part of the process.

Shelly's design day process

Shelly began by reading through the syllabus and the school's scope and sequence. She explained that she was initially going to think about the design of the program by considering the learning outcomes first. She explained that this was not the approach outlined in the PBL protocol, but it was the best way for her to begin because "that is how I think" (Design observation). During this stage of design, Shelly viewed a PBL program from grade four to understand how much detail is appropriate for documenting the learning, but she quickly returned to review the English learning outcomes in some depth.

Shelly began to consider the final authentic task of the program after the initial stage of determining the learning outcomes. Her idea for the task was based on a fantasy movie about imaginary creatures. She explained that this assessment task would determine the structure of the learning activities through the program and so it was necessary to begin to write her ideas for the task early in the design activity. Shelly referred to a sample program she found online when first noting her ideas for the task. Shelly talked about the technology which she would need to integrate to support the final task. She included instructions for using iMovie in her documentation and talked about some apps which students could use which would support some animation creation and a green screen app for special effects. Shelly then moved on to thinking about planned excursions to the zoo and to the botanic gardens and how those real-life experiences would contribute to students' learning in the program. She also made notes about people she knew who might be able to contribute in some way. These were contacts she had, including a filmmaker, a costume designer and a cinematographer.

Shelly then turned her attention to the PBL protocol and its key components. She expressed some difficulty with understanding some of the components and referred to the lack of detail which made it difficult to understand for someone new to the concept of PBL. Shelly then returned to the final task to check its alignment with the identified learning outcomes for the program, after which she made further attempts to document her plans using the PBL template

After lunch, Shelly began to review the grade four PBL program for ideas on how she could organise her learning sequence. She began to make notes on a possible sequence using questions which would guide the learning. In the following stage, Shelly began to write more detail to the learning activities and simultaneously talked about her considerations for technology integration. She considered in detail how the apps she wanted to use could directly facilitate students' collaborative work, while not inflicting a heavy cognitive load on them. This would mean the apps could be integrated easily and without much disruption to learning:

> *So there's a few ways I could do this: so for these first questions here, I could either do something where the students are collaborating all together, or the students create something of their own. Well, I guess it's kind of like a brainstorm, so then I think well, what's the brainstorming tool that I use? And there's a few different ways I could do it – I could ask it as a question on GC, I could use Popplet, so each student would have their own individual Popplet, or we could do a class Padlet. But then there's a few advantages and disadvantages, whereas with Popplet, we could have one for what humans need and one for what animals need, whereas then with Padlet, you don't have that overview. And sometimes then I need to search the App Store for things, so I've got my iPad here. (..) Then once they've created their Popples, and they already know how to use that app so it's not something I would have to teach them because it's just a small quick task, that's why I've chosen it..* (Design observation)

Shelly continued to talk about integrating the app Ed Puzzle and that this app required student interaction, which meant they would be engaged and would maintain their attention in learning the content:

> *The reason I like to use EdPuzzle (for the videos) is because if we're just show it on the board I don't find they're as engaged because it's not on their device, (..) they can see other kids in their peripherals around them and they get distracted and they don't really listen – if you ask them a question, they don't necessarily know the answer. Whereas EdPuzzle, it will let them pause and go back, but it won't let them fast forward, so it's not like just sending them a YouTube clip, but you can also have points along the way when you can stop and either aske them a question, or you can put a voice recording or a comment, that they have to stop, read or listen to before it lets them move on.* (Design observation)

Shelly continued then to iteratively add detail to the program document, while checking the alignment of the activities with the learning outcomes. This process continued until the end of the design activity (90 minutes). She explained how by allowing students to determine which apps they wanted to use in some instances, she is better able to cater to their individual needs:

> *I don't like to dictate what apps they use all the time because students don't always necessarily respond to an app in the same way. Some students for example, they just did a religion assessment task, (..) and some students chose to use Google Slides and create a Powerpoint presentation and import videos and.. they're usually the good writers because they'll do some typing or.. whereas I've got some students who are still at the verbal stage, rather than the writing and so they use Shadow Puppet where they put photos or images and they can talk about it, and a little bit of text, but they're still presenting that information, but in their own way.* (Design observation)

Shelly continued to explain about how she chooses whether to prescribe a specific app for a learning task:

> *Sometimes I do (prescribe the app) because I want them to do something in a certain way or I'm assessing a skill that that app might use, but is I'm not assessing their literacy skills, I'm assessing their knowledge (..) so whatever way they think they can get that information to me, they can.(..) Some kids did their presentations on Popplet, which might not have been the best choice, but we discussed it because they love the app Piccollage, but we just discussed how its good, but how much information can you fit on one Piccollage and is that appropriate.. so we do have those discussions before they go off and do their task.* (Design observation)

Designing TIL

Shelly considered the technologies she wanted to integrate into the program in some depth during her design activity. She explained that she thought about the technology component when she was thinking about the students' work during the learning activities. Shelly reported that she thought about integrating the *Popplet* activity as soon as she decided that the students would do a brainstorming activity about the environmental conditions humans and animals need to survive. She went into detail about the affordances that *Popplet* had which meant that she decided to use it over other possible applications:

> *I thought that with a Popplet, they would be able to map that out easier because they could have a central Popplet, popple for humans, a central popple for plants and a central one for animals and then they could weave them off each other and then they can also make connections between what we share as well whereas Padlet it's basically just typing what you know...* (End of day interview)

Shelly also explained that she would introduce the technology after delivering the content that students would need to do the activity. She further explained that this was so that the content was prioritised rather than the technology:

> *Like I'll think, "Okay, brainstorm, okay, well how are we going to brainstorm", but I'll sort of say, "Well let's just finish what they need to know for the lesson first. Let me just finish the content of the lesson" and then I'll bring that in because if I bring the technology in too early then sometimes that changes the way the content (..) Because sometimes you change the content to suit technology whereas I think the technology is there to complement the content.* (End of day interview)

Shelly further explained that although the brainstorming activity could be done on paper, Popplet[11] allowed students to include images and recordings to the mind maps, which was of particular benefit to her students who struggled more with writing. She also considered the integration of Popplet with the Seesaw[12] app, which would allow students to share their mind maps on the IWB and also with their parents. Shelly commented that extending the discussion about the lesson to the students' families had been beneficial to students' learning in the past because students spoke about what their parents had said and occasionally, parents had expertise in an area which they were willing to share with the class.

Shelly also incorporated video into her lessons, which she did using an app called EdPuzzle[13]. This allowed her to add annotations within the video, and interactive tasks such as quizzes, which students must answer before they progressed to the next part of the video. Shelly explained that this had benefits for students' understanding and engagement:

> *I chose Ed Puzzle because I find the students more engaged when the click is on their own screen; they're also able to go back and re-watch and we put in questions for them to answer along the way.* (End of day interview)

Shelly incorporated the app Puppet Pals [14] as a presentation tool for students to use to explain the adaptations they had devised for their particular animal. The tool is visual and used characters of the students' choice to explain images that the students upload. The app

[11] www.popplet.com
[12] https://web.seesaw.me/
[13] https://edpuzzle.com/
[14] https://apps.apple.com/au/app/puppet-pals

allowed for both text and voice explanations, which supported differentiation in Shelly's classroom:

Shelly designed her students' field work activity to integrate the app Piccollage[15] because she explained that they were very familiar with how to use it and it was a valuable tool for recording their findings and their reflections when working outside. She explained that she would make a decision about whether to use it to report findings in the classroom when she had decided whether that activity would be assessable.

Shelly reported that her decisions about the technologies she would integrate in the program came from her knowledge of what has worked well in previous programs, but most significantly, the decision was based on access to technology. She reported that the 1 -to-1 iPad program in the school meant that each student had access to a mobile device and this was *"a huge factor"* (End of day interview) in her decision to concentrate on using app-based technologies.

By the end of the day, Shelly had completed the first two of the four stages of the PBL protocol. These were:

1. Understanding the design – What are the desired results?

    In this section, Shelly had typed in learning outcomes from the syllabus and 'big idea' questions which would guide the program:

[15] https://piccollage.com/

STEP 1: UNDERSTANDING BY DESIGN - WHAT ARE THE DESIRED RESULTS?	
School: [redacted]	**Topic: Science/English/Religious Education**
Subject:	**Semester: 1**
Big Ideas What big ideas will students tackle in this project? What do you want them to understand?	• What is biology and why do we study it? • What are characteristics and adaptations of living things? • How do the environments of living things affect their growth and survival? • What happens when the environment of an organism changes? • Fantasy worlds - what are they? What are the characteristics of fantasy worlds? How do authors create fantasy worlds?
Knowledge & Skills What specific content standards and learning outcomes will this project focus on?	From the NSW Syllabi: Science: • Living things have structural features and adaptations that help them to survive in their environment. (ACSSU043) • The growth and survival of living things are affected by the physical conditions of their environment. (ACSSU094) English: Speaking and listening: • Communicates effectively for a variety of audiences and purposes using increasingly challenging topics, ideas, issues and language forms and features • plan, rehearse and deliver presentations, selecting and sequencing appropriate content

Figure 18: Excerpt from Shelly's program document on design day (1)

2. Determine the culminating products:

STEP 2: DETERMINE THE CULMINATING PRODUCTS	
Benchmarks What subtasks support student progress and work toward culminating products?	⇒ **Culminating Products:** What culminating products/presentations will students create to demonstrate their understanding and application of the content and skills?
• Understanding of plant and animal adaptations and how the environment influences these • Write a proposal for a plant and animal (text structure, writing to inform) • Gathering data and creating visual representations using digital technologies to justify their choice of characteristics and adaptations (graphs/tables) • Labelled diagram of their plant and animal • Identify the persuasive and descriptive language they will use in their final presentation • Script • Storyboard of their presentation	**Group:** **Authentic task (see above)**
Literacy Warm-up Tasks [English] What **literacy warm-up tasks** support student progress and work toward culminating products?	- Identifying the key points - Text structure/storyboarding - Language: informs, describes and persuades - How to label a diagram - Camera angles
	- *Knowledge of visual techniques (e.g. salience and vectors etc)* - Talking and listening: collaborating and working in a group
Numeracy Warm-up Tasks [Maths, Science, PDHPE, TAS] What **numeracy warm-up tasks** support student progress and work toward culminating products?	Maths: - Read data from tables/graphs etc… - Use data to inform decisions - Construct tables and graphs using digital technologies Science:
Driving Question: *What overarching question will guide student learning throughout the project?* How can we as members of a production company, collaborate to propose a plant and animal for our chosen planet, so that they are realistic and would survive in the environment described?	

Figure 19: Excerpt from Shelly's program on design day (2)

Subsequent design activity

After the design day, Shelly worked at home during the holidays, where she spent 14.5 hours writing an overview of unit and identifying resources for the English component. She searched specifically for resources which would support students in developing the skills they would need to complete the project/task. During this time, Shelly also consulted her fellow PBL teacher and the CEO PBL teacher educator and decided on the main components of the Weebly website. Shelly mainly drew upon her colleagues' expertise in the area of English content, as she explained that they had more experience and knowledge than her of possible texts to use. Her PBL coordinator also advised her to reduce the amount of English content she was planning to teach because she believed Shelly had included too much for the scope of one program.

She designed an 'entry event' to capture students' imagination and enthusiasm for the unit. Shelly explained that the concept of an entry event was part of the PBL approach. She also worked extensively on creating a video and incorporating apps. Finally, she spent four hours over four days designing and creating the website (*Weebly*) for the program:

> *We usually use Google Classroom as our work flow solution but the reason I chose to do this was I just thought the layout is more engaging and it's not linear whereas Google Classroom is linear and.(..). I mean this is linear in a way but it follows on the sequence but I think they'll be able to find the information they need a lot easier*. (Design Progress interview)

Shelly explained that a final design task she wanted to complete before teaching the program was to add information on the imaginary planets for the website. She thought this would be a straightforward process of searching online for "cold climate plan-o-graphs" (design progress interview) which would provide the required information, and then adding it to the appropriate webpages on the Weebly.

Shelly explained that in line with the PBL protocol, there were some learning experiences which had not been designed prior to the beginning of the program implementation. The reason for this is that they would be designed as the program was taught in order to meet the learning needs of the students which became evident through the initial stages of the program.

Shelly reported that she decided to focus on descriptive techniques for the English component in the program because of the interconnection of these with science and technology focus of the program:

I've chosen to do character development and visual techniques because then that links in with the science part where they have to talk about their character animal - they'll have to use some descriptive language there and then when they create the iMovie they'll need skills with visual techniques you know, looking at those sorts of things. (Design progress interview)

Table 25 below presents an overview of Shelly's design process:

Design step	**Contextual design work**	**Observed by researcher/reported by participant**	**Time taken**
Prior thinking	0. Idea of creating technology-mediated PBL program	Reported	
Familiarisation with content	1. Viewed syllabus to establish learning objectives	Observed and reported	27 minutes
Describe	2. Adapted initial design of 'big task' to align with identified learning objectives	Observed and reported	12 minutes
Think	3. Identified real world connections	Observed and reported	5 minutes
Describe	4. Attempted to use the PBL template to document the program	Observed and reported	6 minutes
Think	5. Identified knowledge & skills students would need to achieve final task	Observed and reported	8 minutes
Think and Describe	6. Planned learning experiences and sequence, documented to align with PBL template/protocol	Observed and reported	14 minutes
Describe	7. Noted a few ideas for the entry event for phase 2 of the program to build on later	Observed	15 minutes

Table 25: Shelly's design process

4.8.6 Summary of Shelly's science program

Shelly designed a PBL-based program for science which focused on plant and animal adaptations. The program also integrated learning outcomes for English and religion. The program was documented differently to programs which follow a more traditional approach. This is because the learning activities were devised as the program was taught in order to respond directly to students' learning needs.

Program overview

The following description captures the program documentation prior to teaching:

Learning objectives

Science:

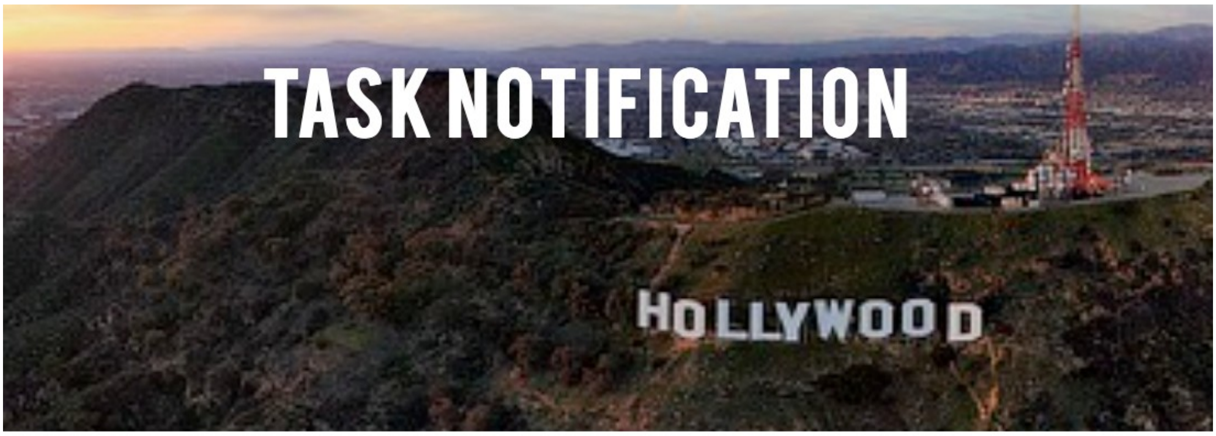
- Students understand the characteristics and adaptations of living things that help them survive in the environment.
- Students understand how the growth and survival of living things are affected by the physical conditions of the environment.

English:

- Students plan, draft and publish imaginative, informative and persuasive texts.
- Students communicate effectively for a variety of audiences.
- Students plan, rehearse and deliver presentations, making appropriate choices for modality and emphasis.
- Students participate in discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions.

Assessments:

- Formative assessments based on brainstorming and comprehension of content.
- Authentic task:



You have been hired as the youngest cinema designer for the next Hollywood blockbuster movie! The movie involves visiting many different fantasy planets. The movie director wants to create realistic plants and animals for their scenes in these planets during the movie. As a designer you have been asked to choose one of the fantasy planets, learn about its environment and habitat, use your knowledge of plants and animals to create a plant and animal with the characteristics and adaptations that could survive in the ecosystem of your chosen planet.

Once you have created your organisms, you and your team will collaborate and create a fact file on the plant and animal and their adaptations. This will be presented to the director for final approval so they can be used in the next Hollywood blockbuster!

For your presentation you will use a number of applications to create a trailer on iMovie of your animal and plant to present to the director. You may also create other visual material to aide your presentation.

Figure 20: Shelly's overarching assessment task from program website

Program structure:

1. Initial ideas workshop: Students were introduced to the topic and in groups brainstormed ideas about the content.
2. 'Knows' and 'Need to Knows' workshop: Students worked in groups to identify what already knew about the topic and what their learning would need to include for them to learn about the topic. The work students produced in this lesson formed the basis of further lesson design as the program was taught so that students' self-identified learning needs would be met:

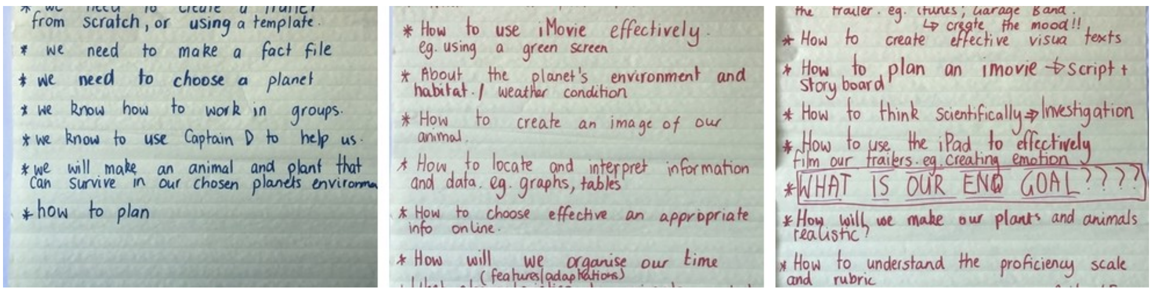


Figure 21: Students' 'Need to Know' work (program website)

3. Workshop 1: Adaptations: Students watched video clips and engaged in a groups discussion about the information they obtained from the videos. In the same groups, they then chose one Australian plant and one Australian animal, which they researched for information on the plant's and animal's environment, and characteristics/behaviours.
4. Workshop 2: Interpreting data: Students chose a planet from the selection on the website. Using the Explain Everything app, they explained how they drew conclusions about the planet from the information in the tables and graphs provided. The end product was uploaded to the PBL Group Google Classroom under the heading Workshop 2.
5. Workshop 3: Fact files: Students worked in groups to create a fact file on their chosen plant and animal from Workshop 1 and uploaded it to their group's Google Classroom. They first viewed example animal fact files from Perth Zoo on the website.
6. Workshop 4: Examining adaptations: Students worked in groups to view and choose one of the fact files of an animal or plant prepared by another group in their class. They then created a presentation using *Explain Everything* to explain how that animal or plant would adapt to life on the planet they selected in Workshop 2.
7. Workshop 7: Making your plants and animals: Students work in groups to design a plant or animal which would survive and thrive on their planet.
8. Students work on the authentic task assessment outlined above.

Technology integration

Technology was integrated throughout the program due to the program resources being accessed through the program website and by students using their iPads to present their work using a range of apps of their choice.

4.8.7 Teaching the science program

The teaching of this program was structured so that there were two workshops, twice a week, where the two stage three classes worked together with both class teachers. In addition to the workshops, students worked in their classes to do their group work and individual tasks. Shelly reported that this process was valuable in terms of student engagement in the learning because they enjoyed working as a large group and seeing the work of students who were not in their class. She also valued the support of working with another teacher in their first foray into PBL:

> *Our major sort of workshops we met together and I think that was good because it not only gave the kids a change of scenery but they were hearing what the other students are doing with their project as well so they were bouncing ideas from each other and then for us as well, being our first time teaching PBL, we were there to support each other I guess.* (Reflection interview)

Shelly reported that it took her and her colleague a little time over the first two weeks to get used to the PBL style of teaching. She explained that because they had not had a substantial amount of time with the PBL coordinator to go through PBL teaching approaches before the program started, they had to work out how to approach the teaching as they went.

Shelly reiterated that because the program was following a PBL structure, much of the design work took place during the teaching phase:

> *As we taught the unit of work, there was a lot of team-teaching involved and as we went along, it was very much guided by the students. I guess the planning that I did was setting up the main... you know, the essence of the unit and mapping all of the outcomes to the unit and I guess giving the overall task to the students but then once we actually were able to dive into the unit, we spoke to the students and they came up with "knows" and "need to know" – what do they already know to complete the project and what do they need to know and that kind of guided the learning path for the project*. (Reflection interview)

There were no significant changes made to the original program while teaching because the PBL process of designing while teaching meant that the program was adjusted as required throughout its implementation.

Shelly reported that she was satisfied with the technology integrated in the program. In line with her initial plan, students were given some flexibility of choice of the technologies they wanted to use to complete the learning tasks. One additional technology the students chose to use was Google Classroom. During the teaching process, the teachers created a 'classroom' on Google Classroom for each PBL group, which they used to collaborate on their projects. This was valuable because of its accessibility:

> *I think it really worked well, the students having a Google Classroom for each PBL group and when they were trying to collaborate they would put things up there and all their work went up there so everyone could access everything even though there was only the one iPad. So that was effective which, you know, if you had a book you*

couldn't really do because not everyone could take the one book home. (..) Yeah, because we often found that they were wanting to do extra work at home as well so they could access everything that they needed to. (Reflection interview)

Shelly reported that giving the students freedom to choose the technologies they used to create their fantasy animals resulted in them producing some very creative and involved work:

> *..others downloaded images of animals from the internet and they used the Lasso tool and cut them and joined them together with other animals and then they added overlays to make them look fluorescent green or something like that so that they look like fantasy creatures. They were really impressive with some of the things they did.* (Reflection interview)

Shelly explained that there the program had integrated the teaching of some digital skills related to the tasks, such as using iMovie for film-making and digital tools for representing data. Shelly reflected that this learning enabled students to work flexibly and efficiently to create their fact files and integrate them in their films:

> *...they were able to create different types of graphs from one set of data quite quickly by using that technology and then they were able to import that into their fact files and their iMovies as well to help explain the reasons that their animal has certain adaptations or to talk about the diet of their animals – some of them created graphs to show what percentage of seaweed or kelp and algae or small fish their creature would eat.* (Reflection interview)

Shelly also reported that the teachers noticed some gaps in students' general digital literacy, which they addressed during the teaching of the program, such as typing conventions and using gestures to control the iPad (e.g. creating a split screen).

Observed lesson

The researcher observed Workshop 2 of the program. On the day of the lesson, there were four other visitors to the classroom from the Catholic Education Office, who were observing this trial of PBL in the primary classroom. Prior to the lesson, Shelly explained that her aim for the lesson was to consider plant and animal habitats in depth. As with all workshops in the program, the lesson was divided into two parts. In the first part, the two classes came together in one classroom and worked with the two classroom teachers and the PBL teacher to reflect on their 'knows' and 'need to knows' for the program, before they moved into their first learning task. This part of the class was teacher-led and focused on eliciting how students could analyse their plant and animal's adaptations for specific environments. Shelly's grade colleague led this section of the class and Shelly contributed intermittently, with thinking prompts to support students if they experienced difficulties. The resources for this part of the class were on the Weebly site, which was loaded on the IWB. As a class, students watched two videos on animal and plant adaptations. After this, they discussed as a group the main ideas and how they could think about their own plants and animals in the second part of the lesson.

In the second part of the lesson, the classes went back to their own classrooms with their teachers and began to research in groups of three. They gathered information on particular animals and plants and spent time together planning and creating a multimodal presentation about their plant or animal using Explain Everything. Shelly organised groups so that each student had a role in creating the resource (e.g. sourcing images, planning audio and vocal input etc.). During this part of the lesson, the students were focused and worked well in their groups. Shelly rotated around the groups to monitor and provide support, but the active technology support was minimal. Students appeared confident in using the app and most support was provided to prompt students' thinking.

As previously described, design decisions were made in response to students' needs. In the observed lesson, the fact that groups progressed with their tasks at varying paces, meant that a planned activity for sharing their work was changed to a reflection activity, as not all groups were ready to present.

Shelly's reflection on the lesson

Shelly reported that she was satisfied with the lesson. However, she felt that if she had been the main teacher on the lesson, she would have progressed at a faster pace, because she observed that students were becoming distracted at some stages:

> *I was quite happy with the way the lesson went. I thought the first part was probably a little bit too long and that the students were getting a little bit restless so I would have preferred to speed that up a bit..* (Post-lesson interview)

Shelly reflected that she was satisfied with the digital resources for the program and specifically for the presentation activity. She explained that students independently used other resources from other apps support their creative work:

> *I think Explain Everything really was the right tool for the task because they could bring so much into it. I think the Weebly is working well; the students know how to navigate it – they're quite happy using that. I really like Explain Everything because they draw from other apps as well so it's not just the one app they're using; some of them were using Keynote and they were importing picture in there and then using the Instant Alpha tool to get rid of the colours around the specific picture they did. (..) and then they were using Google Docs to collaborate and upload images, so then things were going from one iPad to another quite easily. So that kind of breaks down the barrier of Explain Everything being an app that just works on one iPad and is not collaborative.* (Post-lesson interview)

Shelly also reflected that some students needed more support for one of the activities than they received in the lesson:

> *.. and then maybe next time, I would – rather than give them a totally blank canvas, because I think some of the kids needed a little more scaffolding with their Explain Everything (..) You can maybe put guiding questions at the top of the slide of what they need to do for that slide and I would have staged that onto their Google Classrooms and they could have downloaded and started working on the project and just give them that reinforcement of what they needed to include and maybe move them a bit faster.* (Post-lesson interview)

4.8.8 Shelly's reflection on the program

Shelly reported that she was very satisfied with the program and that it had been very positive for many aspects of students' learning. She reflected that the quality of work that the students produced was exceptional:

> *We were absolutely astounded with some of the work that we received from the students and the lack of behaviour incidents that we had. They were all really engaged in the task.* (Reflection interview)

She further clarified that the improved quality of students' work was evident in their depth of thinking and the quality of their sentence and paragraph structures when writing.

Shelly explained that because much of the work the students were doing that term was connected to the final PBL task, they continued their level of engagement to other subject areas:

That was really good to see and just their engagement, the work that they were producing was of a much higher standard than what we have seen in the past. As I said, I think that's got to do with the fact that when they were learning English or they were learning maths they needed to know that to complete their project and they were passionate about the project and so they had a purpose for it that wasn't just "You need to learn how to write an information text or a factual text". It was "You need to learn this so that you can write about your plant and animal and present it to the director". (Reflection interview)

Shelly reported that engagement the students experienced directly contributed to reducing some of the behavioural issues that she had previously experienced with them:

There were a couple that not so much but the majority of them were really engaged in the task, especially some of those high-flyers that we usually have... well, we haven't had too many issues with them but last year they had quite a few behavioural issues. We really saw a decline in their behavioural issues and we've got the data documented because we document all our behaviour incidents so that we have data on that. (Reflection interview)

Shelly also reflected on the value of the real-world connections within the program. The excursion to the zoo and botanic gardens was an opportunity for students to talk to experts in botany and zoology, which the students enjoyed. The use of technology tools in the program allowed Shelly to integrate further exposure to real world experiences, by incorporating and discussing strategies and skills used by graphic designers and cinematographers:

Obviously when I was talking about learning about design principles and formatting and layouts and colour scheming and just all those sorts of things that a graphic designer would think of and that's what we said to them, "What you're using, this is what a graphic designer would do when they're planning a website or an advertisement for marketing" and I guess camera angles – when I was at school, you learned about them and you saw them and you watched them in the films but we didn't get to go out and film something ourselves and use those camera angles and try and do what a cinematographer would have done. They got to actually become cinematographers whereas when I was at school we would just watch what they did. I guess it also allowed them to become

> *graphic designers, especially when they were making their plant and animal.* (Reflection interview)

Shelly explained that she believed this approach led to students producing high quality technology-mediated work:

> *Also, when they did their iMovie, their trailer when they presented their plant and animal, it was kind of like a mini documentary but they used a green screen as well so they could make it like they had a set in the background.*
>
> *Yep, so it wasn't just them standing in a classroom; they were standing in the appropriate place to talk about whatever it was – they might have had an image of what they thought the planets would look like in the background and they would be referring to different parts of that to explain the science behind it or to explain what they'd analysed in the weather charts.* (Reflection interview)

4.8.9 Summary

Shelly approached the design of her PBL program as the development of a new program, which was centred around an extended real-world task facilitated by a range of iPad apps. She considered technology integration seamlessly from the throughout all stages of the design process. When describing technology integration in her program, Shelly considered the pedagogical affordances of each digital tool in great depth, thus identifying how they contributed to the overall learning experiences in the program.

The case of Shelly identified key contextual influences on her design process. These are discussed in the following section using the lens of activity theory. Table 26 presents an overview of Shelly's case through the lens of activity theory:

Activity theory component	Evidence in this case
Tools	In-depth understanding and knowledge of TIL using iPad apps; Strong belief in TIL being critical for students' learning
Rules	1-to-1 iPad policy; Introduction of PBL approach at school; PBL pedagogy
Community	Colleagues; Students
Division of labour	PBL teacher; Literacy coordinator; Grade colleagues; technology consultant(?)

Table 26: Components of Shelly's activity system

Shelly had considerable knowledge and experience of TIL

Shelly's beliefs about TIL and her skills were reasonably strong (AT: *tools*). Shelly demonstrated clearly that she possessed a range of skills which indicated that her TPACK was well-developed. She was very comfortable using apps in the classroom and expressed the belief that that technology was an integral part of the learning process and not something she considered separately when designing programs. She did, however, express some reservations about her knowledge, explaining that she would like to understand more about integrating technology and expand her skillset further. Her practice was based heavily on iPad apps, as the school had a 1-to-1 iPad system in place. It is possible that if other types of technology were available, this could guide her self-learning process towards new ways to transform learning.

Shelly reported and demonstrated strong knowledge and skills as identified by all components of TPACK (AT: *tools*). However, she perceived that she had some gaps in her content knowledge (CK). For this reason, she reported that she relied on more experienced colleagues for their content-related input. Shelly reported a high level of confidence in her use of iPads and iPad apps in teaching and learning (TPK and TCK) and their capacity to improve teaching approaches. However, she explained that she would like to further develop her knowledge and skills in the area, but she did not know how she would approach this. As the school's ICT PL leader, Shelly was a clear source of support for her colleagues in the field of TIL.

School policies were a significant influence on Shelly's design practice

One of the most significant influences on Shelly's design process was the PBL protocol and the school's decision to participate in the trial of PBL in primary schools in the diocese (AT:

rules). The PBL protocol governed the identification of learning objectives and the fact that students were integral to this process. The PBL approach also directly influenced the decision of Shelly and her colleagues to design many of the learning experiences as they taught the program, identifying new learning goals as they arose in the classroom. The PBL approach led Shelly to devise a 'problem' for students to work on through the program using iMovie, which led to digital literacy skills related to movie-making being incorporated in the design of the program.

Another sector of the *rules* component which influenced Shelly's design and practice was the school's 1-to-1 iPad policy. Shelly's school was a volunteer participant in this program facilitated by the diocese's CEO. The technologies integrated into Shelly's program design were naturally iPad-based. The devices were successfully used in group work and to facilitate creative design work throughout the program. The school also had engaged the support of a learning technology advisor through Apple, which meant that advice on integrating technologies from this source was also iPad-focused. Shelly expressed frustration that she did not know how to further her knowledge of TIL and that she was familiar with most apps she could use in the classroom.

Shelly's students were a strong influence on her program design

Shelly's students (AT: *community*) were a primary consideration in her design work, both in terms of their needs and also their input into the design of the program. Shelly's design thinking took into consideration the development of their design skills and their skills of collaboration as they developed their projects. Shelly aimed to use the program to engage them in learning about science. As she was teaching the program, she identified that many students did not have some digital literacy skills associated with using the iPads, and so she integrated these skills into the program as she was teaching.

Shelly's students' parents were considered in the design of the program

The second sector of the *community* component of Shelly's activity system who were an indirect influence on her design process were the parents and wider community. Shelly's decision to organise the learning process using Google Classroom meant that parents were able to follow their children's work as the program progressed. This reflects Shelly's comments regarding the school's efforts to involve parents in the digital learning activities of the students. While not a design decision that Shelly made during her design process, the students' creative work through the program was exhibited to the parents and community at the end of the program, which Shelly identified as having an extremely positive effect on the students' sense of achievement, especially students who had experienced more difficulties with the learning process.

Shelly's colleagues contributed to the design process

Shelly and her colleagues collaborated on the design of the program more than in her previous design experience at the school (AT: division of labour). This occurred for two reasons. Firstly, there was a team teaching approach used to implement the 'workshop' lessons in the program. This meant that Shelly and her colleagues were able to compare their observations of students' learning and students' needs and together identify the next design steps for the program. Secondly, the adopted process of designing much of the program as they were teaching meant that it was necessary to work together to decide how the design of the program progressed.

The involvement of the students (*community*) and the associated work of Shelly's colleagues (*division of labour*) were directly influenced by the *rules* component, as the PBL approach guided the roles and actions of the teachers and students in the design process.

Contradictions

There was minimal evidence of contradictions in Shelly's activity system. In fact, key components of her context were shown to align to support Shelly's design of innovative TIL. Shelly expressed a slight frustration and desire to know more about TIL so she can further improve her TIL design knowledge and skills. This suggests that her contextual components of *rules* (professional development in the school and education diocese) are not effective in supporting her professional development (knowledge and skills=*tools*), their target being the provision of basic professional learning about TIL to all teaching staff.

4.8.10 Conclusion

Shelly was an early career teacher in her third year of teaching at a small Catholic school in a regional suburb. Shelly created a program based on science and English for her grade five class, which focused on adaptations in the natural world. The program culminated in a task to create an animated movie trailer about imaginary animals and their fictitious habitats. Along with the technology associated with the main PBL task, Shelly incorporated apps that she frequently used in the classroom into the program. Viewed through activity theory, Shelly's design activity was strongly influenced by her teaching environment: the leadership in the school for TIL meant that Shelly and her colleagues were prepared and supported to design the TIL they wanted to incorporate into their programs (*rules* and *community*). There was also extensive support for using the PBL approach in the school and the local Catholic education office (*rules*). Shelly's personal knowledge and experience in TIL meant that the design of TIL activities was a familiar practice for her (*tools*) and she had confidence that her students had the technology skills and knowledge to complete the TIL tasks without an additional cognitive burden (*community*).

Chapter 5: Cross-Case Analysis

5.1 Introduction

This chapter presents the comparative analysis of all cases in the study. Section 5.2 presents a summary of the design process of each case in order to understand how the participants engaged in the design of a TIL program. This summary is then followed by a comparison of models of each participants' design process. These models abstract the participants' processes at a higher level by indicating examples of design characteristics from the design literature. This abstraction forms the basis of a theoretical interpretation of the design processes in Chapter 6. Section 5.3 presents a comparison of the technology-integrated learning designed for each program. This comparison presents the TIL in each program in order of the sophistication of technology-integration. This ordering of programs is aligned with the SAMR model. Section 5.4 presents the analysis of the key influences on the design processes across the cases.

5.2 How ECTs engage in the design of TIL programs

This section presents a collective summary of how the ECT participants engaged in the design of a TIL program in this study. Table 27 presents an overview of the participants' processes of designing TIL programs:

	Kiara	Jenny	Elena	Catherine	Simon	Emma	Shelly
1. Key Learning Area	Science	History	History	English	History	Maths	Science
2. Design approach	Redesign	Redesign	Redesign	New design	New design	New design	New design
3. Starting point for design	Existing program	Existing program	Existing program	Big idea for some TIL tasks	Own big idea for part of the program	Big idea for whole program	Big idea for whole program
4. Stages of design process/Main design day work	Searched for sample programs to supplement learning activities in existing program	Searched for new learning tasks to make content more relatable to students; created slides to support teaching of program and deliver video	Added new resources to existing program replaced missing links; creates slides to support teaching of program and deliver video	Created new program incorporating activities from 2 samples programs; explicitly considered role of technology in program and reflected on the SAMR and TPACK models to analyse potential TIL activities	Created new program after searching for learning activities to address his identified learning outcomes and own TIL section of program; explicitly and purposefully designed TIL activities and slides	Created main TIL task and designed matrix to address differentiation in the activities; created task information resource for students	Focused on task design in accordance with PBL protocol; Explicitly considered the incorporation of apps to support students' collaborative work, which could be used flexibly by students
5. Design stage where TIL is first considered	Reviewing lessons in existing program	Reviewing lessons in existing program	Reviewing lessons in existing program	Prior to formally engaging in design	Prior to formally engaging in design	Prior to formally engaging in design	Prior to formally engaging in design
6. Pre-teaching design work	Further refinement of learning activities	Created resources	Added slides and adjusted timing after consultation with colleagues; created resources	Removed one main TIL activity due to students' difficulties accessing and remembering login details	Consideration of pedagogical value of TIL activities, resulting in removal of 1 TIL task; considered design of Google Classroom platform for this program	Changed technology after consultation with students	Built website for the program using Weebly; added PBL resources and created imaginative 'entry event' (PBL term) to engage students
7. Design while teaching	Added scaffolding on advice of colleagues; restructure of some activities due to students forgetting devices	Changed order of some lessons to align with English program; access to computer lab not possible, so TIL some activities were cut	Added supplementary scaffolding resources, e.g. extra slides; allowed more time for some activities	Needed to allow more time for some activities; added scaffolding resources; adaptations due to video not working	Removed a TIL activity because of its lack of pedagogical value; allocated more time to main TIL task	Students' used more sophisticated movie-making methods to document learning. Change made at the students' suggestion.	PBL program design was crafted as they went in consultation with students as they established inquiry questions
8. Key influences on design	Previous year's program; colleagues' recommendations *N.B Neither influence offered design support for TIL*	Previous year's program; Experience of teaching old program	Previous year's program; colleague's concern about changing content; colleagues' possible response to new TIL activities; Students' familiarity with tech tools	Own knowledge of SAMR model; colleagues	Prior experience of teaching this content area; own TPACK	Desire to make maths program more 'hands on' and engaging Students' academic ability & tech skills/knowledge	PBL approach; own TPACK; Students' technology skills

Table 27: Participants' processes of designing TIL

The summary in the table begins in row 2 by identifying the overarching approach that the participants took to the design process. This row identifies that there were two different high-level approaches to design taken by participants. The approach taken by the first three participants in the table was to make changes to an existing program. For the other four participants, their approach was to create a new program based on ideas they had for extended TIL tasks. The following paragraphs illustrate how the participants progressed through the design process.

Participants varied in their starting points for their program design work. This is depicted in row 3. For Kiara, Jenny and Elena, their starting point was the idea of making varying levels of adjustments to an existing program which had been previously designed and taught in the school for the target content area. For these participants, their design approach during the design day was similar (see Row 4). They searched online for learning activities to integrate into the existing program. Their reasons for doing this varied slightly: Kiara wanted to find activities which would be more engaging for her students. Jenny wanted to incorporate activities and resources which would make the complex Australia-centric history content easier to understand for her students, many of whom spoke English as a second language and were recent arrivals to Australia. Elena's rationale for adding new activities was to replace existing activities which she found confusing or which had web-based links which did not work.

Catherine, Simon, Emma and Shelly approached the design process differently to Kiara, Jenny and Elena because they had some overarching ideas for the design of the program which did not relate significantly to their schools' old programs for their content areas. Catherine and Simon both had ideas for extended learning activities, mediated by technology. This meant that they approached their design work with the design of these activities as a priority and having already carried out significant thinking about and visualisation of how these activities would work in the classroom. They were able to focus on key design elements of these tasks and scaffolding activities without the need for extended online searches for inspiration.

These different approaches influenced the way in which the participants considered, analysed and made decisions about the technologies they wanted to integrate in their programs. Row 5 in Table 25 summarises the point of the design process at which participants first considered TIL in their programs. Kiara, Jenny, and Elena identified TIL tasks to include in their programs as they conducted broad searches for resources to add to the individual lessons in the existing programs. This approach to identifying TIL activities was opportunistic, meaning that they did not have preconceived ideas about the types of TIL activities they were searching for, rather they identified activities by searching for the content area generally. This contrasts with Catherine's, Simon's, Emma's and Shelly's consideration of TIL for their programs, which occurred before they formally engaged in the design process on the design day. Emma, for example, knew that she wanted to use 3D software in her program and consequently her search for resources was targeted to this specific type of digital tool. The activities Kiara, Jenny and Elena selected for their programs tended to be stand-alone activities for engagement or content delivery.

All participants engaged in design thinking during their design process. What varied between participants was the amount of time they appeared to spend engaged in design thinking and the focus of the thinking. For Kiara and Jenny, design thinking accounted for less time than other participants during the design process. They focused on student assessment in the program, which was a concrete concept which was a required outcome of the process. Elena's design thinking also did not account for a large amount of time during the design process and focused on the considering her colleagues' potential perception of the program she was developing. For Simon, Emma and Shelly, the design thinking occurred throughout the process and focused on higher level considerations such as pedagogical approaches and interpreting their high-level ideas as a learning program.

5.3 Technology-integrated learning in the programs designed for the study

All participants in the study integrated technology into their program designs. Kiara, Jenny and Elena were not sure about the technologies they wanted to integrate at the beginning of the design activity. They made decisions about technology-based resources they wanted to include in their programs as they designed their learning tasks.

Catherine, Simon, Emma and Shelly had clear ideas about the TIL they wanted to include in their programs. These participants also had clear conceptualisations of how the TIL would support their students' learning. Consequently, their design of TIL in the program was more systematic because there were steps they wanted to take to ensure the TIL they had identified aligned with the learning outcomes and the content areas in their programs. When they were engaged in their design work, they explicitly considered the technologies' affordances and how each technology would support specific pedagogical outcomes.

The first part of this section presents an overview of the technology which each participant had access to in their contexts and the devices they used. The second part of the section presents a comparative overview of the TIL activities the participants designed for their programs and an interpretation of the innovation of these TIL activities through the lens of the SAMR model (Puentedura, 2013), as described in Chapter 3.

5.3.1 Technology devices

The type of device used in each case varied in type of technology and in students' level of access to the technology. In four of the cases (Kiara, Elena, Emma and Shelly), the students had access to individual iPads in line with their school's BYOD policy. In Catherine's case, the students had access to their own laptop computers in line with their school's BYOD policy. Although Jenny had access to a small set of six laptops at her school, her students used computers in the school's computer laboratory for their TIL activities. Jenny was allocated one lesson per fortnight in the computer laboratory. Simon used the school's set of six laptops for his TIL activities. These laptops had to be booked and were shared between five classes.

The findings above highlight that there are differences between cases in terms of the access individual students have to their technology devices. In some cases, they have 24-hour access to their iPads or laptop computers as their families own the devices and so these students are able to build strong familiarity with the technology. Students who access the school-owned devices are limited in their access because the devices are shared between many classes. This limited access means that the students cannot be as familiar with the devices as their counterparts in schools with BYOD policies. There is also a difference in the type of technologies used in the various cases. In four of the cases, students use iPad tablets and in three cases the students use computers. There are comparisons which can be made about the types of technologies accessible by iPads vs computers. It can be assumed that computers have a broader range of affordances than tablet devices. Meanwhile, tablet devices make available a greater range of applications (apps) than computers which can more easily be used for heuristics in the classroom. Examples of this were evident in Elena's case, as her students routinely used their iPads to capture images and to mind map their thinking during lessons. These actions were unprompted by the teacher. Conversely, iPad apps have limited functionality in some cases when compared to software applications available for computers.

5.3.2 Evaluation of TIL programs in this study

The programs designed in this study were categorised according to the SAMR model.
The SAMR model (Puentedura, 2013) depicts four levels of technology integration: Substitution, Modification, Augmentation and Redefinition. The lowest level is Substitution as it relates to activities where technology has been used as a substitution for a non-

technology-based activity and as such the technology does not enhance the learning experience in any way. The highest level, Redefinition, relates to activities where technology is used to create learning experiences which would not have been in any way possible without the use of the technology. Consequently, the learning experience is completely redefined.

The following analyses have been defined after ranking the participants by the level of complex and sophisticated TIL in their program. Table 28 presents an overview of the learning activities, with explanations of the purpose of the technology in each case, a description of the activities and the technologies used, and the identified SAMR level for each case.

	Kiara	Jenny	Elena	Catherine	Simon	Emma	Shelly
Key Learning Area	Science	History	History	English	History	Maths	Science
Purpose of technology in each case	Students' research;	Organising and delivering content, students' research; communication with students	Organising and delivering content, research task;	Delivering content; writing & sharing poetry	diagnostic assessment; delivering content; presenting historical primary and secondary evidence; communication with students;	Students designing in 3D software; students creating digital evidence of design process	Teacher-created website to accompany PBL program; delivering content and setting up creative activities; research;
TIL activities	webquest activity	Videos on IWB; students' research task;	Videos on IWB; creating political advert in iMovie	Videos on IWB; students sharing and reflecting on own poetry work; creating video of slam poetry	Videos on IWB; analysing historical evidence jigsaw research task; presentation of findings	Design of virtual 3D cities as design for real life creation; creating time-lapse movies of design process throughout program	Students' research and design; presenting research work on variety of apps
Technology in program (devices, software applications etc.)	iPads; teacher-identified websites	Computers in computer lab; IWB slides; Wordle app; interactive activity on museum website; Video on IWB; internet; Google Docs	BYOD iPads; IWB slides; interactive activity on museum website; videos on IWB; internet; iMovie app	BYOD laptops; video; Padlet app; cross-platform movie-making software	6 school laptops; Padlet app; video; Google Docs	BYOD iPads; Minecraft for Education app; iMovie app;	BYOD iPads; Weebly website hosting platform; video; internet; Seesaw app; Edpuzzle app; Puppetpals app; PicCollage app
SAMR level	Substitution	Substitution/ Augmentation	Substitution/ Augmentation	Augmentation	Augmentation	Modification/ Redefinition	Redefinition

Table 28: Evaluation of TIL across cases interpreted through SAMR

As presented in table 28, there was a broad range of TIL in the programs designed in this study, with programs ranging from the lower end 'Substitution' level of TIL to the level of 'Modification'. For example, only one program was identified as having TIL at the 'Substitution' level (where a task is the same and the technology affords no additional functionality than a non-technology option, e.g. typing up an essay). Two further programs crossed over between the 'Substitution' and 'Augmentation' levels of TIL in the programs. Two programs were identified as having TIL at the 'Augmentation' level (where a task is the same as a non-technology format, but there are additional functionalities of the technology which enhance the task process). One program was identified as containing TIL at both the 'Modification' level (where a task is able to be redesigned because of technology affordances and at the 'Redefinition' level (where there is a completely new task design afforded by technology). Finally, one program contained TIL at the 'Redefinition' level only. In the following sections, the participants are sorted according to the SAMR analysis so that contributing influences can be easily identified in order to address the second research question.

5.4 Influences on the design process

This section presents the comparative analysis of the key factors influencing the design process for each ECT participant. The key influences for each participant were included as a final row in Table 27. This section presents a cross-case comparison of the influences on practice identified in this study.

5.4.1 The influence of early career teacher's background

ECTs in this study had varying levels of experience with TIL. The experience they had was gained in some cases through exposure during their initial teacher education and in some cases also through professional experience with TIL.
Key findings in relation to the participants' backgrounds are presented here.

Length of service does not indicate more proficiency in TIL

There was no apparent link between the length of in-service experience of the teacher and the SAMR level of the program they designed. The two longest serving teachers in the study were Jenny and Simon. Jenny designed a program which was on the lower SAMR level of TIL integration, while Simon's program was at a higher SAMR level of technology integration. Similarly, the two beginning teachers in the study, Kiara and Emma, designed programs at very different levels of technology integration. Kiara's program was limited in its TIL at the 'Substitution' level of SAMR, whereas Emma's program was very innovative in its TIL design and was at the 'Modification'/'Redefinition' levels of SAMR.

Learning in initial teacher education influences TIL design

There is a clear connection between the extent to which ECTs in the study had experienced learning and teaching about TIL in their pre-service teacher education and the sophistication of their TIL program design: Kiara and Jenny were at the low end of TIL design in their programs. Their experience of learning about TIL at university was limited to, in Jenny's case, learning how to use an interactive whiteboard (IWB), and in Kiara's case to tutors recommending some websites and apps which she could use. In interviews, Kiara articulated that she was frustrated by the lack of opportunity to learn about TIL in her university education.

At the other end of the scale of TIL, those teachers who had designed more sophisticated TIL programs had experienced in-depth, explicit teaching and learning about TIL during their initial teacher education. Simon, Emma and Shelly had all enrolled in compulsory or elected programs of study at university which focused on technology integration. Catherine, who is in the middle of the scale of sophistication of TIL in the program designed for the study, also enrolled in a specific TIL-focused program at university. However, she was critical of the depth of learning within the program, asserting that although it was technology-focused, the program centred mainly on recommending apps to support mathematics teaching.

Experience with TIL makes a difference to TIL design

There is also a clear correlation on the scale of ECTs' TIL SAMR levels between the level of participants' professional experience with TIL and the TIL in the programs they designed. Kiara and Jenny had little experience with TIL in their teaching. Jenny was in her fourth year of teaching following her qualification as a teacher. However, her experience with TIL was limited to using an IWB and video to deliver content and designing online research tasks for students.

Simon and Shelly, who had experience as ICT leaders in their current or previous teaching roles, were able to design programs with mid- to high levels of sophisticated technology integration for their students. Elena, who is placed on the lower to middle range on the scale had initiated her own professional learning about technology, but this was limited to a specific field (robotics) and was not a technology that she was able to integrate into her regular classroom teaching. Shelly reported that she would like to further extend her knowledge beyond the use of mobile applications, but was unsure how to do this.

TPACK makes a difference to TIL design

The focus of TPACK is on the confluence of technological knowledge, pedagogical knowledge and content knowledge, which results in higher level knowledge and understanding about TIL than the sum of its separate components. TPACK was identified in this study subjectively through engagement with the data (see Chapter 3). It is difficult to analyse TPACK in this contextualised study without some consideration of factors within the school context which might have impacted on data from participants which was then used to interpret each participant's TPACK. Examples of these are presented in this section where appropriate.

Despite all participants being in the early years of their teaching careers, their presentation of TPACK was extremely varied across the cases. Beginning with the individual components of TPACK (technological knowledge, pedagogical knowledge and content knowledge), all participants indicated that they were personally confident in their general knowledge of technology. The interaction of participants' TK with other TPACK components is presented in the final paragraph of this section.

Pedagogical knowledge was more varied across cases; it was also more difficult to distinguish as an isolated component of teacher knowledge in this study. Some participants (Kiara, Simon and Emma) referred to their accordance with pedagogical approaches such as constructivism, student-centred learning, students as creators of their own learning. In Jenny's class, where students had high literacy needs, she generally favoured a teacher-centred (didactic) approach to ensure that all students received key information and concepts explained by her. This approach also ensured that by prescribing websites for students to access, she could control the online information which was accessed by students during their learning activities in the program. In this way she could ensure that the information was reliable and in language which was easy for the students to understand.

Elena's, Catherine's and Shelly's pedagogical knowledge were easier to identify within PCK and TPK. Elena had developed some strategies for working with technologies in her classroom during different teaching tasks. For example, she approached organisation of learning for her students using a range of tools from the Google suite. She had also devoted time in her class to ensuring students were familiar with a range of apps which could support different aspects of their learning, such as note taking, higher order thinking and presenting their learning (TPK). Catherine's familiarity with her students' diverse academic needs meant that she had established ways of approaching her teaching with technology which directly allowed her to support those who needed more support. This was through the use of specific apps for peer learning. It was not the affordance of the technology itself which supported the students, but the way in which Catherine used it with her class (TPK). Shelly's situation with pedagogical knowledge was different because she was using a project-based learning approach (PBL), which she had not used before. This was prescribed by the school leadership team. While Shelly expressed confidence in her use of variety of pedagogical approaches in her regular teaching, she lacked confidence in her knowledge of PBL. She commented that she also lacked some knowledge of the content area which was the focus of her program. Therefore, low levels of PCK limited were evident in her case.

Content knowledge varied significantly across the cases. Perhaps predicably, the participants with prior experience of teaching the program's content expressed the most confidence in their content knowledge. Jenny and Simon had both taught the content, or similar content previously. Elena also expressed confidence in her content knowledge because this was a field which was a personal interest for her. Interestingly, these three participants designed programs for the history syllabus. Kiara and Catherine expressed they had limited knowledge in their content areas. Both of these participants spent time searching for model programs online, which might also indicate that they lacked confidence in their PCK in their content areas. Kiara also referred to her university work on her program's content area. She designed a program for the science syllabus and Catherine designed a program focusing on poetry for the English syllabus. As previously mentioned, Shelly also identified gaps in her PCK.

To analyse TPACK as an integrated knowledge system across all cases, we can look at how the participants' TK interacted with their PCK. Some teachers expressed that they lacked confidence in integrating technology for education purposes due to a lack of knowledge of what to do and how to do it. This lack of confidence indicated possible gaps in their overall TPACK. Such a lack of confidence was most obviously the case for Kiara, and as a recently graduated teacher, she reflected that this was due to having limited exposure to TIL during her university studies. While Jenny did not express a lack of confidence her capacity to integrate technology, the limited innovation of the TIL in the program she designed suggests that she had gaps in her knowledge. She described having minimal exposure to TIL through professional learning and no exposure during her initial teacher education; most commonly the opportunities for teachers to build their TPACK knowledge. Three years of her three and a half years' teaching experience was undertaken at the same school, which Jenny acknowledged, did not prioritise TIL. Elena had some specific knowledge of technology in education, having undertaken professional learning in robotics. However, she expressed a lack of confidence in using technology in other (non-STEM) lessons. Catherine, Simon, Emma and Shelly demonstrated medium to high levels of understanding of the use of technology in teaching and learning, indicating that their overall TPACK levels were reasonably strong. These participants had exposure to TIL while at university and as such had time and opportunity to develop their knowledge. Simon and Shelly also had significant experience as leaders of TIL in schools, which was a further opportunity for them to develop their TPACK. Of these four participants, Simon demonstrated the most in-depth and sophisticated TPACK. He demonstrated the most sophisticated holistic thinking about TIL during his design process. Shelly's thinking appeared to focus specifically on the use of apps in the classroom.

5.4.2 The influence of the school context

School demographic does not make a significant impact, but there are challenges in schools with limited access to technology

The participants in the study identified the influence of parents on their students' engagement with technology in the classroom to varying degrees. Elena identified the parents of her students to be protective of the students' rights to social media access, which Elena perceived as a limiting factor on her level of control of technology use in the classroom. Emma found that the BYOD policy meant that her students were very familiar with their devices and the associated affordances, which meant that they had a strong capacity to flexibly engage in TIL. However, this was not always the case with BYOD technologies. Catherine, whose students used BYOD laptop computers, identified that her students had strong skills in some areas of technology, but had gaps in their knowledge of other digital skills. Difficulties in accessing technologies were evident in the cases of Jenny and Simon, who taught at a school where access to technology was a fortnightly session in a computer laboratory or the option to request a set of six laptops which were shared between a large number of classes and were difficult to manoeuvre around the school. For both Jenny and Simon, this meant that technology for students' use featured less frequently in their programs in comparison to other participants.

1-to-1 access to technology does not always translate into sophisticated TIL, but limited access to technology does have an impact when teaching a TIL program

All but one of the schools in the study had a BYOD policy. However, this did not necessarily translate into high SAMR level TIL. Kiara, Elena, Emma and Shelly taught at schools with a BYOD 1-to-1 iPad policy. Catherine's school implemented a BYOD laptop policy for grade 5 and 6 students. Shelly and Elena, whose classes had BYOD iPads, used a broad range of apps with which the students were already very familiar.

There were some noticeable differences in the programs designed for iPads and the program designed for laptops. Programs for iPad devices relied heavily on the use of apps and access to an internet browser for research tasks. The programs designed for laptops (Simon's and Catherine's) made more use of learning platforms such as Google Classroom and Google Docs. The BYOD laptop policy in Catherine's school resulted in her students having laptop computers with various operating systems. This resulted in her researching movie-making software applications for her program which would be accessible across multiple platforms.

Jenny and Simon were the only teachers who did not have 1-to-1 devices available to their students in the classroom. Jenny identified this as a primary barrier to her design of TIL, indicating that she did not consider technology integration in much depth because her students would not have sufficient access to technology to undertake tasks with sophisticated technology integration. Interestingly, Simon, who taught at the same school, prioritised access to the available technology for his students and was able to design a more sophisticated TIL program. However, he also identified that access to technology at the school was a limiting factor for him in his TIL design process.

Strong leadership in TIL has a positive impact on ECTs' design of sophisticated TIL programs

In this study, five schools had BYOD programs, but only Shelly's school had explicitly communicated expectations for TIL which was supported by an extensive professional learning and experience program for all staff in TIL. In that school, Shelly was the ICT leader. Shelly's school was in the Catholic school system and her local diocese office was also proactive in their support of schools integrating technology. Emma's school (also in the Catholic system) had a nominated ICT coordinator on staff who was available to support staff with any TIL they wanted to implement. Other schools implied in various ways, such as through program guidelines documents or by the fact that there was a BYOD policy, that technology integration was important, however, there was no evidence of explicit leadership in TIL. The policy documentation on BYOD in Kiara's, Elena's and Catherine's schools was limited to information on device specifications and expectations of usage (where and when students were permitted to use their devices).

School's accepted design practice often influences ECTs' TIL design process

The way ECTs design their programs is often influenced by their understanding of the accepted design practice in their school. In all cases, participants first engaged in thinking about their program during planning discussions with their team. During these meetings, a similar approach was experienced by all ECTs: They discussed and decided on the content areas and the learning outcomes for each program as a team. After this, each teacher was allocated a subject area for which they would individually design programs for all teachers in the team to use in their classrooms. As previously noted, some ECTs in the study used an existing program designed previously by colleagues as a basis for their program design. It was reported by these participants that this was the way in which they would usually approach program design. Emma also followed a suggested practice, but this was not using an existing program as a design tool. Instead, she used a matrix, introduced to her by a colleague, which supported her thinking about differentiation and did not specify resources or learning tasks, thus allowing for flexibility in the program design process.

Colleagues do not have extensive TIL knowledge, yet significantly influence ECTs' TIL design practice

Colleagues were involved in the participants' design processes to varying extents in each case. Some participants had minimal communication with colleagues regarding the design of their programs (e.g. Simon and Jenny). In these cases, there was some feedback regarding timing of lessons and/or the amount of content in the program, but little else. Others liaised with colleagues during the initial design process and while teaching the program. Often some adjustments were made in liaison with colleagues. In Catherine's case, these adjustments suggested and directed by colleagues regarding TIL activities related to minimising the scope of the TIL activity, or omitting the activity altogether.

In Elena's case, her colleague pressured her to limit the extent to which she varied the program she was designing from the school's program previously designed by him. She reported on several occasions that she felt she should not change the work of more senior colleagues, implying an inequality or lack of empowerment in design. (Researcher notes on Emma: Emma commented following the reflection interview that she probably would not have designed such a sophisticated TIL program if her grade supervisor had not been absent from school, giving some indication of her creativity being restricted by the presence of a senior colleague who reviewed her programs).

Only one participant in the study identified a colleague as a source of support for TIL. Emma's grade colleague was the school's ICT coordinator and usually could offer support for the design process. However, in this study, her colleague was absent during the design activity and did not offer support. No other participants identified their colleagues as a source of support for TIL design. Apart from Emma's and Shelly's cases, there was no evidence that colleagues involved in participants' design process had experience or knowledge which constituted developed TPACK. In the cases of Emma and Catherine, their colleagues articulated that they were impressed with the creativity of the TIL activities in the programs which these participants had designed for this study. Both teachers explained that they were viewed by their colleagues as a support for TIL for other members of staff.

ECTs consider students' technology-focused learning needs and technology skills in their design process

There was a certain level of consideration of students' technology skills in the participants' design processes. For students with BYOD devices, the teachers were generally more confident in the students' capacity to engage in TIL because of their familiarity with the devices and the apps they were using on a regular basis. However immediately before or during the teaching stage, some teachers made adjustments to the TIL because of gaps in students' knowledge or skillset. Catherine removed a TIL activity because her students struggled to log on to platforms easily and she acknowledged this could create significant interruptions to the flow of the program. Conversely, Elena expressed her concern about her students' high level of technology skills and was concerned that they would be over-using their devices or be over-reliant on them for basic learning processes.

Jenny and Simon were in a school with no BYOD policy and this impacted on them in different ways. Both identified that there were some gaps in students' technology skills. Jenny's students had minimal engagement with technology through the program because of the difficulty of access to the computers in the school. She expressed some surprise after the observed lesson that the students had managed the TIL activities without significant difficulty accessing the applications. Simon's design deliberately focused on activities to scaffold students' learning of technology skills in the classroom and as such displayed a different approach.

Syllabus/KLA impacted on the types of technology integrated into the program

There was a range of key learning (subject) areas in the programs designed for this study. Some noteworthy points from the findings were, firstly, that the teachers who chose to design a program for the history syllabus (Jenny, Elena and Simon) all identified that there was a large amount of content to include in the programs. This led to all of them incorporating multiple videos to support students' understanding of the content. Secondly, all programs were designed to be taught over one or two school terms, with one exception. The exception was the program which was designed for the mathematics syllabus. This program was designed to be taught over two weeks. The teacher, Emma, explained that mathematics was often planned and taught within a short timeframe. This, and the frequency of mathematics lessons in comparison to other KLAs, could account for her report that this was a subject where technology was not considered at a sophisticated level of integration. This could be because the need to continually plan for the next two weeks' mathematics lessons (10 lessons), means that there is little time to consider developing innovative TIL. Other KLAs in the study were Science and Technology and English.

5.5 Theoretical interpretation of findings on influences

At the end of each case in Chapter 4, findings were discussed through the lens of activity theory. Table 29 presents these influences through the analytical framework of activity theory:

	Kiara	Jenny	Elena	Catherine	Simon	Emma	Shelly
Tools	School program proforma; limited TPACK	Previous year's program & resources; limited TPACK	Conflicting beliefs about TIL; Good TK, but low TPK and TCK	Good TPACK; sample programs; school's program proforma	Strong TPACK	Strong TPACK; teaching & learning matrix	Strong TPACK; PBL protocol
Rules	BYOD policy; accepted design practice; syllabus; no leadership in TIL	Accepted design practice; syllabus; difficulty accessing technology; no leadership in TIL	Accepted design practice; BYOD policy; no leadership in TIL; syllabus;	BYOD policy; syllabus;	Limited access to technology	BYOD policy; ICT coordinator as support for teacher-initiated TIL	BYOD policy; whole school professional learning program for TIL; school policy to introduce PBL
Community	Students; colleagues; No ICT support on staff	Students (high learning needs); colleagues' limited input on content; No ICT support	Students (high dependency on technology); colleagues (their concern about changing existing program)	Students; colleagues	Students (high learning needs); colleagues' limited input on content	Students; support for TIL if requested; New teacher support from Catholic Education Office; support from school executive	Students with high digital literacy; principal leadership on TIL; colleagues training in TIL
Division of labour	Grade decision on learning outcomes; Colleagues add in scaffolding while teaching	Little interaction during design; limited feedback on content	Limited feedback on content	Colleagues' input into final learning activities in program	limited feedback on content	Grade colleague; assistant principal supported development of resources for TIL	PBL teacher support from CEO; Shelly provides TIL support to other teachers

Table 29: Key contextual influences on design through activity theory

Discussion on the interpretations of these findings through activity theory is presented in Chapter 6.

5.5 Conclusion

This chapter presented results from the cross-case analysis in this study. The chapter began by presenting the comparison of the participants' approaches to designing TIL programs and how they considered technology integration during the design process. The key findings from this section were:

- There were two different approaches to design depending on the starting point of the process. Participants used either an existing school program as the basis of their design or they had an overarching design idea which was a catalyst for the overall design.

The chapter then presented the comparison of the technology integration of each program in terms of how they align with the SAMR model. This section identified that there was a broad range of SAMR levels of technology integration, from the basic level to the most sophisticated.

Interpretations of the cases shows that the key findings in this chapter were:

- *Length of service does not indicate more proficiency in TIL*
- *Learning in initial teacher education influences TIL design*
- *Experience with TIL makes a difference to TIL design*
- *TPACK makes a difference to TIL design*
- *1-to-1 access to technology does not always translate into sophisticated TIL, but limited access to technology does have a restrictive impact*
- *Strong leadership in TIL has a positive impact on ECTs' design of sophisticated TIL programs*
- *School's accepted design practice often influences ECTs' TIL design process and limits their TIL creativity*
- *Colleagues do not have extensive TIL knowledge, yet significantly influence ECTs' TIL design practice*
- *ECTs consider students' technology-focused learning needs and technology skills in their design process*
- *Syllabus/KLA impacted on the types of technology integrated into the program*

Some of these findings reflect the findings of previous research in the field, whereas others contribute new knowledge. There is evidence in the literature that contextual factors can impact on teachers' use of technology in the classroom. The findings regarding access to technology reflect the work of Ertmer (2005) on first order barriers to technology integration, in that difficulties in accessing technology can be a barrier. The finding that good availability of technology in schools does not always translate into sophisticated TIL aligns with work on affective barriers to technology integration (Ertmer 2005; Tondeur, Roblin et al., 2017; Offenbreit-Leftwich, Glazewski et al., 2012). Other contextual factors found to impact on ECTs' design process, such as leadership and culture have been identified as potential barriers to ECTs' integration of technology, however, it has not previously been identified the ways in which such influence directly impacts on ECTs' work. The new knowledge emerging from this study is centred around the influence of these contextual factors on ECTs' actions and thinking when designing TIL, which provides new detailed understanding of how these factors directly influence ECTs' practice.

Chapter 6: Discussion and Conclusion

6.1 Introduction

This study aimed to extend existing knowledge about early career teachers' practices with technology-integrated learning by exploring how ECTs engage in the design of TIL and the contextual factors which influenced their practice. The study was designed to address the following overarching research question:

> How do early career primary teachers engage in the design of technology-integrated learning in context?

The overarching question was guided by two main research questions:

1. How do early career primary teachers approach the design of technology-integrated learning in context?
2. What influences early career primary teachers' design of technology-integrated learning in context?

Each of the above research questions is addressed in a separate section of this chapter.

This study was designed in light of evidence in the literature that while early career teachers commonly express beliefs in the value of integrating technology in learning to enhance learning experiences for students, in practice they often integrate technology in a limited and/or teacher-centred way (Bate, 2010; Gao et al., 2011). The literature review undertaken for this study identified a lack of empirical evidence of what early career teachers think about and do when they design technology-integrated learning, and additionally, what influences their practice. This gap in knowledge is important to address because in order to support ECTs to improve their practice, then it is critical to understand what is causing this disconnect between ECTs' beliefs and practice (Tondeur, Roblin, et al., 2017).

This chapter presents the findings of this study in light of existing research in the field. It then presents the implications of the findings for theory and for practice. Section 6.2 presents the findings from the data which address each research question in the study. The findings for each research question are then discussed in relation to the existing literature in the relevant field. Subsequent sections in the chapter present the implications of the findings for theory and practice, followed by an explanation of the limitations of the study and recommendations for further research.

6.2 Research question 1: How do early career teachers approach the design of TIL?

Each of the participants' schools implemented a similar approach to preparing for designing learning programs. The first step was for all teaching colleagues on the same grade to meet towards the end of one school term to discuss the content area of focus for each KLA in the following term. In some cases, the level of discussion drilled down to deciding on the learning outcomes and the assessments as a teaching team, as in Catherine's case. In other cases, this level of detail was not prescribed during these meetings. Elena, for example, explained that her meeting was very brief and consisted of quickly deciding which teacher would design which program. The next stage was common to all participants in the study: the programs to be designed were allocated to a teacher within the group. The expectation was that each teacher would work independently on the design of their allocated program and on completion, all programs would be shared with all teachers on the grade to use in their classrooms. By the end of these planning meetings, the participants had received a KLA content area for which to design a program for their students and other students on the grade.

For the participants, this group planning time was the most time they spent with their colleagues discussing the programs to be designed. This meant that their colleagues' input to their design process took place mostly prior to their actual design activity. Some participants had a senior staff member as a mentor or supervisor, but these participants reported the supervisors' input to program design was checking that learning outcomes were addressed and that the content was not too ambitious for the timeframe. This finding suggests that the ECTs had a level of autonomy about how they designed their programs.

A common theme across all the cases was that technology integration was not considered at the group planning meetings. It is probable that the reasons for this omission vary across contexts. For example, Jenny and Simon, who were in a school with limited access to technology, their school leadership team's clear focus was on supporting students' high literacy and numeracy needs. These participants explained that this factor dominated program planning considerations in team meetings and technology integration was not a strong focus. The other five of the participants' schools had BYOD policies in place which meant each student had access to a device in the classroom. It is possible, therefore, that there was an implicit understanding that technology would be integrated through the use of these devices.

All participants in the study professed a belief that technology could improve the learning experience for students. The findings of this study identified that the participants' design of technology-integrated programs followed one of two possible approaches. Kiara, Jenny and Elena followed a design process which involved the redesign or refinement of an existing program in the school. Catherine, Simon, Emma and Shelly followed a process where they designed a program with an extended learning task, which was based on their own idea. Each of these approaches is discussed below.

6.2.1 Approach 1: re-designing an existing program

Three participants designed a TIL program in this study by considering technology integration at a micro-level in the program design. Kiara, Jenny and Elena used this first approach. They worked with an existing program in the school, re-designing it to create a program to meet the needs of their students. They reviewed the program lesson-by-lesson and made decisions about which resources and content to include as they progressed through the review of each lesson. Technology integration was considered when a TIL-based activity was found which supported a specific activity within a lesson in the program.

Evidence from the design day indicated that Kiara, Jenny and Elena conducted some preliminary reflections to guide their design process. Prior to the design day, Kiara had identified potential sources of inspiration; she remembered learning about her allocated content area at university and ensured she had access to her study notes from that time when she began the design activity. During the previous school year, Jenny had taught an area of the history syllabus related to the one she was allocated to design for this study. Although she did not design the previous year's program, she reflected on aspects of that program with which her students had encountered difficulties. Examples she recalled were difficulties understanding dense and complex text and understanding political processes in the Australian context. Elena did not consider the program prior to the design day.

The three participants who engaged in this first approach engaged in design by reviewing lessons in an existing program and making changes at lesson level. They began the design task on the design day by assessing the alignment between the existing program and the syllabus. At this point in the approach, these participants did not talk about possible technology integration. There then followed an iterative process of reviewing the lessons in the existing program, identifying those which they wanted to replace, and the subsequent search for resources to replace or enhance those already in the program. Design decisions about whether to include or replace components of the existing program by the participants was shaped by their thinking about their current classes and the extent to which the content might need to be changed in order to meet the needs of those students.

When teaching these programs, all three participants reported that they made few changes to the program designs. Jenny removed one TIL activity because of time limitations during the week it was supposed to take place. Kiara experienced some difficulties with access to technology as a few of her students regularly forgot to bring their devices to school. This meant that she had to make changes to the organisation of students during a TIL task to ensure that all students had access to a device as part of a group activity. Elena made no changes to her program.

Evidence from Kiara, Jenny and Elena's design practice indicated that technology integration in the program was conducted at a micro-level of design work and was considered as they reviewed and amended individual learning tasks in the existing programs. Kiara was highly motivated to identify TIL resources for her program and she spent a significant amount of time during the design process searching for digital resources. Despite this intention and effort, she made minimal changes to the existing program's TIL activities, which were limited in creativity and innovation. Jenny's students' high literacy needs influenced her to use mainly video as a digital resource because she felt that this would support their understanding of complex content areas in the program. Jenny's TIL was predominantly the use of digital media for engagement and comprehension. Elena's approach of redesigning an existing program meant that she retained a video creation activity for students, who she knew had strong technology skills. Her own ideas for TIL which she integrated into the program centred on online research; which was a limited level of integration.

Despite the TIL tasks in Kiara, Jenny's and Elena's programs involved a narrow range of technological application, there was no evidence that these participants considered their TIL tasks to be limited in any way. Their reflections focused on the extent to which the TIL tasks were engaging for the students and whether the technology-mediated lessons were able to run without technological difficulties. They did not reflect on specific ways in which the technologies supported, or did not support, students' learning. This suggests that their understanding of TIL was limited and as such they were not aware of more innovative digital learning opportunities. This explanation aligns with the finding that their knowledge of TIL (TPACK) identified in this study was limited. However, another possible explanation originates in their approach to design: because they actively considered technology-integration at the level of individual lessons, their conceptualisation of TIL in their programs was limited. This means that their design approach constrained their thinking by minimising their conceptualisation of TIL at a macro-level of the programs.

6.2.2 Approach 2: designing a new program

The second approach was a high level, holistic approach to designing technology-integrated learning program. The participants who used this approach considered technology integration in the program in a holistic way, as part of an overarching idea they had for the program. They designed new programs with little or no reference to an existing program at the school. Their overarching ideas each consisted of an extended learning task which was mediated by technology. Each participant's overarching idea for the program was conceptualised after the meeting of grade teachers and before the beginning of the design activity for this study.

Catherine, Simon, Emma and Shelly engaged in their design of a TIL program using this approach. These participants had already engaged in high level design thinking about their program prior to beginning the process of design for this study. Each of these participants had a rationale for their overarching idea which emerged from their consideration of pedagogical approach. Catherine had an idea of creating a TIL-based extended task for her English program, which was based on students using technology to peer review their poetry writing, and then to write and record themselves performing their own slam poetry piece. Simon wanted to create a real-world atmosphere of collaboration on a multi-phase History project for his students. His use of the six laptops available to him in the school were a crucial component as the students developed their projects using Google Docs. The integration of technology in this task was viewed by Simon as essential to reflect real-world use of technology. Emma's motivation for her overarching idea was to make a maths program on 3D shapes less abstract by using an online platform for students to work collaboratively to design a cityscape which they then recreated in the physical world using craft and recycled materials. Students collected digital evidence of their work as it progressed and produced a final reflective video of their projects. They used multiple features of movie-making technologies to create an engaging final video. Shelly designed a PBL-focused Science program, within the concept of a movie where students had to create mythical creatures to feature in the film. Shelly designed the program as a website. As part of the overarching task, her students collected digital evidence of features of plants and animals and used animation and other presentation tools to create mythical creatures, whose physical features were explained and demonstrated using these technologies.

This high-level design thinking prior to the design day meant that these ECTs had some conceptualisation in their minds of how the extended TIL task would work in their classrooms. On the design day, these participants began the design process by documenting their overarching ideas. This was followed by an iterative process of zooming in at a lower level of design to develop stages of the extended task, create learning and teaching resources, and document the design. For these participants the design of the technology-integrated learning tasks was considered from the beginning of the design activity at a high level and the detail of these TIL activities were developed as part of the process of designing the individual components of the extended task. Emma, for example, spent time during the design day thinking about how students would engage with the task, how they would use the various technologies and how this TIL task would support and generate evidence of students' learning of the key concepts. Simon purposefully considered all TIL learning activities in his program to ensure that they all played a role in supporting students' learning of the content. He rejected one of his original TIL ideas because he felt that while it would be engaging, it might distract students and not adequately support their learning. Shelly's design activity on the design day focused on the design of the website and the creation of digital resources for the website. She did not plan any lessons at a more detailed level because the PBL approach meant that she would design the program in collaboration with the students as they worked towards the overarching aim of designing creatures for the program's movie. The findings showed this process to be a holistic approach to designing technology-integrated learning, in which all design activities were integrated and focused on the design of the extended task.

These participants had differing experiences in the classroom during the implementation of the programs. Catherine reflected that this extended task stimulated students' interest in poetry and their motivation to make their writing engaging and topical. Simon found that he was frequently called upon by students to support their TIL activities. The main reasons he was asked for support were to help students to access and navigate the technologies. He reflected after the observed lesson that he could have designed more explicit supports for his students. Emma and Shelly had opposite experiences. Their students were very confident users of technologies and embraced the student-centred design of the TIL tasks. In Emma's class in particular, students took the initiative to use multiple movie-making tools to create their final videos, which meant they went beyond the requirements of the task. Shelly reflected that her students were immersed in the creative tasks and produced impressive digital representations of their mythical creatures, which evidenced their learning of the scientific concepts underpinning the program.

Evidence from Catherine, Simon's, Emma's and Shelly's design processes identified that they considered and designed TIL at a different stage of design to those ECTs who followed approach 1. For the ECTs who followed approach 2, technology was a high-level design consideration and was considered in some detail prior to the design work they undertook on the design day. As such, their conceptualisation of TIL was seamlessly considered as part of their extended task design work. Furthermore, evidence from the study suggest that they used their pedagogical understanding of the content to guide their thinking about the final program designs. All participants who followed this approach considered technology to be a key component of their program designs, which indicates a level of confidence in their capacity to implement a program with multiple technologies integrated across extended learning tasks. It also indicates an understanding these participants had of how technology can directly support students' learning in the classroom. In these programs, the participants used the technologies as more than tools to engage students in the content; they used technologies to support students' creativity, their design thinking and problem-solving.

6.2.3 TIL design in the two approaches

There was an obvious difference between the two approaches in relation to the design of TIL. The ECTs who designed a new program approached the design process by first conceptualising an overarching idea for their programs. This overarching idea included a high-level design of an extended task in which technology was integrated seamlessly and in a creative way. These extended tasks were underpinned by ideas of how the technologies could support contemporary pedagogies and support students' learning experiences in a creative way. The ECTs who used an existing program to underpin their designs appeared to be limited in their consideration of TIL in the programs they designed. The TIL they designed was limited in creativity and focused on supporting students' understanding of content. This finding suggests that the design approach used by ECTs can directly influence their design thinking about technology integration, their understanding of the role of technology in a program and the level of innovation in TIL in the programs they design. The implication here is that choosing to redesign an existing program can limit ECTs' capacity to design creative and pedagogically innovative TIL.

6.2.4 Why two different approaches?

There are several possible explanations for these two different approaches to designing TIL. Firstly, Kiara, Jenny and Elena had little prior experience of designing TIL. They had little practical explicit exposure to TIL during their initial teacher education. They were aware from their university experience that technology was an important consideration in primary teaching and learning, yet they had little understanding of why it was important and how they could approach designing TIL. Catherine had some exposure at university, but perceived that there were gaps in her knowledge, although she could not identify the knowledge she perceived to be lacking. For Simon, Emma and Shelly, however, their university experience included studying TIL as a separate subject or series of subjects. These participants considered themselves to have the capacity to integrate technology into their teaching, and if there were gaps, they demonstrated that they were able to address these gaps independently and efficiently. This knowledge and confidence developed in their initial teacher education is potentially a reason why they considered technology integration at a high level, as a key component of their overarching ideas for their programs.

A possible explanation for the first approach is the concept of accepted practice in the school. The three participants who chose to follow this approach reflected that the approach was the common practice in the school. It may be explicitly communicated through colleagues in the staffroom, or it may be tacitly understood through suggestion between colleagues, that a particular approach is the most acceptable in the context. Bellamy (1995, p.125) identified "a process of internalisation of external activity, such as (..) procedures, (..) methods, laws, forms of work organisation and accepted practices affect the kinds of mental processes that develop." The fact that the participants are ECTs and as such are junior members of the teaching staff could mean that they naturally look to the practices of senior colleagues as an example of how to approach certain tasks. A further possibility is that the participants felt that the existing programs were designed by teachers with more experience than them, and that these programs would therefore be pedagogically-reliable and it would make sense to re-use them.

These findings from the initial stage of the participants' design process draw some similarities with the literature on teachers as designers, but also present some surprising contradictions. As Bennett et al. (2018) explain: "Teacher design involves individual cognitive acts of design thinking." (p. 1019). Studies in the literature identify representations of novice teacher design thinking which is evident in some of the participants' initial design thinking about the programs they designed in this study. Perez & Emery (1995) identified that novice learning designers consider fewer factors when designing, and they consider these factors sequentially. This approach is evidenced in this study in the practices of Kiara, Jenny and Elena, who used an existing program to guide their design approach. In this way, their approach could be described as procedural. More surprising was the finding that Catherine, Simon, Emma and Shelly's practice in the study mirrored characteristics of expert designers. Their capacity to consider a range of pedagogical factors in combination and to consider multiple perspectives at the same time, could be described as a more cognitive approach, and is evidence of a complexity of pedagogical thinking which is more common to experts in learning design (Perez & Emery, 1995; Westerman, 1991). It also contradicts Nguyen and Bower's (2018) findings that novice teachers rarely think about pedagogy when designing technology-integrated learning. This finding is an important contribution to our understanding of novice teachers as designers of TIL and as learning designers more generally. It leads to the question of why this phenomenon occurred and what the conditions were that facilitated these ECTs to emulate expert design practices.

6.3 Research question 2: What are the key influences on the practices of early career teachers designing TIL?

Literature reviewed for this study identified that while there is evidence to indicate that the context within which early career teachers work influences the way in which they integrate technology in teaching and learning in a general sense, what is not yet known is how all contextual factors interact and combine to impact on ECTs' work with technology in practice. The aim of this research question was to capture data about how the early career teacher participants' individual contexts influenced their work as they designed and implemented a TIL program for their students.

The findings from this study show that when early career teachers design TIL programs, they engage in complex thinking processes, in which their TIL knowledge, beliefs and skills interact with their understanding of their school context. All of these factors influence the design of the program throughout the planning and implementation process. In this section, the influences on the design practice of the ECTs in this study are presented, beginning with the internal factors (knowledge and skills), followed by the school contextual factors.

6.3.1 The influence of ECTs' knowledge and skills

Initial teacher education

The extent to which participants had encountered TIL during their initial teacher education was found to be a significant influence on their design practice in this study. This is because it impacted on their TIL knowledge and skills, which in turn impacted on their thinking and capacity to design a TIL program in their context. The participants' exposure to TIL in their teacher education courses was shown to vary greatly. Jenny, Elena and Kiara, for example, had minimal exposure to education technology at university, whereas Simon, Emma and Shelly had extensive exposure. Catherine had some experience of learning about TIL, but she identified that this experience had been limited in scope and she felt her knowledge of the field had gaps. The analysis of the programs designed in this study show that the participants who had a broader and more in-depth exposure to TIL during their initial teacher education had a greater capacity to design TIL programs which were innovative and student-centred, and which were underpinned by evidence-based pedagogies.

The impact of learning about TIL during initial teacher education has been highlighted in this study and therefore presents some insights into how and why universities might address educating pre-service teachers about TIL. Results from this study highlight the value of providing explicit teaching about evidence-based TIL which is grounded in pedagogical understanding. This would ensure that a pre-service teacher is equipped to work in a school which has a sophisticated and holistic approach to technology integration. Significantly, this would also equip teachers to be able to engage in the design of sophisticated TIL in a school with limited technology resources and support from school leaders.

The way in which ECTs' pre-service learning about TIL influences their practices with technology in their early years of teaching has been evidenced in a limited number of studies (Jordan, 2012; Orlando & Attard, 2016; Starkey, 2010; Tondeur, Roblin, et al., 2017). This doctoral research provides a valuable opportunity for comparison between two participants which sheds further light on this concept. Simon and Jenny taught at the same school and had graduated from university at the same time. Simon had extensive exposure to TIL at university, while Jenny's learning about TIL at university was minimal. Simon's design process differed significantly from Jenny's, consisting of a 'big idea' approach, underpinned by pedagogical knowledge, which resulted in a sophisticated program designed to enhance the learning experiences for his students. Jenny's design process was to use the school's existing program and integrate technologies such as video to support students' comprehension of the content. Working in the same school meant that all other contextual factors were the same; the access to devices was problematic and restricted, however the only difference between the two ECTs was the pre-service exposure to TIL. This finding serves to demonstrate the value of learning about and gaining experience of integrating technology while at university.

The findings in this study reflect evidence in the literature which identify that early career teachers have varied exposure to TIL during their pre-service teacher studies (Bate, 2010). Studies of ECTs highlight that this phenomenon is true for Australia and many other countries. Such studies have shown that there is a correlation between learning about TIL in pre-service teacher training and having a more positive attitude towards TIL and a better developed capacity to integrate technology into learning and teaching (Gudmundsdottir & Hatlevik, 2018).

There is, however, evidence in the literature that pre-service teacher education needs to go beyond exposure to TIL and to consider the exposure that pre-service teachers have to the concept of TIL beyond the university walls (Tondeur, Roblin, et al., 2017). Gudmundsdottir and Hatlevik, (2018) exposed further nuance in pre-service teacher beliefs as they identified that while 80% of their PSTs interviewed expressed positive attitudes towards TIL, half of the teachers interviewed expressed a fear that ICT in the classroom could distract students from their learning. In this doctoral study, the participants did not express a concern about technology as a distraction in the classroom, but Elena was alert to what she perceived as her students' over-reliance on technology. This was a concern which emerged from her observation of their behaviour with devices in the classroom and is an example of how the school context can provide a complex range of concerns, which PSTs may not be able to understand through formal instruction. Initial teacher education programs might be able to better prepare PSTs for how their future work contexts might impact on ICT integration through discussions of case-based evidence.

Gudmundsdottir and Hatlevik's (2018) study found that poor experiences with ICT in ITE could affect ECTs' confidence as they began their teaching careers and could hinder their development of a professional digital competence. In this doctoral study, there is evidence that a lack of experience with ICT in ITE has implications for ECTs' capacity to integrate technology effectively. Likewise, some participants reported "superficial" attention to TIL in ITE (Catherine) and found this to be a barrier to integrating technology, indicating a low level of professional digital competence (also comparable to low TPACK). In order to counteract this phenomenon, Gudmundsdottir and Hatlevik (2018) hypothesized that ITE should provide for teacher educator modelling of exemplary use of ICT and should support preservice teachers to critically assess the appropriateness of ICT in their teaching.

Professional experience with TIL

The findings from this study also indicate that professional experience with TIL supported their confidence and capacity to integrate technology in their programs. The exposure the participants had to technology integration in the workplace varied significantly. Some participants, such as Simon and Shelly, had relatively extensive experience with technologies and both had experience working as an ICT coordinator in a school. Other participants, such as Kiara, Jenny and Emma had minimal experience of using technology in schools. For Simon and Shelly, who had reasonably extensive experience with TIL post-qualification, it was evident that they were confident to think flexibly about how their program designs could integrate technology. In Simon's case, his flexibility and problem-solving approach to technology integration allowed him to overcome significant difficulties of access to design a TIL program which was innovative in his school context.

Participants' knowledge about TIL was analysed in this study as TPACK as part of the *tools* component in activity theory. This identification of participants' TPACK allowed for the nuances of their knowledge about TIL to emerge. TPACK influenced participants' design of TIL in this study both where there was evidence of participants' strong knowledge and also where there were gaps in participants' knowledge. The findings show that the TPACK of participants varied across the cases.

The analysis of all integrated components of TPACK across the cases showed that the stronger indicator of a connection between TPACK and sophisticated technology integration in this study is between good technological and pedagogical knowledge. Shelly, Emma and Simon are examples of this, as they demonstrated strong TPK and all designed innovative and creative TIL programs. Interestingly, a low level of CK did not impede the delivery of innovative TIL in Emma's case: she designed an innovative program for mathematics, incorporating multiple digital tools on the iPad, which extended beyond the integration of apps. In contrast, Jenny had a high level of content knowledge, but her technological pedagogical considerations were the delivery of content in a predominantly teacher-centred way in order to ensure that the students understood the key concepts clearly. Her low level of TPK may have been a limiting factor in her design of TIL. Shelly had strong overall TPACK, however she expressed a sense that she could extend her knowledge further. Analysis of her case found that her TIL work, while generally highly innovative, relied predominantly on the use of iPads and iPad apps in the classroom. It is possible that her articulated need to extend her knowledge further might reflect a need to extend her knowledge beyond the use of these technologies. Simon demonstrated the highest levels of TPACK across all components and during his design process carefully considered the design and inclusion of TIL from a range of perspectives, critically analysing the value of the TIL tasks to his students' learning. The most significant finding from this analysis is that while he demonstrated such sophisticated design thinking about TIL, he did not design the most innovative TIL experiences in the study. What emerges from these findings is an understanding of the need to focus on developing ECTs' TPK through formal education and opportunities to gain practical experience. These findings align with research conducted with pre-service teachers, which identified that those who had the opportunity to experience implementing TIL in a real classroom during internships reported greater confidence in working with technology in the classroom (Tondeur, Roblin, et al., 2017).

6.3.2 Access to technology in schools

The issue of access to technology is identified in earlier literature as a dominant barrier to technology integration (Ertmer, 1999). Later studies identified that access to technology was a barrier which had been overcome (Ertmer, 2005). However, this study contributes further to our understanding of access to technology and why it continues to be an important consideration for ECTs. The majority of the ECTs in this study (Kiara, Elena, Catherine, Emma and Shelly) had access to technology in their classrooms in every lesson, through a BYOD policy in the school. However, this did not necessarily result in principled and sophisticated integration of technology in the program, despite these participants espousing positive attitudes and beliefs about the value of TIL. Kiara, for example, used iPads in the class for students to engage in research. The tasks she designed varied, but principally the TIL activities were not innovative in design. Catherine experienced difficulties implementing some of the TIL tasks she had designed due to students' experiencing difficulties logging on to platforms and lacking ICT knowledge that Catherine assumed they would have. Kiara's experience was that her students regularly forgot their iPads and did not view them as an integral part of their learning. In contrast, Elena, Emma and Shelly described their students as having sophisticated ICT knowledge, which meant that implementing more innovative TIL was not impeded by students' capacity to embrace TIL tasks. This expands on the work of Ertmer which shows that early career teachers need other contextual supports in order to be able to design sophisticated TIL. These contextual supports might be features of the school context, but not necessarily.

The findings in this study also identified that while 1-to-1 access to technology did not always translate into innovative TIL, limited access to technology had a restrictive impact. The cases of Jenny and Simon in a school with limited TIL access help illustrate this point. Jenny identified that this was a significant barrier to her using more technology in her teaching. She did not attempt to use the set of six laptop computers available to her because of they were shared by six classes and as such, booking them for specific lessons was difficult. She also found that negotiating somebody in the school to help her move the heavy trolley on which they were stored was challenging. For these reasons, she felt that using laptops in the classroom was too difficult to organise. Instead, she relied mainly on presenting content on her IWB, and using the computer laboratory at the school for students to conduct research and engage in an online game on a museum website. Simon also identified the difficulty in accessing the laptops as a challenge, however, he ensured that he secured access to these for his class so that they could engage in their group projects. Simon and Jenny worked in the same school, with limited access to technology devices: the school had a computer laboratory, which could be booked once every two weeks. They also had access to a set of six laptop computers, which were shared between five classes in the grade. These limitations were a significant barrier to Jenny, who only used the computer laboratory once in her program. The remaining technology integration was through digital resources to present content on the IWB in her classroom. Simon, however, was able to design a program which was technologically innovative for his school. The difference between these two participants was the level of TPACK: Jenny's was low, however Simon's had been developed by through learning and experience both at university and in a previous teaching role. The fact that these internal factors allowed Simon to overcome the significant barriers in the school context lend more support for the value of teachers learning about and experiencing TIL during their pre-service teacher education. Tondeur, Roblin, et al. (2017) identify the value of TIL learning during ITE which is supported by active experience of implementing TIL during teaching practicums. Simon's case supports that finding and adds the contextual finding that this might be especially important for ECTs working in school contexts with limited access to technology or indeed other contextual barriers which have been discussed in this chapter.

6.3.3 School leadership and culture with TIL

Leadership was shown in this study to impact significantly on participants' design practice in this study in relation to creating a teaching environment which supports TIL. Schools involved in the study had demonstrated a willingness to engage in implementing support for teachers in TIL. What was evident from the individual cases was that the structure of this support differed between schools and this in itself indicated a range of leadership perspectives on implementing TIL in schools.

Five schools in the study implemented BYOD policies, yet the communication of these policies in those schools ranged from only prescribing the type of device and specifications (e.g. Kiara) to supporting teachers to use the devices in the classroom with a structured, multi-faceted professional learning and classroom support model of support (e.g. Shelly). These different institutional approaches influenced the early career teacher participants' practice as they designed their TIL programs. The teachers whose schools provided a 'specifications only' approach (Kiara and Elena) expressed a lack of confidence in how they should use their devices and the extent to which they should use their devices in the classroom. Elena was particularly unsure about this, especially as her students were extremely confidence users of their devices and she expressed a lack of control over the use of devices in her classroom. During the design process, she questioned herself and her decisions about technology repeatedly. Ultimately, she relied on the school's existing program she was using as her design tool as a source of technology to integrate into the program. At the other end of the scale, Shelly's school's BYOD policy was supported by an extensive professional learning program. Due to her experience with technology integration, Shelly acted as a supporting classroom teacher for her colleagues, as they worked through the program themselves. Shelly was confident in her capacity to integrate technology and in her design work seamlessly integrated digital tools into her program; her only concern was how she might develop her skills to a higher level, as most of her colleagues' technology skills were lower level than hers.

The school which did not have a BYOD policy (Jenny and Simon's cases) had supported groups of teachers to lead professional learning committees, one of which was dedicated to technology integration. This consisted of several workshops introducing different technologies to staff members, however the topics appeared to be focused predominantly on Google Docs, with both participants at the school identifying the introduction to Google Classroom to be the most valuable. This platform was used by both teachers in the design of the program, but in a minimal way. Not having easy access to technology in the classroom, meant that these teachers experienced the school context as a barrier to technology integration. This is discussed in section 6.3.4 below.

These different models of leadership of TIL in schools provide some insight into the diverse perspectives of how technology integration is supported in schools. The findings suggest that a top-down approach ensuring all staff have access to technology in the classroom through a BYOD policy, which is also supported by an extensive professional learning program, communicates the message that TIL is an important consideration in the school and that the school culture can support all staff to develop their skills in the area. In contrast, ensuring that there are specified devices in the classroom through the implementation of a BYOD policy, which is not supported by professional learning or a nominated support staff member, suggests that the leaders consider technology integration to be the responsibility of individual teachers. By extension, the implication is that senior teaching staff who are appointed to mentor early career teachers at the school, also hold the responsibility to support them as they integrate technology. This conjecture needs to be supported by further research.

Colleagues in the schools were also identified in this study to influence the ECTs' design practice with TIL. This finding is significant, especially because in the majority of the cases, colleagues were found to lack the skills and knowledge to support ECTs in integrating technology in their programs or did not offer support for the design of TIL. Most ECTs who were influenced by their colleagues in this study indicated a sense that their colleagues were more senior mentors and as such, their advice was to be followed. A significant finding in this study is that in some cases, the ECTs had more knowledge of TIL than their more senior colleagues (Catherine, Simon, Emma & Shelly), or their teacher mentors did not have the skills and knowledge to support the ECTs' development of more sophisticated TIL in their programs (Kiara, Jenny & Elena). There is strong evidence in the literature that in order for teachers of any level of experience to integrate technology effectively in their teaching, the cultivation of a positive culture of technological innovation across the school is required (Tondeur et al., 2009), which should be internalised by all parties (Laferriere et al., 2013). For ECTs designing TIL, the need for a school-level culture of innovation with technology would appear to be more significant because of the power imbalance they experience as members of staff with little professional experience who are mentored by more experienced staff members. Tondeur et al. (2009) found there to be an interdependence of structural and cultural characteristics in schools, where even if there is structural support for TIL by the provision of access to technologies for learning, if the cultural characteristic, such as a shared understanding and value of technology in learning and teaching, is missing, then there will be an invisible barrier to technology integration. Laferriere et al., (2013) support this view, stating that "successful ICT integration is a process of overcoming obvious as well as culturally entrenched barriers" (p.471). The analysis of ECTs' activity systems in this study contributes further to this theory, as the evidence points to a further interpretation of the imbalanced power relationship between mentors and mentees, and school leaders and early career teachers. That is that the activity systems of more senior members of the *community* component of an activity system can impact on the activity systems of ECTs. This means that staff members in schools, including school leaders, have their own system of beliefs, values, knowledge and external influences which constitute their understanding of TIL. These activity systems impact on the practices of ECTs designing TIL in informal/implicit ways.

In the cases of Simon, Emma and Shelly, where the ECTs had extensive experience of TIL in their initial teacher education, they demonstrated the capacity to design sophisticated student-centred TIL despite their colleagues' lack of skills and knowledge in the field. This finding thereby indicates that the acquisition of TPACK at university can support teachers to overcome issues of agency relating to technology integration in their school. This phenomenon echoes a finding by Ertmer et al., (2012) who found that teachers with student-centred beliefs tended to enact student-centred TIL despite technological, administrative and assessment barriers in the school context. Not only is Ertmer et al.'s (2012) finding supported by findings in this study, this evidence in the literature may add to our understanding of how two teachers in the same school context, with limited access to technology, demonstrated very different practices with TIL design. Simon focused on his students' learning experiences throughout the design process and designed a student-centred TIL program which was innovative for their school context. Jenny, however, designed a program which was more teacher-led in approach and integrated technology in superficial way, mainly to support students' understanding. It is possible that Simon's student-centred beliefs about pedagogy supported him in overcoming structural barriers to technology integration in their school context.

A further implication for recently graduated teachers is the culture created by school leaders and teaching staff around technology integration. If it is not prioritised in the school, there can be a pervading sense that it is not important. Simon and Jenny identified this to be the case at their school. If the general culture in the school is that TIL is not important, then for its teachers (including ECTs), TIL might also not be an important consideration when designing programs. Again, further research would be required to investigate this issue.

6.3.4 School's accepted design practice

Kiara, Jenny and Elena approached the design activity by referring to the school's existing program for the content area and making changes at lesson level to make the learning tasks and resources more appropriate for their current group of students. These participants chose to follow this process and identified that this is the common practice in the school. In Elena's case, the sense that this was an accepted practice was stronger, as she identified that this was the method prescribed by the school. Emma also referred to a common approach to designing programs, which she used in her program design, although this approach involved the use of a matrix and protocol to identify opportunities for differentiation in the programs she designed. This approach was strongly advocated by her mentor and she found it a valuable approach to use. It is possible that for some of these teachers, a lack of agency as early career teachers could influence the participants to follow the accepted design practice in their school, despite the fact that they engaged the design activity alone for the majority of the time. However, there is a broader understanding that practices within an organisation lead to employees internalising accepted practices and developing their own practice in accordance with common work organisation processes (Bellamy, 1996).

As well as internal tools, physical tools were influential factors in the design practice of some participants. Emma, Jenny and Elena used existing programs to underpin the overall design of their TIL programs. The use of these existing programs meant that the distribution of the content across the lessons, and the learning tasks in the lessons were changed minimally by these participants as they created the new programs. In Elena's case, the existing program contained a creative TIL task for students to engage in and this meant that her program contained a level of TIL innovation. For Jenny and Kiara, however, the existing programs contained little innovation with technology. Their TIL programs in this study incorporated some additional digital resources, such as videos, but there was little innovation in the integration of these resources. Other participants used pedagogical resources as design tools in their practice. Catherine followed protocols for developing programs using the Harvard visible thinking routines, Shelly was following a project-based learning (PBL) protocol, and Emma used a matrix for creating meaningful differentiation for her students.

6.3.5 Influence of students

Findings in this study identified that the participants engaged with their students and perceived their needs differently across the cases. For some participants, the identification of their students' needs was evident as they discussed differentiation requirements. For Jenny, her students' high EALD and literacy needs were a dominant factor in her design process; she carefully considered vocabulary students would need to engage in the topic and incorporated video resources to support their understanding of more complex historical events.

Participants were influenced by their students' existing technological skills. Shelly incorporated apps into her program design which she explained her students were comfortable with using and they understood how they could use these to demonstrate their learning in a content area. Elena was concerned about the reliance her students appeared to have on their devices and worried that they did not spend enough time writing by hand and engaging in deep learning as they relied on quick online searches for information and working through content at a fast pace. Emma, by contrast, understood that her students had a good knowledge of a range of software and applications and sought their input on choice of platform to use for her mathematics program on 3D shapes. These are some examples of the ways in which the participants considered their students throughout the design process. It is interesting to note the diverse considerations these ECTs had regarding their students and highlights the influence of context and the characteristics of a specific group of students on an ECT's practice. In Jenny and Simon's cases, the school context and leadership shaped the ways in which they thought about their students because of the policies in place to support the high literacy and academic needs of their students.

There is much discussion in the literature about designing for learning, and underlying principles which might guide that process (Laurillard, 2012; Beetham, 2013). However, the evidence provided in this study depicts the nuances of designing for a group of students who are familiar to the teacher through the nature of primary education. The pedagogical reasoning depicted in this section is considered as critical for the development of teachers' TPACK (Niess & Gillow-Wiles, 2017) and as such could inform further investigation of ECTs' pedagogical reasoning when designing TIL.

6.3.6 Influence of syllabus/KLA

This study presented the design of programs from a range of KLAs: history, English, science and mathematics. A question which emerged from the cases was whether the syllabus for the individual KLAs influenced participants' design processes. There is some evidence that this is true: for example, Jenny referred to the large amount of content in the history syllabus, indicating that there was a lot to fit into her program. It is possible that she felt this left little time for innovating with technology in the program. Emma explained that she usually planned her mathematics programs every two weeks, rather than every term, as she did with other KLAs, because she had to plan for a mathematics lesson every day. She stated that this meant she had little time to consider technology integration in mathematics. These are factors which potentially influenced the design thinking of the participants and where they spoke about this it was reported in the case chapters. However, there may be scope in future research to explore the influence of the syllabus features for each KLA more explicitly.

6.3.7 The interaction of influences

The above section has discussed the key influences on ECTs' design of TIL. The analysis conducted through the lens of activity theory in this study, however, illustrates a richer picture of each ECTs' context as they engage in the activity of designing a TIL program. From this analysis not only are the key influences for each participant evident, but how these influences interact with each other within each activity system. Examples from each case are provided below.

The key contradiction in Kiara's case was that of *Tools* (internal and external) and *Rules*. Specifically for Kiara, her limited TPACK was evident in the *Tools* component and a lack of support within the school for the design of TIL was evident in the *Rules* component. This was an interesting finding in this case, because the school was a strong advocate of the use of devices in the classroom. However, there were no strategies in place to support teachers in the development of TIL. This factor, when combined with this ECT's low level of TPACK, meant that there were no internal or external contextual supports for Kiara who wished to design an innovative TIL program. An additional contradiction in this activity system was

Kiara's interaction with her mentor (*Community*), who did not offer any support for TIL, or consider that within her scope of support.

The key contradiction in Jenny's case was that of *Tools* (internal and external) and *Rules*. Jenny's limited TPACK (*Tools*)was evident and this contradicted most significantly with the difficulty of access to technology within her activity system (*Rules*). As with Kiara, an additional contradiction occurred within the *Rules* component as the school offered no direction or guidance for teachers wanting to design TIL. Some teacher-led professional learning on education technologies was found to lack clear outcomes for teachers in the school. Jenny did not have a mentor at the school and she did not identify any colleagues as sources of support for TIL (*Community*).

The key contradiction in Elena's case was that of *Tools* (internal and external) and *Community*. Although Elena had some strong TPACK (*Tools*) in the area of robotics, it was limited in terms of mainstream TIL. Despite having BYOD iPads in the classroom, Elena experienced a significant lack of confidence in her capacity to design innovative TIL. While this may have partially been a result of her limited TPACK, Elena also expressed a lack of agency to design her program freely. A senior colleague expressed concern about her making significant changes to the existing program. She made several references to feeling that she was not able to change the content of the program as a result.

Catherine's case provided evidence that her good TPACK (*Tools*) and access to technology (*Rules*) allowed her to overcome some potential barriers in her context to design a program which contained some innovative TIL. As with Kiara, despite the provision of BYOD laptop computers in the classroom, there was minimal support for, or leadership of, the design of TIL in the school. It is likely that without her specific knowledge of TIL, she would not have been able to design a program which contained the level of innovative TIL that she did. In this case we can see that aspects of the Tools and Rules components interacted to create a positive context for her to design a TIL program.

Simon's case provides evidence of how the *Tools* (internal) component was able to support him to create innovative TIL in a context with significant barriers. Simon's TPACK was strong and he had experience of acting as an ICT coordinator at a previous school. This had contributed to a level of confidence (*Tools*) and the development of a problem-solving approach (*Tools*) to designing TIL. Issues such as difficulties with access to technology (*Rules*) and minimal institutional support for TIL (*Rules*) might have been factors which would have significantly limited his design of a TIL program without his internal resources of knowledge (TPACK), beliefs and attitude.

Emma's case provides evidence of how the *Tools* (internal) component and the Rules component created a context which supported her design of an innovative TIL program. Emma's TPACK was strong and combined with that, she demonstrated a risk-taking disposition in her willingness to try using a completely new technology-mediated approach to teaching her content area. These internal tools were further complemented by the provision of some leadership support (*Rules* and *Community*) and by her barrier-free access to mobile digital devices in her classroom (*Rules*).

Finally, Shelly's case provides evidence of critical contextual components working together to create a highly supportive environment for an ECT designing a TIL program. In Shelly's activity system, there was evidence of *Tools* (internal and external), *Rules* and *Community* working in conjunction to support the system's objective. Shelly had strong TPACK and professional experience as internal *Tools*. The PBL approach to designing a program supported the innovative design of digital resources and TIL tasks. The most significant factor in this activity system was the evidence of strong, comprehensive leadership in the school for teachers' design of TIL. This leadership approach involved an ongoing program of professional learning and classroom support for TIL. This was accompanied by a BYOD policy so access to mobile digital devices was not a barrier. The result of this was that the whole school community understood the strategic vision of TIL for all students. Teachers were able to undertake extensive learning to support their specific needs, students understood that their devices were an important component of their learning and parents were also aware of the emphasis placed by the school on TIL. The program designed in this context was innovative and involved student choice of multiple digital tools to achieve their learning outcomes.

The complexities of the activity systems in each of these cases illustrate the interaction between internal and external contexts of the participants in the practice of designing TIL programs. Evidence in this study identifies the close influence on design thinking of components of the activity system, which is modelled through activity theory: Activity theory "*does not accept a dualistic conception of an isolated, independent "mind."*" (Kuutti, 2006). Likewise, Leont'ev, an early theorist of cultural-historical activity theory, posited that "a person's mental processes acquire a structure necessarily linked to socio-historically formed means and modes, which are transmitted to him by other people through teamwork and social intercourse." (Leont'ev, 1974). These conceptualisations of activity systems where internal and external influences are fused with the activity itself support the findings outlined in this section.

6.3.8 Summary

The findings from this study show that the key influences on ECTs' practice are their knowledge and skills with TIL, their experience of initial teacher education, their access to technology and the influence of colleagues. The analysis conducted through the lens of activity theory in this study has resulted in a rich and detailed representation of each ECTs' context as they engage in the activity of designing a TIL program. This is an important contribution to knowledge because not only can we see the key influences on each participant, which differ from case to case, but we can also see how these influences interact with each other within each activity system to create an almost unique context environment for each ECTs' design practice. These interactions within the activity system are critical to understand because the individual components might exact an influence on the design activity when considered on its own. However, each component's influence on the activity is shown to be mitigated by its interaction with another influential component in a way which increases or mitigates support for TIL design. This understanding adds to our knowledge of how ECTs' contexts influence their practice.

Through this analysis, some factors appear to be more powerful influences than others when interacting with other contextual components in the ECTs' design activity systems. An example of this is strong TPACK. Strong TPACK has been shown in this study to be a tool which equips ECTs to overcome significant barriers such as limited access to technology, as in the case of Simon. However, when strong TPACK is not evident as a tool in the activity system, this study provides evidence that a context with good access to technology might not result in the ECT subject producing an innovative TIL program. Leadership is another powerful factor in the activity systems presented in this study. Emma's and Shelly's cases presented different levels of leadership for ECTs designing TIL programs, nevertheless, such leadership was a powerful influence on these participants' practice and supported them to develop innovative TIL programs.

As an overall interpretation of the results of this study, it is evident that the school context is a powerful influence on how ECTs engage in the design of TIL programs. Even when they possess strong TPACK, in a school with significant barriers to technology integration their level of innovation with TIL is shown to be limited. Researchers have recently raised the question of expected level of innovation within a particular context (Burden et al., 2019). This work and the research conducted for this doctoral study indicate that it may be unreasonable to expect ECTs to design max innovative TIL programs regardless of the context.

6.4 Contributions to practice

The findings from this study raise important implications for supporting ECTs' practice in designing TIL programs. Activity theory has been used in many professional contexts to shed light on the processes undertaken to complete specific tasks. Its value is evident in studies across healthcare and education, as well as in specific practices relating to human-computer interactions (Daniels et al., 2013; Nardi, 1996). In this study it has provided critical insights into factors which can significantly improve the support of ECTs as they design TIL programs. These insights are presented below.

6.4.1 Importance of ECTs' approach to designing TIL

This study has highlighted the importance of focusing on ECTs as designers of TIL programs. Through this focus, the study has identified ways in which ECTs' approach to designing programs more generally can impact on the TIL in the program. The findings indicate that ECTs who approach program design by redesigning an existing program can be limited in their design thinking and design practice with TIL. The implication of this key finding is that more attention could be given to supporting ECTs in their TIL design process. There might be an opportunity to develop design thinking support tools, which could prompt ECTs to think about technology in a creative and holistic way, whichever design approach they choose. The research and development of such design support tools would be a way to build on the research in this study.

6.4.2 School culture for TIL

This study presented evidence of the value of building a school culture which is supportive of TIL in schools because of the range of contextual factors encompassed in the concept of leadership of TIL. Broadly speaking, there is evidence in the study that schools should be aware of the impacts of school culture on ECTs' design of TIL. Influences from the school environment which impacted on ECTs' design of TIL include access to technology for students, the communication of policies and strategies for TIL, and the cultivation of a staff culture which values and promotes innovative and pedagogically-principled TIL.

Access to technology is an interesting factor in this study because most participants had good access to devices in their classrooms through a BYOD policy at the school. Two participants were identified as having significant difficulties in accessing technology at their schools as they had not BYOD policy and access to desktop computers and laptop computers was limited due to high demand for a small number of devices. However, even when ECTs had access to BYOD devices in their classrooms, it was not clear from the school leadership how these could or should be used for TIL and how teachers could access support. For some ECTs in these contexts, this led to them experiencing a lack of understanding of how they should approach the design of TIL. It should be noted that other teachers in these contexts who had strong TPACK did not experienced the same personal lack of direction. I suggested earlier in this chapter that school leaders often appear to consider the design of TIL programs as teachers' responsibility. This seems to put an extraordinary cognitive load on early career teachers in those contexts.

One implication for practice might be for school leaders to consider more explicit direction about TIL. It may be that professional learning about TIL might need to be organised and led by school leaders rather than teachers who might have significant gaps in their knowledge. There could be a strategic effort to ensure all teachers have the skills and knowledge to integrate TIL with confidence. Having a more holistic and positive approach to TIL integration across the school would serve to communicate to all stakeholders that TIL is truly valued and that teachers would be supported in their efforts to improve their skills and knowledge of TIL. Such an approach is supported by evidence in this study from one case which presented a leadership strategy to TIL which was multi-faceted and served to promote a teaching environment where staff were supported and empowered to implement TIL. The principal at this school implemented a comprehensive professional learning program, which included team teaching with staff members with strong TIL skills and knowledge.

In sum, there is a need to ensure access to technology in schools. With good access to technology comes the additional need to ensure that school leaders go beyond providing access to technology in policies and procedures, they need to support teachers and especially early career teachers, to engage in the design of innovative TIL for their students. Strategies to create a positive culture towards TIL across a whole school setting would ensure that ECTs would receive a unified message about the value of TIL and know that they would be supported to design innovative TIL. This approach could support ECTs to overcome a lack of agency when designing TIL because the school values about TIL would be well communicated. They would know that when they engaged with senior colleagues that all staff members would have appropriate knowledge and skills and would be supportive of their efforts.

6.4.3 Explicit instruction in TIL in initial teacher education

This study has revealed that strong TPACK is a critical contributing factor to ECTs being able to design innovative TIL. Yet, as teachers in the early stages of their careers, the professional experience they have is limited. As well as limited time spent as qualified teachers, the study shows that professional learning about TIL in schools is limited in scope and often absent altogether. For this reason, there is much focus in the literature on initial teacher education and its capacity to support the development of TPACK in preservice teachers (Ottenbreit-Leftwich et al., 2018; Tondeur, Roblin, et al., 2017). This study provides evidence that initial teacher education can contribute significantly to the development of pre-service teachers' TPACK. However, it also provides evidence that this contribution from teacher education does not eventuate for all early career teachers.

This study identified specifically that pre-service teacher learning about TIL at university can be superficial and minimal. Not all teachers have the opportunity to engage in explicit learning about TIL because there may be no dedicated subject offering this in the degree they pursue. In other cases, there may a subject offering, but it might be an elective which does not fit the timetable of all students. Participants in this study identified tutors in non-TIL subjects who referred briefly to the need to integrate technology, but provided no specific strategies for doing so. Some participants hypothesized that their tutors lacked knowledge and confidence themselves about integrating technology into their subject domains.

Despite these experiences of participants during their university courses, initial teacher education offers an opportunity for students to undertake in-depth learning about TIL and to develop practical skills, whilst also developing an understanding of how these skills connect with principled pedagogical practice with TIL. If they engage in such learning as students, ECTs may enter the profession with a sound pedagogical understanding of the role TIL can play in students' learning and an increased capacity to engage in the development of TIL program with increased confidence. Such confidence may also support beginning teachers to develop the agency and problem-solving capabilities which are important when designing and implementing TIL in contexts with some barriers to technology integration. The implication of the findings in this study is that there is value in pre-service teachers engaging in learning about TIL in stand-alone courses, rather than rely on TIL to be integrated across content-related courses. This aligns with research which suggests the process improving pre-service teachers' knowledge is complex and involves multiple stages of learning: developing a positive attitude, understanding the pedagogical value and understanding how to implement TIL (Koh & Divaharan, 2011). It is clear from the experiences of ECTs in this study that the most in-depth learning about TIL takes place when pre-service teachers have the opportunity to explore technologies and the theories of technology integration separately from other subject areas.

6.5 Contributions to research and theory

The aim of this study was to contribute to empirical knowledge of ECTs' practices with technology integration in teaching and learning, and to understand factors which support or limit their practice. The focus on the participants' work as the design of a TIL program, facilitated through the collection of multiple data sources, was a novel approach which allowed the researcher to develop an in-depth understanding and interpretation of each ECT's design practice with TIL and the contextual factors which influenced their practice. Analysing ECTs' work as design facilitated an analytical interpretation of their practice which is underpinned by theory, thus building on the study's contribution to practical understanding of the phenomenon (Bennett & Oliver, 2011). The use of activity theory as a lens to analyse each ECT's context allowed not only for detailed analysis of each contextual influence, but also provided a model for analysing how individual contextual factors interacted with each other over the course of the design activity. The analysis of these contextual interactions provided further evidence of the influence of contextual factors on ECTs' practice and allowed for an interpretation of how the context operates to support or limit ECTs' design of TIL programs. In this way, this study advances understanding of ECTs' design processes with TIL and how contextual influences impact on ECTs' practice during a specific activity.

This study showed that ECTs often design TIL in relative isolation, which means that they rely a lot on their own knowledge and understanding of technology integration. In this way, it was able to identify the importance of ECTs' knowledge and other internal *tools* to the design process. The importance of this was extended when the analysis provided evidence of how these internal tools interacted with other contextual components to support or mitigate the participants' efforts to design TIL programs. Within each context explored as part of this study, the interactions between the contextual components of each activity system were found to vary across cases and, as a result, created unique contexts which supported or limited ECTs' TIL design practice to varying degrees. The exploration of these contexts through the lens of activity theory facilitated the development of thick descriptions of each ECT's individual design context. Each of these case descriptions presented an in-depth analysis of how contextual components interacted with each other to influence each participant's practice. The study of these contextual interactions allowed the characterisation of each contextual component to emerge, which in turn led to deeper understanding of the influences on ECTs' practice.

This study identified two different approaches to design; one which relied on an existing program at the school to underpin their program design and one which was guided by an overarching pedagogical idea created by the ECT. Through activity theory contextual factors which influenced the adoption of the different approaches was carefully analysed and identified.

There have been calls for a more in-depth and nuanced understanding of how contextual factors impact on early career teachers in their practice with technology integration (Tondeur, Roblin, et al., 2017). The innovative approach of focusing on design practice in this study, provides a contribution to our collective understanding, not only of the factors which influence ECTs' technology integration, but also to our understanding of how they engage in the design of TIL: the steps they take and the thinking they engage in along the way. The capacity of this study to present the internal and external contexts within which the participants designed their programs, and to identify how each contextual component interacted with other components within an activity system, provides an additional contribution to the existing research on early career teachers' technology integration.

Analysis of the influences on ECTs' design practice with TIL through the lens of activity theory allowed for the nuances of contextual interactions to emerge from the data. In activity theory, interactions between contextual components in an activity system which disrupt the activity are referred to as *contradictions*. In some cases, these interactions created a limiting context for ECTs designing TIL programs. In other cases, the interactions between components did not disrupt or limit the activity, instead they created a more supportive context for ECTs designing TIL programs.

This study has produced critical findings in relation to the direction of recent studies. The value of this study was to extend the knowledge provided by the comprehensive body of literature relating to pre-service teachers' capacity to design meaningful TIL, to explore early career teachers designing TIL in context. Chapter 2 presented the evidence in the literature of the significant impact contextual factors have on teacher practices with TIL, yet few studies have focused on recently qualified teachers as they begin to design TIL for a real teaching context. This highlights the importance of the focus of this study. Ottenbreit-Leftwich et al.'s (2018) longitudinal study followed pre-service teachers as they completed their teacher education and began working as practising teachers designing TIL in context.

Critically, their study showed that their context, that is to say the school resources and environment, had a significant impact on their practices, regardless of "*strong internal enabling factors*" (p.283), such as those developed during their initial teacher education. Their results are described as "*disheartening"* in their publication (p.302), yet findings in this doctoral study provide evidence that there is reason to be positive about the capacity of early career teachers to design TIL. The focus on design in this study has revealed that ECTs who have experienced positive engagement with TIL during their teacher education and have demonstrated evidence of a developed TPACK, can engage in a level of design thinking which results in the development of a sophisticated TIL program.

The role and value of TPACK is also highlighted in this study and additionally shed some light on complexities associated with the enactment of TPACK in context, particularly highlighting the influence of colleagues and school leaders in some of the cases: in Emma's case, the support from a pedagogical perspective of her assistant principal, and in Shelly's case, the support of her PBL mentor, also predominantly from a pedagogical perspective. This reflects research on TPACK as a distributed form of knowledge, where TPACK is identified as not only existing as an internal knowledge construct of an individual teacher, but as a collective knowledge contributed across a community of practicing teachers (Phillips, 2017). Evidence in contemporary literature supports this finding and some studies are promoting the value of focusing on design processes in developing TPACK (Boschmann et al., 2015). As this doctoral study highlights some critical insights into TPACK as implemented in the design process, this would be an important focus in future research. The role of TPACK in ECTs' design practice is deserving of further investigation as this has not so far been a strong focus in the literature, despite the strong focus on TPACK in pre-service teachers.

6.6 Limitations of the study

It is important to note that there are several limitations in this research. Part of the way through the data collection for this study, it became clear that it would be beneficial to collect school policy documents from participants in order to triangulate these with the reflections of participants. In order to do this, an amendment to the university ethics approval was requested and granted. New consent documents were prepared and sent to participants. Unfortunately, only two of the participants returned these documents and therefore, the decision was made to not include policy documentation as a datasource.

Secondly, it is acknowledged that the research design was limited in scope, having only seven participants. However, within this small study, the analysis was able to capture a range of educational contexts by ensuring that participants covered a range of geographical, socio-demographic and education sector contexts. It also involved a rigorous examination of ECTs' processes and contextual influences from a range of data sources and across many time points throughout the design process. Another limitation of this study is that the research design focused on the participants' engagement in the design of one TIL program. It is not known if the participants would engage in a similar process when they design another program in the future. While most participants, with the exception of Shelly, reported that their practice in the study was similar the way they usually engaged in the design of programs, collecting further examples of their practice would contribute more substance to the current set of findings.

The analysis of the data through activity theory allowed for the identification of multiple factors which impacted on the participants' contexts. While every effort was made to investigate these factors as they arose, the researcher identified an area which was not probed in sufficient detail. This area related to how each key learning area potentially impacted on design. The reason this was not done during the research process was partly due to the scope and timeframe of this research (being a doctoral study). Another reason was that the identification of this as a potential area of influence on the participants' practice was referred to minimally by some participants. However, this may be due to the lack of specific interview questions about the nature of the KLA. During analysis, the researcher reflected that this is an area which potentially impacted on the process and as such deserves more in-depth attention. If, as suggested above, it were possible to collect data from further examples of participants' TIL program design, from different KLAs, this might contribute additional understanding about how KLAs influence the design process.

What is more difficult to discern is the impact of a lack of other influential factors in the contexts of Kiara, Jenny and Elena. These participants had limited knowledge and experience with TIL, or low TPACK. Their schools did not have policies in place to promote and support teachers implementing TIL. It is possible that their low TPACK was a factor in their approach to designing TIL which meant that the TIL in their programs was limited.

6.7 Recommendations for further research

As suggested in section 6.6, future research could contribute to knowledge in this field through an extended investigation of ECTs' practice, to collect data as they engaged in the design of TIL programs over the course of a year. In this way, it would be possible to explore whether the same process and influences were observed in subsequent TIL program design activities.

A willingness to experiment and take risks was evident in Emma's data, and a practical, problem-solving approach was used by Simon to navigate some difficulties in accessing technological devices. Other participants experienced more limiting mindsets, such as an unwillingness to take risks (Kiara) or problem solve (Jenny) in their design contexts. It is unlikely that these affective dispositions exist in isolation and probable that other contextual factors contribute to their existence. Agency or a sense of lacking agency are factors which were evident in some cases. Elena in particular expressed a sense of limited agency in her design. This is an area which would benefit from further investigation, both in terms of how risk-taking dispositions contribute to ECTs' capacity to design TIL in context, and also how such dispositions might be fostered through professional learning and support structures.

Evidence is provided in this study of the influence of knowledge sources in the activity systems of ECTs. It is identified that ECTs' colleagues often did not have strong technological knowledge to support ECTs' design of TIL, however in some cases there was evidence of non-technological support which helped the participants in their design practice. In Emma and Shelly's cases, colleagues and leaders in the school systems used their extensive pedagogical knowledge to support the participants in approach to implementing TIL. In terms of technological knowledge sources, in Elena's case, innovative TIL design was evident in the existing program on which she based her new program design. Elena used this TIL activity in her new program design and this was the most innovative use of TIL in the new program. In Emma's case, her students were a source of technological knowledge which she used to inform the design of her innovative TIL program. These influences each served to contribute individual knowledge components from the TPACK model to the design of the TIL programs of these teachers. Colleagues contributed pedagogical knowledge (PK), the the program document contributed combined TPACK and students contributed technological knowledge (TK). The concept of TPACK or components of TPACK existing outside of the individual teacher is receiving increasing attention in the literature. The concept of distributed TPACK has been coined by Di Blas et al. (2014) to describe the process of teachers using sources of knowledge outside of their internal knowledge systems to draw on in their work. This concept is particularly interesting in the case of early career teachers whose knowledge is not based on years' of experience and who often receive mentorship and additional informal support from colleagues. I propose that the distributed TPACK of ECTs when designing TIL is worthy of further research.

The findings of the study provide evidence of the value of focusing on ECTs' approaches to design and how these support the design of TIL specifically. In section 6.4.1, it was suggested that the development of TIL design support tools for ECTs would be a way to support them individually. This would be an interesting focus for further research and development building on this study.

The use of activity theory in this study has proven to be extremely valuable in identifying nuances in design activity systems which influence design processes in explicit and also in subtle ways. The activity theory model could be used to investigate the context in which ECTs design TIL programs in more depth. This study has identified that aspects of leadership and culture influence ECTs' practice with TIL, which in turn raises the possibility of designing larger scale activity theory-based research to investigate the activity systems of schools as they implement TIL, thus enabling a deeper understanding of all stakeholders and the influences of school policies and practices at a higher level.

School leaders and leadership teams have been identified as potential sources of substantial support for ECTs designing TIL. What has emerged in this study is the idea that leaders often believe the responsibility for TIL program design sits with teachers and for ECTs, this can be a significant burden. A broad investigation of the attitudes and beliefs of school leaders regarding how TIL should be implemented throughout a school, with consideration of ECTs in their schools, would provide significant insight into the contextual analysis of this field.

6.8 Conclusion

This study addressed gaps in contemporary understanding of how ECTs think about and approach the design and implementation of TIL in context. The focus on early career teachers was critical for two reasons. Firstly, they are practitioners who may remain in the profession for many years against a background of rapid technological change. Secondly, there is limited research about early career teachers, but studies have shown that they often demonstrate a limited capacity to implement creative student-centred TIL. At a time when there is an increased focus on TIL in initial teacher education, this finding is surprising and yet there is a lack of evidence about the nature of difficulties ECTs encounter with TIL in their early years of teaching. This study sought to contribute to our understanding of this phenomenon.

The study took an innovative approach to exploring early career teachers' design practices with TIL in context, by conceptualising ECTs' work of developing and teaching a TIL program as design. By doing this, it was possible identify how ECTs engage in design work with TIL, how their thinking shapes their design decisions and which internal and external contextual factors influence the design process. Early career teachers from a range of school contexts participated in the study. The use of activity theory to analyse the design process of seven ECTs in context resulted in rich descriptions of practice, thinking and contextual influences.

The outcomes of this study have provided a detailed understanding of ECTs' approaches, thinking and consideration of technology integration, and the internal and external factors which influenced their practice throughout the design process. The analysis of the design process through the lens of activity theory facilitated an in-depth understanding of the contextual factors which influenced the activity, and critically, how these contextual influences interacted with each other to enable of limit participants' design work. Key findings from the study show that ECTs used one of two different approaches to designing TIL programs: the redesign of an existing program or the design of a new program. Furthermore, the approach they chose had implications for the way they considered technology integration through the design process. Those who used the redesign approach designed programs with limited innovative TIL. Those who used the new design approach designed more creative and innovative TIL. Findings also contributed to empirical knowledge of which contextual factors influence ECTs in their design work and how these influences interact to impact on the design process. These findings provide evidence of the need for schools to consider how ECTs in their schools might be influenced by context as they design TIL programs, as well as how they might be supported in their practice. Implications for initial teacher education are that there is a need for an explicit focus on TIL so that ECTs can gain the depth of understanding they need for their future teaching roles.

This study contributes to the limited body of research on early career teachers' skills and knowledge of TIL by providing a more nuanced understanding of early career teachers' design practice and how this is influenced by their internal and external contexts.
In doing so, this study has identified key focus areas for practice and it has informed the potential foci of future research in the field.

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Appendices

Appendix A: UTS HREC Ethics Approval

HREC Approval Granted - ETH16-0932

Research.Ethics@uts.edu.au

Fri 18/11/2016 1:37 PM

To:Lori Lockyer <Lori.Lockyer@uts.edu.au>; Lauren Knussen <[redacted]@student.uts.edu.au>; Research Ethics <research.ethics@uts.edu.au>;

Dear Applicant

Thank you for your response to the Committee's comments for your project titled, "Novice Teachers' Approaches to Designing Technology-Integrated Learning". Your response satisfactorily addresses the concerns and questions raised by the Committee who agreed that the application now meets the requirements of the NHMRC National Statement on Ethical Conduct in Human Research (2007). I am pleased to inform you that ethics approval is now granted on condition that evidence of organisational consent is provided once it is received.

Your approval number is UTS HREC REF NO. ETH16-0932.

Approval will be for a period of five (5) years from the date of this correspondence subject to the provision of annual reports.

Your approval number must be included in all participant material and advertisements. Any advertisements on the UTS Staff Connect without an approval number will be removed.

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Research Involving Humans requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually from the date of approval, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

To access this application, please follow the URLs below:
* if accessing within the UTS network: https://rm.uts.edu.au
* if accessing outside of UTS network: https://remote.uts.edu.au , and click on "RM6 - ResearchMaster Enterprise" after logging in.

We value your feedback on the online ethics process. If you would like to provide feedback please go to: http://surveys.uts.edu.au/surveys/onlineethics/index.cfm

Appendix B: NSW SERAP Approval

NSW GOVERNMENT | Education Public Schools

Ms Lauren Knussen
[redacted]

DOC17/207474
SERAP 2016636

Dear Ms Knussen

I refer to your application to conduct a research project in NSW government schools entitled *Novice Teachers' Approaches to Designing Technology-Integrated Learning*. I am pleased to inform you that your application has been approved.

You may contact principals of the nominated schools to seek their participation. **You should include a copy of this letter with the documents you send to principals.**

This approval will remain valid until 03-Mar-2018.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

Researcher name	WWCC	WWCC expires
Lauren Knussen	WWC0279427V	21-Feb-2019

I draw your attention to the following requirements for all researchers in NSW government schools:

- The privacy of participants is to be protected as per the NSW Privacy and Personal Information Protection Act 1998.
- School principals have the right to withdraw the school from the study at any time. The approval of the principal for the specific method of gathering information must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.
- Any proposal to publish the outcomes of the study should be discussed with the research approvals officer before publication proceeds.
- All conditions attached to the approval must be complied with.

When your study is completed please email your report to: serap@det.nsw.edu.au
You may also be asked to present on the findings of your research.

I wish you every success with your research

Yours sincerely

Production Note:
Signature removed prior to publication.

Dr Robert Stevens
Manager, Research
3 March 2017

School Policy and Information Management
NSW Department of Education
Level 1, 1 Oxford Street, Darlinghurst NSW 2010 – Locked Bag 53, Darlinghurst NSW 1300
Telephone: 02 9244 5060 – Email: serap@det.nsw.edu.au

Appendix C: Catholic Education Office Ethics Approval

Monday, 13 February 2017 9:22:50 am Australian Eastern Daylight Time

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Subject: RE: Ethics approval submission for potential follow on to exisitng approved study: Designing effective learning experiences: investigating novice and expert teachers' design processes

Date: Thursday, 9 February 2017 8:11:58 pm Australian Eastern Daylight Time

From: Anne Dal Santo

To: Lauren Knussen

CC: Mark Raue

Dear Lauren
Thank you for your email asking for clarification, I have spoken with Mark Raue, Head of the Ethics Committee. He has given you approval to continue with your research.
We look forward to your update on completion.
Should you require any further assistance please don't hesitate to contact me.

Regards
Anne Dal Santo
Strategic Planning and Policy
Office of the Director
Catholic Education Office - DOW

Appendix D: Email to Principals

Dear <Principal’s name>,

As a PhD candidate at the University of Technology Sydney, I am conducting a study into graduate and proficient primary teachers (with up to five years’ professional experience) and how they approach designing technology-integrated learning for their students. I am particularly interested in identifying what influences their design and the process they go through when designing. Participants will have the opportunity to reflect on their current design practices while developing a unit of work for a NSW syllabus for the Australian Curriculum. This unit of work will be authentic to them and their students, as they will later teach it in their classes. Participants will further benefit from reflecting on how their design strategies impacted their teaching practice.

I am currently in the process of identifying potential participants for this study and I looking for your help in identifying early career teacher(s) who might be interested participating.

The teachers will be invited to participate in a full day planning session at their school, where they will be asked to plan a unit of work for Stage 3 to fit with the NSW syllabuses for English, Mathematics, Science and Technology, History or Geography. A key criterion is that technology/ICT will be integrated throughout the unit. I will ask participants to design a unit which they will then teach in their class and reflect on throughout the process.

The school will be reimbursed for the cost of a relief teacher to cover the participant teacher’s class for the planning day. As this study is on early career teachers, I have also identified aspects of the Australian Proficient Teacher Standards which are relevant to the study and for which teachers may record evidence to support their accreditation or professional learning (2.6, 3.4, 3.6, 4.5 and 7.4[16]).

I will contact you shortly to discuss your school’s potential participation. In the meantime, if you have any questions, please feel free to contact me at [redacted]@student.uts.edu.au, or on my mobile: [redacted].

I look forward to discussing the project with you and hopefully to working with you and your staff.

Regards,

Lauren Knussen
PhD Candidate
University of Technology Sydney

[16] AITSL: http://www.aitsl.edu.au/australian-professional-standards-for-teachers/standards/list

Appendix E: Participant Information and Consent Form

PARTICIPANT INFORMATION SHEET
NOVICE TEACHERS' APPROACHES TO DESIGNING TECHNOLOGY-INTEGRATED LEARNING
UTS HREC APPROVAL NUMBER ETH16-0932

WHO IS DOING THE RESEARCH?

My name is Lauren Knussen and I am a PhD student at UTS. My supervisor is Lori Lockyer (lori.lockyer@uts.edu.au).

WHAT IS THIS RESEARCH ABOUT?

This research is to understand how novice primary teachers engage in the design of technology-integrated learning experiences for their students. It is anticipated that the study will add to our knowledge of novice teacher practices with technology integration and in turn, will form the basis of further research into how we can better support novice teachers to successfully integrate technology into their teaching.

IF I SAY YES, WHAT WILL IT INVOLVE?

I will invite you to participate in a planning task within your school environment. You will be asked to plan a unit of work comprising learning activities and assessment which fit the Australian Curriculum for English, Mathematics, Science, History or Geography for upper primary (Stage 3 in NSW). You will be asked to implement your unit of work with your class.

- I will ask you to participate in a planning/design day at your school, which will consist of:
  - A pre-design 30 minute interview prior to you undertaking the design task, which will be recorded and transcribed.
  - An initial design activity where you begin to plan the above unit of work. This process will be observed and video-recorded for analysis. Questions may be asked during the activity to understand your approach. The length of this activity will be decided by you, the participant, so that you are able to finish at a time which is logical and appropriate for you.
  - A 30 minute end-of-day interview to discuss your approach to the task and the product created.
- I will ask you to keep a planning diary to track development of your program and the details of its implementation. I will ask that you participate in a short, 5 minute telephone interview prior to teaching the unit. This interview will be recorded and may be transcribed.
- I will ask that you let me observe you as you teach one or more lessons within the unit. These lessons will not be recorded. I will ask you to participate in a short, 5 minute reflection interview after the lesson, if appropriate. This interview will be recorded.
- I will ask you to participate in a final 30 minute interview to reflect on the planning and implementation of the unit. This will be recorded and transcribed.
- I will ask to collect school documentation relating to teaching and learning which may influence your decision-making when designing the unit of work.

ARE THERE ANY RISKS/INCONVENIENCE?

There are minimal inconveniences because the study involves investigating work that teachers engage in as part of their professional responsibilities.

WHY HAVE I BEEN ASKED?

You have been approached because you are a stage three teacher, in the first five years of a teaching career, and as such identify as a novice primary teacher for the purposes of this study.

DO I HAVE TO SAY YES?

Participation in this research is voluntary.

WHAT WILL HAPPEN IF I SAY NO?

You are free to withdraw from participating in this research at any time without consequences. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?

You can change your mind at any time. However, changing your mind after data collection may affect analysis and research outcomes. Please advise as soon as possible of any intension to withdraw. I will thank you for your time so far.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact us at: [redacted]@student.uts.edu.au and lori.lockyer@uts.edu.au.

NOTE:

This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix F: Pre-design Interview

Novice Teacher Approaches to Designing Technology-Integrated Learning
Pre-design Interview Schedule

The focus of the interview today is on how you plan units of work, that is, the process you follow and what things you consider. Would you mind if I recorded the interview so that I can concentrate on our conversation rather than taking notes? *(If yes, start the recording)*.

Let's start off by talking a bit about your teaching experience.

1. How long have you been teaching?

2. Where did you complete your training as a teacher?
    a. Was it an undergraduate or graduate-entry program?
    b. Can you tell me a bit about your university experience?
        i. Probe for any big differences between university and current teaching situation regarding the focus on technology integration?

3. Is this your first school?
    a. If no, at which other schools have you taught?
    b. In what capacity did you teach at those schools – casual, temporary or permanent?

4. What years/stages have you taught?
    a. Have you taught a particular stage more than others?
    b. What stage have you most recently taught?
    c. Tell me a bit about your thoughts and experiences using technology for teaching.

5. Tell me about your experience teaching Stage 3.
    a. And, can you tell me about your experience with the NSW Syllabus for the Australian Curriculum?

6. Do you have any specific areas you work in such as special needs, gifted and talented, reading recovery, ICT coordinator etc.
    a. What are they?
    b. How did you get into that?

7. Have you ever held a non-teaching role in a school (e.g. administration, teachers' aide)? *[Probe for what the role was, how long it was for and what it involved, what were the responsibilities]*

8. Let's talk about your current teaching. Can you tell me a little bit about your current school?
    a. What class/stage are you teaching at the moment?
    b. Do you have a teacher mentor?
        i. If yes, who is that and how do they support you?

(*Probe: any support for technology integration?)*

c. Are there any other members of staff who support you in any way?
d. Do you teach on your own or with someone else?
    i. Are there specialist teacher who teach or support particular KLAs or other areas?
e. Are you involved in planning programs or units of work or are they prepared by someone else?
    i. If they prepare… how do you usually plan programs or units of work for you class?
        1. Do you do it by yourself? Is anyone else involved?
    ii. Do you have a choice on how you go about planning your units of work i.e. selecting assessment activities, in class activities, content and resources to include, etc.?
        [Probe:
        - Ask for more detail to get a sense of the 'division of labour' and how the staff community functions in the school
        - Ask for more detail about any specific influences mentioned. (Eg., curriculum documentation)

Now I'd like to find out what technology you have used and the kind of support you receive for using technology

e. What kinds of technology do you have access to for your teaching? Does the school have any policies or strategies about using technology for learning and teaching?

f. As a teacher, what formal support is available in the school for designing technology-integrated learning?
   (*Probe: level and type of support available for technology integration? I.e. is it systematic, ad hoc etc.?*
   Does the school have a system for sharing technology resources
   (probe: access to support staff, professional learning, class release time etc.)

g. When you're planning lessons for the unit, do you do that by yourself or with other teachers?
   (Probe:
   What do you consider in terms of teaching with technology when you are planning a unit? Is this discussed with other teachers?)

h. What role does the school executive or your supervisor and/or your mentor (if they have one) play in the planning of your units?

9. I'd like to talk to you about the last time you planned a unit of work at the school we've just been talking about. Do you have one in mind
    a. What was the unit of work?
    b. Did you plan it yourself or did you work with others?
    c. What is your starting point?

d. What did you do after that? *(Probe for the steps followed on at a time)*.
    i. Prompt for what influences the decisions made for the unit.
    ii. Prompt for – where ideas come from about how to teach the unit? [*e.g. something you've taught before, from a colleague, from a book or article, from a course)*
e. At what point do you start to consider if or how technology will be used in the unit?
    i. Why at that point (and not before/later)
    ii. What influences your decisions about using technology? E.g type of activity: assessment task, delivery of content etc., KLA?)
    iii. Where do you get your ideas for using technology?
f. Would you say this is typical of what you usually do when you're planning a unit? *(Probe for similarities and differences)*
g. Once you've planned a unit,
    i. What do you do before you teach it? (i.e. How do you prepare to teach it?)
    ii. Do you find yourself changing it while you're teaching it?
        1. What kind of changes do you make? Can you give me examples? What prompts you to make those changes?
h. After you've taught it do you think about changes you'd make in the future?
    i. How do you keep track of those possible changes?
    ii. Do you reflect on the technology you have used?

I'd like to ask you now about your personal beliefs about the use of technology in teaching

10. What does technology integration mean to you? *(Probe for examples of use)*

11. What are your personal thoughts or beliefs about integrating technology into primary level learning and teaching?
    (Probe for why these beliefs are held – do they come from personal experience, or from other influences?
12. How confident do you feel in integrating technology into your teaching?
13. Is there anything we haven't talked about that you think is relevant to how you go about planning units of work?

Okay, now it is time for you to plan a unit of work today

14. Can you tell me what you have in mind for the unit you're going to work on today? *[pause and wait for response and probe to get them to describe how they see the 'design problem' they're about to work on, and then go on to the further prompts]*
    a. What syllabus will you be working from?
    b. Why have you chosen to focus on this?
    c. What do you believe is important to consider when teaching this KLA?
    d. Tell me about what resources you have brought with you today
    e. Overall, how much thinking have you given the unit of work before coming here today?

f. Is there anything in particular you want to get out of this unit for yourself as a teacher? *[Prompt for new skills, knowledge, resources, practice or experience in something, trying a new approach/task.)*

Close

Now it's over to you. The next step is to move into planning the unit of work for a Stage 3 class based on the Australian Curriculum.

I'm going to turn the video camera on. It's going to generally record what you are doing and I'm going to take some notes about the process. Just go about your planning as if the video was not on. We are going to take a break around 11:15 but you can take a break anytime. And, please feel free to let me know what you are doing or ask any questions along the way.

Appendix G: Design Observation Protocol

Novice Teacher Approaches to Designing Technology-Integrated Learning

Design Session Observation Schedule

Name of the participant: **Code of participant:** **Date of observation:**
Focus of observation and think-aloud prompts: • How is the participant approaching the design of the units? What are they doing? Why are they doing this? • What activities/process does the participant engage in as they design? Pay particular attention to activity around technology integration • What planning/drafting/note-taking is the participant observed doing? • What tools and resources are they using? • What are they thinking about, what are they considering? • What issues does the participant consider during their design work? • What are they considering around technology integration? I.e. Activity theory influences **Think aloud instructions**: • Record what you can see the participant doing. Complete this form on your laptop (bring your power pack). • After they have arranged the space they are working in, ask them what they are using and why and how they are going to get started. Explain that you're going to interrupt them every now and then to ask them to comment on what they're doing. • Interrupt them particularly when you notice they have changed their focus or what they are doing. Ask them to explain what they are doing and why. Don't be afraid to interrupt them, your aims is to keep it conversational, so take your cues from them. • Encourage them to take breaks when they feel they need them. • When saving, use file name convention: ParticipantCode_Obs_date eg T01_Obs_22Jul2016

Time	Video time-stamp	Description – Participant Acton (use verbs)	Researcher notes	Video Transcription (use this after the observation to come back and record anything you'd like to transcribe in detail)

Appendix H: End of Day Interview

Novice Teacher Approaches to Designing Technology-Integrated Learning

End-of-day Interview

Introduction

The focus of this interview is how you approached the plan for the unit of work you worked on today. Would you mind if I recorded the interview? (If yes, start the recording)

1. You told me this morning that your focus for the unit would be on ______. Is that what you ended up doing?

2. Before you unpack the unit for me, let's talk about how you approached the planning of the unit today.
   a. Where did you start?
   b. What did you do next?
   [Continue until all the steps in the process have been discussed.]
   [Then, summarise the process that you heard back to the participant.]

3. Please talk me through the unit so far.
   [Adapt/reiterate based on what you already know or what you have talked about in think-aloud protocol]
   a. What are the learning outcomes for the unit?
   b. Give me a brief overview of the sequence of activities.
   [ask about order to get the sequence]
      i. How did you decide on this structure?
   c. Which activities are assessable?
      i. How did you decide on the assessment tasks?
      (probe here for personal beliefs about teaching this KLA)
   d. What resources and tools go with each activity?
   [probe here for resources, strategies, tools, supports]
      i. How did you decide on which resources to include?
      ii. At what stage did you consider technology and its integration into the unit?
   e. Where did you get your ideas from?
   [Prompt if needed, something you've taught before, from a colleague, from a book or article, from a course]
      i. Where did you get your ideas for integrating technology?

   f. Please describe the activities using technology and explain your thinking behind those.
      i. How are they used? *[Prompt for specific examples]*

ii. How did you decide on that particular integration of technology? *(Ask what they thought about when making those decisions.)*
iii. Did your initial idea of the plan change in any way because of the technology you chose to use?

4. How did you use the Australian Curriculum to support your planning?
   a. How did your understanding of current and past NSW syllabi support your planning?
   b. In which ways (if any) did the NSW syllabus influence or provide inspiration for the technology integration through the unit?

5. How do the activities integrate multiple curriculum areas?
   a. If they do, how did you decided to integrate curriculum areas for these particular activities?
   b. If they don't, can you see how the unit could be expanded for this?

6. How did concepts of the Quality Teaching framework influence your plan?

[For my ref but do not prompt for this…]

   a. Intellectual Quality – deep knowledge, deep understanding, problematic knowledge, higher-order thinking, metalanguage, substantive communication.
   b. Quality Learning Environments – explicit quality criteria, engagement, high expectations, social support, students' self-regulation, student direction.
   c. Significance – background knowledge, cultural knowledge, knowledge integration, inclusivity, connectedness, narrative.
   d. Use of ICT

7. I asked you to consider multiliteracies in the design of the unit. What does multiliteracies mean for you?
   a. How did you include this in the unit?
   b. What do you want to achieve with this?
   c. Did you consider technology when thinking about multiliteracies?

8. How far did you get with developing this unit?
   a. *If complete:* What decisions did you have to make to finalise it?
   b. *If incomplete:* What would you have to do to finish it? How long do you think it would take you to finish the unit?

9. Is the process you've gone through today in planning this unit typical of what you normally do?
   [Probe: Ask about how it is similar or different.]

Other comments

Is there anything we haven't covered that you would like to add?

Close

That's the end of our interview. Thank you for your time.

I will have the interviews from today transcribed. After that I will send you the transcript so that you can check over it in case there is anything you want to clarify.

Now I'd like to explain the next steps in this research project.

Next step in research project

I would like you to continue to work on your unit so you can finish it and then teach it.
During this time I would like you to complete an online diary to record your planning and teaching activities for this unit.
The diary will be made available in Google Drive and there are two parts to the diary.

[Have a print out of the 2 parts to show the participant – or show them directly in Google Drive]

<u>Part 1: Planning Diary</u>
I ask that you record regular entries in the first part of the diary describing what you do as you complete your planning and preparation for the unit. You will receive a daily email and/or text message to remind you. If you have done any planning that day please update your diary using the link provided in the email or text message. If you haven't done any planning you can just ignore the reminder.

When you have finished the planning stage and are about to teach the unit, please contact me to arrange a quick catch-up over the phone. At this point you will move on to Part 2 of the diary.

<u>Part 2: Teaching diary</u>
In this second part of your diary we ask you to record entries each time you teach your unit. Again, we'll send you regular reminders by email and/or text.

After you finish teaching the unit, there is a space for you to record your overall reflections. When you have completed this please contact me to arrange a final interview with you.

So we can organise the online diary and reminders, and have some indication of when you will contact us, could you please let me know the following information:

Email address for Google Drive access: (either gmail account or school email address)	
Preference for daily reminders – SMS text/email or both?	

Anticipated date when unit of work planning will be finished	
Anticipated date to start teaching unit of work	
Anticipated duration of unit of work (in weeks and how many lessons per week)	

Part 3: Teaching observation

I would also like to observe some of the classes you teach in this unit where technology is strongly integrated. When you are ready to teach the unit, I will be contact you to find out a time to visit your classroom which is acceptable to you and your students.

Appendix I: Planning Diary

Novice Teacher Approaches to Designing Technology-Integrated Learning
Unit of Work Diary

Part 1: Planning Diary - Finishing your unit of work

Use this part of the diary to keep track of what you do to prepare your unit of work for teaching. Please complete it electronically. Fill out a row for each time you work on your unit of work. Some rows have been provided. If you need more please insert them.

Date	What part of the unit did you work on? (Please be as specific as you can)	What did you do to the unit of work and why?	What resources did you draw on to support your work on this unit? (eg. syllabus or resource documents, web sites, digital resources, colleagues etc.)	How much time did you spend?

When you have finished your plan and are about to teach the unit, please:

1. Contact me to arrange a quick phone interview;

2. Send me any planning documents you've completed

Appendix J: Design Progress Interview

Design Progress Telephone Interview

Introduction

The focus of this interview is for us to discuss the work you have done on the unit of work since we last spoke. Would you mind if I recorded us? (If yes, start the recording).

1. According to your planning diary, you have spent about *X hours* working the plan for your unit of work. If this pretty accurate or do you think there's work you did but didn't record in the diary?
   [Refer to the diary prior to the interview and add up the time and confirm this with the participant.]

2. Where have you worked on the unit of work? (eg. at school, at home)
   a. How do you set yourself up to work there?
   [Prompt for whether own office, kitchen table]
   b. Why did you work there?

3. Have you made any major additions or changes to the unit of work since our last interview?
   a. *If yes:* Can you tell me about what you did?
   Did you draw on any particular resources to help you? (eg. documents, colleagues)
   [Probe for specific examples and reasons. Particularly probe for whether they worked with someone else or consulted with them and how.]

   b. *If not*: And why was that?
   [Prompt if needed for whether they were happy with original design, likes to leave some elements to improvise or do at the last minute, didn't have time, etc.]
   c. Were there any changes made to the unit around technology integration or resulting from technology integration
   d. Have you changed the way you originally thought about this unit?

4. What do you need to do to get ready to teach the unit?
   [Prompt for collecting/creating/organising resources, preparing support documents, worksheets, booking equipment etc.]
   a. Is your unit plan helping you with this?
   [Prompt: eg. have you documented what you need to prepare in your unit of work, made a to-do list?]

   [Remind them to add changes to the teaching diary]

Other comments

Is there anything we haven't covered that you'd like to add?

Close
That's the end of our interview. Thank you for your time.

For the next stage of the project, I would like to come in and observe one of the lessons you plan to teach where technology features quite significantly. Would this be ok? Looking at your unit of work, I think lesson <*number*> might be a good one to observe, what do you think? So according you your schedule, what would the teaching date for that lesson be?

Lesson Observation Date	
Approximate Lesson time	

I will be in contact with you closer to the time, to make sure the schedule details are still the same. Do you prefer that I contact you by email or by phone?

Participant email address	
Participant phone number	

In the meantime, as you implement/teach the unit of work could you please record after each lesson how it went. Please use Part 2 of the Diary template I have provided to you….

We will get this interview transcribed. After that we will send you the transcript so that you can check over it in case there is anything you want to clarify.

Appendix K: Teaching Diary

Novice Teacher Approaches to Designing Technology-Integrated Learning

Implementation Diary - Teaching your unit

As you teach your unit of work, please make a note of each lesson by recording in this part of the diary what happened when you taught your unit.

Date	What did you teach from your unit?	What happened? (Did the lesson go to plan? Explain if you made changes as you taught the lesson?)	Were you satisfied with how you taught the lesson? (Please give your reasons)	Is there anything you would change if you were to teach the lesson again? (Please provide a brief explanation)

After you've finished teaching your unit, please complete the final section to capture your overall reflection.

Part 3: Reflecting on your unit

Use this part of the diary to record your reflections on teaching your unit.

Date:

1. What worked well?
2. What could be improved?
3. What changes, if any, would you make for teaching this unit again?
4. What are your reflections on the technology integration?

Appendix L: Pre-Lesson Observation Interview

Novice Teachers Approaches to Designing Technology-Integrated Learning

Pre-lesson Interview Schedule

10 minutes

Introduction

In this interview we'll discuss the lesson you are going to teach and what preparations you have made.

Would you mind if I recorded the interview so that I can concentrate on our conversation rather than taking notes? *(If yes, start the recording)*.

1. Please talk me through what you plan to do in the lesson.
   [Prompt with the following as needed.]
   a. How are you planning to use technology in the lesson? *(how will these be used? What specific preparation did you need to do for these activities?)*
   b. Which resources are you planning to use?
   c. Are you anticipating any challenges with any of the tasks/activities? *(If yes, what are they? How do you anticipate managing these?)*

Other comments

Do you have anything else you'd like to add that we haven't already talked about?

Close

That's the end of our interview. Thank you for your time.

Our next step is to get this interview transcribed. After that we'll send you the transcript so that you can check over it in case there is anything you want to clarify.

Appendix M: Lesson Observation Protocol

Novice Teacher Approaches to Designing Technology-Integrated Learning

In-school Teaching Session Observation Schedule

Name of the participant: **Code of participant:** **Date of observation:**
Focus of observation: • How is the participant approaching the teaching of the lesson? What are they doing? Why are they doing this? • What activities/process does the participant engage in as they teach? • What note-taking is the participant observed doing? • What tools and resources are they using? • How does the participant engage with the technology in the room throughout the lesson? • How does the participant approach the technology-based activities? • Are there any issues with using the technology? If so, what are the issues and how does the participant address/resolve the issues?

Time	Description – Participant Acton (use verbs)	Researcher notes

Appendix N: Post-Lesson Observation Interview

Novice Teacher Approaches to Designing Technology-Integrated Learning
Post-lesson Reflection Interview Schedule for Observed Lessons
10 minutes

Introduction

In this interview we'll discuss what happened when you taught the lesson and how you might revise it for future implementation. We will then go on to talk about what happened over the course of teaching the unit and how you might revise it for future implementation.

Would you mind if I recorded the interview so that I can concentrate on our conversation rather than taking notes? *(If yes, start the recording)*.

2. Please talk me through what happened when you taught the lesson.
   [Prompt with the following as needed.]
   a. Did it go as you planned?
      [Ask about for them and for the students – probe for specific examples.]
   b. Did you need to adjust the timing? *(If yes, why and how?)*
   c. Were there any unexpected interruptions? *(If yes, what were they? ICT related?)*
   d. Were there any (other) challenges?
   e. Did you make any changes to the lesson while you were teaching it? *(Ask about what those were and why they were needed.)*

3. Overall, how satisfied were you with the way the lesson went? *[Prompt for reasons.]*

4. How did the technology-based activities go? *(Prompt for any disruptions or changes and their causes)*

5. Can you reflect for a moment on the students' learning in this lesson? What did you observe? (*Prompt for any learning outcomes or issues relating to technology)*

6. Is there anything about the lesson you'd change if you were going to teach it again?
   a. *If yes:* What modifications would you make?
      How have or will you document those modifications

Other comments

Do you have anything else you'd like to add that we haven't already talked about?

Appendix O: Reflection Interview

Novice Teacher Approaches to Designing Technology-Integrated Learning
Post-implementation Reflection Interview Schedule
25 minutes

Introduction

In this interview we'll discuss what happened when you taught your unit of work and how you might revise it for future implementation.

Would you mind if I recorded the interview so that I can concentrate on our conversation rather than taking notes? *(If yes, start the recording)*.

7. Please talk me through what happened when you taught the unit of work.
   [Prompt with the following as needed.]
   a. When did you start teaching the unit?
   b. How long did it take? How many lessons did it take?
   c. Did you finish teaching the unit? [*Prompt for those that say no - what are the plans for finishing the teaching of this unit.]*
   d. Did you teach all of the unit by yourself or were other teachers involved? *[If others were involved find out how, that is, did they teach as a team in 1 class or were there multiple teachers across multiple classes? Did teachers make individual decisions on how to teach each lesson such as did they tailor the unit for their class? Did they talk about it as a group during teaching? Did they plan resources together? Etc.]*
   e. Did the unit of work go as you planned? *[Ask about for them and for the students – probe for specific examples.]*
   f. Can you think about the plans you had for using technology and can you elaborate more on how that went?
   g. Did you make any changes to the unit of work while you were teaching it? *(Ask about what those were eg., activities, resources, assessment and timing and why they were needed and how these changes were documented.)*
   h. Were there any unexpected interruptions? *(If yes, what were they?)*
   i. Were there any (other) challenges?

8. I'd like to ask you now about your students.
   a) What are your reflections on their learning throughout this unit? *(Prompt – assessments? Understanding? HOTS? Creativity? Etc.)*
   b) How did you document students' learning throughout the unit? *(Is it possible to have a copy of any notes or de-identified assessment results?)*
   c) To what extent do you think the technology integration supported and fostered your students' learning in this unit?

9. Overall, how satisfied were you with the way the unit went? *[Prompt - in terms of you teaching it and in terms of your students learning from it and in terms of the ICT used: did it enhance student learning?]*

10. Is there anything about the unit you'd change if you were going to teach it again?
    a. *If yes:* What modifications would you make? Would you make any changes to your choice of technology?
    How have or will you document those modifications?
    b. *If no, prompt for reasons why*

11. Thinking back over your experience of planning and teaching this unit is there anything you would say you've learned that informs your practice at a teacher?
    a. What about as a teacher integrating technology?
    [Prompt if needed: Lesson learned that go beyond this particular unit? A new skill, or a new way to teach, some insights about planning? Anything about using technology? Have a look at what they said about having a personal goal in the first interview.]

12. Is the way you've described working with this unit what usually happens when you plan and teach a unit? *(Ask about similarities and differences.)*

13. How have you documented this unit of work *(ie. Word document, included it in Program Builder, etc.)*
    a. Have you shared it with anyone else?
    b. Will you save it on the school server?
    c. Is there any documentation in addition to the unit of work that you will include? *(Eg., assessment rubrics, activity sheets/ instructions, etc.)*

Other comments
Do you have anything else you'd like to add that we haven't already talked about?

Close
That's the end of our interview and the last interview for our project. Thank you for your time.

Before we finished up completely could I please collect the final version of the unit plan and any other resources that go with it.

And could I also please collect your teaching diary for the unit?

Our next step is to get this interview transcribed. After that I'll send you the transcript so that you can check over it in case there is anything you want to clarify.

Thank you very much for your participation in this project. I will keep you updated about the project via email.

Appendix P: Coding Analysis Framework

Code	Definition	Notes (e.g. theory link, literature link, data source)	Example (based on N01 & N02)
1.0 Current design context		This section focuses on identifying the key features of the context within which the ECT designs TIL programs.	
1.1 School context	Descriptions of school context, including students, staff, colleagues, executive/managers, parents, non-teaching staff	AT: Community	
1.2 Teaching context	Whether ECT teaches alone or with colleague, specialist staff, e.g. learning support, specific student characteristics	AT: Community	
1.3 Professional context	Connections outside of the school environment with other professionals and peers. These might include university contacts and former colleagues, for example.	AT: Community	
1.4 Division of labour for design	Who is involved in the development of a program, e.g. colleagues, executive/supervisors, librarian	AT: Division of labour	
1.5 Autonomy & agency in design	Extent to which ECT is free to, and feels empowered to, make own design decisions about TIL	AT: Division of labour	
1.6 Guidelines & policies	Any school, department, or education-related documents or policies which might influence the design practice and process. E.g. syllabus, scope and sequence, 'old' program etc.	AT: Rules	
2.0 Design Tools		**AT: Tools** **This section focuses on the tools the ECT uses to engage in the design of TIL. These tools include psychological resources as well as physical resources.**	
2.1 Beliefs	Any beliefs articulated by the ECT regarding technology-integrated learning.		
2.2 Experiences	Any reference to past experience with TIL		
2.2.1 University experience	University-based experience		

2.2.2 Post-qualification experience	Experience gained while working as a teacher (or in another role) after qualifying as a teacher.		
2.3 Knowledge		TPACK model	
2.2.1 Technological knowledge	This relates to a broad understanding of technologies and their affordances.	TK	
2.2.2 Content knowledge	This relates to a knowledge of concepts related to a specific key learning area	CK	
2.2.3 Pedagogical knowledge	This relates to knowledge of teaching approaches and strategies.	PK	
2.2.4 Technological content knowledge	This relates to a knowledge of the content to be taught and how technologies might be used to support students' learning of the content.	TCK	
2.2.5 Technological pedagogical knowledge	This relates to a knowledge of the pedagogical affordances of technologies to support particular teaching approaches and strategies.	TPK	
2.2.6 Pedagogical content knowledge	This relates to a knowledge of pedagogical approaches and strategies related to the content of specific key learning areas.	PCK	
2.2.7 Technological pedagogical content knowledge	This refers to the knowledge of how technologies may be used to implement pedagogical strategies related to the teaching of content-specific concepts.	TPACK	
2.4 Physical tools	Any reference to non-psychological tools used to aid design process. E.g. program proforma document		
3.0 Technology	References to the integration of technology in the program	This section captures the types of technology used in the design of a TIL unit.	
3.1 Technology for teaching	Technology selected for teaching purposes (including delivery of content)	AT: Tools: TPACK	
3.2 Technology for students' learning	Technology for students to use in the learning process	AT: Tools: TPACK	
4.0 Design influences and decision making	References to the steps taken in the design process	This answers the questions: how do ECTs engage in the design of TIL? What is the process they follow? At which stage do they consider the integration of	

		technology and why?	
4.1 Rationale	ECTs stated reason behind overall design of TIL program		
4.2 Inspiration	Person, or experience, which has inspired the design of the unit e.g. colleague, professional learning		
4.3 Explanation for design decisions	Reasons stated for specific design decisions at any time during design process.		
4.4 Design while teaching	Decisions and changes made to design of unit while teaching.		
5.0 Reflection	Reflection on design process, practice, and the program designed.		

Appendix Q: Design Process Analysis Protocol

Design Process Analysis protocol

The objective of the design process analysis is to identify the design processes of participants in a sequential format, while at the same time identifying key influences at each stage of the process. The reason for this is to gain a better insight into the design thinking throughout the design process.

Documenting the design process consists of the following steps:

1. Create a new design process analysis document for each participant from the template in the process design analysis folder. Save the document with the suffix for the relevant participant (e.g. design process analysis_N03) in the same folder.
2. Open the relevant data sources for the participant (all those with reference to the design process: Observation document, endofday interview, planning progress interview, planning diary, teaching diary, reflection interview).
3. From each data source, identify the sequential design steps taken by the participant in column 1 on the analysis table.
4. For each step in column 1, identify any design tools used by the participant and enter these in column 2.
5. For each step in column 1, identify any thinking articulated by the participant at that stage, and enter into column 3.
6. For each step in column 1, identify any influences articulated by the participant at that stage and enter these in column 4. If these influences can be categorised in terms of components of the activity theory framework, a note on this should be included in this cell on the table.

Amendment as per 25.08.18:

7. Column 5 has been added to allow for the identification of the design work taking place at each stage. These descriptions match design stages identified in design work that happens in other professional fields. The possible stages are:
    a. Conceptualisation of design or problem
    b. Search for inspiration
    c. Documentation of design
    d. Re-conceptualisation of design
    e. Reflection on design

Design Process Analysis Template

Process (incl. data source)	**Tools**	**Thinking**	**Influence** (incl. AT component & clash if present)	**Design process**
1.				
2.				
3.				
4.				
5.				
6.				