Unravelling pedagogy: The role of technology in shaping IT academics' perceptions and application of teaching philosophy

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Abstract

Advancements in technology provide new possibilities for learning and teaching. This brings a need to understand the mystique of pedagogy, the innovative potential of technology, the missed opportunities afforded by new and emerging technologies, and the use of technology to support student-centred learning approaches. This research was an investigation of factors influencing pedagogical practices, including the impact of technology on new digitally based pedagogies. Twenty-five IT academics from a number of Australian, specifically Victorian universities participated in this project. An interpretive qualitative theoretical perspective was utilised, while data was gathered and analysed using Straussian Grounded Theory and semi-structured interviews. The research was conducted over two phases. Phase one comprised four interviews selected via an open sampling approach conducted over a one-year period. Phase two included 21 interviews selected via a theoretical sampling over a five-year period. The theoretical sampling approach adopted targeted technology-using IT academics with reputations as great teachers. Data was coded and analysed in nVivo with four main categories emerging. These categories included pedagogical development, teaching practice, technology adoption and techno-pedagogical practice. Techno-pedagogical practice emerged as the core category and was central to the storyline of the data. Modelling determined complex reciprocal relationships between the categories with a mutual interdependence on the core category. The core category formed the basis of the substantive theory of techno-pedagogical practice. In this theory an IT academic must be working in all three identified categories (teaching practice, pedagogical development, and technology adoption) to be classified as a techno-pedagogue demonstrating techno-pedagogical practice. This theory helps to demystify the many ways technology influences IT academics' pedagogy, and the complex relationship between practice, pedagogy and technology. Exploring these ideas can lead to new ways of thinking, improve the quality of teaching, better utilise new and emerging technologies, nurture contemporary student-centred learning environments, and is required for universities to leverage the best possible outcomes of technology enhanced IT learning and teaching.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

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1 Introduction

Technology provides exciting learning and teaching opportunities for students and teachers. New and emerging technologies present a need to understand and engage with technology to utilise its enormous potential in various educational contexts. This research focuses on Information Technology (IT) academics' perceptions, feelings and approaches to learning and teaching, and technology integration. The investigation includes IT academics' purpose for technology adoption, factors influencing IT academics' pedagogy and the development of IT academics' digitally-based pedagogies, aimed at facilitating better learning and teaching. The purpose of this chapter is to introduce the research, provide rationale outlining the importance and scope of the research, and an overview of outcomes and contributions of the research.

This chapter reports on the importance of this topic for IT academics. Details of the research aim and specific questions under investigation, an outline of the approach, and scope of the research are presented. A brief description of the key contributions, a discussion of key terms, and a brief summary of the thesis structure is provided.

1.1 Problem statement

In this technologically driven knowledge society, it is vital to understand the impact of technology on IT academics' pedagogy formation and growth. The need to understand this paradigm is four-fold. Firstly, there is the didactic promise and quality improvement associated with un-ravelling the notion of pedagogy, and its formation and development in a digital context. Secondly, is the innovative potential of new and emerging technologies and their capacity to improve learning and teaching. Thirdly, are the missed opportunities resulting from failure to integrate technology into teaching practice. Finally, there is the opportunity to develop an understanding of how technology can improve student learning by enabling a student-centred approach—ways of thinking and approaches where students influence and direct the learning process (see King & He, 2006; Lea, Stephenson, & Troy, 2003). Following is a brief discussion of each rationale.

First, developing an understanding of pedagogy and the factors influencing its formation helps to improve teaching practice, particularly when incorporating the use of technology.

> "The fundamental reason why pedagogy deserves careful thought is that pedagogy is the primary force, the engine, that accomplishes the 'leading out' (from Latin *educare*) that lies as the etymological source of educate and that also describes education's most basic aim" (Gregory, 2001, p. 73).

Harris (2005) suggests that most academics (apart from those in education schools) do not have a sufficient background or formal training in pedagogy to facilitate the use of technology in an educational setting, teach online, or, develop technology enhanced resources. Harris (2005) found that by introducing academics to education theory and pedagogy such as Bloom's taxonomy they were better equipped to begin working with the technology. Research by Chee (2002) suggests "As a tool, technology is neutral. It can be used, misused, and even abused. Pedagogical wisdom is needed to guide productive use" (p. 9). These authors all promote the notion that an awareness of pedagogy can better equip academics in a digital educational context and provide supportive evidence for the importance of this research project.

Secondly, in this digital age, there are many opportunities for integrative technological teaching practices such as, blogging, podcasting, vodcasting, simulations, and educational games (Laurillard, 2005). There is also the opportunity to improve learning and teaching using new and emerging technologies (Yadova, Bubnov, & Pluzhnik, 2016) some examples include, artificial intelligence, virtual reality, holographics, robotics (Morley, 2015), social media, and mobile technologies (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014). Technologies have always held great promise for transforming learning and teaching thinking (Halverson & Smith, 2009). Understanding Educational Technology (ET) integration provides information regarding the uses, practices, benefits and constraints of technology, as well as a better understanding of the complex relationship between pedagogy and technology (Perrotta, 2013). This understanding will enable us to better utilise the creative learning and teaching benefits of technology, such as promoting higher order and critical thinking skills (Blanchard, Freiman, & Lirrete-Pitre, 2010), the development of social interaction and collaboration skills (Mavengere & Ruohonen, 2016), increased student engagement, and enhanced learning outcomes (Perrotta, 2013).

Thirdly, despite the innovative potential of technology in education, the opportunities for procurement of teaching excellence, and the increasing appearance of digital natives, there are still many examples of missed technology adoption. Some key examples include, horseless carriage thinking (Horton, 2000), the digital divide (Morley, 2011), and digital laggards (Luftman, 2004; Rogers, 2003). Some other impediments include: high workloads (Tripathi & Mukerji, 2017), limitations on technology ownership, inadequate professional development support, and limited access to a supportive community of practice (Leask, 2001). Examining these missed opportunities helps to mitigate the severity of their impact, improves capability, effectiveness, and enables agility and better planning for learning and teaching.

Horseless-carriage thinking as defined by Horton (2000) is our tendency to use new technologies in exactly the same ways as we used earlier technologies. Horton (2000) illustrates this point referring to early automobiles which were just like horse-drawn carriages. Horton (2000) reports that for the first six or seven years most automobiles came with a buggy whip holder, exemplifying the point that we do not make the most use of new and emerging technologies and hang on to old ideas and ways of doing things. Clark (2002) supports Horton’s (2000) notion of horseless carriage thinking. Clark (2002) believes for each new technology that appears on the scene, we typically start by treating it like older media with which we are familiar. For example, much early web-based training looked a lot like books, mostly using text on screen to communicate content. By using new technologies in old ways, the potential benefits of digitally enhanced learning and teaching is diminished, and the innovative potential is lost. Horton (2000) and Clark’s (2002) observations support a need to understand, and evaluate IT academics’ technology enhanced teaching practices.

Gunkel (2003) defines the *digital divide* as “the gap separating those individuals who have access to new forms of information technology from those who do not” (p. 499). Even though there has been much effort to bridge the digital divide, there are still many examples of its persisting, detrimental effects. Pomerantz (2001) reported problems with unfamiliarity with technology, limited student computer facilities, problems with access, and pressure on students to juggle their studies with work and family obligations as part of the digital divide dilemma. Pomerantz (2001) also provided insight in academic experiences with the digital divide. Many of Pomperantz's (2001) peers had little or no experience using the Internet or computer-based technologies in teaching. Many were only minimally computer literate. A number even felt that the Internet has very little to offer as a research tool, and thus the incentive to experiment with new technology and use it was practically non-existent. Current research has found the digital divide is still prevalent, marginalising technology adoption and use (Centeio, 2017; Hillier, 2018). Understanding academics' experiences with technology will help to identify the issues around its integration into everyday practice.

Luftman (2004) defines a *digital laggard* as a true technology cynic. Laggards wait so long to adopt a technology the cost of adoption outweighs the economic gain. Much research explores the reasons why educators resist the adoption of new technology. Roger's (2003) innovation diffusion theory is a robust model, which suggests that human characteristics affect the rate at which technologies are adopted, and that when these rates are mapped, they follow a normal distribution curve (Luftman, 2004). To capitalise on the promise of new and emerging technologies, and support the spread of digitally enhanced practice, there is a need to identify influences on IT academics' pedagogy. There is also a need to understand what factors, affect an academics' inclination to integrate technology into their practice. This research will provide a current snapshot of teaching practice and reflective insight into likely approaches that support continuous quality advances in digitally enhanced learning and teaching.

Fourthly, this research is important in developing an understanding of technology and how it can be used to foster a student-centred learning approach. Some benefits of student-centred learning include; engaging and motivating students, developing independent thinking skills (Palanissamy & Taqui Syed, 2017), increased autonomy, and facilitating active learning and deep learning (Filatova, 2015). A student-centred approach requires academics to make significant changes to their practice (Pedersen & Liu, 2003). Research on pedagogical change and educational reform suggests a change in learning and teaching approaches is not an easy undertaking (Richardson, 1990), and particularly the introduction of new technologies (Yadova, et al., 2016). Hannafin and Land (2000) suggest the ubiquitous nature of ET can be used to facilitate a student-centred approach. This research will provide an understanding of IT academics' approaches to technology facilitated student-centred learning. By better understanding the benefits and inhibitors, a change to a technology enhanced student-centred learning approach is possible.

Pedagogy, innovative technologies, missed adoption, and student-centred learning have been investigated in the literature, however a holistic approach investigating factors impacting the digital pedagogical development of Australia IT academics, has not previously been undertaken.

1.2 Research aim

There is research available on quality teaching (Biggs, 2003; Ramsden, 2003; Trigwell, Martin, Benjamin, & Prosser, 2000), technology enhanced teaching practices (Salmon, 2005), and discipline specific work (Shulman, 2005a). However, this research extends existing knowledge and focuses on how technology influences IT academics' philosophy and practice of teaching.

This research seeks to uncover the ways in which IT academics think about their teaching and develop their practice. The study will focus on experiences and influences of technology on philosophical development, and the emergence of new digitally-based pedagogies of IT academics within a range of Victorian universities, in an Australian context. The primary aim of this study is to:

> *Investigate ways IT academics develop their teaching practice, with a focus on experiences and influences of technology on philosophical development, and the emergence of new digitally-based pedagogies.*

Specifically, this study will investigate the following research questions with a focus on the influence of technology.

1. How do IT academics develop their pedagogy?
2. For what purpose do IT academics adopt technology?
3. What role does technology play in shaping IT academics pedagogy?

1.3 Research approach

A detailed description of the research approach and the methodology used to address the research questions is presented in Chapters 3 and 4. This research investigated IT academics' pedagogical development, technology adoption and the influence of technology on pedagogy. Twenty-five technology using IT academics with reputations as great teachers were recruited from four Australian, specifically Victorian universities. An interpretive qualitative approach, using Straussian Grounded Theory (GT), conducted over two phases was utilised. An overview of the research phases adopted is presented in Table 4–1. Phase one was largely exploratory, with data collected over a one-year period through a series of semi-structured interviews, using an open sampling technique on a small cohort of four IT academics. Preliminary analysis of phase one data provided key themes and a development of understanding around IT academic pedagogy formation and technology use. Phase two provided rigorous data gathering from an additional 21 interviews conducted over a five-year period, using a GT, theoretical sampling approach. Coding of data is offered in Chapters 5 and 6, and a detailed analysis is provided in Chapter 7. A key outcome of the research was the development of the substantive theory of techno-pedagogical practice. A description of the theory inclusive of definitions, models and a questionnaire tool is provided in Chapter 8.

1.4 The researcher

It is important to acknowledge existing assumptions, experience and knowledge of the researcher in order to ensure a transparent research process (Birks & Mills, 2011). According to Birks and Mills (2011) there are a number of factors the researcher needs to acknowledge, these include; philosophical position, existing knowledge of the topic, expectations, and concerns or fears in relation to the study. A brief outline of each follows.

An interpretive philosophical approach underpins this work. Details of interpretivism are described in Chapter 3.3.

Existing knowledge of the topic extends from an IT teaching career that spans over 20 years, encompassing three years as a sessional Vocational Education and Training (VET) IT teacher, seven years as a full-time VET teacher, and, fourteen years as a full-time Higher Education (HE) IT academic. Early career teaching consisted of multimedia, and new emerging technologies specialisations, which led to an interest in student learning and engagement through adoption of educational technologies.

Fears and concerns at the commencement of this research included correct interpretation and application of the GT methodology, and the ability to generate a theory. This fear turned out to be unfounded, after an extensive review of the literature and attention to detail. A deepening of understanding, and the generation of an emergent theory was a complex process, requiring deep quality data and development of a rigorous analytical approach.

1.5 Contributions

This research contributes to a deepening understanding of pedagogy, ET use, and, the development of digitally-based pedagogies in an IT academic teaching context. Research outputs inform potential practical application of technology in contemporary IT teaching and learning environments. They also provide advice and guidance for developers of teaching and learning policy and professional development programs for IT academics. They facilitate the development of a deeper understanding of the relationship between technology and pedagogy and inform a conceptual model and substantive theory contributing to research and the literature. A brief description of each contribution follows.

- A coding structure (see Table 6–1) and detailed description containing factors impacting pedagogical development, teaching practices, technology adoption and the techno-pedagogical practice of IT academics.

- A list of 18 recommendations (see Appendix E) containing advice and suggestions regarding pedagogical development, teaching practices, technology adoption and the techno-pedagogical practice of IT academics.

- An expanded definition of techno-pedagogy (see Chapter 8.2.1). The seminal definition noted by Newson (1999) discussed in Chapter 2.4.4 has been updated to reflect the deeper understanding of the impact of pedagogy and quality learning and teaching, and represents a shift from instructor driven to student-centred thinking.

- A definition of a techno-pedagogue (see Chapter 8.2.1). No existing definition was able to be located in any peer reviewed journals.

- A model profiling a techno-pedagogue (see Chapter 8.2.2), including an accompanying questionnaire (see Appendix F). This profile can be used as a standalone tool or in conjunction with the model of techno-pedagogical practice.

- The model of-pedagogical practice (see Chapter 8.2.3). The presence of all three identified categories (teaching practice, pedagogical development, and technology adoption) supports the existence of techno-pedagogical practice. This model can be used as a standalone tool or in conjunction with the profile of techno-pedagogue.

- The substantive theory of techno-pedagogical practice (see Chapter 8.2). IT academics who work in all three identified categories (teaching practice, pedagogical development, and technology adoption) are classified as techno-pedagogues and demonstrate techno-pedagogical practice.

- Elements which may contribute to an IT discipline-based signature pedagogy (see Chapter 8.3). This comprises a list of attributes and a brief description which may represent IT academics' teaching, inspired by features of pedagogy, teaching practice, technology adoption and techno-pedagogical practice.

- Analysis and application of Straussian GT to investigate the phenomena of techno-pedagogy in IT academics and the formulation of the substantive theory of techno-pedagogical practice (see Chapters 3 and 4). GT has mainly been applied to Health Sciences research, particularly for exploring new phenomena and the development of new theoretical models. Its use in computing education is limited (Kinnunen & Simon, 2010).

1.6 Terminology

An explanation of terminology used in this thesis is provided in the glossary (see Chapter 11). The first time a term is used and defined it is typically presented in *italic* font for ease of identification. The term IT academic is used throughout this thesis to represent any Computing, Information Systems (IS), IT or Computer Science (CS) academic.

1.7 Outline of thesis

This thesis consists of nine chapters and is structured around two research phases. The following provides an overview of the thesis structure.

Chapter 1 introduces the topic and provides an outline of the research.

Chapter 2 is the main literature review and is presented in three parts. Part one provides a review of pedagogy and a working definition of pedagogy. Part two provides a definition of ET and a discussion of its impact on teaching practice. Part three provides a discussion of new and emerging technologies, digital natives, a review of the technological pedagogical content knowledge model, and a definition of techno-pedagogy. The chapter concludes with a summary of key gaps in the literature.

Chapter 3 provides a description and justification for the research framework adopted including; details of the theoretical perspective, research methodology and the data collection method. A literature review comparing the two main grounded theory approaches (Glaserian and Straussian) is also provided, along with justification for Straussian GT.

Chapter 4 provides a description of the research implementation approach. This details processes and procedures followed for interviewee selection, data collection and analysis, also the two-phase implementation of Straussian GT.

Chapter 5 provides a draft coding structure, descriptions and sample quotes for phase one data.

Chapter 6 provides a finalised coding structure, descriptions and sample quotes for phase two data.

Chapter 7 is the discussion and analysis chapter. It is presented in six parts. These include an introduction, a conclusion, and a section for each of the four data categories identified in Chapter 6. For each category there is an analytical narrative comprising of ideas from existing literature, an explanation detailing the purpose and importance of the category and its components, and an analysis of the findings with supporting quotes.

Chapter 8 provides an overview of the key outcomes of this research, mainly the substantive theory of techno-pedagogical practice. The components of the theory are described in detail including; an expanded definition of techno-pedagogy, a definition of techno-pedagogue, a model profile of a techno-pedagogue, and a model of techno-pedagogical practice. Finally, elements contributing towards an IT discipline signature are provided.

Chapter 9 presents the final thesis conclusion, including a summary dialogue in response to each research question, limitations of the study and possible future work.

1.8 Summary and conclusion

This chapter provided a discussion on the importance of technology and pedagogy, along with details of the research aim and research questions. A brief outline of the approach taken, details and application of contributions of the research, a discussion of key terms and a descriptive outline of the thesis structure are provided.

Rationale for undertaking this research is four-fold. First, the promise of improved quality learning and teaching associated with developing a better understanding of pedagogy. Second, appreciating the innovative potential of technology better leverages the possibilities of its application to learning and teaching. Third, understanding the missed opportunities afforded by new and emerging technologies provides a deeper understanding of technology and stimulates creative adoption and outcomes. Finally, developing an understanding the role technology plays in facilitating student-centred learning environments, enables improved learning and teaching outcomes for students.

This research investigated ways IT academics develop their pedagogy, uncovered purposes for technology adoption, and demystified the relationship between technology and pedagogy. An interpretive qualitative theoretical perspective underpins this work. Data was gathered and analysed using Straussian grounded theory and semi-structured interviews. This approach was time consuming to master and administer, but is a known, valid, reliable and rigorous technique used by qualitative researchers. An understanding of the researcher positions the researcher within the work and acknowledges any preconceptions. Details of the contributions provides an understanding of the outputs of this research and sets up expectations for research outcomes.

The next chapter presents the main literature review in three parts and forms a foundation for this research. In the first section is a discussion providing a working definition of pedagogy. This is followed by an overview of ET and its effect on learning and teaching, an analysis of new and emerging technologies and a definition of techno-pedagogy.

2 Pedagogy Technology Crossroad

2.1 Introduction

Background details supporting the rationale for this research, research aim, contributions and the thesis structure were presented in the previous chapter. The aim of this chapter is to examine current research pertaining to pedagogy and technology enhanced teaching in a higher education context, with specific examples from IT learning and teaching where available.

The structure of this chapter is as follows; a review of the evolution of educators' understanding of pedagogy, and factors influencing it. An overview of ET including its influence on learning and teaching, and its impact on the IT discipline. New technologies and the intersection of technology and pedagogy are explored. Finally, a discussion of gaps in the literature is identified.

2.2 A review of pedagogy

The literature shows that over time educators' views of the concept of pedagogy have become more complex and show a divergence from teacher-directed instruction to student-centred learning. The context for this exploration seeks to develop meaning in a higher education setting, encompassing other educational levels on an informative basis. Understanding the evolution of pedagogy and factors of influence will assist in providing us with pedagogical themes and identify the development journey.

2.2.1 Defining pedagogy

Pedagogy is a complex, misunderstood, ill-defined word, with its meaning evolving over time (Canning, 2007; Wang, 2010). One of the earliest definitions of pedagogy was reported by Charman (1895):

> Pedagogy is the term applied to the principles or ideas underlying the art of education, or it is another term for the science of education (p. 14).

Charman (1895) followed his definition with a lengthy discussion of children and suggested that educators' ideas of children underpinned the theory of education. Historically, pedagogy has been associated with the teaching of children as its background emanates from the Greek word *paid*, meaning child, and *agogus* meaning leader of (Conner et al., 1996). As defined by Smith and Lowrie (2002) pedagogy refers to the teacher's relationships with children. More explicitly, it refers to "appropriate ways of teaching and giving assistance to children and young people" (Loughran, 1999, p. 14). Traditional notions of pedagogy were associated with teacher-centred instruction (Conner, et al., 1996). It is thought to have originated from the Calvinists, who believed that wisdom was evil. They advocated adults monitor, control, and restrict children's learning to keep them innocent (Conner, et al., 1996). In this traditional pedagogic model, teachers held responsibility for making decisions about what, how, and when learning would take place. Teachers directed the learning (Conner, et al., 1996).

According to Beetham and Sharpe (2007) pedagogy:

> Despite its etymological connection with children (*paidia*), contemporary use of the term has lost its exclusive reference to childhood while retaining the original sense of leading or guiding to learn (p. 1).

Academics have needed to alter their thinking and recognise how pedagogical concepts and practices have altered (Schilb, 1999). For centuries the pedagogy of the classical curriculum was a dry and sterile pedagogy of grammar instruction, whereas contemporary thinking is one of ideas, values, critical thinking, moral deliberation, and logical reasoning (Gregory, 2001).

Contemporary authors describe pedagogy as the philosophy and instructional approaches associated with good teaching (Kemmis & Smith, 2006). Some educators use it as a synonym for teaching (Conner, et al., 1996), however pedagogy means more than teaching. As reported by Ladwig and King (2003), pedagogy is about how teaching is done rather than what is taught. Pedagogy is about the teaching and learning activities teachers use and how they assess their students' progress. Smith and Lowrie (2002) also support this concept, and indicate that pedagogy can be an effective way of describing the relationships between teaching, learning, and assessment in classrooms. They believe to talk of pedagogy is to talk of the appropriate ways teachers interact with learners. Beetham and Sharpe (2007) suggest some educators are at odds with the emphasis on teaching, with their preference on the activity of learning, indicating in a learner-centred environment teaching should not be the focus of concern. Contemporary writers suggest that the traditional teacher-centred view of pedagogy is becoming student-centred, and more complex. Mortimore (1999) contends that academics and researchers notion of pedagogy has become more complicated over time. He argues that a deepening in our understanding of cognition and meta-cognition have influenced the conceptualisation of pedagogy. He describes the current model of pedagogy as being a complex one, which includes relationships between the teacher, learning context, content, and learning. Chapuis (2003) suggests pedagogy requires a broad repertoire of strategies and sustained attention to what produces student learning in a specific context. Smith and Lowrie (2002) believe pedagogy embodies “the relational, emotional, moral and personal dimensions of the teaching and learning process” (p. 6), whilst Waters (2005) endorses pedagogy as encompassing both formal and informal knowledge about teaching and learning and is reliant on both the learner and the teacher.

These authors provide evidence of a growing conception of what pedagogy embodies, note the gradual change from teacher-focused to student-centred learning, and the co-relationship between educator and student. There is no widely accepted contemporary definition of *pedagogy*, however, the following definition by Fulks (2004) encapsulates the expanding dimensions of pedagogy.

> Pedagogy is the art and science of how something is taught and how students learn it. Pedagogy includes how the teaching occurs, the approach to teaching and learning, the way the content is delivered and what the students learn as a result of the process (Fulks, 2004).

It is this expanded, broader vision encompassing learning, relationships and student-centredness that will underpin this research.

2.2.2 Why not andragogy?

The term *andragogy* has been used to describe “the process of life-long learning in adults” (Cyr, 2003, p. 23) or more succinctly described as “the art and science of helping adults learn” (Knowles, 1970, p. 38). Knowles reported that andragogy is based on four crucial assumptions about the characteristics of adult learners that are different from those about child learners. Adult learners:

1. Self-concept moves from being a dependent personality toward one of being a self-directing human being.
2. Accumulate a growing reservoir of experience that becomes an increasing resource for learning.
3. Readiness to learn becomes oriented increasingly to the developmental tasks of their social roles.
4. Time perspective changes from one of postponed application of knowledge to immediacy of application (Knowles, 1970, p. 39).

There has been much controversy and discourse around the notion of andragogy. Knowles eventually rescinded his claims that andragogy was a theory of teaching and promoted it as a technique for teaching adults. Knowles conceded three of the four critical assumptions described above, were true of children also (Davenport & Davenport, 1985).

Knowles (1979) concluded:

> So I am not saying that pedagogy is for children and andragogy is for adults, since some pedagogical assumptions are realistic for adults in some situations and some andragogical assumptions are realistic for children in some situations. And I am certainly not saying that pedagogy is bad and andragogy is good; each is appropriate given the relevant assumption (p. 53).

Critics such as Elias (1979) believed “teaching adults is essentially the same as teaching children. Any differences between the two processes are not essential and cannot form the basis for a distinction between andragogy and pedagogy” (p. 252). Many other authors argued against the use of the term andragogy.

Despite the dialogue and the distinguishing characteristics of andragogy, the term pedagogy is frequently used today to denote teaching students of any age. It is this broader view of the term pedagogy, which encompasses andragogy that will be adopted in this research.

2.2.3 Factors influencing pedagogy

Some of the factors that influence educators' pedagogies include folk pedagogies, understanding of teaching, perception of teaching and learning roles, ET, government and institutional policies, peer evaluation, reflective practices, student evaluations, and teaching and learning spaces (see Firmin, Sheard, Carbone, & Hurst, 2012). A brief overview of each follows.

Educators' existing beliefs about teaching influence their approach (Raths, 2001). These beliefs have been termed 'folk pedagogies'. According to Olson and Bruner (1998) *folk pedagogies* are lay theories or intuitive beliefs teachers have about the way students learn.

Educators' knowledge of teaching can influence pedagogical development. University teaching is very complex and Ramsden (2003) proposes that most educators feel they have a better grasp on its complexities than they actually do. There are increasing demands on educators in terms of teaching skills (Biggs, 2007). Traditional approaches no longer work with a much more diverse student population. Biggs believes a fresh look at teaching is necessary.

The educators' perspective of the teaching role is an important factor in determining their teaching approach. Biggs (2007) suggests these are divided by who is in major control – the teacher or the student. These roles have been characterised in educational language as 'Sage on the stage' (teacher-directed) and 'Guide on the Side' (student-directed) (King, 1993). Biggs (2007) suggests that each approach results in very different engagement from the learner. Furthermore, the way educators have been taught is likely to have an impact on the way they teach. According to Shulman (2004) an educators own learning experiences influence their approach to teaching.

ET has played a significant role in shaping many educators' contemporary pedagogies. Newson (1999) coined the term techno-pedagogy describing it as models of teaching and learning associated with instructional technology. The notion of technology-enhanced teaching shows a shift in the teacher's role from controller to coach of learning (Jonassen, Howland, Marra, & Crismond, 2008).

Government and institutional policies have been reported as influencing factors on tertiary IT educators' teaching approaches. Tutty, Sheard and Avram (2008) reported a lack of support and encouragement for IT academics, restricting them with teacher-centred policies which are counter to their preferred student-centred styles.

Peer evaluation and observation can provide educators with useful commentary about the quality of course content, structure, and assessment (Bain, 2004). Carbone and Kaasbooll (1998) found that peer observers could also offer feedback on teaching based organisational and communication issues providing a chance for educators to reflect and compare without the pressure of performance. Ladwig (2005) suggests that peer review can provide analysis and thinking at a pedagogical level and that this process can lead to improved educational outcomes.

Reflective practice influences the different ways educators think about teaching and function as teachers. Burn et al (cited in Marsh, 2008) found that critical self-reflection is an essential tool for teachers to utilise as it helps them undertake informed action and provides a rationale for practice. Ramsden (2003) found that just thinking about teaching is not enough, the challenge is to merge the thinking and doing. Ramsden (2003) found this could have likely implications for student learning outcomes.

Evaluation tools can provide educators with an opportunity to reflect on the quality of their teaching. Kaplan (cited in Bain, 2004) suggests that by asking students the right questions, their answers can aid educators to make judgements about the quality of their teaching. Bain stresses that the student ratings are not by themselves evaluations. Hattie, Brown, Ward, Irving and Keegan (2006) recommend evaluation tools as a way of encouraging teachers to modify their thinking and teaching, improve assessment, and to measure the competence of their educational practice.

Educational learning spaces are complex busy environments in which varying groups of students must be organised. Teachers require a highly developed ability to manage these complex situations, multiple activities and unpredictable events (Doyle cited in Mortimore, 1999).

2.3 Educational technology

An understanding of the types of technology available and utilised by IT educators, and the ways in which technology enhanced IT teaching has evolved, will provide background information to this research.

2.3.1 What is technology?

Technology is a confusing, poorly defined term (Miller & Mosley, 1987). Scharff and Dusek (2003) suggest it is used to represent things, actions, processes, methods and systems. Davidson, et al (2006) enhances the definition adding technology is the conversion process used to transform inputs into outputs. Technology in this sense includes technical methods, skills, processes, techniques, and tools, for example, in such uses as computer technology. *Technology* may be thought of as the practical application of knowledge particularly in a discipline or specific field such as ET (Merriam Webster Inc., 2010).

2.3.2 What is educational technology?

ET, like technology is a difficult concept to define (Miller & Mosley, 1987). ET relies on the broad notion of technology, and is also referred to as instructional technology and learning technology (Lewis, 2002). Ingle (1975) refers to ET as “the communication media born out of the electronic revolution which can be used for educational purposes” (p. 1). While Rowntree (1988) defined ET as a:

> Systematic way of designing, carrying out and evaluating the total process of teaching and learning and communication and employing a combination of human and non-human resources to bring about more comprehensive instruction (p. 22).

Contemporary authors provide a process driven definition of ET:

> A complex, integrated process involving people, procedures, ideas, devices, and organisation, for analysing problems, and devising, implementing, evaluating and managing solutions to those problems, involved in all aspects of human learning (Anderson, 2003).

Anderson's definition is more complex than Ingle's (1975), and Rowntree's (1988), and focuses on process first. Januszewski, Molenda and Harris' (2008) define ET as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (p. 1). This definition provides a basis for this work focussing first, on the needs of the learner.

An understanding of ET allows educators to harness the power of technology and employ it in their teaching.

2.3.3 Types of educational technology

The term ET can refer to technology of all types. In its broadest sense ET could include data projectors and even a blackboard and chalk, however in the context of learning technology, it is usually used to refer specifically to technologies that have arrived with the information revolution, that is those associated with digital computer technology (Lewis, 2002). Some common examples include; photographs, film, video (Solosy, 2003), audio recordings, graphics tablets, interactive whiteboards (Hennessy et al., 2007), data projectors, mobile phones, music devices, scanners, laptops (Nettelbeck, 2000), television (Ingle, 1975), learning management systems (LMS) such as Blackboard (Brothen & Wambach, 2003; Wang, 2008). More recent important ET developments for higher education and beyond include; virtual environments (Yadova, et al., 2016), adaptive learning environments, mobile learning, the Internet of Things, next generation LMS, artificial intelligence and natural user interfaces (Adams-Becker et al., 2017), and virtual education environments such as PIAVEE (Krishnaswamy, Markham, Chhetri, Hurst, & Casey, 2004).

2.3.4 Affordances of technology on teaching practice

The use of technology in education settings has influenced teaching and learning in many ways. There is no doubt technology has had a large impact on teaching and learning (Halverson & Smith, 2009). Changes facilitated by the introduction of the digital age, serve as indicators in advances of the evolutionary process in which technology and pedagogy are moving towards unification.

Some of the way's technology has changed learning and teaching are listed and described, including examples of changing practice and some specific examples from the IT discipline.

- process of learning (Bhatia, 2011);
- active learning (Keyser, 2000);
- applied learning (Harrison, 2006);
- assessment structure, style and delivery (Deeley, 2017; Deneen, Brown, & Carless, 2017);
- augmented learning (Klopfer, 2008);
- communities of practise membership (Adams-Becker, et al., 2017; Wenger, McDermott, & Snyder, 2002; Wenger & Snyder, 2000)
- computers as mind or cognitive tools (Jonassen, 2000; Meyer, 2003; Wegerif & Dawes, 2004);
- constructivism (Pelech & Pieper, 2010);
- course materials availability and format (Centre for Educational Research and Innovation, 2005);
- gamification (Bennedsen & Caspersen, 2007; Fokkens-Bruinsma & Canrinus, 2014);
- guide on the side (Weiger, 1999);
- immersive learning (Zender, Dressler, Lucke, & Tavangarian, 2009);
- learning styles are accommodated (Waterhouse, 2005);
- lecture delivery format (Waterhouse, 2005);
- life-long learning (De La Harpe & Radloff, 2000; Kearns, McDonald, Candy, Knights, & Papadopoulos, 1999; Leask, 2001)

- problem-based learning (Keane & Keane, 2005; Watson, 2002);
- student-centred learning (Grady, 2004; Waterhouse, 2005); and
- ubiquitous learning (Li, Zheng, Ogata, & Yano, 2003; Yang, 2006).

2.3.4.1 Process of learning

Learning and teaching today is far more widespread than it once was (Bhatia, 2011). Technology has empowered teachers and students alike. Academics need to clearly articulate required learning outcomes and tasks since the information resources available to students are no longer limited to printed textbooks. The Internet is a source of instant (Tavani, 2016), global information for many students and teachers (Cross, 2004).

2.3.4.2 Active learning

Active learning is any teaching approach which gets students actively involved and reflecting on what they are doing (Keyser, 2000). It is also known as learning by doing (Gentry, 1990). Students minds are actively engaged (Barkley, 2010). Active learning is flexible and helps students to question, relate new ideas to old, and retain information, providing a deep lasting learning essential for student engagement (Barkley, 2010). Technology enhances active learning approaches, for example the use of quizzes. Quizzes are a common tool used engage students and gauge understanding (Keyser, 2000). Active learning has been used to improve engagement, attendance and performance of CS students (Hakimzadeh, Adaikkalavan, & Batzinger, 2011).

2.3.4.3 Applied learning

The concept of applied learning is often associated with hands on, or practical learning experiences which motivate and empower students (Harrison, 2006). *Applied learning* may be defined as practice of using technology to support key skills and knowledge required for employment, further education and participation in the wider community (Harrison, 2006). A webquest is an example of digital learning resource used to support applied learning. A *webquest* is an inquiry based activity that embeds the use of a variety of mainly digital learning resources (Eady & Lockyer, 2013). Technologies such as computer games and simulations are also used to support applied learning (Fletcher & Tobias, 2011). Gilbert (2010) used applied learning with project students and Downing (2017) with education students who were embedded in organisations applying and extending skills in a work placement situation. Applied learning techniques have been used to improve CS student's debugging skills (Wang & Souder, 2012), to develop team building and collaboration skills (Phillips, Zimmermann, & Bird, 2014), and to improve, communication, problem solving and critical thinking skills on live projects (Becker & Becker, 2011).

2.3.4.4 Assessment structure, style and delivery

Assessment and technology are important in facilitating technology-enabled assessment, such as the use of e-portfolios to develop and assess students' learning (Deneen, et al., 2017). Different types of technology have been found to be beneficial in facilitating effective learning feedback in higher education. Some examples include, Mahara for providing feedback on reflective journals, Echo 360 for recording students' oral presentations and Camtasia for providing audio and video feedback (Deeley, 2017).

2.3.4.5 Augmented learning

Augmented learning "is defined as an on-demand learning technique where the learning environment adapts to the needs and inputs from learners" (Huang & Wen, 2016; Klopfer, 2008). Examples of augmented technology use in education include the creation of augmented reality textbooks. These have been found to have a positive impact on student learning (Wang, 2012). Augmented reality technology has also been used in the education of health care professionals as a way of practicing and maintaining surgical skills in a safe environment (Danciu, Fordan, Vlaicu, & Antone, 2011). Aspects of Moodle have been adapted through the integration of Flash animations to teach core computing concepts, emulating aspects of augmented learning for CS students (Rosling et al., 2010).

2.3.4.6 Communities of practice

Communities of practice maybe defined as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact on a regular basis (Wenger, et al., 2002; Wenger & Snyder, 2000). Technology supports communities of practice in many ways, for example, by capturing and facilitating knowledge sharing (Sethi, 2017), it can provide online support for academics, and encourage collaboration, process ideas and co-creation of new knowledge (Golden, 2016). Singer and Schneider (2011) found that social online communities of practice foster support and cooperation amongst end-user programmers, improving software quality.

2.3.4.7 Computers as mind or cognitive tools

Wegerif and Dawes (2004) state that through working with computers, students will be encouraged to think logically and by doing so will develop internal cognitive tools for their own use to construct later concepts. This is supported by Jonassen (2000), who considers computers to be mind tools, which represent what students know and can engage them in critical thinking about the content they are studying in different and meaningful ways. As reported by Jonassen (2000) computers can function as mind tools in numerous ways. Synchronous communication tools such as live text chat, shared whiteboard space, video and audio streaming, file transfer, application sharing can be used to foster socially shared cognition through conversation and support critical, creative and complex thinking. Asynchronous tools such as electronic mail (e-mail), bulletin board services (BBS), wikis and computer conferencing engage students in reflective, constructive more analytical thinking, which can further enhance meta-cognitive skills and lead to conceptual change. Research by Meyer (2003), found that higher-level thinking occurs in students involved in writing threaded discussions, particularly discussions that require exploratory or integrative analysis and need time for reflection. Learning programming has been associated with developing thinking skills in IT students (Rinard, 2008), while human-computer interaction design has been used to develop computational thinking skills in CS students (Calderon & Crick, 2015).

2.3.4.8 Constructivism

Constructivism views knowledge as being shaped by experiences, and as new experiences are encountered, these are related to previous knowledge and understanding (Pelech & Pieper, 2010). Learners construct their own understanding and knowledge of the world through their lived experiences (Educational Broadcasting Corporation, 2004). Constructing meaning is learning (Kruger, 2011). Constructivist approaches have successfully been applied to improve learning environments for adult online students, by making the learning resources and the learning environment resemble the real world (Huang, 2002). Medical educators have used a combination of constructivist and PBL approaches and found students developed specialist skills levels in shorter time periods (Hendry, Frommer, & Walker, 1999). Constructivist approaches have been used to improve the success rate of struggling computing students in introductory programming courses (Lui, Kwan, Poon, & Cheung, 2004).

2.3.4.9 Course materials availability and format

Research by Blackboard Inc. (2000) found that when course content and activities were provided electronically, students became less frustrated and less worried. They could complete assignments during their most convenient times and obtain materials at any time. Access to materials and other resources was found to be important for students wishing to revise a particular component of a class, or for a student with limited understanding of the concepts, and remote access to library materials services (Centre for Educational Research and Innovation [CERI], 2005).

2.3.4.10 Gamification

Gamification is a learning and teaching approach used to motivate students to learn by using video game design and game elements in learning environments (Bennedsen & Caspersen, 2007; Fokkens-Bruinsma & Canrinus, 2014). Gamification has been found to have a positive impact making learning fun fostering intrinsic motivation in students (Kankanhalli, Taher, Cavusoglu, & Kim, 2012). Gamification has been used in higher education eLearning to improve effectiveness of learning and stimulate engagement (McGrath & Bayerlein, 2013). Gamification has been reported to increase motivation and to improve recall of computing concepts in secondary school computer science courses (Papastergiou, 2009). Gamification has been reported to improve both engagement and retention amongst CS students (Harrington, 2016; Pirker, Rinaller-Schiefer, & Gutl, 2014). Alternatively, Callan, Bauer and Landers (2015) suggest that issues resulting from gamification have generally been overlooked by educators. In addition, gamification has even been found to reduce student motivation (Hanus & Fox, 2015).

2.3.4.11 Guide on the side

Technology changes the teacher role from that of a lecturer, talker or disseminator of information to that of a tutor, facilitator or guide for students (Weiger, 1999). '*Guide on the side*' is a phrase used to describe teachers who provide occasional guidance to students, while encouraging them to play a more active and collaborative role in their learning (Palloff & Pratt, 1999). A report of the abandoning of the style of 'chalk and talk' teacher for one of a 'guide on the side' coupled with the integration of IT, found students were able to discover their own meanings, and take responsibility for their learning (Weiger, 1999). Smith (1993) also found that by shifting teacher roles from disseminator of information to democratic negotiator, students were empowered to solve problems when left to do so. Research by Wegner, Holloway, and Garton (1999), found that the introduction of Internet-based instruction changed the responsibilities of the academic, accentuating the roles 'student as worker', and 'teacher as coach'. Wegner et al (1999) found that academics anticipated the needs of students in advance developing contingencies, and became philosophical questioners, resource providers and motivators responding to and accommodating students to develop their own meaning rather than interpreting it for them. CS educators implemented the use of e-books in an introductory programming class moving from a teacher directed class to student led learning. Educators were able to customise learning activities based on analysis of student's use of the e-books, transforming the way the courses were conducted (McFall, Dershem, & Davis, 2006).

2.3.4.12 Immersive learning

Immersive learning is a targeted individual explorative interactive learning experience in a virtual world. The educational material can be real or virtual, for example simulation and role plays (Zender, et al., 2009). Immersive learning has been used in higher education, for example the use of 3D virtual environment to teach business students how to apply theory in a practical setting (Cheng & Wang, 2011). Immersive visual displays have been used to enable engineering students to learn basic fluid dynamics (Mazur, 2004). Virtual worlds have been used to increase student motivation in IS and computer engineering courses (Barata, Gama, Fonseca, & Gonçalves, 2013). Virtual reality modules have been used to teach object-oriented programming (OOP) concepts to CS students, as an effective technique for learning (Stigall & Sharma, 2017).

2.3.4.13 Learning styles

Technology can help improve learning by enhancing digital communication to meet the needs of students' different learning styles (Whittenberger, 2013). Utilising the potential of IT academics can present course materials and other resources in many formats to accommodate different types of learning styles (Blackboard Inc., 2000).

Technology has been found to engage students and support learning when aligned to learning styles (Chen, Toh, & Ismail, 2005), also to aid construction of knowledge (Solvie & Kloek, 2007). IT educators teaching introductory Internet, webpage and network courses designed an online learning environment where students could customise a specific learning paths to suit their individual needs (Krichen, 2005). The literature is conflicted as to the usefulness of learning styles. According to Guzdial (2015) there is no such thing as learning styles. Guzdial (2015) and Neighmond (2011) suggest it is best to teach in a variety of ways, so as not to limit students' learning.

2.3.4.14 Lecture delivery format

Technology use in lectures has been found to engage students and foster collaborative learning experiences (Tshuma, 2012). Waterhouse (2005), suggests teachers' roles are changing from a decrease in time spent preparing and delivering lectures, and an increase in the time spent creating interactive learning activities. Students use their mobile devices, such as laptops, smartphones and tablets in lectures for activities such as taking notes, and also social communication and entertainment. While technology used in conjunction with a support systems (such as Backstage) was found to enable students' motivation, questioning and discussion (Gehlen-Baum, Weinberger, Pohl, & Bry, 2014), changing the landscape of modern lectures.

2.3.4.15 Life-long learning

Lifelong learning is a continual process providing stimulation to empower individuals. to acquire the knowledge, values, skills, and understandings required in life and apply these skills to give them confidence, creativity and enjoyment in all roles, circumstances and environments (Kearns, et al., 1999). Leask (2001) found that telecommunications-centred leaning environments are central to the achievement of lifelong learning. Lifelong learners embrace technological developments and can respond to the needs of a rapidly changing workplace. Digital technologies play an essential function in facilitating every aspect of knowledge production (McKavanagh, Kanes, Beven, Cunningham, & Choy, 2002). De La Harpe and Radloff (2000) found that students need to possess a number of characteristics in order to be lifelong learners. Amongst others these include; self-knowledge, self-confidence, persistence and a positive view of the value of learning. Students also need to be motivated to learning by having a positive attitude, confidence in themselves and be able to manage negative feelings effectively. Research by Pierce and Stacey (2004) reported that the when students with a positive attitude valued the accessibility of Computer Algebra Systems (CAS) as a means for practising and learning mathematics they might be likely to persevere with the use of CAS. Firmin and Miller (2005) found that IT students showed positive perceptions of the usefulness of Computer Mediated Communication (CMC) in the learning environment. As students became more familiar and comfortable in the use of CMC qualitative feedback indicated an increase in their confidence, creativity, enjoyment, perseverance and application of the skills in real life situations.

2.3.4.16 Problem-based learning

Problem based learning (PBL) is a pedagogical approach for adopting substantial, real-world problems and providing resources and support to learners as they cultivate the knowledge and skills necessary to solve the problem (Keane & Keane, 2005). Technology can dramatically improve problem-based learning because of student access to Computer Mediated Communication (CMC), collaboration, file sharing, and other Web based activities used to facilitate teamwork (Waterhouse, 2005). Kellett (2005) reported an example of PBL where a traditionally taught interdisciplinary module on environmental liabilities was transformed into an eLearning format. The transformation included the creation of a project-based simulation, developed around the student(s) occupying and exploring a virtual office space. This framework allowed the learner to investigate problem-based solutions and, in the process, acquire required skills and knowledge. At the University of Delaware, Watson (2002) found that IT was the foundation of success in PBL courses. Students developed their skills as problem solvers using PBL. They were better prepared for the real world where they found themselves in workplaces where IT is embraced as an essential tool. PBL provided an excellent context for the development of problem solving and technology skills that will serve them well in their careers (Draper, Smith, & Sabey, 2004). PBL has been used to enable CS students to learn team work and collaboration skills (Vivan, Falkner, Falkner, & Tarmazdi, 2016). It has also been used to teach Software Engineering to CS students, and was found to have a positive effect, helping increase student enthusiasm and provide experience in dealing with real world scenarios (Fioravanti et al., 2018).

2.3.4.17 Student-centred learning

Student-centred learning shifts the focus of instruction from the teacher to the student (Jones, 2007). In a student–centred environment, students take more responsibility for the learning and become more dynamically engaged in the learning process (Waterhouse, 2005). A student-centred environment is engaging and interesting and allows students to take increased responsibility for their own growth and development (Crumly, Dietz, & D'Angelo, 2014). eLearning can assist this pedagogical approach because the student–centred environment can be fostered. Grady (2004) presents an excellent example of student-centred learning in the context of innovative uses of technology. A group of students studied a business administration course, 100 percent online. The course involved a holistic approach centred on the students planning and conducting a virtual conference. The students organised the entire concept from catering, and marketing to speakers and conference programs online using the eLearning environment to foster learning, teamwork and collaboration. The learner-centred approach facilitates student choices about learning and suggests that design of lessons accommodate human learning processes (Clark, 2002). Through the use of eLearning environments, such as WebCT students can work through online content, reading and activities to fit with their own schedule (Farrington, 1991; Lea, et al., 2003). A student centred approach has been used to improve creativity and student engagement in CS courses (Giabbanelli, 2012).

2.3.4.18 Ubiquitous learning

Ubiquitous learning is an innovative approach that integrates wireless, mobile, and context-awareness technologies (Hwang, Yang, Tsai, & Yang, 2009) providing a pervasive, seamless learning architecture (Yang, 2006) available to anyone anyplace, anytime (Li, et al., 2003). Ubiquitous learning environments are accessed by technologies which are web-based, on devices such as PDA or mobile phones (Li, et al., 2003). Ubiquitous learning techniques have been used as a support mechanism when teaching introductory computer architecture concepts to CS students (Tseng, Hsu, & Hwang, 2009).

2.3.5 Constraints of technology on teaching practice

Some of the way’s technology has constrained learning and teaching are listed and described, including examples of changing practice and some specific examples from the IT discipline.

- Collaborative technologies
- Technology as a tool
- Technology is not neutral
- Replication of practice
- Conservative practice

2.3.5.1 Collaborative technologies

Collaborative technologies are a grouping of online collaboration software that facilitate synchronous communication and co-operation between globally dispersed teams (de Vreede, Antunes, Vassileva, Gerosa, & Wu, 2016). Collaborative technologies can enable students to hide behind their computers (Marjanovic, 1999). In addition, Daniels, Cajander, Clear, & McDermott (2015) found that a group of Engineering students lack the skills to use collaborative technology.

2.3.5.2 Technology as a tool

“Technology is just a tool” this phrase was first coined by Bill Gates. Contemporary teaches use technology as a tool focussing more on the teaching and learning than on the technology (Barnett, 2011). Orlikowski and Iacono (2001) suggest that if technology is taken for granted there is a lack of understanding around its complexity, cultural meanings, social relationships and political interests in local and global environments.

2.3.5.3 Technology is not neutral

Technology is designed by someone for someone (Floyd, Kelkar, Kramarae, Limpangog, & Klein-Franke, 2002). It is argued that technology cannot be neutral because it engenders change (Strate, 2012), is culturally crafted and conveyed (Hlynka, 2003), and can manifest different ways of thinking (Harris, Mishra, & Koehler, 2009;

Maclaren, 2018). “Mathematics technology is said to be not neutral because it leaves out aspects of reality, alters concepts of what constitutes the social world” (Warnick & Stemhagen, 2007, p. 303).

2.3.5.4 Replication of practice

Transitioning from traditional face-to-face to online teaching can challenge the role of teachers (Redmond, 2011). According to Sharrar and Bigatel (2014) a re-design process is required to incorporate multimedia content that is engaging and pedagogically sound when transitioning a course from face-to-face to online. While, Voogt, Fisser, Pareja Roblin, Tondeur and van Braak (2013) recommend active participation in the redesign of lessons, and practice in teaching technology-enhanced lessons. However, in their study, Reeves, Herrington, and Oliver (2004) found that academics simply tend to replicate their existing teaching practices when moving to an online environment. Similarly, Valtonen, Kukkonnen and Wulff (2006) found the most common approach to online course design by secondary school teachers is a teacher centred approach.

2.3.5.5 Conservative practice

According to Maclaren (2018) institutional policies have caused significant constraints limiting technology adoption. Maclaren (2018) reported a bias in approaches and opinions of academics who prefer traditional technologies and practices. Maclaren (2018) recommended a change in institutional culture in order to develop innovative technology-enhanced teaching practices.

2.3.6 Technology influences on discipline-based teaching practice

There has been much research about the use of IT to support teaching and learning in various academic disciplines (for example (Apple Computer Inc, 2002; John, 2005)) some include Mathematics (Pierce & Stacey, 2004; Severinsen, 2004), Science (Felder, 1993; Hennessy, et al., 2007), Arts (Grady, 2004), English (Nettelbeck, 2000; Solosy, 2003), Geography (Hutchinson, 2004).

Shulman (2005a) provides a detailed discussion of the notion of signature or discipline-based pedagogies in the teaching of fields such as law (use of cases) and medicine (hospital rounds). *Signature pedagogies* are the types of teaching that characterise the fundamental ways in which students are educated for their professions (Shulman, 2005b). Shulman suggests that signature pedagogies improve student learning and engagement. Shulman postulates that teachers of different disciplines can learn from the pedagogies of each other. He gives an example of what could be deemed a ‘digital pedagogy’ as used by an astrophysics lecturer, using a wireless clicker device to elicit student responses during lectures.

Despite the numerous examples of technology enhanced teaching and learning, research into IT academic’s reflections on the use of technology to support the IT discipline does not appear prevalent in the literature.

2.4 New technologies, new pedagogies

The intersection of technology and pedagogy is an evolving phenomenon, which requires dedication and enthusiasm from those educators who operate in this constantly changing landscape.

2.4.1 New and emerging technology

The term emerging technologies describes new and potentially powerful technologies, which are just appearing from research and development labs. Emerging technologies is a relative term (Luftman, 2004). By this Luftman (2004) argues that what appears to be emerging to one person, might be viewed as old to another. In an educational context Ruddell and Unran (2004), report that there is an absence of a precise definition. Another term that was often used to denote new technologies was web 2.0. Tim O’Reilly (2005) coined the term, below is his compact definition:

> Web 2.0 is the network as platform, spanning all connected devices; web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of web 1.0 to deliver rich user experiences (O'Reilly, 2005, para. 1).

O'Reilly's (2005) definition includes many dimensions such as software, data, and communication aspects particularly relevant in an educational context. O'Reilly (2005) identifies a number of web 2.0 technologies including wikis, blogs, RSS, social networking tools and more. More recently the term web 3.0 (also semantic or intelligent web) has been used to describe the evolutionary stage of the web that succeeds web 2.0. Web 3.0 is an ambiguous term, with an exact definition difficult to pin down. Handler (2009) defines *web 3.0* as "semantic web technologies integrated into, or powering, large-scale web applications" (p. 111). Handler's (2009) definition focuses on the technology aspect. Markoff (2006) originally coined the term web 3.0. At the time, Markoff (2006) did not provide a definition, but talked about web 3.0 as third generation of Internet-based services, which emphasise machine-facilitated understanding of information in order to provide productive and intuitive user experiences. This is supported by Giustini (2007) who discusses web 3.0 as being more mature, providing better pathways for information creation and retrieval, and greater capacity for cognitive processing of information. The combined views of Handler (2009), Markoff (2006), and Giustini (2007) provide a working definition of web 3.0, and inform the understanding of new and emerging technologies in this research. Web 3.0 is an intuitive user experience of cognitive information creation, processing and retrieval, powered by large-scale semantic web technologies. Examples of web 3.0 technologies include; natural language search, data mining, machine learning, and artificial intelligence technologies (Markoff, 2006). These technologies have the potential for powerful influence in educational settings.

An understanding and appreciation of new and emerging technologies will assist with the paradigm shift in teaching practice and educational philosophy required to integrate emerging technology in a seamless invisible way (Goodbourn, 2006). Some relatively new and emerging technologies in the field of education include those listed below.

- augmented reality (Klopfer, 2008);
- blogs (Clarke, 2004; Farmer & Bartlett-Bragg, 2005; Phipps, 2005);
- digital video (Lakkala, Lallimo, & Hakkarainen, 2005);
- intelligent agents including neural computing and expert systems (Turban, Leidner, McLean, & Wetherbe, 2006);
- Internet of Things (Reddi & Kim, 2016);

- podcasts (Katz, 2009);
- really simple syndication or RSS (Glotzbach, Mordkovich, & Radwan, 2008);
- social networking (Conole & Culver, 2009);
- tweeting (Joly, 2009; Young, 2008);
- virtual reality (Jerald, 2016);
- vodcasts (Lee, Pradhan, & Dalgarno, 2008);
- wearable technology (Kietzmann, Pitt, McCarthy, & Schau, 2018);
- wikis (McKavanagh, et al., 2002); and
- wireless networking (Myles, 2005).

The use of new and emerging technologies in education augurs a time of change to both pedagogical philosophy and teaching practice, and the way forward is not always apparent. The latest Horizon report noted key trends affording technology adoption in higher education including an innovative culture, advances in deeper learning, learning analytics, new learning spaces, and a growth in blended and collaborative learning. At the same time challenges impeding adoption included issues with digital literacy, integration of formal and informal learning, continuing digital divide, knowledge management and the changing role of educators (Adams-Becker, et al., 2017).

General trends in emerging technologies suggest great diversity in availability (Neira, Salinas, & De Benito, 2017). Low costs, ease of implementation, optimisation time, portability, ubiquity and connectivity are all key factors which influence ET uptake (Neira, et al., 2017). Many of these trends are typical of the broader community, with high levels of adoption by business and consumers. Millea (2005) proposes that educators need to develop a culture of continuous technology adoption and an integration of technology with pedagogy. The broader concept of new and emerging technologies, encompassing web 2.0 and 3.0 technologies will be adopted in this research. An understanding and appreciation of these technologies will assist with the paradigm shift in teaching practice and educational philosophy required to integrate emerging technology in a seamless invisible way. As supported by Goodbourn (2006) "... success however will come when we have integrated and embedded eLearning and e-business in such a way that it becomes invisible" (p. 4).

2.4.2 Digital natives

A profile of users of new and emerging technologies is an important aspect assisting educators to understand the complexities of this student-centred technological driven educational environment. Prensky (2001) first used the term *digital native* to refer to anyone too young to recall the arrival of digital technology. Digital natives, also referred to as the n-gen (n for net), d-gen (d for digital), are the native speakers of the digital language of computers, video games, and the Internet (Thrupp, 2005). They are those who have grown up with computers, the Internet, e-mail, instant messaging, text messaging, mobile phones, video games, video cams and mp3 players. Not surprisingly, the natives expect to have access to ICT in the environment they inhabit for much of the time. Years of using technology have taught them to receive information at a fast pace, with interaction, networking, graphics and movement. Digital natives are used to taking in information from multiple sources at once and applying knowledge to multi-faceted tasks.

Conversely, while technology is embedded in their lives, digital native's skills are not similar and there is no support for different learning styles (Bennett, Maton, & Kervin, 2008). This is supported by Daniels (2015) who found gaps in students' technology skills particularly in how they "establish and mediate the use of collaborative technologies" (p. 278). A large study by Bullen and Morgan (2016) found that educators should concentrate on digital learners and not digital natives. They found that all users "regardless of age are on a continuum of technological access, skill and comfort" (p. 65).

It is important for educators to have an understanding of the student learners as part of reflecting on their teaching practice and planning technology use to support student learning.

2.4.3 Contributing student pedagogy

Contributing student pedagogy (CSP) includes activities that require collaboration, sharing and reviewing of other students work, or learning materials purposely created for use by other students (Hamer, Sheard, Purchase, & Luxton-Reilly, 2012). According to Hamer et al (2008) CSP is a

> Pedagogy that encourages students to contribute to the learning of others and to value the contributions of others. CSP in formal education is anticipatory of learning processes found in industry and research, in which the roles and responsibilities of 'teacher' and 'student' are fluid. Preparing students for this shift is one motivation for use of CSP. Further, CSP approaches are linked to constructivist and community theories of learning, and provide opportunities to engage students more deeply in subject material (Hamer, et al., 2008, p. 194).

CSP focusses on the hands-on characteristics of student learning and it emphasises the acknowledgement of value by students to the work of their peers (Cajander, Daniels, & McDermott, 2012). In addition, in CSP students participate in the other students learning (Hamer, et al, 2008).

CSP helps to establish student networks (Falkner & Falkner, 2012), it also helps to value the contributions of other students (Cajander, et al., 2012), it is useful in establishing cross-institutional learning activities (Denny, Cukierman, Luxton-Reilly, & Tempero, 2012), and can be used to promote students' intrinsic motivation (Herman, 2012; Søndergaard & Mulder, 2012). CSP has been used in CSE in a range of activities, for example students' oral presentation have been assessed by peers, a student wiki has been used to replace lecturer-maintained course web pages, and computer programs have been shared between students (Hamer, et al, 2008). One drawback of CSP is that in some environments and applications it requires the lecturer to maintain accurate attendance records (Paterson, Wilson, & Leimich, 2010). Another weakness of CSP is that students can feel uncomfortable having their learning displayed in a public environment (Gunnarsson, Larsson, Månsson, Mårtensson, & Sönnerup, 2017).

2.4.4 TAM Model

Davis (1985) proposed the technology acceptance model (TAM) to explain a user's behavioural intention to adopt technology (King & He, 2006). TAM is based on the theory of reasoned action (TRA), a psychological theory that attempts to understand human behaviour (King & He, 2006). According to the TAM model, a user's attitude towards using a technology is a major factor in determining whether or not the user will adopt the technology (Davis, 1985). “TAM involved two primary predictors—perceived ease of use (EU) and perceived usefulness (U) and the dependent variable behavioural intention (BI), which TRA assumed to be closely linked to actual behaviour” (King & He, 2006, p. 740). See Figure 2-1 below. TAM facilitates the role of perceived ease of use and perceived usefulness in their connection to external characteristics and the likelihood of system success (Legris, Ingham, & Collerette, 2003).

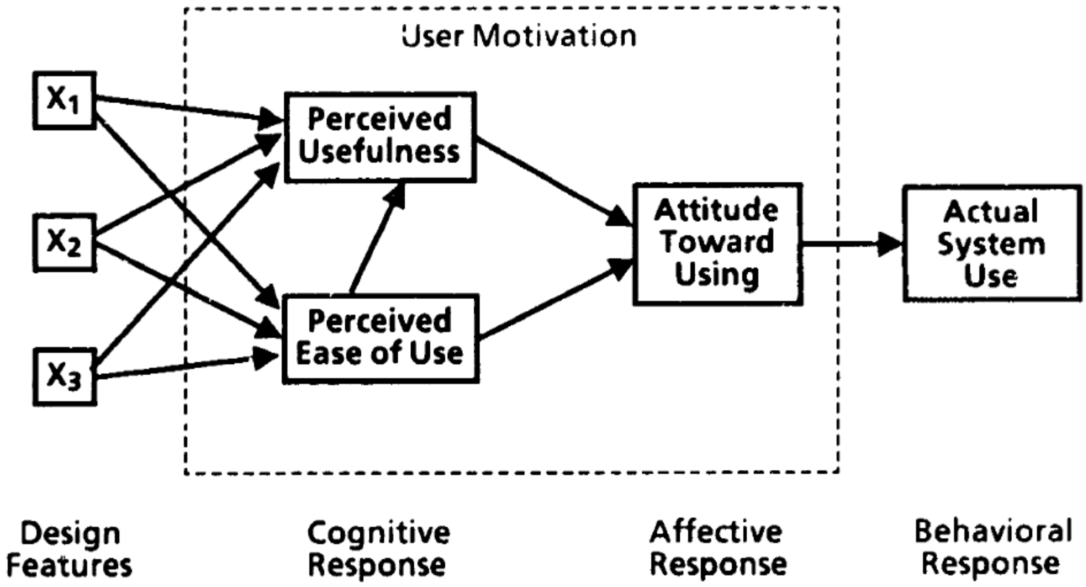


Figure 2-1 Technology Acceptance Model (Davis, 1985, p. 24)

TAM has become one of the most widely used models in IS, mostly due to it understandability and simplicity (Ajibade, 2018). However, TAM results are not consistent or clear (Legris, et al., 2003), there is extensive diversity in the predicted impacts in a range of studies with varied types of users and systems (King & He, 2006). TAM has been reported as only being effective for individual use and not suitable for enterprise or corporate administration (Ajibade, 2018). In addition, researchers report varied impressions regarding the validity of its theoretical assumptions, practical effectiveness, and adequate rigor of TAM (Chuttur, 2009). Attempts have been made to limit the weaknesses of TAM by extending the model (King & He, 2006), however TAM does not consider demographic factors such as age and education as external variables which could influence uptake of technology (Ajibade, 2018). Though this model is interesting and is easily understood, the observations made by researchers regarding the various weaknesses of this model make it of limited use in the field of techno-pedagogy.

2.4.5 TPACK model

The technological pedagogical content knowledge (TPACK) model is based on Shulman's (1987) work. Shulman (1987) suggested teachers have both content knowledge (a knowledge of their subject) and a pedagogical knowledge (knowledge of how to teach it). Shulman referred to the intersection of these as pedagogical content knowledge (PCK). His theory was updated by Koehler and Mishra (2009), who added technological knowledge. This purpose of updated model was to describe the knowledge that primary and secondary school teachers require to teach their discipline successfully and use technology (Koehler & Mishra, 2009). The basic three components of the model comprise content, pedagogy and knowledge. The intersections represent PCK (pedagogical content knowledge), TCK (technological content knowledge), TPK (technological pedagogical knowledge), and TPACK. TPACK can be used by teachers to create and develop integrated knowledge to improve learning outcomes for students (Harris et al., 2010). This is an interesting generic model based on theoretical knowledge that teachers require relation to content, pedagogy and technology.

Studies which have focussed specifically on the content knowledge of CS educators include Hubwieser, Berges, Magenheim, Schaper, Broker, Margaritis, Schubert, and Ohrndorf (2013) who examined PCK from a curriculum viewpoint. Yadav, Berges, Sands and Good (2016) and Margaritis (2014) used video recordings to determine teacher content knowledge, and Ohrndorf and Schubert (2013) and Hubbard and Kao (2017) experimented with testing and assessment tools. A common finding amongst these studies was the inherent difficulties in measuring PCK due to the complicated nature and infancy of the field. These studies did not appear to address the development of technology-based pedagogies (techno-pedagogy or digital pedagogy). The development of techno-pedagogy for CS/IT and IS academics, is the focus of this research project.

2.4.6 Techno-pedagogy

Techno-pedagogy is a relatively new term, whose development and use, shows a shift toward the student-centred philosophy. Newson (1999) an Associate Professor of Sociology, at York University, in Toronto, Canada, claims to be the first to coin the term, techno-pedagogy. Newson (1999) defines *techno-pedagogy* as the "various models of teaching and learning associated with instructional technologies" (p. 56). Newson's definition is interesting for several reasons. Firstly, there is the hint of the expanded notion of pedagogy including both teaching and learning, and secondly the instructional technologies component of Newson's (1999) definition. Seels and Richey (2012) define *instructional technology* "as the application of principles of science in order to solve learning problems" (p.6). Instructional technology is also considered to utilise of a range of teaching tools aimed at improving student learning (McDonnell, 2008), and provides support for effective learning (Gagne, 2013). This idea focuses the student at the centre of the educator's thinking influencing pedagogy and technology. Gibson (2001), also talks about techno-pedagogy in the context of the learner. Gibson (2001) believes that the illusive intersection of technology and pedagogy finds the academic looking back at the learner. He believes the latest technology and the most popular pedagogy are most effective with the adoption of a student-centred approach. When considering styles of teaching and learning Gibson (2001) believes, the most important question for educators to consider is, what should drive the process of learning – the needs of the individual learners. Gibson (2001) refers to this as a 'pedagogy of learning'. This view is supported by Cook-Sather (2001), who believes in fostering a collaborative team approach, with a reflective emphasis on the roles of those using new technologies, and their application to teaching and learning. In particular, an examination of course content, the pedagogical approaches of academics, and the kinds of learning needs and interests their students have.

By embracing the notion of this relatively new concept, *techno-pedagogy*, educators can support individual learner needs, and develop a student-centred approach in the learning environment.

2.5 Gaps in the literature

The literature pertaining to pedagogy is vast and spans over many decades, whilst that of ET is relatively new spanning over the past forty years becoming prevalent in recent years. The literature pertaining to the intersection of technology and pedagogy is relatively new spanning approximately the past decade. Whilst there is much literature discussing examples of technology enhanced teaching practices in a variety of different contexts and disciplines, very few of these studies review the reasons why educators use technology in the way they do. There is work in the education field but very few projects have been identified in the technology supported discipline of IT teaching, thus providing an opening for this research.

The gap in the literature that this research addresses is an investigation which specifically addresses IT academics pedagogical development and the influence of technology on their teaching practice in an Australian context.

2.6 Summary and conclusion

The following are some general conclusions emerging from the literature:

- Pedagogy is a nebulous term whose history in the literature is complex and ambiguous.
- Pedagogy has evolved in its focus from teaching centred thinking to student-centred thinking.
- Technology is an equally confusing, poorly defined concept used to represent a vast array of tools.
- ET has had a profound effect on the teaching and learning landscape. ET has facilitated new ways of teaching and learning, and centres on the needs of the student;
- Web 2.0 technologies are the focus of educators and their research in various teaching and learning contexts. Web 3.0 technologies provide potential for future innovations in teaching and learning.
- There is still much to learn about the intersection of pedagogy and technology, interestingly whether this relationship has resulted in the development of new digitally based pedagogies.

This chapter provided an outline of the background literature regarding theory and application of pedagogy and technology in an educational context. The next chapter provides an outline of the research design approach adopted on this project.

3 Research Design

3.1 Introduction

The previous chapter provided an overview of literature pertaining to pedagogy, ET and the technology enhanced teaching practice of IT academics. The aim of this chapter is to provide a description of the research design adopted in this study.

This chapter commences with an overview of the research design framework adopted, including the underpinning philosophy, the research methodology, and the data collection method. A description of the underpinning philosophy (interpretivism) and the qualitative approach adopted is included, along with a discussion detailing their appropriateness to this study. Following is an overview of the grounded theory methodology, including an introduction, and a comparison of the two main approaches (Glaserian and Straussian). Rationale for the Straussian approach selected, and a detailed description of Straussian GT, is included. Finally, a discussion of the semi-structured interview method and validation of its suitability is included.

3.2 Research design framework

Research design, is a plan or proposal to conduct research, it involves the intersection of epistemology, philosophy, strategies of inquiry, and specific methods (Creswell, 2007). For the purposes of this study *epistemology* is defined as “the philosophy of knowledge” (Byrne, 2001, p. 209).

In a research design framework, the epistemology and underpinning philosophy (philosophical framework) support the research methodologies, which in turn support the data collection methods. The literature is confusing on the topic of research design frameworks. There are many varied terms used to represent the same concepts. For example underpinning philosophy may also be called, theoretical perspective (Crotty, 1998), worldview (Creswell, 2007), or fundamental philosophies (Quinlan, 2011). The stacked Venn diagram provided in Figure 3-1 illustrates how the fundamental philosophies fit with the different methodologies, and methods. Some authors deal with the underpinning philosophy and epistemology, as one philosophical framework. The researcher in this study has taken a combined approach.

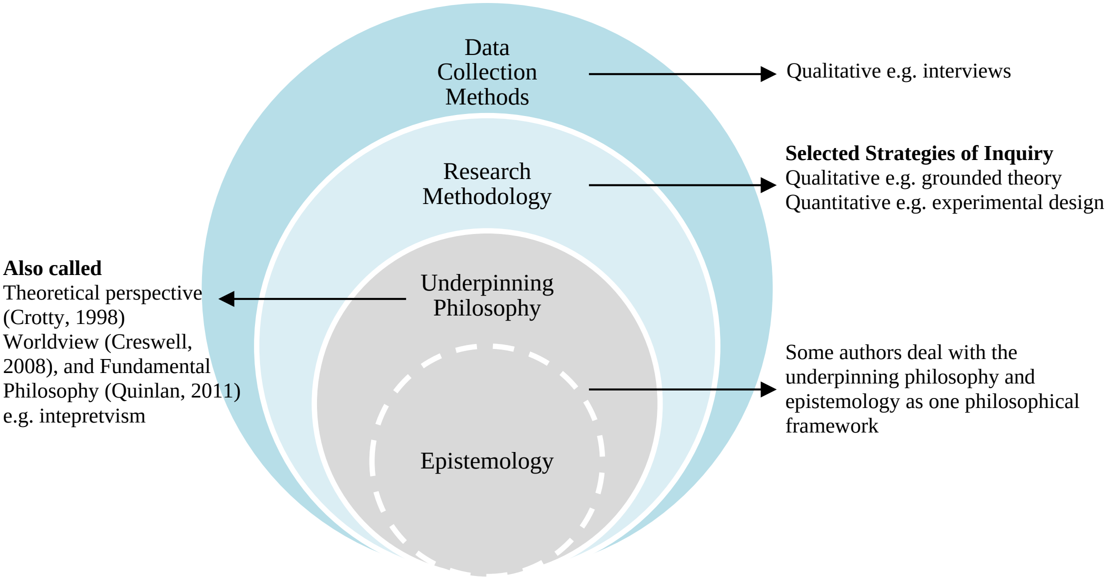


Figure 3-1 Research Design Framework

Table 3-1 provides an outline of the research design framework proposed for this study including a clarification of the meaning of each element adopted. A detailed analysis and description of each follows (see Chapter 3.2, 3.3, 3.4 and 3.5). The framework for this study is based on the work of Denzin and Lincoln (2000), Crotty (1998) and Quinlan (2011).

Table 3-1 Research Design Framework

Framework Element	Element Description	Selected Technique
Underpinning philosophy	The researcher's philosophical, epistemological, and ontological premises	Interpretivism
Research Methodology	General logic and theoretical perspective underlying the choice and use of particular methods	Qualitative: Grounded Theory
Data Collection Method	Refers to the specific techniques or procedures used to gather the data	Interviews

There are numerous approaches, which can be categorised under the selected technique heading in Table 3-1. It is not the intention here to provide details of all approaches available. However, provided is a description of the selected techniques with some analysis and validation for each approach.

All research is based on some underpinning notions about what constitutes valid research (Myers, 1997). “A researcher needs to align his or her personal perspective with a philosophy, which will underpin the assumptions of the study” (Byrne, 2001, p. 208). In order to conduct qualitative research, it is important to know what these philosophical perspectives are. There is no easy way to identify these. Byrne (2001) suggests the following options; use a tool suggested by supervisor, read extensively to broaden views, and review methodologies common to the discipline in question. All three of these approaches have been utilised as part of the selection process for this study.

3.3 Interpretivism

According to Crotty (1998) the *theoretical perspective* indicates the philosophical view underpinning the methodology. The theoretical perspective provides a context for the research process and a basis for its logic and criteria.

Interpretivism is a view that cultures can be understood by examining what people believe about, their ideas, and the meanings that are significant to them. All knowledge is a matter of interpretation (McNabb, 2010). Crotty (1998) suggests interpretivism attempts to characterise how people experience the world, the ways they interact together, and the settings in which these interactions take place (the social reality). As opposed to a *positivist,* approach, which assumes reality, is objective, and described by measurable properties, which are independent of the researcher and his or her instruments.

Weber (2004) provides the following features of interpretivism:

- Ontology: a holistic philosophy that knowledge is not independent of life experiences (Byrne, 2001).
- Epistemology: knowledge of the world is represented through a person's lived experiences.
- Research object: the research phenomenon is interpreted through the researcher’s experiences.

- Method: examples include hermeneutics, phenomenology, grounded theory etc.
- Validity: explanations are true or accurate and correctly capture what is actually happening (Gibbs, 2013).
- Reliability: researchers recognise and address implications of their subjectivity (Weber, 2004, p. 4).

Interpretivism is an appropriate choice because this study is examining what educators believe or trust is true about their teaching and learning. Weber's (2004) features can be applied in the context of this research as further evidence of its appropriateness. For example, an educator's knowledge of their world is formed through their teaching and learning experiences (epistemology), these experiences inform and shape pedagogical approaches in a unified manner (ontology). The phenomena under investigation (pedagogy and technology) are examined through a lens of stories of teaching experiences. Data collection methods are the ways in which researchers gather data (Patton, 2002), in this research, the interview method has been utilised to gather teaching anecdotes. Documented experiences of teaching and technology approaches as told by IT educators provides the validity of this research. Finally, the reliability of the research is through the application of Straussian GT, a complicated and rigorous methodology (see Chapter 3.5.4).

3.4 Qualitative inquiry

According to Anderson and Poole (1998) "quantitative research is typified by experimental studies in science based disciplines where findings are usually expressed in numerical form" (p. 24). Quantitative studies are characterised by research questions expressed in terms of hypotheses for statistical testing. Typical quantitative methods include surveys, laboratory experiments, and numerical methods such as mathematical modelling (Myers, 1997). Whereas *qualitative* research is "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990, p. 17). Qualitative research emphasises meanings in context (Anderson & Poole, 1998), and is typically used for the investigation of social phenomena, or, situations in which individuals are involved with various types of processes, such as educational ones (Hazzan, Dubinsky, Eidelman, Sakhnini, & Teif, 2006; Myers, 1997).

A qualitative research approach underpins this work. Rationale for this selection includes the alignment with key attributes mentioned above. Primarily the research is associated with the social phenomena of pedagogy, teaching and technology. Other factors considered as part of this decision include the nature of the problem under investigation, existing knowledge of the phenomenon, context of the research, style of question under investigation, and richness of the data. A brief outline of each follows.

One consideration when deciding whether to do qualitative research is the nature of the problem being investigated (Strauss & Corbin, 1990). Patton (2002) indicates that some questions do not lend themselves to numerical answers. Whilst Strauss and Corbin (1990) believe that some areas naturally afford themselves to more qualitative types of research. For instance, research that attempts to discover the nature of the person's experiences with a phenomenon. In this study, the nature of the IT academics' experiences with technology is under investigation.

Another consideration is existing knowledge of a phenomenon (Strauss & Corbin, 1990). Strauss and Corbin (1990), and Hoepfl (1997) suggest that qualitative methods are particularly useful when there is little known about the phenomenon under investigation. In terms of this study, there is research compiled by Webb and Cox (2004) which considered existing literature on IT and pedagogy, in a primary and secondary school context. There is work done on scholarship pursuits of IT academics by Lynch, Sheard, Carbone and Collins (2005) and work by Tutty, Sheard and Avram (2008) which presents a model of IT academics teaching experiences and there is Shulman's (1987) work which looks at discipline specific pedagogies. Of prevalence is the work by Kutay and Lister (2006) whose research aimed at promoting pedagogical debate between IT academics. The literature review revealed little published research examining technology's pedagogical influence on the teaching and learning philosophies and the practice of IT academics.

In deciding on a qualitative approach it is important to consider the context of the research (Hazzan, et al., 2006; Myers, 1997). Myers (1997) suggests qualitative research is constructed to assist researchers understand people and the social and cultural contexts within which they live. This is supported by Hazzan et al (2006) who contends that the qualitative approach enables the researcher to focus on people-centred settings. While Hatch (2002) deems qualitative research to be about the lived experiences of real people in real settings. The nature of this study focuses on the teacher and the development of their pedagogy and the influence of technology in university teaching settings.

Another consideration is the style of questions being asked (Patton, 2002). Patton (2002) provides the following analogy to illustrate differences in question styles and the resultant data gathered between the quantitative and qualitative approaches.

Patton (2002) believes:

> If you want to know how much people weigh, use a scale. If you want to know if they're obese, measure body fat in relation to height and weight and compare the results to population norms. If you want to know what their weight means to them, how it affects them, how they think about it, and what they do about it, you need to ask them questions, find out about their experiences and hear their stories (p. 14).

Applying Patton's (2002) analogy, researching the development of IT academics' pedagogy and their experiences with technology would be like researching types of technology used by academics as opposed to investigating experiences of using. Technology. Here Patton (2002) infers a qualitative approach is desirable in order to discover the answers to the how, what, and why type of questions. This approach is supported by Bogdan and Biklen (2007) who suggest a qualitative researcher asks basic questions such as: 'What's going on here?' 'How do the people in the study think about what they are doing?' 'How does what I see fit with how others talk about it?' In terms of this study, these questions include; what are the most important characteristics of being a teacher? What is your feeling regarding technology enhanced teaching? How, if at all, has technology influenced your teaching?

Richness of the resulting data is another important factor to consider. "Qualitative methods facilitate study of issues in depth and detail and typically produce a wealth of information about a much smaller number of people and cases. This increases the depth of understanding of the cases and situations studied" (Patton, 2002, p. 14). Qualitative analysis results in a different type of knowledge than does quantitative inquiry (Hoepfl, 1997). This is the circumstance of this IT pedagogy study where the cohort is small, has been studied in depth, providing rich, detailed data leading to a deeper understanding of the influence of technology on pedagogical development.

3.5 Grounded Theory methodology

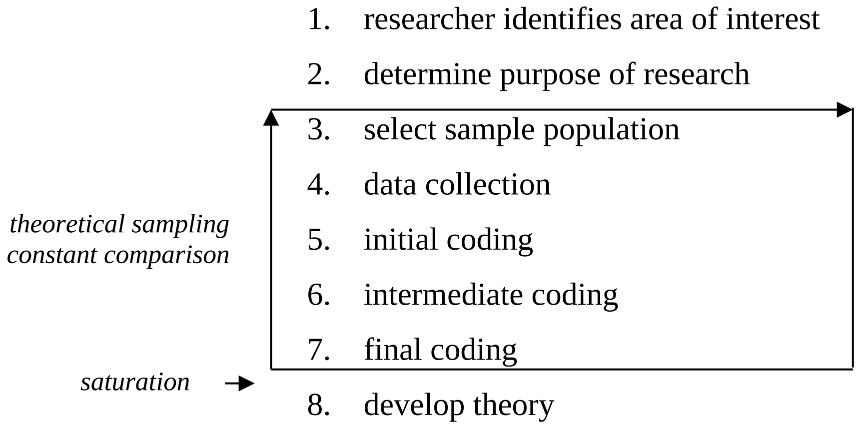
3.5.1 Introduction to Grounded Theory

This project uses a grounded theory approach. GT provides a set of techniques and principles that guide researchers through doing data collection and analysis (Denzin & Lincoln, 2005; Mansourian, 2006). A *grounded theory* is one that is inductively derived from the study of the phenomena (Moghaddam, 2006; Strauss & Corbin, 1990). This means the researcher uses conceptualisation, a type of reasoning that extrapolates from the specific to the more general (Bryant & Charmaz, 2007). GT is characterised by its inductive interpretive approach to inquiry, and is thought of not only as a way of doing, but also a way of thinking (Stern & Porr, 2011). According to Strauss and Corbin (1990):

> The grounded theory approach is a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon (p. 24).

The purpose of GT is to generate or discover a theory that is grounded in the data, and that is faithful to the area under study (Creswell, 2007; McNabb, 2010; Strauss & Corbin, 1990; Urquhart, 2013). A grounded theory can be presented in many forms depending on the audience, such as, descriptive narratives, oral presentations, or illustrative models (Birks & Mills, 2011; Corbin & Strauss, 2008).

Developing a grounded theory is a complex and iterative process. Lee (1999, pp. 46-47) and Mc Nabb (2010, p. 255) present a generic process for conducting GT:



1. researcher identifies area of interest
2. determine purpose of research
3. select sample population
4. data collection
5. initial coding
6. intermediate coding
7. final coding
8. develop theory

Steps three through seven are applied iteratively using a theoretical sampling with a constant comparative approach, until data, saturation occurs. Theoretical sampling (see Chapter 3.5.4.6) directs more sampling of data based on the emerging analysis (Urquhart, 2013). Constant comparison (see Chapter 3.5.4.3) is the process of comparing instances of data with other instances of data within a category (Urquhart, 2013), while saturation (see Chapter 3.5.4.8) is when no new information emerges during the coding process (Strauss & Corbin, 1998). Data collection methods utilised are typically interviews, observation or document analysis (McNabb, 2010). A noted omission from Lee (1999) and McNabb's (2010) generic process is the important technique of memoing (see Chapter 3.5.4.4). Memos are diary like records of a researcher's thinking while gathering, coding and analysing data (Birks & Mills, 2011).

The main advantages of GT include its intuitive appeal, the ability to foster creativity, its conceptualisation appeal, and its systematic approach to data analysis (El Hussein, Hirst, Salyers, & Osuji, 2014). GT has intuitive appeal for novice researchers (El Hussein, et al., 2014; Myers, 2013), as it enables the researcher to become immersed in the data at a detailed level, with analysis commencing as soon as data collection begins with the first interview (Allan, 2004; Myers, 2013). GT facilitates growth and fosters the creation of innovative ideas. "GT encourages the researcher to move through a process of discovery whereby themes and interpretations naturally emerge from the data" (El Hussein, et al., 2014, p. 3). Conceptualisation used in GT is a process where specific instances of concepts (or ideas) about a phenomenon are abstracted to a general level and attributed theoretical meaning (Lewis-Beck, Bryman, & Liao, 2004). Conducted through the processes of constant comparison and memo writing (El Hussein, et al., 2014; Glaser, 2002). GT provides detailed strategies and procedures which provide a structured approach for conducting research (Matavire & Brown, 2008; Schreiber & Stern, 2001). This systematic detailed approach is regarded as the main benefit of GT, as it affords support for novice researchers and delivers a high degree of rigour (Martin & Gynnild, 2011; Myers, 2013).

Some of the key disadvantages of GT include the complexity of its approach, the researcher's preconceptions, multiple approaches, and the difficulty in precise project planning due to the unique GT (theoretical) sampling approach. GT is considered very complicated, time consuming and laborious (Bryant & Charmaz, 2007; Denscombe, 2010; El Hussein, et al., 2014; Suddaby, 2006). The level and detail of coding can be overwhelming to the researcher and as a result can lead to generation of lower level theories (Myers, 2013). Researcher bias can be a problem with grounded theory, as the researcher's prior knowledge can contaminate a researcher's perspective (Suddaby, 2006). There are several main versions of GT (see Chapter 3.5.2), which causes confusion among scholars (El Hussein, et al., 2014). The sampling approach used in grounded theory does not lend itself to precise planning as it is not possible at the outset to predict the eventual size of the sample (Denscombe, 2010).

3.5.2 Comparison of Glaserian and Straussian GT

There are a number of well-known versions of GT, including Glaserian and Straussian. A genealogy of these major approaches is as follows: a). Glaserian GT: Glaser and Strauss (1967) and Glaser (1978), and b). Straussian GT: Strauss (1987) and, Strauss and Corbin (1990, 1998, 2008). As identified, there are several main versions of GT, however the informed inquirer should be aware of the alternative approaches for applying GT, such as Charmaz's (2006, 2014) Constructivist GT, and Clarke's (2005) Situational Analysis (Kiggins, 2002). Charmaz was a student of both Glaser and Strauss, while Clarke was a student of Glaser and followed his approach carefully (Morse et al., 2009). See Figure 3–2 for a visual representation of the key releases of the major approaches of GT. This project follows the work of Strauss.

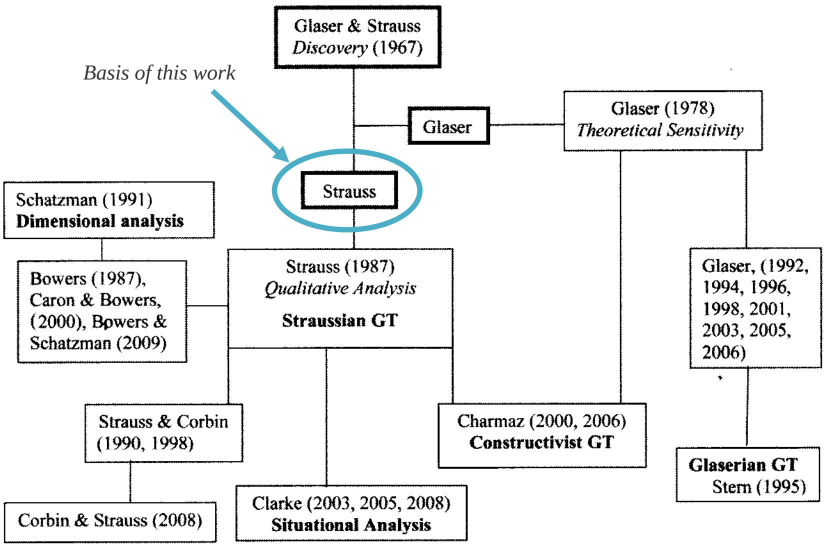


Figure 3-2 Grounded Theory Genealogy(Morse, et al., 2009, p. 17)

A comparison of the key features which differentiate the two major approaches is provided in Table 3-2.

Table 3-2 Comparison of GT Methodology Key Features

Element	**Glaserian GT**	**Straussian GT**
Philosophical basis	Objectivist, positivism (Charmaz, 2014)	Interpretivism (Levers, 2013)
Preconceptions	Guards against preconceived ideas (Glaser & Holton, 2004)	Natural process, informs research (Corbin & Strauss, 2008)
Use of the literature	Avoid literature at commencement of study	Review relevant literature at commencement of study
Research questions	Research questions emerge from data	Define research questions at commencement of study
Coding stages	Initial (open) coding Selective coding Theoretical coding (Glaser, 1978; Saldana, 2013, p. 51)	Open coding Axial coding Selective coding (Strauss & Corbin, 1990, 1998)
Theorising	Theory emerges from data process of induction	Theory generated (constructed) from data through process of deduction, and induction. Later work showed use of abduction

(Allan, 2004; Annells, 1997; Bryant & Charmaz, 2007; Heath & Cowley, 2003; Mills, 2009; Strauss & Corbin, 1990; Urquhart, 2013)

Key features differentiating Glaserian GT and Straussian GT include; the underpinning philosophical basis, knowledge and acceptance of preconceived ideas, the approach to literature, the timing of research questions conception, coding stages, and production of theory. Following is a brief discussion of each.

Research is typically based on a particular theoretical perspective or fundamental philosophical view (Crotty, 1998; Quinlan, 2011). Glaserian GT is known to be influenced by Glaser's objectivist/positivist background (Charmaz, 2014). *Objectivism* is a philosophical belief that certain things, especially moral truths, exist independently of consciousness and experience (Crotty, 1998). *Positivism* is a philosophical system recognising only that which can be scientifically verified, or which is capable of logical or mathematical proof. Glaser articulates the central aspects of positivism (Charmaz, 2014). Positivists attempt to keep their attitudes and beliefs out of their research to prevent distortion of the results (Charmaz, 2014; Morse, et al., 2009). Alternatively, Straussian GT is said to be philosophically based on interpretivism (El Hussein, et al., 2014; Levers, 2013; Stern & Porr, 2011). *Interpretivism* is a view that cultures can be understood by examining what people believe about, their ideas, and the meanings that are significant to them, all knowledge is a matter of interpretation (Crotty, 1998; McNabb, 2010). Interpretivism centres on “understanding and accounting for the meaning of human experiences and actions” (Fossey, Harvey, McDermott, & Davidson, 2002, p. 720).

Typically researchers select an area of research due to their passion or personal interest in the area (Birks & Mills, 2011). Some degree of knowledge or impression is associated with this interest. These impressions or preconceptions are ideas that result from informal experiences in everyday life (Leh, 2007), and can influence a researcher’s ability to remain theoretically sensitive to concepts in the data (Birks & Mills, 2011). The literature is divided in its stance on preconceived ideas by the two opposing fundamental viewpoints, Glaserian GT and Straussian GT. The Glaserian GT approach requires the researcher to enter the research field with no preconceived problem statement, interview protocols, or extensive review of the literature (Bryant & Charmaz, 2007; Glaser & Holton, 2004). Whereas the Straussian GT approach asserts the researcher’s background, past experiences and engagement with the literature support the academic intellect required to evaluate, organise, and synthesise the messages hidden in the data (Corbin & Strauss, 2008).

A *literature review* is a “written document that presents a logically argued case found on a comprehensive understanding of the current state of knowledge about a topic of study” (Machi & McEvoy, 2009, p. 4). Glaserian GT encourages researchers to avoid the typical practice of reviewing relevant literature at the commencement of the research process (Bryant & Charmaz, 2007; Dunne, 2011; Glaser & Holton, 2004; Grbich, 2007; Urquhart, 2013). Glaser and Strauss (1967) explicitly stated: “An effective strategy is, at first, literally to ignore the literature of theory and fact on the area under study” (p. 37). The reason behind this approach is to persuade the researcher to stay open to the concepts and relationships that will emerge from the data, to prevent the formation of assumptions about what should be revealed in the data, and to enhance theoretical sensitivity, by engaging with an extensive range of varied interdisciplinary concepts (Bryant & Charmaz, 2007). In contrast to the Glaserian approach, Corbin and

Strauss (2008) suggest an awareness of the relevant literature can stimulate thinking, improve understanding of variations in the data, and enhance the analytic process. An early investigation of the literature helps to identify previous research in the area, as well as discover gaps in understanding (Strauss & Corbin, 1990). In addition, the literature review is essential for academic integrity, and also to illustrate how the research builds on and contributes to existing knowledge within the field (Bryant & Charmaz, 2007).

A *research question* (objective) is a clear, focused, concise, complex and arguable question around which you centre your research. Research questions should be considered in terms of aim (overall purpose) and objectives (questions and sub-questions). According to van Niekerk and Roode (2009) a Glaserian GT researcher does not commence with a research question. Glaser states that the research problem is discovered through emergence as a natural consequence of open coding, theoretical sampling, and constant comparison (Babchuk, 1996). Alternatively Straussian researchers indicate it is important to define the basic research questions (Pandit, 1996), and there should be “consistency between research questions (and their assumptions about the world and how people come to understand it) and the methods used to answer the questions” (Suddaby, 2006, p. 640). Charmaz (1990) supports this view suggesting grounded theorists begin with general research questions.

Coding is the process of deriving and developing concepts from data, and defining what the data is about (Bryant & Charmaz, 2007; Corbin & Strauss, 2008). Coding is the term used for attaching conceptual labels to data (Urquhart, 2013, p. 35), and a way of analysing qualitative data (Saldana, 2013). In GT coding is the process of defining what data is about (Charmaz, 2014). The variation in coding techniques is considered one of the main differences between Glaserian and Straussian GT (Ng & Hase, 2008). Originally Glaserian GT consisted of the following two coding stages (a) initial (open) coding, and (b) theoretical (selective) coding (Glaser & Strauss, 1967; Heath & Cowley, 2003; Saldana, 2013). In 1978 Glaser updated his coding strategy to include three stages (a) initial (open) coding, and (b) selective coding, and (c) theoretical coding (Glaser, 1978; Heath & Cowley, 2003). While Straussian GT consists of the following three coding stages (a) open coding, (b) axial coding, and (c) selective coding (Strauss & Corbin, 1990). Strauss and Corbin added axial coding as a intermediate step to assist beginning researchers to produce clear and cogent theory from the data (McNabb, 2010). A number of authors have disagreed with the use of axial coding including Moghaddam (2006), Kendall (1999) and in particular, Glaser (2004).

GT is an analytical description of the production of theory, which extends our understanding of the world (Birks & Mills, 2011). The technique researchers adopt for data analysis and theory conceptualisation varies between Glaser and Strauss (Ng & Hase, 2008). Glaser’s approach to theory generation allows for a central idea to emerge during the coding process (Douglas, 2003). Glaser emphasises the generation of theory (Babchuk, 1996; Stern & Porr, 2011). Strauss and Corbin focus data collection and coding around a specific issue or phenomenon (Douglas, 2003). Some scholars believe Strauss’s approach forces data rather than fostering the emergence of theory (Douglas, 2003). Strauss and Corbin stress the importance of verification and validation of theory (Babchuk, 1996; Strauss & Corbin, 1998).

3.5.3 Justification for Straussian GT

There are several well-known versions of GT, including Glaserian and Straussian (see Chapter 3.5.2). According to Bryant and Charmaz (2007) there are a number of factors of difference between the approaches of the originating authors, researchers typically use these points of difference when selecting between the various approaches. After a detailed investigation of both the main approaches and a review of Constructivist GT, a Straussian GT approach emerged the most appropriate. Straussian GT was selected for the following reasons; detailed clear guidelines and procedures to follow (Matavire & Brown, 2008; Schreiber & Stern, 2001), the ability to enter the study with pre-conceived ideas (Corbin & Strauss, 2008), the ability to conduct a literature review at commencement of study (Bryant & Charmaz, 2007; Strauss & Corbin, 1990), particular phenomena and predetermined research questions to investigate (Pandit, 1996; Suddaby, 2006), the ability to look at a phenomenon from a different angle (Stern & Porr, 2011, p. 41), and the growing use of Straussian GT in the IT education discipline area.

Strauss and Corbin provide a comprehensive set of instructions describing what their version of GT is about, and how to go about applying it. Their detailed approach provides a clear framework for novice researchers to follow (Matavire & Brown, 2008). The clear guidelines and prescriptions provided by Strauss and Corbin have encouraged more researchers to adopt Straussian GT than Glaserian GT (Matavire & Brown, 2008; van-Niekerk & Roode, 2009). This approach is particularly appealing to novice researchers such as PhD students, as is the case with this research.

Prior knowledge and experiences possessed by the researcher are an important part of applying Straussian GT, and can be used to improve its application (Birks & Mills, 2011; Bryant & Charmaz, 2007). Birk and Mills (2011) recommend acknowledging and documenting existing ideas, experiences and knowledge as a technique to position the researcher in relation to the phenomenon under investigation. The research approach should take into account what is known already and build it into the design the ways this can be used (Richards, 2009). In this study the researcher's interest in teaching and ET helped frame the scope and aims of the project.

Conducting a review of the literature is a fundamental element of a PhD research project. Delay of this has severe implications for research students (van-Niekerk & Roode, 2009). Methodological selection often occurs after the relevant literature has been explored and a better understanding of the research problem developed (Pace, 2003), supporting the idea of conducting a thorough literature review early as part of the process. Strauss and Corbin prescribe an early review of the pertinent literature (Dunne, 2011). Strauss and Corbin (1990) also believe knowledge of existing writings and theories can strengthen data analysis and interpretation. Strauss and Corbin's approach is practical and supportive of contemporary research situations (Birks & Mills, 2011), such as that of PhD students who are required to demonstrate a focused research topic (Stern & Porr, 2011). In this study a review of the literature was conducted early in the process.

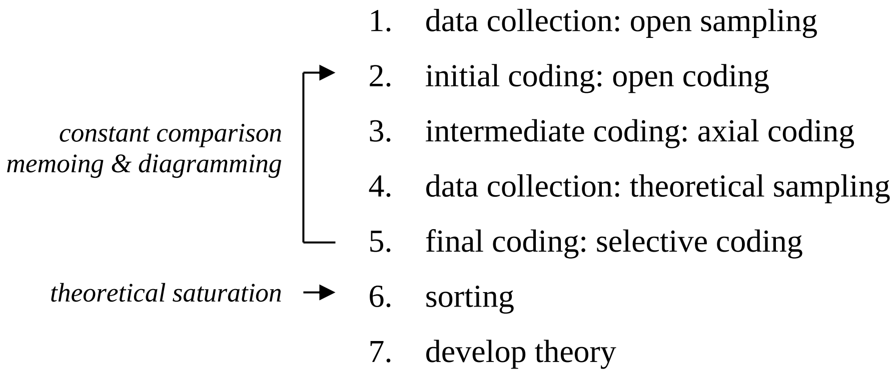
PhD students are required to propose a substantive area of study and a documented research question (Ng & Hase, 2008; Stern & Porr, 2011; Strauss & Corbin, 1990). Pandit (1996) recommends defining basic research questions as an initial step in the research process. Strauss and Corbin (1990) suggest the technical literature (research reports, theoretical or philosophical papers) as a good source of research questions. In the context of this study research questions were generated from the literature, early in the process providing a focus and guide for the study.

GT allows for looking at existing problems from a new angle. It is particularly useful when all the concepts pertaining to the given phenomenon have not been identified in a particular context (Strauss & Corbin, 1990), as is the case with this study.

GT's use is widespread in many discipline areas. Its use in IT education is growing. For example, it has been used as a research methodology to investigate IT student capstone projects (Kollanus & Isomottonen, 2008a). GT was used by Kollanus and Isomottonen (2008b) in several studies on using test driven development in extreme programming. Kinnunen and Simon (2010) and Dunican (2006) used GT to investigate the learning and teaching of novice computer programming. There is a notable study by Fincher and Tenenberg (2007) who used GT to investigate the practices of CS educators.

3.5.4 Description of Straussian GT

See Chapter 3.5.1 for a generic seven-step process of GT. Straussian GT is also an iterative seven-step process. Steps two through five are repeated iteratively guided by the processes of constant comparison, and memoing and diagramming (modelling). These steps are repeated until theoretical data saturation occurs (Corbin & Strauss, 2008; Strauss & Corbin, 1998).



1. data collection: open sampling
2. initial coding: open coding
3. intermediate coding: axial coding
4. data collection: theoretical sampling
5. final coding: selective coding
6. sorting
7. develop theory

3.5.4.1 Open sampling

In GT an open sampling approach is used to identify interviewees in the early stages of the study (Strauss & Corbin, 1990). *Open sampling* identifies the interviewees using a broad set of criteria (Goulding, 2007; Strauss & Corbin, 1990). The purpose of open sampling is to discover as many relevant categories about the phenomenon under investigation as possible (Coyne, 1997; Draucker, Martsolf, Ross, & Rusk, 2007; Strauss & Corbin, 1990). An open sampling approach also helps to scope the data's relevance to the research question (Davidson, 2001).

The selection techniques adopted in this research are supported by Goulding (2007) who suggests that in later data collection phases, as themes and patterns begin to emerge, the researcher can commence more focussed sampling techniques known as theoretical sampling. This approach is outlined in Chapter 3.5.4.6.

3.5.4.2 Open coding

According to Strauss and Corbin (1990) *open coding* is "the process of breaking down, examining, comparing, conceptualizing, and categorizing data" (p. 61). In the literature open coding is also referred to as initial coding. In this work the term open coding is used in line with Strauss and Corbin's approach. Open coding is a first cycle technique where data is organised into discrete parts, and comparisons made for variations (Saldana, 2013; Strauss & Corbin, 1998). The purpose of open coding is to investigate any conceptual possibilities in the data (Birks & Mills, 2011; Charmaz, 2006). Charmaz (2006) advises initial coding should stick closely to the data, to allow categories to emerge rather than applying pre-existing labels. Open codes are ephemeral, comparable and predicated in the data, allowing rewording to improve fit with the data in later coding passes (Charmaz, 2006; Stern & Porr, 2011). The advantage of this approach is to discover any disparities in the data in the initial stages of the project (Charmaz, 2006).

3.5.4.3 Constant comparison

An important part of data analysis is the process of constant comparison (Urquhart, 2013). *Constant comparison* is defined as “the analytic process of comparing different pieces of data for similarities and differences” (Corbin & Strauss, 2008, p. 65). According to Strauss and Corbin (2008) the process of constant comparison when, applied in a repetitive, consistent manner leads to discovery of emergent categories and their properties. The process commences with open coding and multiple passes over the data, reducing and further reducing and recoding in a cyclical process of comparison and reflection on existing and new data is repeated until no new information emerges (Boeije, 2002; Fram, 2013), and the categories become saturated (Charmaz, 2014). Underpinning this cyclical approach are the processes of “induction (inferences from observations), deduction (reasoning from general to particular instances) and verification (double checking or cross-checking against other data)” (Grbich, 2007, p. 75).

Gibbs (2013) recommends the following techniques which can be used by the researcher in applying the method of constant comparison. These include analysis of word, phrase or sentence, flip-flop technique, systematic comparison, far-out comparisons, waving the red flag, and line-by-line coding. Line-by-line coding is the approach adopted by most grounded theorists (Gibbs, 2013). *Line-by-line coding* requires naming each line of the written data (Charmaz, 2006; Glaser, 1978). A line-by-line approach helps to identify many ideas and concepts as possible without worrying about early relationships (Given, 2008), and encourages the researcher to focus on the participant, developing codes that are reflective of their experience (Gibbs, 2013). In applying a line-by-line approach Glaser (1998) recommends the researcher keep in mind the following questions: ‘What is this data a study of?’, ‘What category does this incident indicate?’, What is actually happening in the data?’, ‘What is the main concern being faced by the participants?’, and ‘What accounts for the continual resolving of this concern?’ (p. 140). Coding is not about counting. The frequency of occurrence is not an indicator of significance (Birks & Mills, 2011). The process of coding is about analysis, reflection, conceptualisation and abstraction of ideas (Saldana, 2013). This approach helps to ensure a rich, dense theory with no sense that any important concepts have been omitted (Holton, 2010).

The constant comparative method is used in this research along with theoretical sampling.

3.5.4.4 Memoing and diagramming (modelling)

The process of memoing is essential in the development of theory, and is considered the most significant factor in developing quality (Birks & Mills, 2011). “Memos are written records of a researcher’s thinking during the process of undertaking a grounded study” (Birks & Mills, 2011, p. 10). Corbin and Strauss (2008) characterise them as specialised written records. When a researcher writes a memo there is a level of analysis occurring (Corbin & Strauss, 2008). This analysis involves augmented thinking that would be challenging to keep track of without the use of memos (Corbin & Strauss, 2008). Memos function as log trail of introspection, and emerging ideas (Richards, 2009), and assist with scoping and focussing the core ideas (Stern & Porr, 2011). Memos should be written regularly, and diligently throughout the duration of the research project (Gibbs, 2013).

Diagrams offer visual a representation of the researcher’s thinking (Charmaz, 2006). According to Corbin and Strauss (2008). “*Diagrams* are visual devices that depict relationships between analytic concepts” (p. 117). A benefit of diagrams is that they offer a discernible representation of categories and connections (Charmaz, 2006), and have long been considered an essential aspect of the analysis process (McNabb, 2010). Diagramming also supports identification of any disparity in theoretical development (Birks & Mills, 2011), and provides a vehicle for reaching and displaying any conclusions emerging from the data, and encourages the researcher to think more systematically and creatively about the data (Dey, 1998). Diagramming should be conducted concurrently and methodically with the writing of memos continuing throughout the GT lifecycle (Birks & Mills, 2011; Strauss & Corbin, 1990).

A diagramming and memoing method is used in this research.

3.5.4.5 Axial coding

Axial coding is “a set of procedures whereby data are put back together in new ways after open coding, by making connections” (Strauss & Corbin, 1990, p. 96). Strauss sees axial coding as developing “a dense texture of relationships around the axis of a category” (Charmaz, 2006, p. 60). The term axial is coined from the metaphor of a wooden wheel with spokes extended from its axis, with the axis representing the category, and the spokes comprising the axial codes (Saldana, 2013). In earlier versions of Straussian GT, Strauss and Corbin (1990) split the processes of open and axial coding. Open coding separated the data allowing categories and properties to emerge, while axial coding reformed the data in different ways forming relationships and connections between the data. Axial coding was seen as a transition cycle (Saldana, 2013). In later iterations of Straussian GT, Corbin and Strauss (2008) clarified that open and axial coding be conducted simultaneously (van-Niekerk & Roode, 2009).

The purpose of axial coding is to arrange, combine, and strategically reassemble a substantial amount of data, split or fractured during the open coding (Charmaz, 2006; Saldana, 2013). Axial coding helps the researcher describe the studied phenomenon more fully preserving the character of the data (Denzin & Lincoln, 2011), and answering questions such as when, where, why, who and with what consequences (Charmaz, 2006; Strauss & Corbin, 1998). With these questions a researcher can describe the studied experience more fully.

Axial coding designates the properties and dimensions of a category (Charmaz, 2006). *Properties* are “attributes or characteristics pertaining to a category, and dimensions are the location of properties along a continuum” (Strauss & Corbin, 1990, p. 61). *Dimensions* specify the location of properties along a continuum (Strauss & Corbin, 1990). Axial codes can have either properties and/or dimensions. A property may also have dimensions (Martin & Gynnild, 2011).

Axial codes are related to their categories through Strauss and Corbin’s (1990) paradigm model. The *paradigm model* is a “perspective, a set of questions that can be applied to data to help the analyst draw out the contextual factors and identify relationships between context and process” (Corbin & Strauss, 2008, p. 89). The paradigm model is based on standard scientific language. The basic components of the paradigm model are as follows:

- Conditions: allow a conceptual way of grouping answers about why, where, how and what happens.
- Interactions and emotions: are responses made by individuals or groups to situations, problems, happenings and events.
- Consequences: these are outcomes of interactions or of emotional responses to events. Consequences answer the questions about what happened as a result of those interactions or emotional responses (Corbin & Strauss, 2008, p. 89).

In Strauss and Corbins' (1990) earlier work the paradigm model contained additional features. The components of the paradigm model can be applied explicitly or implicitly to structure the data (Kelle, 2005). Dey (2008) suggests this approach makes good heuristic sense. Filtering the data through the lens of the paradigm model allocates specificity to the theory (Flick, 2009). Paradigm modelling is also useful in providing answers to questions of context and developing insight into a phenomenon (Corbin & Strauss, 2008; Dunican, 2006), and to think systematically about data (Kelle, 2005). It is used to develop a deeper understanding of categories from different perspectives (Dunican, 2006), and provide a rich explanation of the phenomenon under investigation (Kinnunen & Simon, 2010). Instead of thinking about categories, axial codes and properties in a hierarchical sense, the paradigm model encourages exploration in a contextual sense (Firmin, et al., 2012). Corbin and Strauss (2008) stress the importance of not focussing on the specifics of the paradigm, but rather concentrating on the logic behind it, and what it is designed to do. In terms of this study, paradigm modelling provides the background thinking for understanding the four categories.

Axial coding is reportedly the most contentious aspect of Straussian GT (Kendall, 1999), there is debate about its nature and value (Ezzy, 2002). Arguments against axial coding include; it forces data into a framework, it is too complicated, it can halt the analytical process, and it limits an inductive approach to theory building. Glaser claims axial coding ignores theoretical coding and coding families, and forces data into a preconceived framework (Kelle, 2005; Walker & Myrick, 2006). Urquart (2013) suggests axial coding is too complicated, and the process of identifying categories and their relationships simultaneously is difficult. In addition axial coding is thought to limit the analytical process (Charmaz, 2014; Dey, 2008; Saldana, 2013). Glaser also claims that axial coding limits the inductive nature of theory building (Ezzy, 2002; Saldana, 2013).

3.5.4.6 Theoretical sampling

"*Theoretical sampling* is the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides what to collect next and where to find them, in order to develop his theory as it emerges. This process of data collection is controlled by the emerging theory" (Glaser & Strauss, 1967, p. 45).

Theoretical sampling occurs after open sampling and initial coding procedures have been implemented (Denzin & Lincoln, 2011). The researchers then decide based on analytic grounds (for example, excellent IT educators) where the next sample should come from (Urquhart, 2013). This targeted data sample provides the opportunity for extension and refinement of properties and dimensions of categories, and facilitates a deeper understanding of the phenomenon under investigation (Stern & Porr, 2011). It enables a connection between sampling choices and research questions (Ezzy, 2002). Theoretical sampling aims to facilitate the process of theory generation through the application of constant comparative analysis (Birks & Mills, 2011).

Theoretical sampling provides many advantages including; investigating data relevant to the problem, investigating new areas of study, leads to quality theory, provides researcher with ability to make choices about data collection, results in a deep understanding of the research area. Theoretical sampling encourages researchers to conduct in-depth investigations into concepts that are relevant to the problem and population (Corbin & Strauss, 2008), to explore analytic leads, and is a useful tool for identifying and remedying problem areas (Charmaz, 2006). Theoretical sampling allows for discovery in new or unexplored areas, and encourages researchers to benefit from unexpected events (Corbin & Strauss, 2008), and helps the researcher identify the best quality theory (Creswell, 2007) very quickly based on emerging concepts

(Urquhart, 2013). Application of theoretical sampling allows the researcher to make strategic choices about what or who will provide the most information-rich source of data (Birks & Mills, 2011), and results in a shrewd awareness of the phenomena under investigation (Ezzy, 2002), strengthening the rigour of the study (Dudovskiy, 2015).

3.5.4.7 Selective coding

Selective coding is the name given to the practice of organising a structure to the data and ascertaining an order of significance of the conceptual categories (McNabb, 2010). Saldana (2009) refers to selective coding as a term which is synonymous with theoretical coding. Saldana (2009) describes a theoretical code as being like an umbrella that covers and accounts for all other codes formulated within the data. With selective coding a core or central category is identified which represents the synthesis of all the ideas and the key theme defining the research (Flick, 2009; Saldana, 2009). Strauss and Corbin (1990) suggest that the core category represents the conceptualisation of the storyline, and describe it as “the process of selecting the core category systematically relating it to other categories, validating those relationships and filling in categories that need further refinement and development” (p. 116). Strauss and Corbin’s (1990) definition highlights two key elements, the core category and the relationships between the categories. A discussion of each follows.

Understanding and identification of the core category, its importance, identification point, and emergence require consideration. Strauss and Corbin (1990) describe the core category as “the central phenomenon around which all the other categories are integrated” (p. 116). In later iterations of GT (Charmaz, 2006; Clarke, 2005; Corbin & Strauss, 2008) the importance of identifying a core category has become less of a focus. However according to Glaser (2007) a *core category* “is often a high impact dependent variable of great importance; it is hard to resist; it happens automatically with ease. Researchers tend to see their core category everywhere” (2007, p. 14). According to Birks and Mills (2011) the point at which the core category may be selected is when frequent connections between it and other categories, codes and properties occur. Typically, this could be anytime between open and axial coding. McFadzean (2007) suggests these connections will also depend on the aim of the research. When a core category is identified, theoretical sampling becomes limited to the collection of data that will saturate the core category and its related axial codes (Charmaz, 2006). See Chapter 7.5.5 for details of the core category.

Defining the relationships between the categories is an important step and facilitates depth of the emergent theory (Bryant & Charmaz, 2007). *Relationships* may be described as linkages or connections between data concepts (Bazeley, 2009; Edhlund, 2008). These relationships (linkages or connections) between categories are also referred to as hypotheses (Glaser & Strauss, 1967), or more recently termed propositions by Pandit (1996). Whetten (1989) prefers the term proposition, as propositions involve conceptual relationships whereas hypotheses require measured relationships (Pandit, 1996). The GT approach produces conceptual and not measured relationships. In this study, the term relationship is used to denote the conceptual relationships (propositions) as proposed by Pandit (1996). See Chapter 8.2.3.2 for details of the relationships between each category.

3.5.4.8 Theoretical saturation

Theoretical saturation (data saturation) is “the point at which gathering more data about a theoretical category reveals no new properties, nor yields any further theoretical insights about the emerging grounded theory” (Bryant & Charmaz, 2007, p. 611). A saturated category is like a sponge that has absorbed as much water as it can (Birks & Mills, 2011).

Creswell (2007) advises in order to achieve theoretical saturation, researchers need to gather data applying the theoretical sampling (see Chapter 3.5.4.6) and analyse data using the constant comparative technique (see Chapter 3.5.4.3). Theoretical saturation is reached when instances of the same codes emerge repeatedly in the data (Hesse-Biber & Leavy, 2010; Urquhart, 2013).

Theoretical saturation is important for a number of reasons. It is a key aspect in the integration of the final theory (Birks & Mills, 2011), it is characterised by gathering and analysis of a new data samples which confirm the final theory, rather than developing it further (Auerbach & Silverstein, 2003), and it indicates the researcher has reviewed the breadth of data (Richards, 2009).

3.5.4.9 Sorting Memos

Dick (2005) recommends a process of sorting memos. In GT sorting is the means to providing an emergent theory. Sorting is a vehicle for developing and refining theoretical links. Charmaz (2006) suggests the following technique for sorting, comparing and integrating memos:

- sort memos by the title of each category;
- compare categories;
- use categories carefully;
- consider how their order reflects the studied experience;
- think how their order fits the logic of the categories; and
- create the best possible balance between the studied experience, categories, and theoretical statements about them (p. 117).

Memo sorting can be done manually or electronically. Charmaz (2006) recommends using a paper based approach, for creating and sorting of memos. She advocates the use of a large dining room table or the floor where memos can be laid out and shuffled into different positions. This approach allows the researcher to compare and refine categories and form an outline of relationships between categories (Charmaz, 2006). Alternatively, specialist qualitative software applications such as QSR NVivo[1] provide facility for creating, importing, linking and sorting of electronic memos. Bazeley (2009) suggests there are advantages in utilising electronic memos. These include access and availability, the ability to create links to literature, and other data sources (for example, interview transcripts). Also linking to codes or categories (called nodes in NVivo), and

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[1] NVivo is a software program that facilitates qualitative analysis. It has been designed for rich text-based and/or multimedia information, where deep levels of analysis on small or large volumes of data are required (Bazeley, 2009)

creation of relationships (Edhlund, 2008). In addition electronically created and sorted memos help to avoid anxiety about losing track of thoughts and ideas (Bazeley, 2009).

3.5.4.10 Develop theory

Dick (2005) suggests the final step is the GT process is the write up of the theory. Dick (2005) suggests the first draft of the theory is often a matter of organising the memo's in a sorted sequence. The sorted sequence becomes the structure of the writing and the emergent theory. Following is a discussion of the term theory, what constitutes theoretical contribution, essential elements of a theory and methods of presentation.

There are different notions of what constitutes a theory. Charmaz (2006) suggests ideology, and underpinning epistemological beliefs distinguish the two main approaches to theory development. Charmaz (2006) classifies these as positivist and interpretive. Charmaz (2006) indicates positivist theory "seeks causes, favors deterministic explanations, and emphasizes generality and universality" (p. 126), whereas interpretive theory, "calls for the imaginative understanding of the studied phenomenon. This type of theory assumes emergent, multiple realities; indeterminacy; facts and values as linked; truth as provisional; and social life as processual" (p. 126). Charmaz (2006) suggests that GT contains both positivist and interpretivist inclinations, with Glaser (1978) stressing strong positivist learning's, and Straus and Corbin (1998) more interpretivist, with an emphasis on relationships. Birks and Mills (2011) "define a theory as an explanatory scheme comprising a set of concepts related to each other through logical patterns of connectivity" (pp. 112-113). Strauss and Corbin (1998) define theory as "a set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena" (p. 15). Commonality in these definitions exists through the relationships, connecting the ideas together. Strauss and Corbin's (1998) definition builds on Birks and Mills (2011) as it also suggests that a framework—a hypothetical description of a complex entity or process (Farlex Inc., 2011)—be used to explain the phenomena. This interpretively based expanded definition underpins this work.

Not all studies generate theory but those that go beyond descriptive analysis have the potential to add further to what we know of the world and improve our understanding of it (Birks & Mills, 2011; Corbin & Strauss, 2008). Dick (2005) adds, a contribution to knowledge is a valuable one if it cross-validates existing theory using a different methodology. These authors provide a baseline for this research.

Glaser and Strauss (1967) distinguish between formal theories and substantive theories. Formal theories focus on high-level conceptual areas such as social capital or organisational learning, while substantive theories relate to the phenomena being studied and make no claims to generalise beyond that phenomena, for example patient care or education (Glaser & Strauss, 1967; Urquhart, 2013). Glaser and Strauss (1967) suggest that it is possible to develop a formal theory from a substantive theory, by using theoretical sampling to extend the range of the theory. However, it should be noted that there are not many formal theories produced by GT (see Bryant & Charmaz, 2007). This study focused on building a substantive theory.

There are various methods of publishing theories. A holistic fashion adopting a storyline approach is favoured in Straussian GT (Birks & Mills, 2011; Strauss & Corbin, 1990). A *storyline* is a conceptualisation of the central phenomenon or core category (Strauss & Corbin, 1990), and an explanation of the theory. The storyline encompasses a descriptive narrative incorporating illustrative models. The purpose of the storyline is as an aid in the development of the theory and provides a tool for presenting study findings (Birks & Mills, 2011).

Whetten (1989) does not distinguish between a model and a theory, however for this work a model will be defined as "a schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics" (Farlex Inc., 2011).

Strauss and Corbin (1998) suggest eight conceptual questions for evaluating a formal or substantive theory.

1. Are concepts generated?
2. Are the concepts systematically related?

3. Are there many conceptual linkages, and are the categories well developed? Do categories have conceptual density (richness of the description of a concept)?
4. Is variation within the phenomena built into the theory (how differences are explored, described, and incorporated into the theory)?
5. Are the conditions under which variation can be found built into the study and explained?
6. Has process been taken into account?
7. Do the theoretical findings seem significant, and to what extent?
8. Does the theory stand the test of time and become part of the discussions and ideas exchanged among relevant social and professional groups? (pp. 270-272).

These eight factors provide a basis for evaluation to determine the quality of the theory generated from this study. For a discussion of the implementation and validation of these factors, (see Chapter 8.2.5).

3.6 Interview method

Many data collection techniques may be utilised during qualitative research. According to Patton (2002) typical methods include; interviews, direct observation, and written documents or artefacts. Hatch (2002) also adds focus groups to Patton’s list but indicates that these may be considered a type of interview.

The term interview may be defined in various contexts however the research interview and its various types are the focus here. A *research interview* "... involves direct interaction between the investigator and the research subject. The investigator speaks directly with the subject asking questions related to a specific topical area" (Thompson Gale, 2009, para. 5). There are various types of research interviews used in qualitative work. According to CERG (2004) the main types interviews include unstructured, structured and semi structured. A definition of each type of interview is as follows:

- *Unstructured*: “have the most relaxed rules of the three. In this type, researchers need only a checklist of topics to be covered during the interview. There is no order and no script. The interaction between the participant and the researcher is more like a conversation ...” (Santiago, 2009, para. 7)

- *Structured*: “the interviewer has a schedule of questions that he/she wishes answered by the interviewee. Little allowance is made for any more open responses on the part of the interviewee. Most of the questions will be the closed form” (CERG, 2004, para. 5)
- *Semi structured*: “are a bit more relaxed than structured interviews. While researchers using this type are still expected to cover every question in the protocol, they have some wiggle room to explore participant responses by asking clarification or additional information” (Santiago, 2009, para. 5).

The semi-structured interview technique is the primary research method adopted in this project for a number of reasons. Semi-structured interviews are commonly utilised as the primary data collection tool on qualitative research projects (Bogdan & Biklen, 2007; Hatch, 2002; Santiago, 2009). Interviewing is a basic form of investigation (Seidman, 1991). Interviews are considered an important data source, as they provide researchers with the opportunity to step back and review the interpretations of interviewees in detail (Walsham, 1995). In addition they promote intense in-depth exploration of a particular topic and generate direct, candid dialogue from individuals about their experiences, opportunities, emotions and knowledge (Charmaz, 2006; Patton, 2002). Importantly in the context of this research “Interviewing provides access to the context of people’s behaviour and thereby provides a way for researchers to understand the meaning of that behaviour” (Seidman, 1991, p. 4). Charmaz (2006) sees the interview as providing the researcher with the opportunity to investigate below the surface of ordinary conversation and examine past events, views and beliefs.

3.7 Summary and conclusion

This chapter contained an outline of the research design adopted for this study. Followed by a detailed description and validation of each element including the underpinning philosophy (interpretivism), the research methodology (qualitative, Straussian grounded theory), and the data collection method (semi-structured interviews).

The underpinning philosophy described provides an approach for viewing the data collected in this project. Given interpretivism is about understanding people and their ideas, with a view to understanding their culture. The application of this approach provides a lens for exploring IT academics' teaching and technology experiences, in a university cultural context. While grounded theory is known to be complicated, the detailed instructions provided by Strauss and Corbin (1998) allow the researcher to conduct a thorough and rigorous investigation, resulting in a theory grounded in the data. The use of the semi-structured interview provides the researcher with a rich source of data, in a more relaxed environment.

The next chapter contains a detailed description of the processes and procedures followed for interviewee selection, data collection and analysis. In particular, details of ethics, data handling and storage, and the two-phase implementation of Straussian GT.

4 Implementing Grounded Theory

4.1 Introduction

An overview of the research design approach adopted in this study was presented in the previous chapter. This included a description and justification for the interpretive philosophy underpinning the study, the application of a grounded theory methodology used to analyse data and the semi-structured interviews used to gather the data. The aim of this chapter is to provide details of the implementation of the research approach (as described in Chapter 3).

This chapter commences with an overview of the two-phase study, followed by details of ethics approval, data handling and storage approaches. Finally, a detailed description of the implementation of Straussian grounded theory applied to each phase, including data collection, coding and analysis techniques.

4.2 The study

A model of the two-phase series of semi-structured interviews including the data collection timetable is presented in Table 4-1. The collection process commenced with phase one, consisting of four 1-hour interviews, conducted in 2009. As indicated by Byrne (2001) carrying out a preliminary study is always good practice regardless of the data gathering instruments adopted, as it supports a systematic approach to actual data collection and analysis. The full study duration included 2010 to 2015 and comprised twenty-one, 1-hour interviews. Twenty-five interviews were conducted across the two phases.

Table 4-1 Data Collection Schedule

Phase	Year	Data Source	Interviewees
Phase 1	2009	Interviews	4
Phase 2	2010 – 2015	Interviews	21
Total			25

Preliminary research project considerations included completion of ethics applications for phase one and phase two data collections. Data handling and storage procedures and, the selection of data analysis software was also considered.

4.3 Ethics

Phase one was conducted with permission from the Monash University Human Research Ethics Committee (MUHREC). Ethics approval was granted by MUHREC project number CF09/2572 – 2009001490. A copy of the phase one ethic's approval letter is available in Appendix A.1. Phase one was a trial phase, with all interviewees recruited from a regional Victorian university. An invitation was sent to IT academics soliciting their participation in the project. The response was generous with four interviewees selected using the open sampling approach, and interviews were arranged within a day of the invitation. All other volunteers were thanked, and their future interest documented.

An ethics amendment was submitted to allow for phase two of the project to commence. The amendment requested permission to expand the data collection interviewee group size from the original four, to allow up to an additional thirty interviewees. Ethics approval was granted by MUHREC. A copy of the approval email is available in Appendix B.1. Phase-two interviewees were recruited using a theoretical sampling technique (see Chapter 3.5.4.8).

A further ethics amendment was submitted to allow for additional time to complete the interviews. Approval was granted by MUHREC extending the research collection period from 5th October 2014, to 3rd October 2019. See Appendix B.2 for a copy of the approval email.

4.4 Data handling and storage

Data recording, transcription, confidentiality, storage and analysis software issues all required consideration. The approach adopted for each is outlined.

The recording and transcribing of the interview data was an important logistical factor. Early interviews were recorded using an iPod classic 80GB with a Belkin TuneTalk Stereo recorder attachment. Later interviews were recorded with an iPhone 5c and the Voice Memos app. Electronic files were uploaded into Apple iTunes, and converted to MP3 format, the MP3 files were subsequently imported into Apple Quick Time and transcribed into text (specifically docx format) using MS Word. Apple Quick Time allowed the audio files to be played at a slower speed enabling a continuous text transcription process. An outside transcriber was considered, however, in line with GT processes the researcher gained valuable insight and knowledge of the data by transcribing it herself. The same approach was adopted in the full study. As suggested by Walsham (1995) the researcher supplemented the audio recordings by taking notes on key themes and important comments made by the interviewees throughout the duration of each interview. Minichiello, Aroni, Timewell and Alexander (1990) support this procedure suggesting that audio recording "in conjunction with note taking is the most useful way of capturing the full dimensions of the conversation" (p. 254).

Confidentiality was also a consideration. Phase one interviewees were provided with a printout of the project explanatory statement. A copy is available in Appendix A.2. The statement was explained, and questions solicited prior to the commencement of each interview. In addition, each interviewee was asked to sign a consent form. A copy is available in Appendix A.3. The same process was repeated in phase two, with the explanatory statement being updated to reflect the expanded nature of the project. A copy of the phase two explanatory statement is available in Appendix B.3. No changes were made to the consent form for phase two. However, a copy of the interview questions and a pre-interview questionnaire were distributed to interviewees several days prior to the interview to allow time for reflection. A copy of the pre-interview questionnaire is available in Appendix B.4, a copy of the phase one and phase two interview questions are available in Appendices A.4 and B.5 respectively.

Data storage procedures for both phase one and phase two complied with Monash University regulations. Data collected has been stored on Monash University premises in a locked cupboard/filing cabinet of the principal researcher Judy Sheard. Only the research group Judy Sheard, John Hurst, Angela Carbone and Selena (Sally) Firmin were given access to the secured data. Data was retained for five years. At the end of five-year period data was removed and stored for disposal in security waste bins awaiting removal and destruction.

In phase one a combination of manual and computerised data analysis approach was adopted. Hard copy interview transcripts were analysed and hand coded using a Straussian GT approach. Anonymised stylised interview transcripts in MS Word docx format were imported into QSR NVivo[2] and the manually identified codes entered. Birks and Mills (2011) suggest this is a favoured approach by many researchers particularly novices. In phase two, a computerised approach was adopted. NVivo's reporting and data management processes provided useful tools and facilitated analysis of large amounts of data. Sequential numbering and date versioning control of NVivo data files enabled identification and control of phase one data, and phase two data.

4.5 Phase 1

Phase one was conducted in 2009 and consisted of four 1-hour interviews. Phase one was conducted as a preliminary data collection stage, addressing some general project goals. Appropriate number of interviews, interview duration and the number of interviews conducted are factors specific to phase one. A discussion of these factors along with phase one Straussian GT implementation approach follows.

Phase one addressed a number of general goals. It helped to frame the interview questions prior to the full study in phase two, it assisted with identification of any issues or weaknesses in the approach, and it also allowed the researcher to become comfortable with the interview protocol and develop interviewing skills. A list of clear objectives outlining the purpose of a preliminary data collection phase is important, allowing the researcher to be clear on what they are trying to achieve and to be in a position to ascertain if they have discovered anything (Daines, Daines, & Graham,

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[2] NVivo is a software program that facilitates qualitative analysis. It has been designed for rich text-based and/or multimedia information, where deep levels of analysis on small or large volumes of data are required (Bazeley, 2009)

1998). According to Lancaster, Dodd and Williamson (2004) having a clear list of objectives adds methodological rigour and validity to a study. Following is a list of objectives from phase one of the project:

- Discover any unforeseen issues, ideas, and approaches that have not been anticipated (Woken, 2007).
- Determine consent rate for interviewees (Lancaster, et al., 2004)
- Test interview protocol (Lancaster, et al., 2004).
- Develop resource requirements estimation, such as how much time and money is required per interview (Simon, 2008).
- Collect preliminary data and determine any progress answering research questions.

A theoretical sampling approach was adopted. In this approach "initial sampling provides a point of departure, not theoretical elaboration and refinement" (Charmaz, 2006, p. 100). For more information on theoretical sampling refer to Chapter 3.5.4.6.

The duration of the interviews was another factor considered. Patton (2002) indicates that "interviewing with an instrument that provides respondents with largely open-ended stimuli typically takes a great deal of time" (pp. 227-228). Patton (2002) concludes that he has conducted interviews ranging from 30 minutes in duration to 16 hours conducted over several days. Patton's (2002) experiences illustrate there is much variation in the appropriate length of qualitative research interviews. Gillhan (2000) suggests that in determining the length of an interview the researcher should focus on those questions which are best answered using this method. In phase one of this project, the interviews were found to take approximately one-hour to complete. As outlined by Gillhan (2000) this was deemed to be an appropriate amount of time to cover the questions posed.

The appropriate number of interviews that should be conducted as part of a preliminary study in qualitative research practice is not clearly articulated in the literature. However, Gillhan (2000) does report that "any research which aims to achieve an understanding of people in a real-world context is going to need some interview material ... this can be very effective even with as few as four or five interviews of individuals carefully selected as typical, or in different positions" (p. 12). This is further supported by

Charmaz (2006), who recommends "whatever methods you choose, plan to gather sufficient data to fit your task and to give you as full a picture of the topic as possible" (p. 18). Adopting Gillhan's (2000) approach four academics were carefully selected from a larger group. For a description of the population, see section 4.5.1.1.

A model of the Straussian GT approach implemented is included in Figure 4-1. The proposed approach is based on modelling presented by McNabb (2010, p. 256), and, Hoda, Nobel and Marshall (2010, p. 1). A description of the application of each step is outlined in the following sections. The process commences with data collection open sampling.

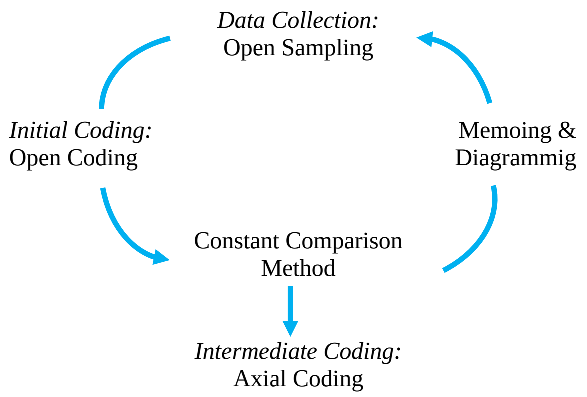


Figure 4-1 Phase 1 – Grounded Theory Implementation

4.5.1 Data collection: Open sampling

An open sampling approach was used to recruit interviewees in phase one (see Chapter 4.5.1). Interviewees were recruited based on a range of demographic characteristics. A specific description of the interviewees along with interview questions used to gather preliminary data are discussed.

4.5.1.1 Description of population

Phase one consisted of four interviews. An open sampling approach was used to select interviewees based on a range of demographic characteristics including gender, age, teaching experience, year level and IT sub-discipline. Two academics, one male and one female, each with over forty years teaching experience were selected along with two additional academics, one male and one female, both with less than twenty years teaching experience. All academics had experience in teaching both undergraduate and post-graduate programs.

Variation in discipline specific expertise among the academics in the phase one group was observed. Computing is considered a vast knowledge area as suggested by Shackelford et al (2005) "computing is a broad discipline that crosses the boundaries between mathematics, science, engineering, and business" (p. 3). Shackelford et al (2005) categorises computing into five major discipline areas including computer engineering (CE), computer science (CS), information systems (IS), IT and software engineering (SE). Of the four interviewees in phase one, three indicated they had expertise in the area of CS, one in the area of IT. See Table 4-2 for a summary of the phase one interviewee profiles.

Table 4-2 Phase 1 – Interviewee Profiles

Pseudonym	Gender	Teaching experience	Qualifications	Sub-Discipline Areas
Interviewee 1 (I1)	Female	40 years	PhD Maths Education	IT, maths and statistics
Interviewee 2 (I2)	Male	18 years	Grad Cert in Leadership in Education and Training PhD, Computer Science BA, BSc (Hons), Computer Science, Geography	Programming, multimedia, database, networking and software quality assurance
Interviewee 3 (I3)	Female	9 years	BComp(Hons) BAppSci Maths, Computing	Programming, database, and operating systems
Interviewee 4 (I4)	Male	48 years	M.Comp., B.Sc., B.Ed., B.App.Sc., Dip. Internat. Educ. Services, A.Mus.A	Programming, software engineering, statistics, professional development, communication, physics, maths

4.5.1.2 Interview protocol

Data for phase one was collected using a semi-structured style interview protocol, which consisted of predominantly open-ended type questions. Open-ended questions encourage interviewees to respond using their own language. This facilitates many possible wide ranging rich responses (Jackson, 1993). The survey consisted of eight questions divided into two sections. The first section was designed to build a profile of the academic, and gathered information concerning, mentors, teaching career highlights, perceived characteristics of good teachers, course preparation, assessment and delivery. The second section was aimed at gathering information regarding use and experiences of technology enhanced teaching practices, including the range of technologies used and their purpose, experiences using technology, perceptions of the usefulness of technology. Refer to Appendix A.4 for a copy of the full phase one interview protocol. Interview questions were mapped to research questions in order to ensure full data coverage. Refer to Appendix D for an alignment of research and interview questions.

The author designed protocol was adapted from published work of several similar studies. These included a study by Kutay and Lister (2006), whose research aimed at facilitating a community of practice to foster ways of discussing pedagogy in a higher education IT school, and a study by Judson (2006), whose research identified a miss-match between teacher’s beliefs and their practice in integrating technology in a secondary school classroom context.

4.5.2 Initial coding: Open coding

After the initial four interviews were conducted, an open coding process was initiated. This was consistent with Straussian GT procedures (Corbin & Strauss, 2008). Saldana (2013) classifies open coding as a first cycle coding method. The open coding cycle in this study consisted of several iterations. Each consisting of the researcher conducting a repetitive analysis of the interview scripts, using a line-by-line approach identifying any open codes. See Figure 4-2.

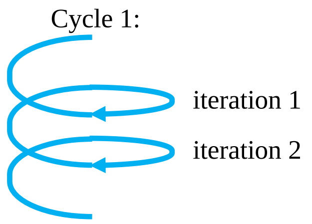


Figure 4-2 Phase 1 – Open Coding Cycle

In line with Charmaz (2006) attempts were made to code using verbs (words that reflect action), also nouns (person, place, animal or things). Each interview was coded with the previous interview in mind, this is known as a constant comparative approach (Glaser & Strauss, 1967). The first interview transcript was coded in a sequential fashion. Subsequent interview transcripts were coded in an iterative fashion using the constant comparative method to revisit, revise and identify any additional codes.

The first cycle identified at total of 111 open codes. This is consistent with other GT studies, which typically generate a large number of codes during initial iterations (Kinnunen & Simon, 2010). Refer to Appendix C for a full list of first cycle open codes and descriptions identified during phase one.

4.5.3 Memoing, diagramming and constant comparison

The process of memo writing and diagramming (modelling) was conducted in parallel with the data collection, coding and constant comparison method. In this project, memo writing was undertaken in order to capture thoughts containing analysis, comparisons, connections about codes, categories and relationships which link the categories (Charmaz, 2006). Writing of memos throughout the research lifecycle assisted in elevating the level of abstraction of ideas, with codes beginning to stand out and take shape into theoretical categories. Memos developed in MS Word were themed and chronologically dated for efficient future comparison, reflection and retrieval. During phase one, 17 memos were written containing reflections on interview data, grounded theory codes and themes. Refer to Appendix A.5 for a sample memo from phase one.

Models were created using MS Word, Adobe Illustrator and Adobe Photoshop. Multiple drafts were constructed, each iteration used to refine ideas and illustrate categories and conceptual relationships. Eight models were developed during phase one. These models facilitated early conceptualisation of the data. Refer to Appendix A.6 for a sample model from phase one.

A process of constant comparison was applied iteratively to identify connections and meaning in the data (Stern & Porr, 2011; Urquhart, 2013). Refer to Chapter 3.5.4.3 for a description of the constant comparison process.

4.5.4 Intermediate coding: Axial coding

The last step in phase one was axial coding. Axial coding is known as a second cycle coding method (Saldana, 2013). The axial coding cycle was included detection of additional open codes and multiple iterations of the following activities carried out in a simultaneous fashion:

- identification of any additional open codes; } open coding
- grouping of open codes into axial codes and properties; and } axial coding
- grouping of axial codes into draft categories.

Figure 4-3 illustrates the cyclical process of the second coding cycle adopted. This is consistent with Corbin and Strauss (2008) who suggest open and axial coding is a methodical repetitive process.

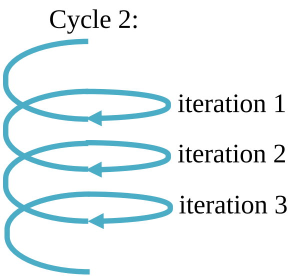


Figure 4-3 Phase 1 – Axial Coding Cycle

After multiple iterations of axial coding (also called cycle two), axial codes began to naturally aggregate into categories. The axial codes and properties provided specific descriptions forming a profile for each category (see Strauss & Corbin, 1990). Four preliminary categories emerged during this phase of the project. Draft names for these categories included: pedagogical development, teaching practice, technology adoption, and techno-pedagogical actualisation. For details of the axial codes and properties generated in phase one of this study, refer to Chapter 5.3.

As part of selective coding, further iterations of axial coding were continued in phase two, including identification of additional open codes, refinement of axial codes including the clarification of properties, and the development of axial paradigm models (see Chapter 4.6.2.1).

4.6 Phase 2

Phase two data collection commenced in 2010 and was completed 2015. It comprised of twenty-one, 1-hour interviews. Phase two aimed at addressing specific objectives of the full study to discover answers to the research questions. For details of the research questions refer to Chapter 1.2. An overview of research question changes, the interview duration and numbers, and the phase two Straussian GT implementation approach follows.

The second research question was updated after phase one. Originally research question two read: What are IT academics experiences of using technologies in their teaching? After reflection and review, the question was changed to: For what purpose do IT academics adopt technology?

Interviews in phase two were of 1-hour duration, analysis of phase one data revealed interviews were of adequate duration; however, in some cases further clarification or additional information was required. Follow up emails were utilised in these cases, eliciting further reflective material. Phase one consisted of four interviews and phase two consisted of twenty-one 1-hour interviews, for a total of twenty-five interviews. Data was combined from both phases prior to analysis in phase two.

A model of the Straussian GT approach implemented in phase two is included in Figure 4-4. The approach is based on modelling presented by McNabb (2010, p. 256), and, Hoda, Nobel and Marshall (2010, p. 1). A description of each step follows, the process commenced with data collection using a theoretical sampling approach.

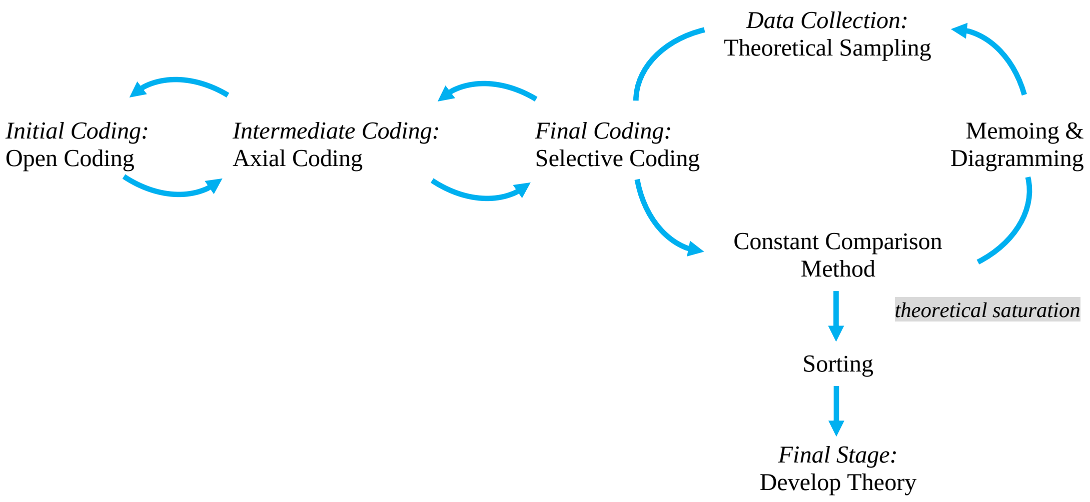


Figure 4-4 **Phase 2 – Grounded Theory Implementation**

4.6.1 Data collection: Theoretical sampling

A theoretical sampling approach was adopted for interviewee selection and induction during phase two. The main aim of theoretical sampling is to expand and refine categories constituting the theory. Theoretical sampling is carried out by sampling to develop the properties of categories until no new properties emerge (Charmaz, 2006). A description of interviewees along with interview questions used to gather current phase two data are discussed.

4.6.1.1 Population selection

Phase two interviewees were carefully identified using Strauss' theoretical sampling approach (Ezzy, 2002), and were obtained using a snowballing technique (Auerbach & Silverstein, 2003; Miles & Huberman, 1994). Theoretical sampling bases the selection of the next interviewee on analytic grounds (Urquhart, 2013). That is, the researcher makes a strategic decision about who will provide the most information-rich source of data to meet their analytical needs (Birks & Mills, 2011). In order to answer the specific research questions, the theoretical sampling approach adopted commenced by targeting *IT academics with reputations as great teachers* and progressed to a focus on *technology using IT academics with reputations as great teachers*. In this study great is defined as wonderful, first-rate, or very good (Dictionary.com, 2014). Great IT teachers were recruited as part of the theoretical sampling approach in order to investigate the research questions associated with pedagogy, given that contemporary definitions of pedagogy are associated with the science of great teaching (Kemmis & Smith, 2006). In addition, the emergence of the core category—techno-pedagogical practice—directed further investigation into the phenomenon of technology and pedagogy, guiding the sampling of great technology using teachers. This approach follows Birks and Mills (2011) who recommend that once a core category emerges, theoretical sampling becomes delimited to the collection of data that will theoretically saturate the core category.

In order to obtain this specific cohort a snowballing (or chain sampling) approach was utilised. *Snowballing* is a technique used to recruit interviewees for a study in which the initial population is small. In snowball sampling interviewees are asked to recommend acquaintances who might be willing to participate in the study (Miles & Huberman, 1994). Patton (2002) suggests asking experts to identify potential interviewees, whilst Bryant and Charmaz (2007) suggest the researcher requests introductions from initial interviewees. Criteria used for obtaining great teachers in phase two included; those with a local reputation as a great teacher, recipients and/or nominees of teaching and learning awards (locally and nationally), and those recommended by interviewees, discipline experts, various university teaching and learning coordinators, and head of schools.

Like phase one, a variation in discipline specific expertise among the academics in the phase two group was observed. Of the 21 interviewees in phase two, evidence of CS, IT, IS sub-disciplines were evident, along with statistics and mathematics. See Table 4-3 for a summary of the phase two interviewee profiles.

Table 4-3 Phase 2 – Interviewee Profiles

Pseudonym	**Gender**	**Teaching experience**	**Qualifications**	**Sub-Discipline Areas**
Interviewee 5 (I5)	Male	18 years	B Arts, GDip Adv Comp, PhD	Artificial intelligence, health informatics
Interviewee 6 (I6)	Female	12 years	PhD, M Ed, Bach Stats	IS, emerging technology, e-commerce

Pseudonym	**Gender**	**Teaching experience**	**Qualifications**	**Sub-Discipline Areas**
Interviewee 7 (I7)	Male	30 years	TPTC, Bach Arts, M Ed	Statistics
Interviewee 8 (I8)	Male	20 years	MIT	Programming
Interviewee 9 (I9)	Female	17 years	Grad Dip Ed (TT), Grad Dip Comp	Creative multimedia, web design, image manipulation
Interviewee 10 (I10)	Male	10 years	Bach Elec & Comp Eng, Grad Cert (HE), PhD	Games development, programming
Interviewee 11 (I11)	Female	18 years	Bachelor of Computing, Masters of IT	Web programming
Interviewee 12 (I12)	Female	14 years	MCS, PhD	Computer science
Interviewee 13 (I13)	Male	13 years	Bach Sci (Maths & Stats), Dip Ed., PhD	Maths, statistics
Interviewee 14 (I14)	Male	8 years	Bach IT, Bach Comp (Hons), Cert IV(TAA)	Multimedia, games design
Interviewee 15 (I15)	Male	19 years	Bach Comp (Hons), PhD	Programming, games and artificial intelligence
Interviewee 16 (I16)	Male	26 years	Bach Eng (Civil), MUrban Planning, PhD	IS development, IT management & strategy, web design, GIS, information management
Interviewee 17 (I17)	Female	27 years	PhD, MCS, Bach App Sci	IT practice
Interviewee 18 (I18)	Female	15 years	PhD Comp Sci, MApp Sci(IT), MBA, Grad Dip (Comp), Grad Cert Ed(HE), Bach Eng.	Intelligent systems project management, programming, HCI
Interviewee 19 (I19)	Male	5 years	BSc (Hons), MMultimedia	Multimedia, programming
Interviewee 20 (I20)	Male	27 years	Bach Sci (Hons), PhD Maths & Stats	Maths, statistics and IT
Interviewee 21 (I21)	Female	38 years	Cert IV in Workplace Training and Assessment, Diploma of Teaching, Bachelor of Educational Multimedia (Hons), Masters of IT	Games development, programming
Interviewee 22 (I22)	Female	8 ½ years	Bach Comp (Hons), Master Teaching (Secondary)	DBMS, mobile computing
Interviewee 23 (I23)	Male	2 years	Bach of IT (Hons), Bach Games Design & Development	Programming
Interviewee 24 (I24)	Female	12 years	Bachelor of Engineering, Master of Technology, PhD	Project management, information systems
Interviewee 25 (I25)	Male	10 years	Bach of CS (Hons), PhD	Artificial intelligence, security, education studies

4.6.1.2 Interview protocol

Data for phase two was collected using a semi-structured style interview protocol, which consisted of predominantly open-ended type questions. After the phase one analysis and prior to the commencement of phase 2, updates were made to the interview protocol. Reflection and thinking behind the changes made were as follows.

- Questions were grouped under themes that loosely related to the axial codes which emerged in phase one. These included; influence of others, quality teaching, teaching practice, and, technology, teaching and student learning.
- Question one, phase one (available at Appendix A.4) required reframing. The concept of mentors was too narrow. A review of data suggested that mentors are one aspect of influence however, there were others such as, literature read, conferences attended, one’s own learning experience, and, one’s own learning preferences. This question was reworked, and additional components added which align to the axial code, ‘influences of others’. According to Dictionary.com (2015) influence is about “the power to have an important effect on someone”. In the context of this project, influence of others is a determinant of pedagogical thinking. At the conclusion of phase one these influences included mentor, literature and professional development, and provide a spring board for eliciting other factors. There was also a need to gather data about the cognitive factors that influence pedagogy. Farlex Inc. (2011) describes a cognitive factor as “something immaterial (as a circumstance or influence) that contributes to producing a result ... a cognitive factor that tends to have an effect on what you do”.
- Question two phase one (available at Appendix A.4) was rephrased and grouped under question one casual influences of teaching, as key moments or experiences can influence teaching philosophy.
- Question three phase one (available at Appendix A.4) was grouped under quality teaching with three additional questions included. These questions provided further depth and reflective responses from the interviewees than the original

questions. They explored notions of quality teaching from the perspective of the teacher and the teacher's perceptions of their students' notions of quality.

- Question four phase one (available at Appendix A.4) was grouped under teaching practice with an additional question included. This question, gathered data about the teaching environment, including the internal and external environmental influences on teaching.
- The remaining phase one questions 5, 6, 7 and 8 were grouped under the final heading; technology, teaching and student learning. An additional question (question f), was included. This question aimed at gathering data about the teacher's relationship with technology, and any influence on their practice. The second part of the question was aimed at uncovering the cognitive factors of influence.

Refer to Appendix B.5 for a copy of the full phase two interview protocol. Interview questions were mapped to research questions in order to ensure full data coverage. Refer to Appendix D for an alignment of research and interview questions.

4.6.2 Final coding: Selective coding

The final coding cycle conducted was selective coding. Birks and Mills (2011) refer to selective coding as an advanced coding technique. Advanced coding is essential for theoretical integration. All interviews were included in the analysis.

Open, axial and selective coding was carried out in a simultaneous fashion. The following activities were performed:

• identify any additional open codes;	open coding
• identify, refine and clarify axial codes and properties;	axial coding
• develop axial paradigm models;	
• identify core category;	selective coding
• identify relationships between categories; and	
• develop a conceptual storyline.	

The processes of open and axial coding were conducted repeatedly throughout the grounded theory coding lifecycle. Building on Charmaz's (2006) approach to use verbs and nouns when coding, attempts were made to use gerunds in line with Denzin and Lincoln's (2011) approach. A gerund also referred to as a verb-noun, or verbal noun, is a verb ending in *ing* that functions as a noun, for example wash and wash*ing*, or litter and litter*ing* (McKenzie, 2004; Nash, 1998). Denzin and Lincoln (2011) suggest using gerunds as they simply the process of identifying relationships between categories.

There are no set rules in the literature which state how long quotes and extracts should be, and how many should be used for each code. However, some researchers argue for at least two different quotations from two different people to support each argument. While Gibbs (2013) recommends using only the best quote, and using several quotes if they illustrate a range of different responses. Glaser and Strauss (1967) suggest if one quote resonates with the researcher and provides the opportunity to reflect, conceptualise and abstract then this is appropriate. A mix of these approaches was adopted. The majority of the codes in the project contain at least two quotes from two different interviewees, this approach was used in conjunction with Gibbs' (2013) technique, selecting the best quote, and there were some codes which contained only a single quote in line with Glaser and Strauss' (1967) recommendations. To preserve the anonymity, places, names etc were edited out of interviewee quotes. Where the interviewee mentioned another person's name, it was deleted, and text inserted [name]. Likewise, for places [place], university names [university], and university proprietary software [software].

During each cycle and iteration, open codes, axial codes and categories were reviewed and refined, in terms of names, content and meaning moving from mostly descriptive codes to analytical style codes (Birks & Mills, 2011), until data saturation was reached, and the final coding structure completed. The finalised coding structure comprised four categories, further divided into 18 axial codes, and 78 properties (see Chapter 6.2). This is consistent with educational research projects which typically have 80-100 codes (Saldana, 2013).

4.6.2.1 Axial paradigm model

A paradigm model was developed for each of the four categories; pedagogical development, teaching practice, technology adoption and techno-pedagogical practice. In this study, the paradigm model was used to facilitate background thinking and conceptual understanding, and provided a lens to analyse data from a different perspective (Dunican, 2006; Heath & Cowley, 2003). It has also assisted with identification of relationships between categories (Charmaz, 2006; Corbin & Strauss, 2008). In this study, the paradigm models were used as a lens to view data from a different angle alongside the coding framework developed. Corbin and Strauss's (2008) process of grouping interviewee responses to a series of questions in order to determine conditions, interactions and consequences was applied to facilitate paradigm development for each category. For details of the paradigm models, refer to Chapter 6.4.

4.6.2.2 Core category

The core category characterises the central phenomenon of the research (Corbin & Strauss, 2008), and is crucial because it is the category from which the emergent theory evolves (Glaser 2001; Goulding 2002). The high impact category (Glaser, 2007), techno-pedagogical practice emerged as the core category in this study. The phenomena of interest technology and-pedagogy, combined naturally during the iterative processes of coding, conceptual memo writing and theoretical sampling (Holton, 2010; Ng & Hase, 2008).

Guidelines provided by Dey (2008), Holton (2010) and Corbin and Strauss (2008) were adopted as a technique for guiding identification of the core category. These state that the core category:

- Be well connected to other categories.
- Mentioned with high frequency.
- Be logical and consistent.
- Take longer to saturate than other categories.
- Have clear implications for a more formal theory.

- Be powerful in its explanatory power aiding the researcher to carry through the analysis to a successful conclusion.

For a description of the core category—techno-pedagogical practice—refer to Chapter 6.3.4. For a discussion of the application of the above criteria validating selection of the core category, refer to Chapter 7.5.5.

4.6.2.3 Relationships between categories

Relationships between the core category and the other categories were identified through the assistance of the paradigm models (Grbich, 2007), as well as the implementation of GT processes including memo writing, diagramming, sorting and constant comparative analysis. This study, examined the relationships between pedagogical development, teaching practice, technology adoption and the core category techno-pedagogical practice. The paradigm models provided context, through identification of conditions, interactions and emotions, and consequences (Corbin & Strauss, 2008). For details of the paradigm models, refer to Chapter 6.4, and for details of the relationships between each category refer to Chapter 8.2.3.2.

4.6.2.4 Storyline

According to Strauss and Corbin (1990) the storyline is the conceptualisation of the core category. The 'storyline' describes 'what happens' in the phenomenon that is being studied. A story emerged through the writing of memos and the development of multiple iterations of diagrams (Birks & Mills, 2011). In narrating these memos, the researcher adopted Corbin and Strauss' (2008) approach by considering the following questions:

- What is the main issue or problem being grappled with?
- What keeps striking me over and over when I read these interviews?
- What comes through in the data though it may not be said directly? (p. 107)

No final formal storyline is offered in line with later iterations of Corbin and Strauss' texts giving less prominence to this approach (Birks & Mills, 2011). However, the story, which emerged through writing memos and diagramming, was a valuable aid to researcher in assisting with conceptualisation of the data, the formulation of categories, and their interrelationships.

4.6.3 Memoing, diagramming and constant comparison

The memoing approach adopted in phase one was continued during phase two. Memos were used over the duration of the project to develop complexity, depth and conceptual thinking. The constant comparative process of data analysis was used as a guide for collection of additional data. Some experimentation with the use of the memo function in NVivo was undertaken. NVivo is a costly piece of software for which the researcher had limited access. The cost factor was prohibitive in obtaining an additional license to facilitate a ubiquitous work approach. Memos continued to be developed using MS Word. During phase two, an additional 34 memos were written containing reflections on interview data, grounded theory codes, themes and conceptual ideas. Refer to Appendix B.6 for a sample memo from phase two.

Models continued to be created using a combination of MS Word, Adobe Illustrator and Adobe Photoshop. Multiple versions and styles of models were developed and used to refine ideas and illustrate the substantive theory. An additional 17 models were developed during phase two. Refer to Appendix B.7 for a sample model from phase two.

4.6.4 Theoretical saturation

Data saturation is achieved through continuous data collection until no new evidence emerges which can inform or underpin the development of a theoretical point or reveals new categorical properties (Charmaz, 2006; Dick, 2005; Goulding, 2007). As previously discussed in Chapter 4.5, twenty-five interviews were conducted. Theoretical saturation was first experienced during interview 19 and by interview 24 theoretical saturation had occurred. An additional interview was carried out which provided no new theoretical insight. At this point data collection was halted in line with Strauss and Corbin (1990) who suggest theoretical saturation occurs when no new codes are identified and categories are conceptually well developed with clearly stated axial codes and properties (Birks & Mills, 2011).

4.6.5 Sorting

Charmaz’s (2006) technique for sorting, comparing and integrating written memos manually was not implemented as it was felt to be inefficient and difficult to manage as the number of memos grew. An electronic approach was utilised, aiding efficiency, and minimising paper wastage. Memos were individually named by theme, dated and versioned, this technique facilitated easy location and retrieval. It was also convenient to add to existing themes using a versioning approach.

4.6.6 Final stage: Develop theory

Each step in the grounded theory process built upon the previous, by arrival at the final step, a basis of the substantive theory—the theory of techno-pedagogical practice—had naturally emerged. The substantive theory was refined through the synthesis of the axial paradigm models, discovery of the core category, identification of relationships between categories, memo writing, and diagramming, sorting and constant comparative analysis. Following is an outline of the approach adopted to develop, evaluate and publish the substantive theory of this study.

Birks and Mills (2011) and Strauss (1987) approach was followed in order to develop the substantive grounded theory:

1. Identify the core category.
2. Develop an accumulation of analytical memos.
3. Theoretically saturate the major categories.

Refer to Chapter 4.6.2.2 the category—techno-pedagogical practice—emerged as the core category of this study, fulfilling Birk and Mills (2011) and Strauss’ (1987) first criteria of identifying a core category. Refer to Chapter 4.5.3 and 4.6.3, seventeen memos were written in phase one and an additional 34 in phase two a total of 51 analytical memos. These ranged in depth and length, satisfying criteria two of developing an accumulation of analytical memos. Finally, for details of criteria three see Chapter 4.6.4. Theoretical saturation was first experienced during interview 19 and by interview 24 saturation was reached, an additional interview was conducted, to ensure saturation of the four major categories.

The substantive theory was evaluated using Strauss and Corbin’s approach of applying eight conceptual questions. See Chapter 3.5.4.10 for a list of these questions, and Chapter 8.2.5 for a discussion of their application.

The final substantive theory in the form of a model and accompanying descriptive narrative is available in Chapter 8.2.

4.7 Summary and conclusion

This chapter commenced with details of the study, ethics, and data handling procedures. This was followed by a description of each of the two phases of the study using the Straussian GT approach adopted. The description of phase one included details of the data collection approach, open and axial coding, facilitated through the processes of memoing, diagramming, and constant comparative analysis. The phase two discussion presented details of the above, as well as the selective coding phase.

The application of Straussian grounded theory was found it to be complicated and laborious. There were multiple iterations of the three interlinked coding phases and the building of a complex paradigm model. It was also time-consuming due to the theoretical sampling, memoing, diagramming, and constant comparison analytic tools utilised. However, it was found to be effective, offering robustness and a level of confidence that the data gathered and interpreted follow a strict set of guidelines and procedures.

The next chapter provides an outline, detailed description, and set of sample quotes composing the draft code structure for phase one.

5 Phase 1 – Results

5.1 Introduction

The previous chapter provided a detailed description of the grounded theory process used to gather and analyse phase one and phase two data. The aim of this chapter is to present phase one data results in a structured code format.

This chapter commences with an outline of the draft code structure for phase one (the final refined version is presented in Chapter 6). Following is a descriptive narrative, which details each level of coding and accompanying interview data. Finally, a brief discussion, which describes the need and direction of the phase two data collection.

5.2 Phase 1 – Draft code structure

Details of the grounded theory methodology and its implementation strategy for this research have been described previously in chapters three and four. Coding was separated into two phases. The coding approach utilised in phase one consisted of identification of: open codes, axial codes and axial properties. As part of the axial coding process, preliminary categories emerged (these categories became the basis of selective codes in phase two). In both phase one and two, coding was conducted over multiple passes in an iterative bottom up fashion, utilising the process of constant comparison (see Chapter 3.5.4.3). Formalisation and refinement of the coding structure was completed in phase two (see Chapter 6.2).

Four draft categories emerged during phase one; ***pedagogical development***, ***teaching practice***, ***technology adoption***, and ***techno-pedagogical actualisation.*** A brief description of each of these categories follows. Please note these categories were further refined and finalised during phase two.

- ***Pedagogical development*** describes IT academics' philosophy of teaching. This includes attitudes, experiences and reflections that inform and influence beliefs guiding teaching practice. For example: teachers’ understanding of student engagement and motivation.

- ***Teaching practice*** describes approaches and techniques which illustrate the behavioural act of teaching. This is about the practical aspects of teaching. For example, the teacher’s approach to assessment and delivery, the teacher’s technical expertise, and the university policy, processes and practice.
- ***Technology adoption*** describes the types of technologies used to facilitate student learning, teaching preparation, research and administration. Also included are the affordances and constraints of these technologies and rationalisation of its acceptance or rejection. For example, details of the teacher’s technology miscellany, and anecdotes describing technology use.
- ***Techno-pedagogical actualisation*** describes changes in the teacher’s philosophy and practice resulting from technology adoption, facilitating the merging of technology and pedagogy. For example, the use of specialist software to encourage students to explore and learn.

Each preliminary category consisted of a number of axial codes and associated properties. The ***pedagogical development*** category was represented by six axial codes. Each axial code contained a number of descriptive properties. The ***teaching practice*** category contained four axial codes, each with two or more descriptive properties. The ***technology adoption*** category contained four axial codes each with two or more descriptive properties, and finally the ***techno-pedagogical actualisation*** category contained two axial codes, each with two descriptive properties.

An outline of the phase one draft summary code structure is provided in Table 5–1. The summary is sorted by: category | axial code | properties.

Table 5-1 Phase 1 – Draft Summary Code Structure

Category	Axial Code	Properties
Pedagogical development	Discipline preference	Logic based Skills based
	Influence of others	Literature Mentor Professional development
	Language used	Educational Technical
	Pedagogical development constraints	Industry experience Self-confidence
	Quality teaching attributes	Caring Communicator Honest Passionate
	Understanding of students	Engagement and motivation Learning approach
Teaching practice	Assessment considerations	Assignments Examinations Tests
	Discipline expertise	Computer Science Information Technology Mathematics and Statistics
	Teaching approach	Laboratories Lectures Tutorials
	University management and administration	Imposed policy Imposed process and practice
Technology adoption	Affordances	Communication Delivery Interest
	Constraints	Bandwidth Complexity Culture Fear and apprehension
	Exemplars	Student learning Teaching administration Teaching preparation Teaching research
	Repertoire	Hardware Software
Techno-pedagogical actualisation	Contemporary learning strategies	Applied Technology enhanced
	Convergence	Student learning and technology Pedagogy and technology

5.3 Phase 1 – Draft code description

A detailed description and illustration for each of the four emerging categories, and their associated axial codes, properties and sample interview quotes are included in the following sections.

5.3.1 Pedagogical development category

The ***pedagogical development*** category describes factors that inform IT academics' philosophy of teaching and learning. These aspects represent the thinking behind the practice. For example, the influence of literature, the support of mentors, and values attributed to quality educators. Figure 5–1 provides a visual representation of the draft ***pedagogical development*** category code structure. This is an extract of data presented in Table 5.1.

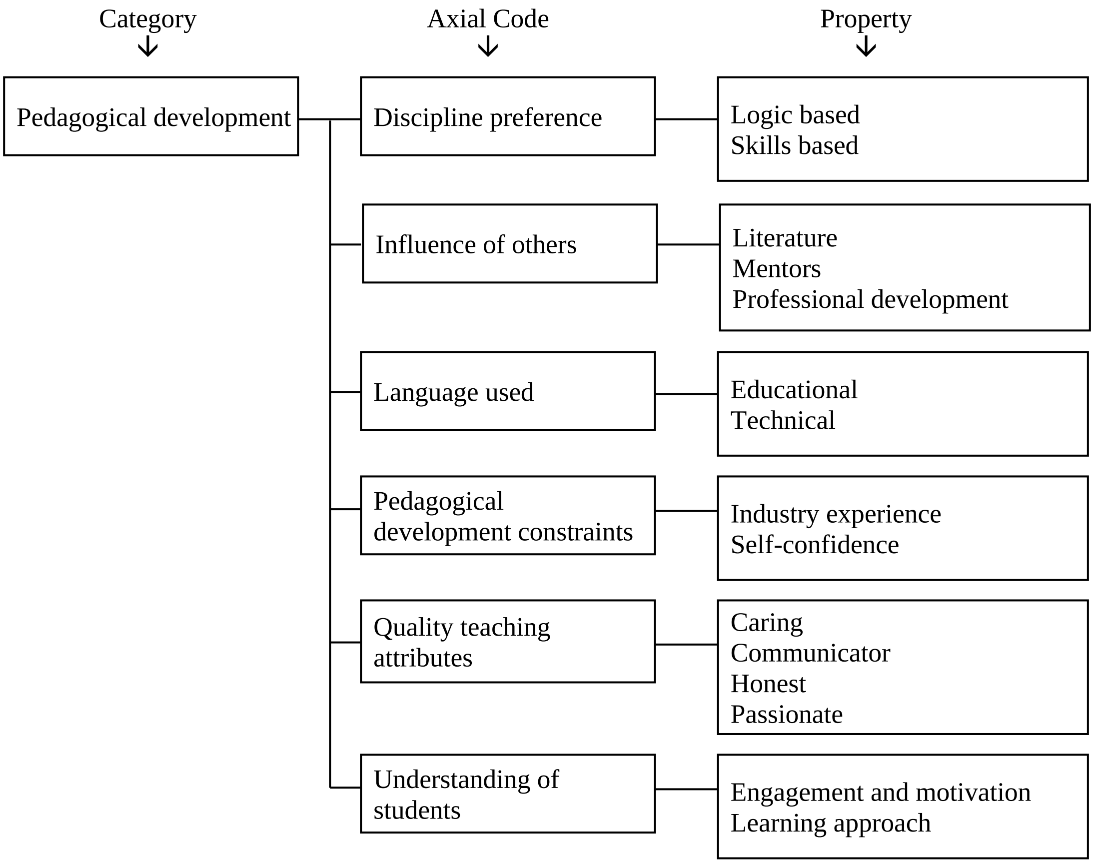


Figure 5-1 Phase 1 – Visual Summary of Draft Pedagogical Development Code Structure

This category consists of six axial codes, which aid understanding of IT academics' pedagogy formation and development. The axial codes include; *discipline preference, influence of others, language used, pedagogical development constraints, quality teaching attributes,* and *understanding of students*.

5.3.1.1 Discipline preference

Discipline preference represents the identification of learning and teaching techniques tailored to various sub-discipline areas of IT, and how these emerge from educators' own experiences and preferences. This axial code contains two properties: *logic-based*, and *skills-based*.

- The *logic-based* property represents IT academics' preferences for teaching content which requires logic, reasoning and systematic thinking, such as programming.
- The *skills-based* property represents IT academics' preferences for teaching practical, applied or real-world content. Skills based content is typically composed of tasks that are intended to provide experience based on repetitive practice, such as application software.

See Table 5–3 for a sample of interview quotes which describe the *discipline preference* axial code.

Table 5-2 Sample Quotes Representing Discipline Preference

Property	**Sample Interview Quotes**
Logic based	I3: "I've taught that in Java, C and C++. I enjoy that one, I find it a challenge, because the students come in, and to me programming is a completely different way of thinking, it's very logical and you have to follow steps, and there [are] rules."
Skills based	I2: "We are focussed on practical skills over understanding of theory." I2: "Very much skills based."

5.3.1.2 Influence of others

The *influence of others* represents the development of IT academics' teaching philosophy as a result of counselling, guidance and lessons learned from professional development activities and various teaching role models such as mentors. This axial code contains three properties: *literature, mentors,* and *professional development*.

- The *literature* property describes reflections from reading and researching the published experiences of other academics, for example, academic textbooks. These inform the development of pedagogical philosophy and teaching practice.
- The *mentors* property describes experiences and guidance from other IT academics that influence thinking and approaches to teaching, for example peer reviews.
- The *professional development* property describes teaching innovations discovered through participation at research conferences and other activities, for example demonstration of effective presentation skills.

See Table 5–2 for a sample of interview quotes which represent the *influence of others* axial code.

Table 5-3 Sample Quotes Representing Influence of Others

Property	**Sample Interview Quotes**
Literature	I1: "The educationally critical aspects. Somehow, they need to be determined. Often it is by reading the research of other people." I3: "So I went through and decided, ok, what are the topics that we need to go through? What's a good order? I looked in text books, and online and I looked at other courses that people had delivered." I4: "I tend to look at books, up to date, but making increasing use of the Internet."
Mentors	I2: "We have the policy of a couple of times a year sitting in on someone else's lecture and getting them to do the same thing for you, and that's what I noticed some of the good teachers doing." I3: "I had him as an undergrad here, I found him fantastic because he just had that really good teaching style, really open and really helpful, his lectures were entertaining. He wasn't the monotone that stood up the front and he really verbalised it well." I3: "In the way that he presented, he made it entertaining and it wasn't just delivery of the material, he went through it different ways so that different people would understand it." I4: "We used to discuss various ways of doing things. And as a young teacher it was also good to have a senior person, who was, not so much a protector, that [is] to strong a word but a supporter with some strength and some credibility."
Professional development	I3: "I went to a conference and they highlighted the idea of early assessment." I4: "I watched her give a presentation one day, I watched her pause, and I thought, ah yes, that's effective."

5.3.1.3 Language used

Language used provides examples of IT academics' using educational and technical language. It includes IT academics' describing teaching and learning experiences using colloquial or folk language consistent with educational frameworks and theories presented in the literature. It also includes technical language adopted by IT academics, related to IT discipline specialisations. This axial code contains two properties: *educational* and *technical*.

- The *educational* property provides examples of colloquial language used by IT academics when discussing teaching and learning, for example dividing learning content into small parts.
- The *technical* property describes language used by IT academics when discussing specialised expert knowledge and skills related to IT professions, such as programming terminology.

See Table 5–4 for a sample of interview quotes from the *language used* axial code.

Table 5-4 Sample Quotes Representing Language Used

Property	**Sample Interview Quotes**
Educational	I1: "They go to a lecture maybe do the homework problems, build up that foundation, build on it for the next portfolio. So, it's a building process." I3: "I would try and design it so that they could work on small parts each week and encourage them in the class."
Technical	I3: "Generally with programming units I try and have and an early assessment task ... I had them working on terminology, because I'm a firm believer in that they understand what the terms are and that they can talk about them." I4: "A well rounded lecturer will have research interests and research experience, will have commercial experience, to get good understanding of the way in which IT is used in the world, as well as a good theoretical knowledge of IT."

5.3.1.4 Pedagogical development constraints

Pedagogical development constraints describe IT academics' perceived obstacles to pedagogical development. This axial is about constraints that limit or act in a prohibitive fashion so that IT academics feel like they can no longer develop and enact their pedagogy in a natural way. This axial code contains two properties: *industry experience*, and *self-confidence*.

- The *industry experience* property reflects IT academics' lack of work experience in industry and the limiting impact this has on being able to include practical examples when teaching, for example limited understanding of the application of IT in the commercial world.
- The *self-confidence* property describes IT academics' reported lack of self-confidence in their teaching, and its resulting impact on their thinking and teaching approach, for example making mistakes on the board in front of students.

See Table 5–5 for a sample of interview quotes describing the *pedagogical development constraints* axial code.

Table 5-5 Sample Quotes Representing Pedagogical Development Constraints

Property	**Sample Interview Quotes**
Industry experience	I4: "I have never been involved, apart from minor projects, with the commercial and business side of IT." I4: "I have never left school since I started kindergarten, and I've seen that as a deficiency in my education. I haven't had the commercial experience." I4: "I just think that a well-rounded lecturer will have research interests and research experience, will have commercial experience, to get good understanding of the way in which IT is used in the world, as well as a good theoretical knowledge of IT."
Self-confidence	I3: "I'm making more mistakes, I don't know what it is, I think it's the level of pressure that we work under, the large groups, and the stress situation, [or] me perhaps less able to cope with the situation."

5.3.1.5 Quality teaching attributes

Quality teaching attributes describe characteristics identified by IT academics as those embodied by quality (great) teachers. As mentioned previously (see Chapter 4.6.1.1) in this study a quality (great) teacher is one considered to be wonderful, first-rate, or very good. Commonality was observed in the notion of what makes a great teacher. IT academics indicated being a good communicator, identifying with the feelings of students, and engaging and amusing students as key characteristics. Also, being fair and sincere, and having a strong desire and enthusiasm for teaching as the main attributes for great teachers. This axial code contains four properties: *caring*, *communicator*, *honest*, and *passionate*.

- The *caring* property describes IT academics nurturing and fondness for their students' welfare and learning, for example being sympathetic and taking an interest in students as people.
- The *communicator* property identifies the presence of good communication skills facilitating effective two-way communication between educators and students of varying abilities, for example being able to explain a concept in different ways.
- The *honest* property describes IT academics' philosophy of truthfulness, straightforwardness, and conduct of trust and integrity, for example teachers admitting to a lack of knowledge or understanding regarding a particular concept.
- The *passionate* property describes IT academics' affection and interest in their students, and the content being taught, for example discussions with students raising ideas and concepts beyond the scope of the course.

See Table 5–6 for a sample of interview quotes describing the *quality teaching attributes* axial code.

Table 5-6 Sample Quotes Representing Quality Teaching Attributes

Property	**Sample Interview Quotes**
Caring	I1: "The most important feature of a good teacher is that they care about their students." I2: "Try to be as sympathetic as you can be." I4: "An interest in students as people."
Communicator	I3: "They have to be a good communicator, and to different levels, so it can't just be, being able to, they have to be able to explain things in ways that various different people understand. So, you can't just be at the high level, with the higher students, especially here because we have such a range, you have to be able to deliver it in a number of different ways and look at it from different perspectives."
Honest	I2: "One of my key philosophies is never being afraid to say I don't know." I3: "Admitting to something when you are out of your depth, so that if a student asks a question that you are not sure of, don't bluff your way out of it."
Passionate	I2: "Enthusiasm an absolute must. If the teacher doesn't seem to be interested in the topic it is very hard to expect the students to be enthused about it either." I2: "He was very enthusiastic, always available to talk to you about things, even beyond what was actually being taught in the course." I4: "A love of what you are teaching, the content. Passion and demonstrating a passion for my students and for what I am teaching."

5.3.1.6 Understanding of students

Understanding of students encapsulates IT academics' reflections and perceptions of motivational triggers and learning requirements of students. This axial code contains two properties: *engagement and motivation* and *learning approach*.

- The *engagement and motivation* property describes considerations, motivational techniques, stimuli and encouragement approaches used by IT academics aimed at keeping students focussed on learning, such as using examples from real life to illustrate an idea.
- The *learning approach* property describes assumptions IT academics make about students' preferences and approaches to learning, for example lab work designed to suit learners who prefer hands on tasks.

See Table 5–7 for a sample of interview quotes from the *understanding of students* axial code.

Table 5-7 Sample Quotes Representing Understanding of Students

Property	Sample Interview Quotes
Engagement and Motivation	I1: "I encourage them to get involved with their learning. The best students are mature age students, who have had some experience of life, and are aware of how much they are paying for it, and want to make, and want to get their money's worth." I3: "Keep it entertaining, so you will engage the students. I can remember one year I was reading a book, like just a fiction book as I was doing my hair, and there was a bit in there where they were doing some stuff on Unix. So that day I photocopied that in and put that up as an overhead."
Learning approach	I1: "I change things a lot and approach concepts from a number of different directions, so that it picks up on the different sorts of learners in my classroom, and in that I gotten in mind the visual learner, the audio learner." I2: "In particular the lab exercises are quite often larger than they can finish in the lab time, particularly when they have only one-hour labs. So, I am not trying to keep everyone in lock step, going through things at the same time, if someone needs longer to carry out a particular exercise then they can do it at their own speed." I4: "The lab work is wonderful for the kinaesthetic students. I think the PowerPoint has probably [satisfied visual learners rather] than the auditory learners. The auditory learners have always had somebody speaking to them."

5.3.2 Teaching practice category

The ***teaching practice*** category describes strategies, techniques, and implementation of practical teaching approaches. For example; assessment schemas, discipline knowledge and expertise, methods of teaching in various contexts, and policy guiding practice. Figure 5–2 provides a visual representation of the draft ***teaching practice*** category code structure. This is an extract of data presented in Table 5.1.

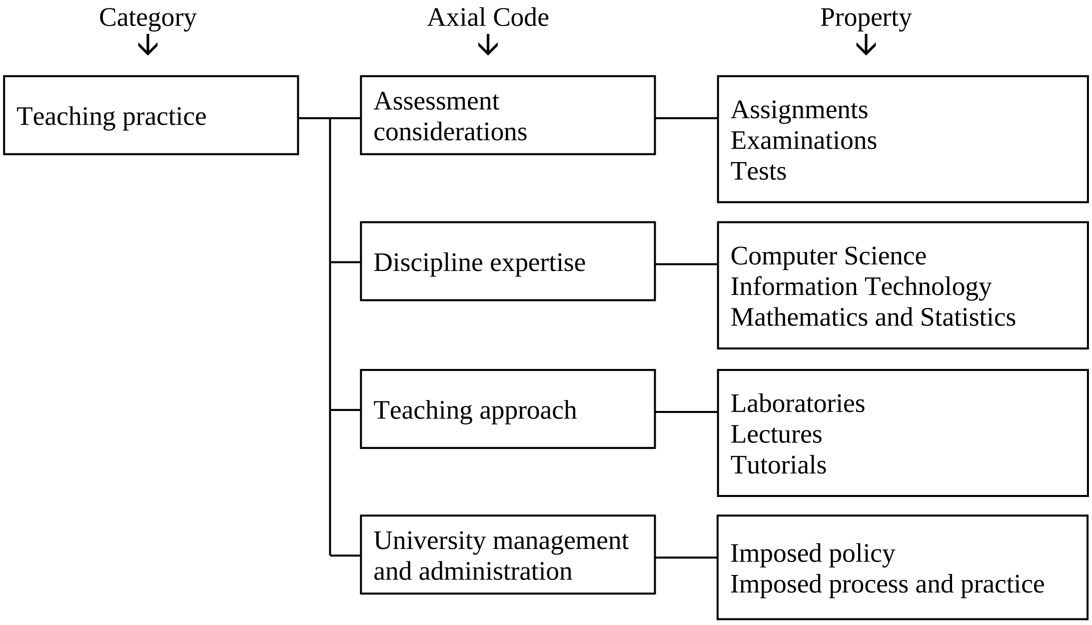


Figure 5-2 Phase 1 – Visual Summary of Draft Teaching Practice Code Structure

This category includes four axial codes, which aid understanding of strategies, techniques and the implementation of IT academics' practical teaching approaches. The axial codes include; *assessment considerations*, *discipline expertise*, *teaching approach*, and *university management and administration*.

5.3.2.1 Assessment considerations

Assessment considerations define IT academics' approach to assessment tool development and application. This axial code contains three properties: *assignments*, *examinations* and *tests*.

- The *assignments* property describes IT academics' thoughts and approaches to content creation, and implementation of assignments, for example the quantity and distribution of assignments in any given course across a semester.
- The *examinations* property describes IT academics' approaches towards content, type and usefulness of summative assessment, for example adopting an open book examination.
- The *tests* property describes views of processes and thinking in relation to supervised testing, for example the frequency and assessment value of in-class tests.

See Table 5–8 for a sample of interview quotes describing the *assessment considerations* axial code.

Table 5-8 Sample Quotes Representing Assessment Considerations

Property	**Sample Interview Quotes**
Assignments	I1: "I introduced a portfolio assignment which involved every two weeks working individually on two or three questions from the text. Then swapping them around so they did a peer review of other peoples' work." I4: "With assignments I try and think about the experiences that I think that the students should have when they are doing a particular course. So, giving them a chance to do things – assignments they'll actually learn quite a lot from."
Examinations	I1: "You must have a fifty percent exam. [pause] and that changes assessment from being formative to being summative, and when it is summative it is too late to fix [pause] and so I would prefer to have portfolio sessions, mid semester test, and a final test, and have the final test not actually worth very much at all." I4: "I see advantages of having open book exam, is that it forces you to think carefully about what questions you want to ask. The second reason I don't have a problem with open book exam, when somebody during there working life has got a problem they have their resources in front of them to deal with that problem."
Tests	I1: "Every second week, they had a test, and because it was worth four marks each time, they came to class for those sessions. I think that was a very successful innovation that I trialled."

5.3.2.2 Discipline expertise

Discipline expertise defines expert technical knowledge and course specialities of IT academics. This axial code contains three properties: *Computer Science*, *Information Technology*, and *Mathematics and Statistics*.

- The *Computer Science* property describes the teaching area of science that deals with the theory and methods of processing information in digital computers, the design of computer hardware and software, and the applications of computers (Dictionary.com, 2015). For example, a Computer Science academic who specialises in teaching programming using languages such as Java and C.
- The *Information Technology* property describes the teaching area of development, implementation, and maintenance of computer hardware and software systems to organise and communicate information electronically (Dictionary.com, 2015). For example, an IT academic who specialises in teaching database and networking.
- The *Mathematics and Statistics* property describes the teaching area of measurement, properties, and relationships of quantities and sets, using numbers and symbols, and the science of collecting and analysing numerical data in large quantities (Farlex Inc., 2011; Oxford University Press, 2015).

See Table 5–9 for a sample of interview quotes describing the *discipline expertise* axial code.

Table 5-9 Sample Quotes Representing Discipline Expertise

Property	**Sample Interview Quotes**
Computer Science	I2: “Teaching background is primarily in the programming side of computer science.” I3: “It’s predominantly that first-year programming unit. I’ve taught that in Java, C and C++.” I4: “Main teaching areas tertiary – programming, software engineering.”
Information Technology	I1: “I have a longitudinal overview of the development of IT in schools and in universities. My sessional experience has meant that I’ve become very flexible in my teaching areas and [I] teach the gamut across IT, Maths and Stats.” I2: “I have taught a fairly broad range of things, Multimedia a little bit of databases, some networking, and software quality assurance.” I4: “Professional development.”
Mathematics and Statistics	I1: “[I] teach the gamut across IT, Maths and Stats.” I4: “Statistics.”

5.3.2.3 Teaching approach

Teaching approach describes teaching strategies, techniques and informal instructional models (such as face-to-face or online learning) adopted and implemented by IT academics in various learning contexts. The teaching approach axial code contains three properties: *laboratories*, *lectures*, and *tutorials*.

- The *laboratories* property describes IT academics' thinking and approach to teaching skills in a hands-on context (computer labs), where activities build on and apply knowledge delivered in the lecture, for example the use of extension activities, to encourage students who are progressing well.
- The *lectures* property describes IT academics' thinking and techniques when delivering theoretical content using a variety of styles including the traditional sage on the stage, to the guide on the side (see Van Ast, 1997), for example maintaining close proximity to the console while lecturing.
- The *tutorials* property describes IT academics' thoughts and approach to working with students in smaller groups on the application of theory using group based sharing and interactive techniques, for example activities promoting collaborative learning amongst students.

See Table 5–10 for a sample of interview quotes describing the *teaching approach* axial code.

Table 5-10 Sample Quotes Representing Teaching Approach

Property	Sample Interview Quotes
Laboratories	I2: "Labs, my tendency has been to give very detailed written instructions and then to a large extent, leave the students to their own devices, circulate round the room, answer questions as they arise." I2: "[What] I tend to do is to have an extension section at the end of the lab. So, ok you've got to this point, you've got the basics of this game working, now try adding this function to it, and so the students who are going well can go ahead with it." I3: "I think you can go back and work on the lab sheets, spend time, more time practising, because it's important that they practice their skills on a computer." I4: "I might introduce some lab work in lectures, but I regard that time as student time, normally the content of the lab sheet will be more than say the fifty minutes which is assigned to the students, so I want them to get on with it, and to get to the stage on the lab sheet [where] they feel reasonably confident they should be able to finish it off on their own."
Lectures	I1: "I don't think lectures are a very efficient way of learning [pause] and I try and run my lectures more like classrooms, where I say something [then] they do something." I2: "I was very much in the old chalk and talk style. Then we merged with a different school, and that school very much had the tradition of using PowerPoint instead. I set the slides going and I'm off to all parts of the lecture theatre."

Property	Sample Interview Quotes
	I3: "I'll wander in and have a bit of a chat with students while I'm setting up, I'll ask them how their week's been, what they've been doing, how people are going on assignments, that sort of thing, so pretty informal before I start. [Then] delivery wise I try and deliver a bit of content then provide an example, so I do it quite step-by-step." I4: "I tend to stick pretty close to the console, because I do rely on the PowerPoint slides for recall for me during the lecture ... I like to be physically close ... so that I'm part of the group [and] it's not just a narration from afar."
Tutorials	I1: "I found that during tutorial students were often working on their portfolio questions with each other, and that kind of talking is good." I2: "Tutorials I tend to still be more interactive. So, I might give the students a few minutes to work through a couple of questions, then we'll get together as a group and compare answers." I4: "With the lab and tutorial my expectation is that I have the materials prepared, so programs for the tutorials and labs for students to follow, and that I have actually tested."

5.3.2.4 University management and administration

University management and administration describes the influence of university management, administrative, and legislative requirements which guide teaching. The university management and administration axial code contains two properties. These include; *imposed policy*, and *imposed process and practice*.

- The *imposed policy* property describes rules and guidelines imposed by management and university governance which impact on IT academics' pedagogical approach, for example marking standards.
- The *imposed process and practice* property describes processes and procedures which govern teaching and assessment procedures, for example maintaining the status quo when teaching a course for the first time.

See Table 5–11 for a sample of interview quotes describing the *university management and administration* axial code.

Table 5-11 Sample Quotes Representing University Management and Administration

Property	Sample Interview Quotes
Imposed policy	I1: "Working on the restrictions that we've had where we are not able to give sessional teaching any more than thirty minutes marking per student per semester." I1: "Course descriptions are automated we have very little impact. Indeed, the only thing that I get to put in it is the assessment tasks [pause] and what they are allowed to use in the exam."

Property	**Sample Interview Quotes**
Imposed process and practice	I2: "The approach within this school is generally [that] you don't teach the same subject three years in a row, because generally they try to rotate the subjects around. I can see why they do that, because that means there is back up available if someone leaves or gets sick. It does tend to mean you never quite get to that level in a unit [where] it is routine." I4: "Courses [that] have been developed by other people and the first contact with the course you are encouraged strongly to present the course as it has been presented previously. So that you have the experience of teaching it and understanding the materials that are there, and then you are in the position to make changes."

5.3.3 Technology adoption category

The ***technology adoption*** category describes the types of technologies used in teaching and administration, and the affordances and constraints of these technologies, including rationalisation of their acceptance or rejection. For example, the use of technology to facilitate communication, a catalogue of software adopted, and examples of technology used in teaching and learning. Figure 5–3 provides a visual representation of the ***technology adoption*** category draft code structure. This is an extract of data presented in Table 5.1.

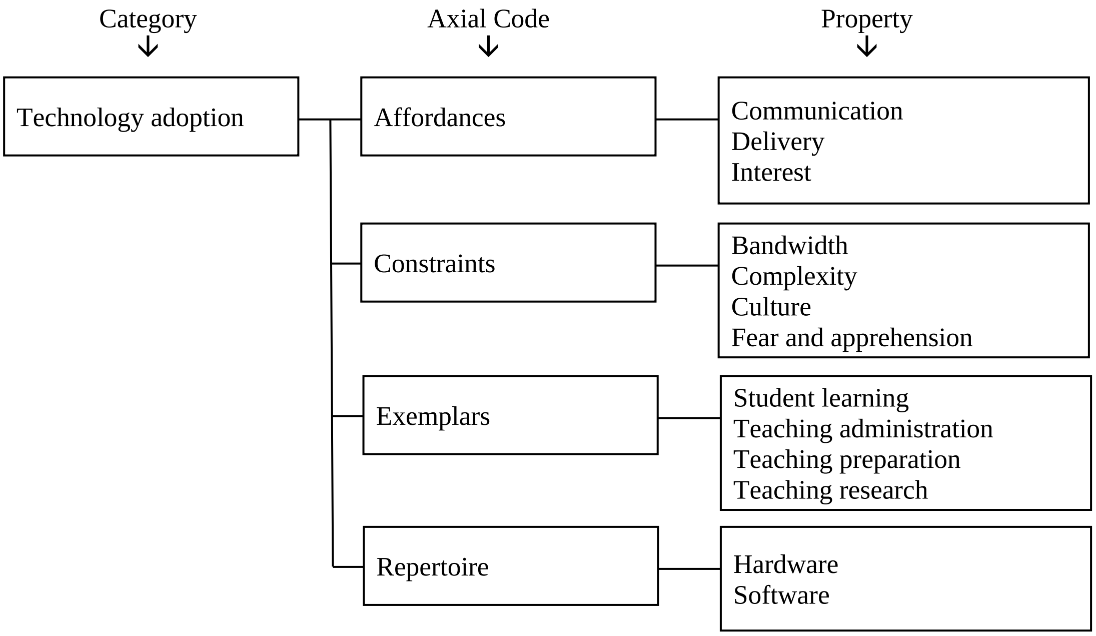


Figure 5-3 Phase 1 – Visual Summary of Draft Technology Adoption Code Structure

This category consists of four axial codes, which aid understanding of technology selection and implementation. The axial codes include; *affordance, constraints, exemplars,* and *repertoire*.

5.3.3.1 Affordances

Affordances define IT academics' reflections and stories of technology improving and adding benefit to learning and teaching. This axial code contains three properties: *communication*, *delivery,* and *interest.*

- The *communication* property describes examples of technology use to aid verbal communication between educator and student in a learning environment, for example use of a mobile microphone.
- The *delivery* property describes examples of technology used to enhance teaching performance, for example animating concepts on slides.
- The *interest* property provides reflections of IT academics discussing the interesting and engaging properties of technology, for example the trialling of new technologies.

See Table 5–9 for a sample of interview quotes describing the *affordances* axial code.

Table 5-12 Sample Quotes Representing Affordances

Property	**Sample Interview Quotes**
Communication	I1: "I can see people struggling with the next step then I'll send the next step to the screen and talk about it, which is getting to be a bit of a problem with my voice, I'm actually going to try to get a mobile microphone."
Delivery	I1: "The laser pointer thing which also moves the slides on. My slides are animated, one step of at a time, no matter what I'm doing, and I can animate those from anywhere in the room. I have been trialling is online delivery of my lectures, and I've been using iSpring. It is an open source software which chunks my audio up according to mouse clicks, and matches each mouse click with a sound byte. Using PowerPoint keeps me on track, I don't get side tracked, I don't forget what it is I want to talk about, I actually go with my plan, rather than go someplace else. I think that is a really important aspect of using PowerPoint."
Interest	I1: "It also gives me an increased level of interest in what I am doing. To be constantly trying out new things is interesting."

5.3.3.2 Constraints

Constraints include IT academics' reflections and examples of technology which limits their teaching practice. This axial code contains four properties: *bandwidth*, *complexity*, *culture*, and *fear and apprehension*.

- The *bandwidth* property describes limitations experienced in Internet connections frequency range, transfer rate and data capacity (Rouse, 2015), for example when using large files.
- The *complexity* property is reported as an inhibitor of adoption in terms of the labour, and the time it takes to master software, for example complex software such as Camtasia.
- The *culture* property represents lack of inspiration to adopt technology. For example, conforming to peer pressure (no one else is using it, so I won't either).
- The *fear and apprehension* property represents observations of missed opportunities to utilise technology in teaching practice, typically due to fear of technology failure, for example deliberately being a generation behind in gaming technologies.

See Table 5–14 for a sample of interview quotes describing the *constraints* axial code.

Table 5-13 Sample Quotes Representing Constraints

Property	**Sample Interview Quotes**
Bandwidth	I1: "One of the problems is the file that you end up with is fairly big, and so download bandwidth issues matter."
Complexity	I1: "I looked at Aadobe Captivate, but that's exceedingly labour intensive."
Culture	I4: "Nobody else is using a lot of different technology. There are things going on in the school, but there not widely being used."
Fear and apprehension	I2: "I'm too afraid of everything going wrong. I didn't buy a CD player until they had been on the market for four or five years, I a generation behind in my games consoles, I just never been the person to go out and grab the technology straight away. I let someone else find all the problems first then adopt it." I2: "I ran into some issues using a multimedia unit a couple of years ago, so I tend not to use that anymore." I4: "I haven't' investigated podcasting or lots of the you know, all the other things that people have got themselves involved in. I'm not exactly a luddite but I'm not one of the leading figures in that area." I4: "I'm conscious that some lax in the research in the business world, but it doesn't stop me from believing that I can help students, as long as some of my colleagues will contribute to my lack and my gaps which I believe happens."

5.3.3.3 Exemplars

Exemplars represent examples of technologies used to support teaching and learning. This axial code contains four properties: *student learning*, *teaching administration*, *teaching preparation* and *teaching research*.

- The *student learning* property provides examples of technology use where the educator outlines its application and purpose to aid student learning, for example using online bulletin boards to promote discussion.
- The *teaching administration* property provides examples of IT academics using technology to support teaching management activities, such as grade entry.
- The *teaching preparation* property provides examples and rationale of technology to develop teaching and learning materials, such as using a scanner to convert text and diagrams into digital form.
- The *teaching research* property represents examples of technologies used in supporting background and sourcing of teaching resources, for example researching concepts using the Internet.

See Table 5–14 for a sample of interview quotes describing the *exemplars* axial code.

Table 5-14 Sample Quotes Representing Exemplars

Property	Sample Interview Quotes
Student learning	I1: “I have posted discussion points each week based on some higher education research findings, and it didn’t get off the ground, it worked for about the first two weeks, and then people were either too busy, or didn’t see the need, or it didn’t help.” I1: “In class I use PowerPoint to present solutions one step at a time. On the screen they will see the next step of a solution and I will be explaining that solution.” I4: "Well PowerPoint for lectures.”
Teaching administration	I1: “For the early teachers’ program at the beginning of the year, I set up a Blackboard shell to provide ongoing support for new teachers to the university.” I2: “They get their marks back through Blackboard and [software].” I3: “I provide the students marks and put them online and then for example we’ve been using Blackboard, so I’ll enter the marks there, get the tutors to enter the marks there as well export it from there and directly import into [software] to eliminate data entry errors.” I4: “In an administrative way I use things like Excel.”

Property	Sample Interview Quotes
Teaching preparation	I1: "I use the scanner a great deal. I use it to turn the written word into editable text. I use it to put diagrams into my work. I use it a lot in the process of animating solutions."
Teaching research	I3: "I'll look at the books, or … look on line, or if it's something in class that we are doing I might say I'll look at the manual or check out the help." I4: "[I am] making increasing use of the Internet."

5.3.3.4 Repertoire

Repertoire provides a list of hardware and software used by educators. This axial code contains two properties: *hardware* and *software*.

- The *hardware* property describes various kinds of devices (machinery and physical components of computer systems) used by educators in the teaching and learning process, such as mobile microphones, and laser pointers.
- The *software* property describes various kinds of programs (instructions interpreted and executed by computers) used by educators in teaching and learning, for example MS Office.

See Table 5–15 for a sample of interview quotes from the *repertoire* axial code.

Table 5-15 Sample Quotes Representing Repertoire

Property	Sample Interview Quotes
Hardware	I1: "CAS calculators ... Laser pointer ... Microphone ... Scanner."
Software	I1: "iSpring ... MS PowerPoint ... MS Word ... Inspiration ... Java Maths World, Eggshell." I2: "Blackboard ... MS Word ... MS PowerPoint ... MS Excel ... Visual Studio ... GL and Ogre graphics libraries." I3: "MS Word ... MS PowerPoint ... Latex ... Eclipse ... WebCT and Blackboard ... Notepad ... Google." I4: "MS Word ... MS PowerPoint."

5.3.4 Techno-pedagogical actualisation category

The ***techno-pedagogical actualisation*** category describes changes in learning and teaching philosophy. This includes changes in teaching practice as a result of technology adoption, facilitating digitally enhanced teaching and promoting student-centred learning practices. For example, the use of technology to facilitate new ways of learning, and the use of specialist technology to support struggling students. Figure 5–4 provides a visual representation of the draft ***techno-pedagogical actualisation*** category code structure. This is an extract of data presented in Table 5.1.

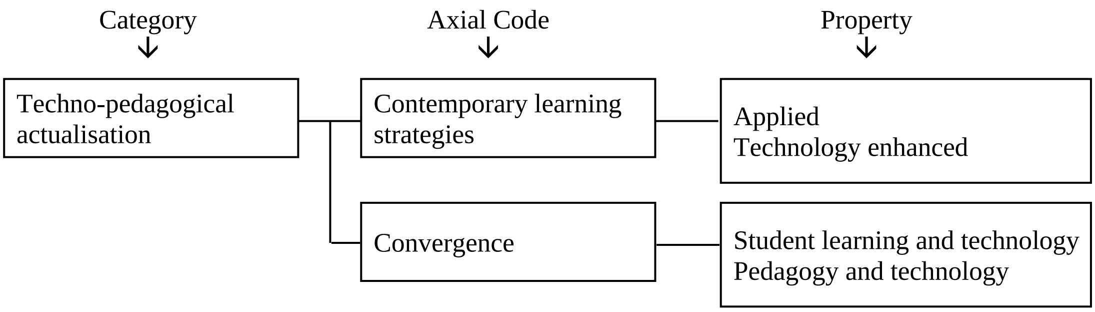


Figure 5-4 Phase 1 – Visual Summary of Draft Techno-Pedagogical Actualisation Code Structure

This category consists of two axial codes, which aid an understanding of pedagogy and technology, and their interrelationship. These axial codes include; *contemporary learning strategies* and *convergence*.

5.3.4.1 Contemporary learning strategies

Contemporary learning strategies describe IT academics' perceptions of learning approaches facilitated using technology. This axial code contains two properties: *applied* and *technology enhanced*.

- The *applied* property describes IT academics' practice of using technology to facilitate workplace related skills. For example, offering learning online in conjunction with work placement requirements. Applied learning is a contextualised approach which motivates students, to develop key skills and knowledge required for employment, further education and participation in the wider community (see Harrison, 2006).
- The *technology enhanced* property describes IT academics using technology to deepen and strengthen the student's learning experience, for example using CAS calculators.

See Table 5–16 for a sample of interview quotes describing the *contemporary learning strategies* axial code.

Table 5-16 Sample Quotes Representing Contemporary Learning Strategies

Property	Sample Interview Quotes
Applied	I3: "The professional practice degree combines university blended learning with real world experience. The degree is spread over a 4-year period to give students time to complete hours for their scholarship in years 2 and 3, and then to be employed for a semester in their final year. Many students are able to complete their final year project as a part of their work placement as well."
Technology enhanced	I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds."

5.3.4.2 Convergence

Convergence describes the joining of technology and traditionally separate spaces, for example the convergence between technology and learning, or between technology and pedagogy. This axial code contains two properties: *student learning and technology*, and *pedagogy and technology*.

- The *student learning and technology* property describes IT academics' reflections on connections between student learning and ET used in the teaching and learning process, for example IT academics using MS Project to allow students to explore project management concepts.
- The *pedagogy and technology* property describes IT academics' reflections on the overlap or relationship between technology and pedagogy, for example IT academics admitting to not understanding the complex relationship between student learning, technology and pedagogy.

See Table 5–17 for a sample of interview quotes describing the *convergence* axial code.

Table 5-17 Sample Quotes Representing Convergence

Property	Sample Interview Quotes
Student learning and technology	I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds." I4: "It will vary from course to course because with a programming unit there is a high use of technology. With software engineering they have to make a great use of case tools, in project management they have made great use of Microsoft project."
Pedagogy and technology	I4: "I don't understand how much overlap there is between education and technology. Because the technology is there, we used it, so on one hand I

Property	Sample Interview Quotes
	might under estimate the amount of overlap, on the other had I might also overestimate the overlap, when I consider the potential.”

5.4 Progression to phase 2

Interviewees in phase one were selected using open sampling (see Chapter 3.5.4.2, and 4.5.1). Initial results highlighted a need to further understand and gather data around the phenomenon under investigation (techno-pedagogy). During phase two a theoretical sampling approach (see Chapter 3.5.4.6, and 4.6.1) was used in order to focus on interviewees who were able to provide data on the phenomenon.

The open sampling approach adopted in phase one enabled discovery of many relevant categories about the phenomenon (techno-pedagogy) under investigation. From the phase one data, four categories emerged: ***pedagogical development***, ***teaching practice***, ***technology adoption*** and ***techno-pedagogical actualisation***. The first three categories provided a basic overview of pedagogy, teaching approach and technologies used by IT academics. Initial analysis of the content and relationships between these categories provided a starting point for understanding the fourth category and the phenomenon under investigation. To more deeply understand the phenomenon of techno-pedagogy, phase two interviewees were selected using the theoretical sampling approach of GT. The theoretical sampling approach enabled the researcher to target interviewees based on the analytical needs of the project.

5.5 Summary and conclusion

Data gathered in phase one was presented in this chapter. A draft code structure, a detailed descriptive narrative, and accompanying sample quotes were provided.

The draft code structure described in this chapter, presents the phase one data in a format ready for review and analysis. It also facilitates some initial understanding, and insight into the research questions under investigation. It offers a structure and starting point for phase two coding. It provides background and direction for population selection, and collection of phase two data.

The next chapter provides a list and rational for coding changes made between phases one and two. This includes deletion of codes, renaming and the inclusion of new codes. This is followed by an outline of the final code structure for phases one and two, and a descriptive narrative detailing each level of coding and accompanying interview data.

6 Phase 2 – Results

6.1 Introduction

The previous chapter provided a draft code structure, a detailed descriptive narrative, and accompanying sample quotes of phase one data. The aim of this chapter is to present the results from phase two data in a finalised code structure format.

This chapter provides an outline and detailed description of the finalised coding framework containing phase one and phase two data. The finalised framework describes categories, axial codes, properties, and supporting quotes. Each section includes a chart detailing coding changes and updates from phase one, also notations clearly identifying the phase to which the axial codes and properties belong. A paradigm model representing each of the four categories is included in the final section of the chapter.

6.2 Phase 2 – Finalised code structure

For details of the grounded theory, methodology and its implementation strategy for this research refer to Chapters 3 and 4. The study comprised two stages of coding with phase two coding building on the draft structure from phase one. Open codes, axial codes, axial properties continued to emerge. The four draft categories from phase one were finalised in phase two during selective coding (the final coding stage) along with the development of the paradigm model. The same approach used in phase one was continued during phase two, including the use of constant comparison with multiple passes in an iterative bottom up fashion (see Chapters 3.5.4.3 and 4.5.3). As the data collection, progressed and understanding deepened, codes were consolidated and refined. Additional codes identified were incorporated. The finalised dataset includes data from phase one and phase two. A complete formalised coding structure emerged.

The four finalised categories at the end of phase two included: ***pedagogical development***, ***teaching practice***, ***technology adoption***, and ***techno-pedagogical practice***. A brief description follows.

- ***Pedagogical development*** describes the factors influencing the development of IT academics underpinning philosophy of teaching. It includes the agency of technology-based discipline preferences, and the impact of people such as family, industry, mentors, etc. Also included are the teacher's discourse and innate use of language, factors constraining thinking, perceived attributes of quality teaching and an understanding of students' needs.
- ***Teaching practice*** describes approaches, techniques and the implementation of teaching practice. This is about the practical aspects of teaching. It includes the IT academic's approach to assessment, marking and feedback, the IT academic's discipline expertise, imposed university policies, processes and practice, the IT academic's approach to class structure and delivery, student motivation approaches, and knowledge of subject content.
- ***Technology adoption*** describes the types of technologies used to facilitate student learning, teaching preparation, research and administration. It includes the affordances (advantages) and constraints (disadvantages) of these technologies and rationalisation of their acceptance or rejection. Also included are details of the IT academic's technology miscellany, and anecdotes describing technology use.
- ***Techno-pedagogical practice*** describes the embodiment of IT academics' philosophy and teaching practice resulting from technology adoption, facilitated through the merging of technology and pedagogy. This includes flexible digitally enhanced learning environments and contemporary learning approaches. Also included are the convergence of technology with the environment, learning and teaching, pedagogy, society and students teaching promoting student-centred learning practices.

An outline of the phase two finalised summary code structure is provided in Table 6–1. The summary is sorted by: category | axial code | properties. Codes from data collected and coded during phase one is depicted with a superscript one ^{1} character, whilst data collected and coded during phase two is depicted with a superscript two ^{2}. In addition, phase two properties are shaded with a dark grey background, while updated phase one properties are shaded with a light grey background. There is no shading on codes which remain the same from phase one to phase two.

Table 6-1 Phase 2 – Finalised Summary Code Structure

Category	Axial Code	Properties
Pedagogical development[1]	Discipline preference[1]	Creative outlet[2] Educational successes[2] Logic based[12] Skills based[1]
	Influence of others[1]	Family[2] Industry[2] Mentors and teachers[12] Scholarship[12] Society[2]
	Language used[1]	Educational[1] Technical[1]
	Pedagogical development constraints[1]	Generation gap[2] Industry experience[12] Self-confidence[12]
	Quality teaching attributes[1]	Approachable[2] Caring[12] Communicator[12] Entertaining[2] Honest[12] Passionate[1]
	Understanding of students[1]	Attendance[2] Engagement and motivation[12] Learning approach[12] Learning highlights[2]
Teaching practice[1]	Assessment considerations[1]	Assignments[12] Examinations[1] Feedback and marking[2] Tests[1]
	Discipline expertise[1]	Computer Science[12] Information Systems[2] Information Technology[12] Mathematics and Statistics[1]
	Environment[12]	Imposed policy[1] Imposed process and practice[1] Collaboration[2]
	Teaching approach[1]	Classes [12] Competition and rewards[2] Content knowledge[2] Delivery[2]
Technology adoption[1]	Affordances[1v]	Communication[1] Convenience[2] Delivery[1] Interest[1] Repeatability[2] Ubiquity[2]
	Constraints[1]	Bandwidth[1] Barrier and distraction[2] Complexity[1] and time[2] Culture[12] Fear and apprehension[12] Support services[2]
	Examples of use[12]	Content preparation[1] and delivery[2] Educator entertainment and

		engagement[2] Learning engagement[12] Teaching administration[1] and research[2]
	Repertoire[12]	Hardware[12] Software[12]
Techno-pedagogical practice[12]	Learning environments[2]	Immersive[2] Interactive[2] Online eLearning[2] Simulation[2] Student-centred[2]
	Learning strategies[12]	Applied[12] Flipped classroom[2] Gamification[2] Problem-based[2] Social learning[2]
	Technology convergence[12]	Environment[2] Learning and teaching[12] Metaphor[2] Pedagogy[12] Society[2] Students[2]
	Technology relationships[2]	Emotional[2] Mastery[2] Physical[2] Thinking and problem solving[2] Tool[2]

6.3 Phase 2 – Finalised code description

The finalised updated detailed descriptions and illustrations for each of the four emerging categories, and their associated axial codes, properties and sample interview quotes are included in the following sections.

6.3.1 Pedagogical development category

The ***pedagogical development*** category describes the influence of people and factors that inform and shape IT academics' philosophy of teaching and learning. These aspects represent the thinking behind the practice.

Table 6–2 provides a summary and rationale for coding changes made to the ***pedagogical development*** category from phase one to phase two. No new axial codes emerged during phase two, however a number of additional properties were identified, and some existing properties were renamed, merged and/or refined.

Table 6-2 Phase 1 to 2 Code Changes – Pedagogical Development Category

Axial Code	**Phase 1 Name(s)**	**Phase 2 Name**	**Reason for Change**
Discipline preference[1]	N/A	Creative outlet[2]	New property
	N/A	Educational successes[2]	New property
Influence of others[1]	N/A	Family[2]	New property
	N/A	Industry[2]	New property
	Mentors[1]	Mentors and teachers[12]	The mentor property has been expanded to include experiences and changes in thinking resulting from IT academics' personal educational experiences.
	Literature[1], and Professional development[1]	Scholarship[2]	The literature and professional development properties have been merged into one, new property called scholarship. Literature represents research published in texts and papers, while professional development activity includes exposure to research at conferences attended.
	N/A	Society[2]	New property

Axial Code	**Phase 1 Name(s)**	**Phase 2 Name**	**Reason for Change**
Pedagogical development constraints^{1}	N/A	Generation gap^{2}	New property
Quality teaching attributes^{1}	N/A	Approachable^{2}	New property
	N/A	Entertaining^{2}	New property
Understanding of students^{1}	N/A	Attendance^{2}	New property
	N/A	Learning highlights^{2}	New property

Figure 6–1 provides a visual representation of the finalised ***pedagogical development*** category code structure. Note the shading and superscript characters adopted in Table 6-1 are continued here for ease of identification. The dark grey background denotes phase two properties while updated phase one properties are shaded with a light grey and no shading for those which remain the same.

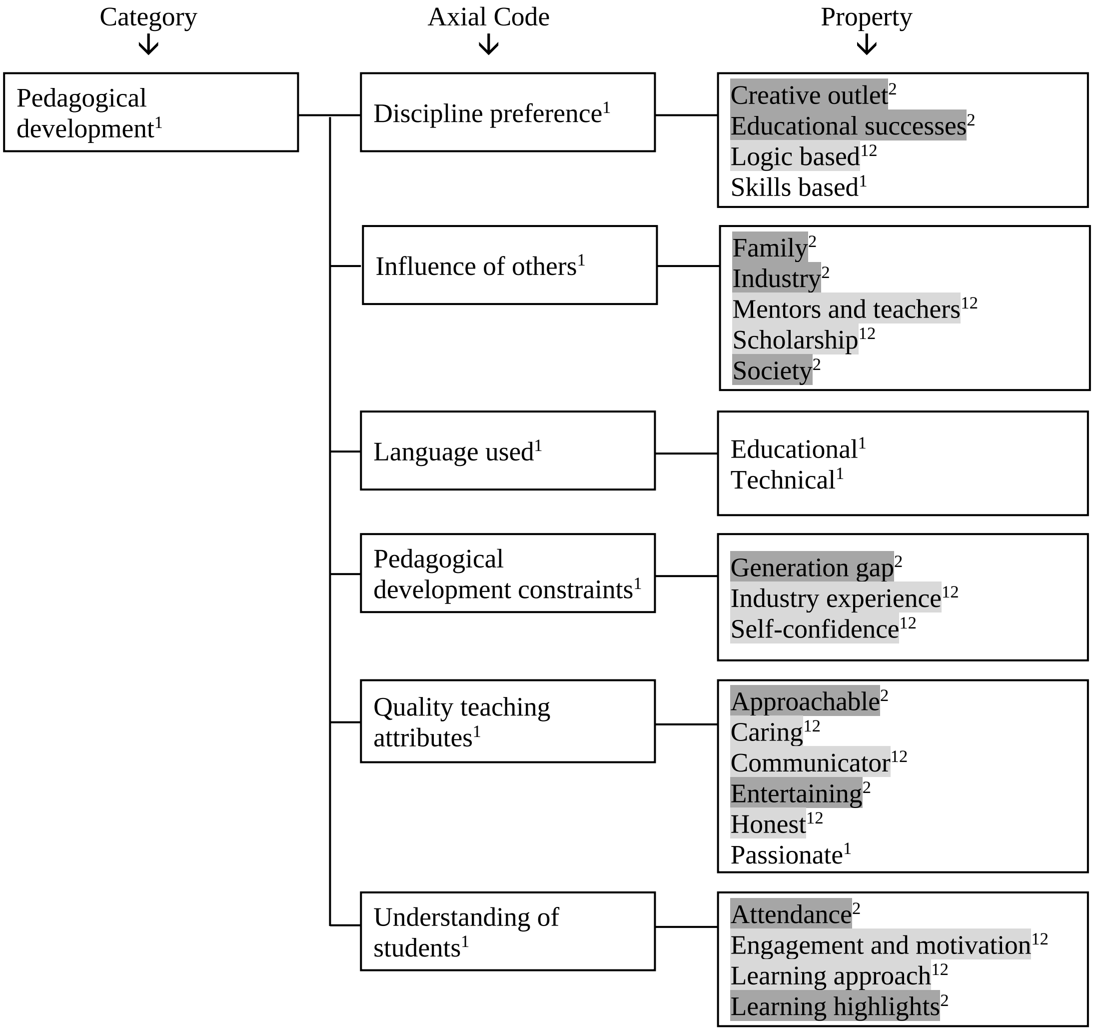


Figure 6-1 Phase 2 – Visual Summary of Finalised Pedagogical Development Code Structure

The finalised ***pedagogical development*** category for phase two contains six axial codes: *discipline preference*[1], *influence of others*[1], *language used*[1], *pedagogical development constraints*[1], *quality teaching attributes*[1], and *understanding of students*[1]. New and updated descriptions and sample quotes follow.

6.3.1.1 Discipline preference

Discipline preference represents the identification of learning and teaching techniques tailored to various sub-discipline areas of IT. IT Academics preferred sub-discipline areas are developed from the attractive, creative appeal of IT, and their successful personal education experiences.

In phase one this axial code contained two properties; *logic based,* and *skills based*. See Section 5.3.1.1 for phase one descriptions and sample quotes. Two additional properties emerged during phase two, these included; *creative outlet* and *educational successes*. The finalised phase two axial code consists of the following four properties: *creative outlet*[2], *educational successes*[2], *logic based*[12], and *skills based*[1]. Descriptions of the phase two properties follow.

- The *creative outlet* property describes IT academics choosing IT because of the imaginative, innovative appeal it holds, for example loving programming because of the ability to make something.
- The *educational successes* property represents a love of learning and discipline areas IT academics are attracted to teaching as a result of their own successful learning experiences, for example loving Maths because it was easily done and understood in secondary school.

Table 6–3 contains sample interview quotes for the phase two properties. Additional quotes have been provided for the phase one property; *logic based*.

Table 6-3 Sample Quotes Representing Discipline Preference

Property	Sample Interview Quotes
Creative outlet	I15: "I've been into programming since I was a kid, since computers were new, so that goes back to Commodore 64 days, programming games on that in machine language. And I always loved programming. So my two loves were film and programming, probably for much the same reason: you're making something. I like to make things." I19: "The games stuff I'm, I'm getting into it, I'm working on it. I'm actually learning a lot of, in my own time about that side of things. Because I'd love to write video games, you know that would be fun, wouldn't that be amazing, just write, you know work on a project that you love."
Educational successes	I4: "I think with the Physics and Math, as an astute secondary student, I think that I felt more on top of the content ... the attraction of Physics and initially Chemistry until that became a lot of memory work, and the Maths also appealed to me. I mean I was successful at it and I think that was the reason that I decided that I wanted to continue." I5: "I was doing a Graduate Diploma in Computing and they had just started the course, and there was 120 of us or something enrolled, and I think 25 finished. There was a dramatic drop out and the 25 of us that finished, really felt that we had achieved something because it was a tough course." I7: "I enjoyed school because I was good at it I suppose. I wasn't one of the ones that got into trouble, or never understood what was going on. It must of been hell for those kids, I was lucky, and I remember when I was in grade four or grade five all we used to do was draw spitfire fighter planes, and we were going to be pilots" I13: "I've always known I didn't have any trouble with [learning]. But it wasn't something I placed any value on either as a young person."
Logic based+	I13: "I like rules, and Maths is all about rules. But fundamentally, once you get far enough into Maths you find that there's an intellectual stimulation in Mathematics that I've never experienced in any other subject. You [pause], the only other thing I've ever done actually that gets close to the academic experience in Maths is programming. There's a moment programming where you've got a problem that you've got a program for, and you realise a neat, elegant piece of code that will solve your problem."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.1.2 Influence of others

The *influence of others* represents the development of IT academics' teaching philosophy as a result of counselling, guidance and lessons learned from teaching role models, such as; mentors, professional development activities, presentations by other educational professionals at conferences, friends, family, professional work experience, society, and formal education experiences.

In phase one this axial code contained three properties: *literature*, *mentors*, and *professional development*. See Section 5.3.1.2 for descriptions and sample quotes. In phase two, the *mentors*' axial code was renamed to *mentors and teachers*, while the *literature* and *professional development* properties were combined forming a new property called *scholarship* (see Table 6–2). In addition, three new properties emerged. These include; *family, industry*, and *society*. The finalised phase two axial code consists of the following five properties: *family*^{2}, *industry*^{2}, *mentors and teachers*^{12}, *scholarship*^{12} and *society*^{2}. Descriptions for phase two new and updated properties follow.

- The *family* property describes IT academics experiences with family, friends and loved ones, and the influence of these on teaching practice, for example a parent encouraging considered thinking and this approach then adopted as part of reflective practice.
- The *industry* property describes IT academics' own experiences while working as IT professionals and the influence on their teaching practice, for example passing on programming standards required in the professional workplace to students.
- The *mentors and teachers* property describes experiences and collaboration with other academics, and lessons learned from personal educational experiences, influencing thinking and approaches to teaching, for example feedback obtained after a peer review.
- The *scholarship* property describes the influence of research published in texts, journals and conferences on the development of teaching thinking and practice, for example acquiring new ideas regarding assessment from a conference presentation.
- The *society* property describes IT academics' experiences with various activities including; sporting, recreational, religious, and the media, and their influence on teaching thinking and practice, for example, using current news items to promote discussion amongst students.

Table 6–4 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the re-named phase one properties; *mentors and teachers*, and *scholarship*.

Table 6-4 Sample Quotes Representing Influence of Others

Property	Sample Interview Quotes
Family	I7: “Obviously family, upbringing and so forth is going to mould your values in a particular way, but that will go through whatever you find yourself doing in life.” I8: “My uncle was a lecturer at the university in [place]. That has influenced me a bit in my teaching. He is a chemistry lecturer. So, at home I have a connection with those academic people, and also the students coming [to our] home, and he has been writing papers. So that has influenced, a little bit I guess, why I got into teaching. At home also, my parents.” I9: “My father was a big influence on me. My mother not so much. My mother was the typical housewife who knew her crafts incredibly well, but my father was a thinker. And my father expected, not deep thinking but considered thinking from his children.” I13: “My kids have profoundly influenced the way I think about teaching and the way, mostly because of the way, they influence the way you think about life. But I think if you can explain things, if you can explain the ramifications in an action to a two-year-old then you can probably teach well.” I15: “So watching the kids and pretty much watching them, how they learn, learning how to teach them is the most.” I16: “My father [laughing] was a high school principal, who had started teaching at the age of 15, okay, in a small country town and had taught all his life. My mother was a school teacher. My older sister is, both my older sisters are school teachers.” I21: “I think perhaps the fact that my parents allowed me to be creative and didn’t say, ‘No, you’re going to be a doctor,’ or, ‘No, you’re doing to do this.’ I wanted to be a teacher and Mum said, ‘Well, you know, if you want to do that you’re going to have to make sure you meet these goals at school, so you can get into teacher’s college.’”
Industry	I8: “I worked in the industry as an analyst/programmer, I worked in an e-commerce company where I used to maintain a wine company, we had a C++ database, so what we did is keep track of all the transactions. So, we had our own programming practices, for example we had coding standards, and then when you have a problem like how to communicate with team members, those sort of things. Those explanations I gave to them.” I14: “In the multimedia course I’m probably at an advantage because I’ve worked in [multimedia], I’ve done certain things in it so I can easily talk about, you know, 'I’ve worked on this and I’ve done this.'” I17: “I got myself contracting as an IT consultant which was great, it was fantastic, did some really wonderful varied projects, worked on varied projects. And at this point, my husband was an academic, he was working at [university]. And he said to me, 'Why don't you try tutoring at [university]?' 'cause we lived in that area. So, I got in touch with the computer science department there and they said, 'Yes, we could do with a tutor, particularly with your industry experience.” I19: “I was a software engineer in the [place] so I was a bit of a generalist. I would program in this, program in that, you know half a dozen languages, not a problem, lots of web dev and all that kind of stuff, and so that’s what I ended up teaching at higher ed. I would teach C++, I would teach Python, I would teach systems analysis and all that stuff.”
Mentors and teachers +	I6: “When I was an undergrad, he was one of the teachers, one of the lecturers and later became head of the department. What happened with him – he had a huge influence on me as a lecturer, and he created, I don’t know exactly what it was, but he created some kind of wiz bang computer science thing, his

Property	Sample Interview Quotes
	company hit the Internet back then and he made millions and so he quit his job as an academic and he ran the company and he became a multi-millionaire, and he woke up one day and he said, I can't do this anymore, I don't care how much money I made, I just want to be a teacher, and so he sold the company and he came back to the same university and went back into the same office and started to teach the same subjects because that's what he wanted to do. I think I learned from that that money doesn't make any difference and at the end of the day as long as you can feed yourself and your family, that was huge for me to run into him and find out where he had been, what he had done." I7: "I was teaching, a guy, a principal came along called [name], he was a crazy ... wonderful crazy guy. We ripped that school apart, we tore walls down, we painted this, and we painted that ... we were a bit all effected by the [name] type thing, which was a big educational thing back in [place], back in the early seventies, [name] I think it was." I18: "I heard, for example, [name] started using them. So, I thought, I'll try out online quizzes using Moodle." After I started it I saw the value of it. It's actually a learning tool both ways, for the students and for me. Yeah. And to make sure that the question is not trivial." I25: "I come from a pedagogical background in peer learning, so the peer assisted study sessions, or [name] or [name] programs that exist in various places. I've had a fair bit to do with them, I've trained a lot of people to run those programs at different unis, and I guess that was a really formative thing for me as a teacher."
Scholarship +	I6: "I started to read things like Freire and his work in radical pedagogy." I7: "I went to a conference last year in [place] ... there was a guy [name] from [place] and he's got these graphs that he uses ... and he portrays graphically five or six dimensions in his graphs, and they are just fabulous, and I have shown them to different groups of students and that just blows them out of the water to see just what can be done, and just how interesting it is to see what happens."
Society	I7: "One guy was a lay preacher in the church and it was interesting to hear him preach and hear him teach in school, and then I also partnered him in tennis when we played doubles in tennis they would often put me with this guy." I7: "It was through sport on the weekend. We had a couple of teachers that would play football on the weekends for the local team. And you'd see them go in and get crunched, and they earned the respect of people ... It was good and that had a positive impact on me, and I just went into teaching naturally." I8: "You need to have a connection with the government departments, my cousin's sister was very good at marketing, so she drove all the marketing and I'd drive all the educational training things ... So, there were bureaucratical political situations where you need to have connections." I8: "I think students can understand what's happening around them, if I talk about [news item], they want to participate, what it is, because they have been listening to the news and reading those things and they are very quick to give their opinion."

+ denotes additional quotes from phase two added to a phase one property

6.3.1.3 Language used

No additional properties emerged during phase two for the language used axial code. See Section 5.3.1.3 for phase one descriptions and sample quotes.

6.3.1.4 Pedagogical development constraints

Pedagogical development constraints describe perceived obstacles and fears constraining or limiting the development of IT academics' pedagogical philosophy.

In phase one this axial code contained two properties; *industry experience*, and *self-confidence*. See Section 5.3.1.4 for phase one descriptions and sample quotes. In phase two a single additional property emerged, called *generation gap*. The finalised phase two axial code consists of the following three properties: *industry experience*[12], *generation gap*[2], and *self-confidence*[12]. Descriptions of the phase two property follows.

- The *generation gap* property describes feelings of an age difference between IT academics and the students they are teaching. There is a sense of being out of touch or out of date.

Table 6–5 contains sample interview quotes for the phase two property. Also, additional quotes have been provided for the phase one properties; *industry experience*, and *self-confidence*.

Table 6-5 Sample Quotes Representing Pedagogical Development Constraints

Property	**Sample Interview Quotes**
Industry experience +	I16: "It has worried me the older I've gotten the further I've got away from that workplace. Because that is still very deep within me is that useful part that that's a very powerful thing."
Generation gap	I16: "I think age is an issue, I think it is. I think students start to perceive you as being a different generation, you know you're like my father or you're like my grandfather [laughing] or whatever." I17: "I've given up on 1st years. I'm too old for first years. Seriously. I mean, I'm just so far removed from the current thinking, mentality, of first years. They just annoy me now. But once they've been groomed by our younger staff I'm more than happy to take them on in second year."
Self-confidence+	I8: "I think it's much easier if, to teach students in your area, you can teach in other but you won't be that confident and you need to practice and you need to prepare and it takes a lot of time." I18: "Whenever I got this, when after teaching and I found my mistake, or I found [a] different way of doing it, it actually strikes me. I feel sometimes when. I would say "I didn't do a good job". You know what I mean? Like if only I was given more time then I would be really better, something like that".

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.1.5 Quality teaching attributes

Quality teaching attributes are thoughts, reflections and comments by IT academics which describe qualities of good teaching, and key traits of great teachers, such as being approachable, caring, having good communication skills, keeping it interesting and entertaining, being honest and passion for the students and content.

In phase one this axial code contained four properties; *caring*, *communicator*, *honest* and *passionate*. See Section 5.3.1.5 for phase one descriptions and sample quotes. Two additional properties were identified during phase two, these included; *approachable* and *entertaining*. The finalised phase two axial is made up of the following six properties: *approachable*^{2}, *caring*^{12}, *communicator*^{12}, *entertaining*^{2}, *honest*^{12}, and *passionate*^{1}. Descriptions of the phase two properties follow.

- The *approachable* property describes IT academics that are accessible to students, for example, the adoption of an open-door policy.
- The *entertaining* property describes IT academics that hold the attention of students in amusing or interesting ways, for example the use of jokes or humour to encourage students to relax.

Table 6–6 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the phase one properties: *caring*, *communicator* and *honest*.

Table 6-6 Sample Quotes Representing Quality Teaching Attributes

Property	Sample Interview Quotes
Approachable	I2: "I try to have an open-door policy, you have to balance it with other teaching behaviour, other concerns." I3: "So I think that sort of friendliness, and approachability, is what came across with some of the staff." I6: "Someone who is able to make mistakes and admit it, not have to know everything all the time. Because they are approachable, and if you are approachable then you'll learn more." I12: "You need someone who, or has the time of course, but is, not – yeah friendly I guess, approachable enough. They cannot feel scared or you know, distant, too distant. I mean it's good to keep a certain respect distance, but it cannot be that they're not willing to come and talk to you."
Caring +	I6: "Compassion, you have to really actually care, or else you have to have compassion for students." I7: "They have also got to have compassion, they have got to be compassionate. I think that is really important they have got to understand that

Property	Sample Interview Quotes
	some students are scared stiff by not knowing something, and to be able to handle that in a nice, non-threatening way." I19: "I think that comes through in my teaching that I do care, and I do want them to get better, or I certainly hope it does. And that came through in the best teaching from the teachers that I had, that they cared about my education, about where it would take me, about what I would do in my life. So, because they cared, I liked them for that, and I think that if the students know that I care then they will (not that it's about like) but they will respond well to me because they know that I care about them and I have their best interests at heart."
Communicator +	I13: "She was one of the clearest communicators I think I've ever met; she had a way of simply being able to lay out very complex ideas in very easy to grasp stages, and she was able through that, she was able to expose the structure of Maths which had not been exposed to me before."
Entertaining	– I3: "Keep it entertaining, so you will engage the students, so not entertainment for entertainment sake, but keep it so that it's interesting, and you do things differently and you bring in different ideas." I7: "I used to play little jokes on the kids, like you might have ... when you are giving them a spelling test you usually put the word in a sentence so there is a context with it. Like 'bird', I saw a bird down the street' or, a 'bird up in the tree', you know. Occasionally I'd go 'bird' 'b i r d spells bird', and you'd see the kids giggle, just a bit of fun." I12: "You need someone who is a bit of a performer, so that it doesn't bore them to tears." I13: "Humour is very important, mostly to keep myself sane. I can't take myself that seriously for that long, so, and you know, I laugh at my own jokes; I do it at home too. I laugh at my own jokes; nobody else laughs at them." I20: "There's a lot of humour. It only takes a week or two for students to know this guy [is] on our side. Do you know what I mean, he's supportive and … I don't know what the magic element is but quickly at the end of a week students are coming to see us to say, "This is all right." I don't know what it is, if it's the humour or … I mean, I think it's knowing your audience that's in front of you and being able to pitch at that sort of a level and have a laugh."
Honest +	I14: "Honesty. I think students love that. I think when you're totally upfront and honest to the student about the course itself, the content, even yourself… because I'm even upfront in some areas that I'm not actually strong on so I'll say "Look, we're going to be covering this course this week in this subject matter. To be honest, I'm not very strong in this area."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.1.6 Understanding of students

Understanding of students describes IT academics' reflections and perceptions of student learning approaches, engagement and motivational triggers for learning, such as student attendance habits and key learning moments.

In phase one this axial code contained two properties; *engagement and motivation*, and *learning approach*. See Section 5.3.1.6 for phase one descriptions and sample quotes.

Two additional properties were identified during phase two; *attendance* and *learning highlights*. The finalised phase two axial code is made up of four properties: *attendance*[2], *engagement and motivation*[12], *learning approach*[12], and *learning highlights*[2]. Descriptions of the additional phase two properties follows.

- The *attendance* property describes IT academics' views on student attendance behaviour and the impact on their learning, for example poor attendance due to family and work commitments.
- The *learning highlights* property describes IT academics' talking about highlights of students' learning experiences, especially significant or interesting details and/or events, for example conversations with students on ideas beyond the course curriculum.

Table 6–7 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the phase one properties; *engagement and motivation* and *learning approach*.

Table 6-7 Sample Quotes Representing Understanding of Students

Property	Sample Interview Quotes
Attendance	I5: "So they are not going to go to lectures when there is a shift at work to be done, so attendance at lectures is going to be very difficult for them." I9: "The end results always match up what they've done in class, the attendance that they have shown, it's that whole coming together." I17: "Some of them are just totally immature, you know, they haven't developed a maturity in school to be able to come into the less constrained university experience, and so they're just playing around. And they feel like they have to come to lectures occasionally, so they do but they don't pay attention." I18: "I use … attendance, tutorial attendance, so you mark the tutorial attendance and students see that you actually see them, I'm not saying attendance is compulsory. I just show them that we take attendance." I19: "Not as many people as should have been in the labs were there … Sometimes you'd get two or three and you're expecting like eight or nine." "One guy I talked to didn't turn up to anything but the first class and maybe one lab. He said I don't like being in lectures, don't like sitting still, just nothing against you."
Engagement and Motivation +	I5: "How you engage peoples' natural curiosity is by not telling them too much, if you [give] them too much … you are taking from the fun of figuring it out. But not giving too little, so there's how much content is there. Probably the biggest thing is stories, if you wrap the concepts around some stories, and sometimes it's harder than others, that sort of seems it." I6: "I had showed them a lot of examples of technologies and then I let them go and investigate. I think students are curious, I think that technology can encourage that if that makes sense."

Property	Sample Interview Quotes
	I14: "It's looking at the hierarchy of students, where they're sitting and why they're sitting and where they commonly sit and then working out where to focus in the future, who's focused, who's not focused, who's understanding, who's talking a lot.'. I15: "I connect everything to games that they've played. So if you're talking about a particular technique, they're doing some graphical thing, you identify where they've seen that in games, so "It's such-and-such game where you've seen this connect to that" and start answering the questions, sit behind their head." I22: "So, I really wanted to turn it around so that people don't see them just as entertainment devices, and they don't just see it as a social interaction tool. I want to be able to use tech in ways, so people actually can see, "Wow, there is so much power to learn new things and access information on this, that I can just, I can really use this to help me in all sorts of facets of life."
Learning approach +	I6: "The students want to be taught how to do these things I think, and they want to be challenged, and I think technology is a natural challenger. … One of the things I do use for my students is Skype, because then if I'm not [having] very many lectures they can actually Skype in and talk to me about anything they want to ask questions and stuff, and so it gives them a certain freedom about their learning that they wouldn't get otherwise." I8: "I don't know whether that, all the students are different the way they learn. Some are kinaesthetic some are visual learners." I20: "Using technology it's much harder to get to know your audience and how to pitch things but I guess you have got to use as much variety then as possible to account for all the different tastes and learning styles and what have you out there." I23: "So it's just about providing for these different mindsets they have these days. They're digital natives these days … it's right up their alley anyway. They're always watching videos."
Learning highlights	I1: "I've just recently had a female student … especially good student ah kind of … above average, but not a really really good student, but saying things like "now I know how I'm going to teach." I2: "I think conversations that I have with students, quite often the ones you have outside of the formal class material. It is where the student is infused enough about something to want to talk to you about it, and obviously has a high enough opinion to think that you are the right person to talk to about this subject." I4: "The happy relationships I've had with so many students, has been a highlight. Particularly a student whom I had a run in with at one stage, and the relationship has turned around and become a positive relationship." I7: "Another highlight has been to teach children of the people I went to school with, and also teach the children of mothers and fathers that I taught back in the late eighties here when I first started."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.2 Teaching practice category

The ***teaching practice*** category describes IT discipline specialities, strategies, techniques, and its manifestation in practical teaching and assessment approaches.

Table 6–8 provides a summary and rationale for coding changes made to the ***teaching practice*** category from phase one to phase two. No new axial codes emerged during phase two, however a number of additional properties were identified, and some existing properties were renamed, merged and/or refined.

Table 6-8 Phase 1 to 2 Code Changes – Teaching Practice Category

Axial Code	Phase 1 Name(s)	Phase 2 Name	Reason for Change
Assessment considerations[1]	N/A	Feedback and marking[2]	New property
Discipline expertise[1]	N/A	Information Systems[2]	New property
Environment[1]	University management and administration[1]	Environment[2]	The phase one axial code, university management and administration, has been renamed to environment. Allowing for properties in a policy environment, and physical environment.
	N/A	Collaboration[2]	New property
Teaching approach[1]	Lectures[1], Labs[1] and Tutorial[1]s	Classes[2]	The lectures, labs and tutorials properties from phase one have been merged into one new property called classes, this is a more inclusive descriptor.
	N/A	Competition and rewards[2]	New property
	N/A	Content knowledge[2]	New property
	N/A	Delivery[2]	New property

Figure 6–2 provides a visual representation of the finalised ***teaching practice*** category code structure. Note the shading and superscript characters adopted in Table 6–1 are continued here for ease of identification. The dark grey background denotes phase two properties while updated phase one properties are shaded with a light grey and no shading for those which remain the same.

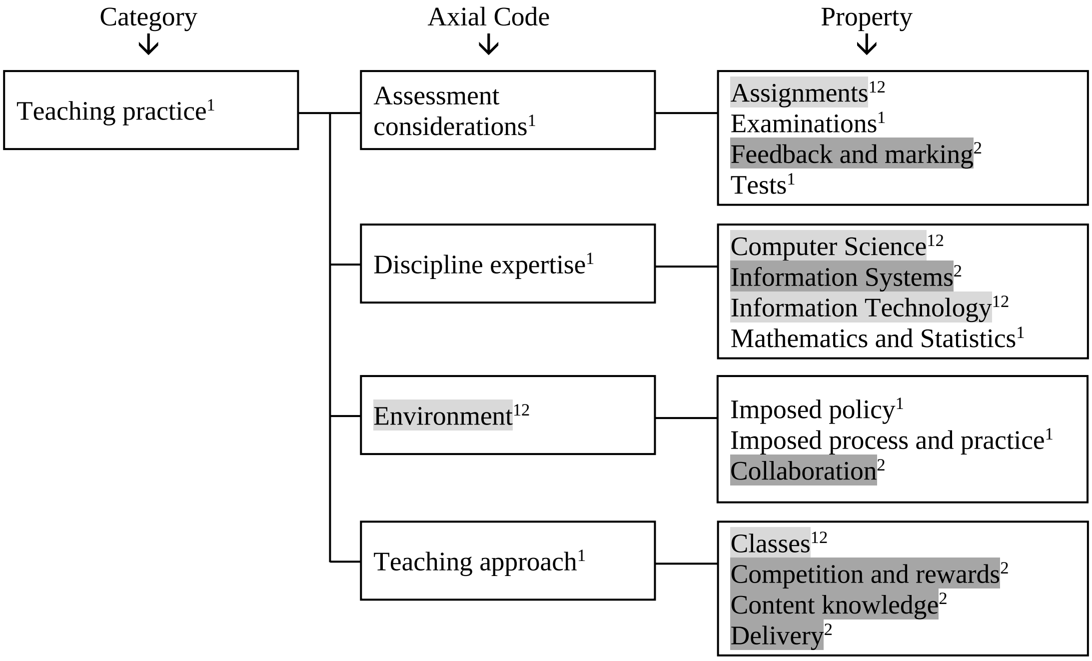


Figure 6-2 Phase 2 – Visual Summary of Finalised Teaching Practice Code Structure

The finalised ***teaching practice*** category for phase two contains four axial codes: *assessment considerations*^{1}, *discipline expertise*^{1}, *environment*^{12} and *teaching approach*^{1}. New and updated descriptions and sample quotes follow.

6.3.2.1 Assessment considerations

Assessment considerations define IT academics' approach to assessment tool development and application, as well as marking and feedback to students.

In phase one this axial code contained three properties: assignments, examinations and tests. See Section 5.3.2.1 for phase one descriptions and sample quotes. In phase two a single additional property emerged, called; *feedback and marking*. The finalised phase two axial code consists of the following four properties: *assignments*^{12}, *examinations*^{1}, *feedback and marking*^{2}, and *tests*^{1}. A description of the additional phase two property follows.

- The *feedback and marking* property describes the purpose and type of feedback provided to students on their assessable work, and the marking of assessment by IT academics, for example providing students with prompt feedback.

Table 6–9 contains sample interview quotes for the additional phase two property. Additional quotes have also been provided for the phase one property; *assignments*.

Table 6-9 Sample Quotes Representing Assessment Considerations

Property	**Sample Interview Quotes**
Assignments +	I5: "Setting an assignment where students can choose to do their own thinking. They were mature age students, and the assignment was build a database for an organisation or an association or something in your life, but just make it real, and deliver it as a thing." I5: "Often they are sharing a house or a flat together with other students doing the same assignment, so it is very difficult for them not to work together in ways that we call plagiarism. So understanding their context you sort of say trying to make an assignment that's non plagarisable." I6: "I think about what assessments might challenge those students, and I try to come up with assessments that either engage them or challenge them in some way, which is why a lot of times my assessments include technology, because it forces them to get outside that comfort zone, and they learn a lot." I9: "There are people now who are looking at the assignments and say 'Will I do that assignment?', which is something that is so stupid. We need to make assignment hurdles I think, 'I'll do that assignment because I can do that very well, and that gives me just the 25% I need to pass that'. There is no pride in achieving something higher."
Feedback and marking	I8: "Giving students prompt feedback is very important, last semester what I did was in [course], I marked the assignments and I used PDF writer, when I was marking I put all the comments, and also I added some audio comments as well. The students liked that. Some of the students think that I was a hard marker, they were happy that I did give them good feedback. Feedback is an important part, for their learning progress. So, we need to give feedback, so engaging students" I12: "From marking, and seeing … the same patterns of code and from, knowing that they don't get enough feedback about their work and that we don't have the capacity of having one-to-one, we then through the code and going, "No that's wrong." I18: "I always have feedback on, I put the right answer and explanation about why it is the right answer. So students get feedback before the next lecture so then I can see which questions students get, most students get it wrong, which question is easy, how they right, and then after the quiz is closed."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.2.2 Discipline expertise

Discipline expertise defines expert technical knowledge and specialities of computing academics. For example, a Computer Science academic who specialises in teaching programming using languages such as Java and C.

In phase one this axial code contained three properties: *Computer Science*, *Information Technology*, and *Mathematics and Statistics*. See Section 5.3.2.2 for phase one descriptions and sample quotes. In phase two a single additional property emerged, called; *Information Systems*. The finalised phase two axial code consists of the following four properties: *Computer Science*^{12}, *Information Systems*^{2}, *Information Technology*^{12}, and *Mathematics and Statistics*^{1}. A description of the phase two property follows.

- The *Information Systems* property describes the study of the use of computer hardware and software to solve business problems (Shackelford, et al., 2005).

Table 6–10 contains sample interview quotes for the additional phase two property. Additional quotes have also been provided for the phase one properties; *CS and IT*.

Table 6-10 Sample Quotes Representing Discipline Expertise

Property	**Sample Interview Quotes**
CS and IT+	I22: "I've done it across the board, like, well as far as, well face-to-face teaching here has been the tutorials for project management, health informatics, professional communications and network operating systems. And then I've had database management systems as a tutor, and then I've had e-commerce, contemporary challenges for IT managers, software engineering design and analysis, and mobile computing platforms and introduction programming. I like variety."
Information Systems	I6: "Information Systems, Emerging Technology and e-Commerce." I6: "I had skills in the information systems area from being in industry. I had the right qualifications and so they hired me, and so I ended up as an information systems teacher." I16: "IS development and IT management and strategy." I18: "I teach project management, information systems, networking, that kind of stuff."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.2.3 Environment

Environment describes the influence of university management, administrative, legislative imposed requirements and the collaborative nature of the educational environment. For example, marking standards, and enforced summative assessment weightings.

In phase one the environment axial code was named *university management and administration* (see Table 6–8) and contained two properties; *imposed policy*, and *imposed process and practice*. See Chapter 5.3.2.4 for phase one descriptions and sample quotes. In phase two a single additional property emerged, called; collaboration. The finalised phase two axial is made up of the following three properties: *imposed policy*^{1}, and *imposed process and practice*^{1} and *collaboration*^{2}. A description of the phase two property follows.

- The *collaboration* property describes a willingness to work with others to produce something.

Table 6–11 contains sample interview quotes for the phase two property.

Table 6-11 Sample Quotes Representing Environment

Property	Sample Interview Quotes
Collaboration	I14: “I think it’s the environment which is the inspiring point, not the people individually here, if that makes sense.”

6.3.2.4 Teaching approach

Teaching approach describes teaching strategies, techniques and informal instructional models adopted and implemented by IT academics in various learning contexts.

In phase one this axial code contained three properties; *lectures*, *labs* and *tutorials*. See Section 5.3.2.3 for phase one descriptions and sample quotes. In phase two the *lectures*, *labs* and *tutorials* properties were merged forming a new property called *classes* (see Table 6–8). In addition, three new properties emerged. These include; *competition and rewards, content knowledge* and *delivery*. The finalised phase two axial code is made up of the following four properties: *classes*^{12}, *competition and rewards*^{2}, *content knowledge*^{2} and *delivery*^{2}. Descriptions for new and updated phase two properties follow.

- The *classes* property describes IT academics’ thinking and approach when teaching lectures, labs and tutorials classes. Lectures illustrate approaches when delivering theoretical content. Labs illustrate approaches when teaching hands on content and tutorials illustrate approaches when working with small groups.
- The *competition and rewards* property describe the use of tangible benefits to engage and motivate students, for example providing chocolate frogs as a bonus,

and the use of competition to encourage students to pursue excellence, for example publishing the name of a top performing student.

- The *content knowledge* property describes the importance of IT academics having a deep knowledge of the subject content they are teaching, for example the ability to prove and justify concepts.
- The *delivery* property describes various strategies and teaching approaches such as chunking (breaking down information into smaller pieces), learn by example or concept learning (providing samples, exemplars and solutions for students to follow), and use of stories and storytelling (interactive use of words and gestures to illustrate concepts and encourage participation and imagination of students).

Table 6–12 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the re-named phase one property; *classes*.

Table 6-12 Sample Quotes Representing Teaching Approach

Property	Sample Interview Quotes
Classes +	I5: “The actual depth of content in the lectures, I sort of purposefully kept a little shallower. The kind of thing that some of the things in AI can get pretty complicated so you can say spend a two-hour lecture on how to prune a search tree for example and it gets pretty tricky. I5: “The lecture material on PowerPoint slides is a very passive kind of thing to do, they download the slides and then read through the slides, and then when you find that at the end of a semester that if you ask a question that’s even vaguely deeper than the bullet points on the PowerPoint slides you don’t get an answer. And it sort of makes sense that you don’t get an answer because you have set it up that way.” I7: “My PowerPoint slides have got a fair bit of information on them, they are not just dot points, because I am using them as a potential reference when I’ve gone, you know when the students are swotting up for their exams or even looking back at their notes after a few years. So the PowerPoint slides are much more than dot points, they are really a source of information, so that’s one thing. The other thing with the PowerPoint slides is I use builds a lot, so I’ll start off ... you know you might ... rather than just put a whole slide up there I’ll build it step by step, it’s this ideas of taking and idea from your head and putting the little bits at a time in, so it’s like a building block.”
Competition and rewards	I12: “They were telling me that they wanted more, so I made it kind of a, hall of fame question in which rather [than] getting points, the game is the name, the best – so it’s kind of a competitive one. Rather than getting points it’s whoever is the best of the people who have done that. And I get my tutors to rank the best, and the name goes into the Moodle page and, every week it will say who has been the hall of fame person and if they get twice their name up there.” I18: “I always publish saying ‘Hey, the winners for this week’s quiz is’, I say first place, second place, third place. The good students got recognised, and then it’s, and this ten quizzes for ten weeks it’s worth 3% bonus mark.”

Property	Sample Interview Quotes
	I18: "To increase unit evaluation participation, the response rate, to actually have chocolates at the end of, in the last tutorial". At the beginning of the last tutorial, week 12, she would get the students to do the online unit evaluation and then she got another student to look at the student's screen after they've done evaluation it says, "Thank you for doing the unit evaluation". And when the student sees there is this thank you screen, give the chocolate, like Tim Tam or something."
Content knowledge	I13: " You need really good sound subject knowledge, so you can only unpack those things if you understand how they all go together in the first place. And in order to understand how they go together in first place you really need to understand the subject you're teaching." I15: "There needs to be a level of confidence in the teaching, you've got to go in there with, 'I know what I'm talking about. I can prove and justify anything that I'm saying' and really understanding your material. It allows you to stop worrying about the material. I know when I've struggled as a teacher it's always been when I wasn't confident about the material." I18: "To start off with you need to know your subject area, right. So like for example data mining, I know that the fundamental topics they need to know and how to go from there."
Delivery	I5:" But instead of that is to cut it back so that you leave out the technical sort of details, but instead spend more time in telling stories around who developed it in the first place. The context of the development, who's working with these things now, what are they doing with these things now?" I7: "I use PowerPoint. I use animations a lot to bring in information. So a slide will start out simple with some words and then I'll bring in a diagram and I'll add to the diagram quite a lot, so things get built on top of each other quite a lot within the particular slides." I12: "For the class they get the entire code that I talk about in the class, which I just keep … at a minimum, they get the full code on a file, commented, tested and everything. So they see what I expect from them in terms of coding, how much comments, how many comments, how many you know … So for every single lecture they get that. And then … I have labs and I have tutes. For the tutes they get the solutions for the tutes, detailed solutions every, every week after the thing." I13: "I always try and build a course as a story, so start and an end, and it can jump around a little bit but you should always know where you are in the story." I18: "I always give solutions to the tutorial questions. Some like say 'I don't give solutions because I want you to find it for yourself'. …. They learn from your solutions, why won't you give them solutions." I19: "The art and the skill of teaching comes in explaining complicated things in a simple way and that's what the best teachers can do and that's what I strive to do. To take something which is very hard and break it down into components, so you can then work on each component at a time." I22: "They don't see it used like that. In classrooms they go through an education system where they might use a laptop to type up notes or to do what the teachers are doing, they might see PowerPoint presentations projected on a screen, and they might use a calculator. But those, you walk into a classroom and most teachers would tell them to put their phones away, and if they get them out they'll get confiscated. The teachers … [what] they see is that the kids have got their phones and they're texting or they're Facebooking or they're doing things that they shouldn't be doing in class. I want to use technology in a way that they can use it in class. Now, while they're doing a Cahoot quiz they're not off texting or Facebooking because the device [laughs] is being used, and it's being used in a way that they're learning from it."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.3 Technology adoption category

The ***technology adoption*** category describes the types of technologies used and their application in teaching, learning, and administration. This also includes the affordances and constraints of these technologies, such as rationalisation of their acceptance or rejection.

Table 6–13 provides a summary and rationale for coding changes made to the ***technology adoption*** category from phase one to phase two. No new axial codes emerged during phase two, however one was renamed, and a number of additional properties were identified, some existing properties were renamed, merged and/or refined.

Table 6-13 Phase 1 to 2 Code Changes – Technology Adoption Category

Axial Code	**Phase 1 Name(s)**	**Phase 2 Name**	**Reason for Change**
Affordances[1]	N/A	Convenience[2]	New property
	N/A	Repeatability[2]	New property
	N/A	Ubiquity[2]	New property
Constraints[1]	N/A	Barrier and distraction[2]	New property
	Complexity[1]	Complexity and time[12]	The complexity property has been expanded to include experiences which reflect negative perceptions around the time it takes to learn and implement new technologies (software).
	N/A	Support services[2]	New property
Examples of use[12]	Exemplars[1]	Examples of use[2]	The phase one axial code, exemplars, has been renamed to examples of use, providing a simpler more easily identifiable label.
	Teaching preparation[1]	Content preparation and delivery[2]	The teaching preparation property has been renamed to content and preparation delivery, to reflect the expansion of this code to include the process of teaching and also the development of learning materials.
	N/A	Educator entertainment	New property

Axial Code	Phase 1 Name(s)	Phase 2 Name	Reason for Change
		and engagement^{2}	
	Student learning^{1}	Learning engagement^{2}	The student learning property has been renamed to learning engagement to better reflect the curiosity and interest inspired by technology adoption.
	Teaching administration^{1}, and Teaching research^{1}	Teaching administration and research^{2}	The teaching administration and teaching research codes have been merged together to form the teaching administration and research code, this allows for simplification and refinement of coding.

Figure 6–3 provides a visual representation of the finalised ***technology adoption*** category code structure. Note the shading and superscript characters adopted in Table 6–1 are continued here for ease of identification. The dark grey background denotes phase two properties while updated phase one properties are shaded with a light grey and no shading for those which remain the same.

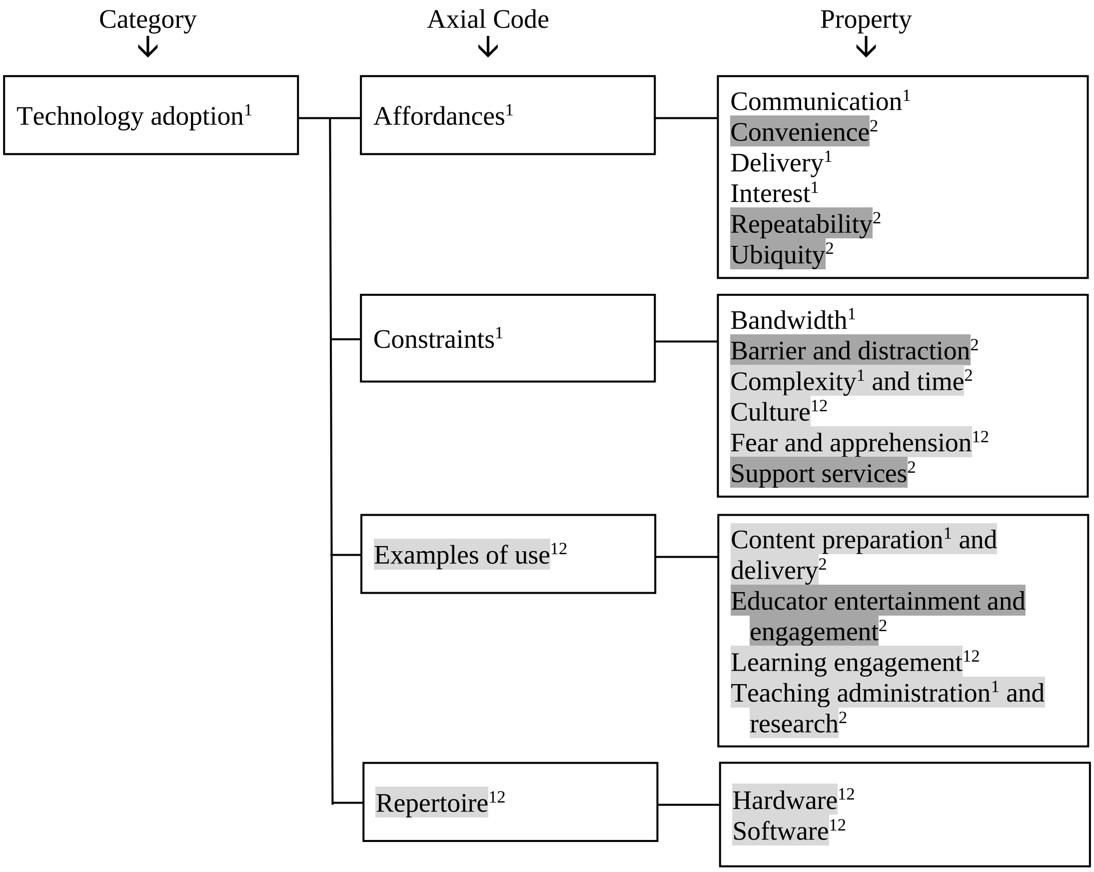


Figure 6-3 Phase 2 – Visual Summary of Finalised Technology Adoption Code Structure

The finalised ***technology adoption*** category for phase two contains four axial codes. These include; *affordances*^{1}, *constraints*^{1}, *examples of use*^{12} and *repertoire*^{12}. New and updated descriptions and sample quotes follow.

6.3.3.1 Affordances

Affordances define IT academics' reflections and stories of technology improving and adding benefit to teaching and learning.

In phase one, this axial code contained three properties; *communication*, *delivery*, and *interest*. See Section 5.3.3.1 for phase one descriptions and sample quotes. In phase two, three additional properties emerged, including; *convenience*, *repeatability* and *ubiquity*. The finalised phase two axial code consists of the following six properties: *communication*^{1}, *convenience*^{2}, *delivery*^{1}, *interest*^{1}, *repeatability*^{2} and *ubiquity*^{2}. Descriptions for the new phase two properties follow.

- The *convenience* property describes the ease of use, expediency and opportunities afforded by technology. These technologies facilitate the teaching and learning process and promote accessibility and utility for educators and learners, for example video lectures.
- The *repeatability* property describes the way technology can facilitate teaching and learning in such a way that concepts can be accessed over and over again, for example students' ability to replay video lectures.
- The *ubiquity* property existence or apparent existence everywhere at the same time in the context of technology enhanced learning and teaching environments, for example the ability for students to study whatever they want, whenever they want, wherever they want.

Table 6–14 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the phase one properties; *communication*, *delivery* and *interest*.

Table 6-14 Sample Quotes Representing Affordances

Property	Sample Interview Quotes
Communication +	I1: “I can see people struggling with the next step then I’ll send the next step to the screen and talk about it, which is getting to be a bit of a problem with my voice, I’m actually going to try to get a mobile microphone.” I6: “Computers are fantastic in a lot of ways, for things like being able to stay in touch.”
Convenience	I7: “They are just visual shots of the slides that I have in the lecture, and there is a commentary that goes with them ... The lecture is at 8:30 am on Monday morning and a lot of kids have trouble getting out of bed, mature age students have got kids that they have to get off to school and all that sort of stuff. You know what it’s like. From that point of view that has been useful.” I23: “The other great benefit is that you can download this. That really benefits those students who … as I said, we had 140 off campus this semester. It's an engineering unit, so about 25 percent of them actually work full time. Actually, nearly all of them work full time but some of them work … maybe on oil rigs or in mines or something. It's very poor access to Internet, so these are fantastic. When they're released, they can maybe download them when they've got good Internet and then later on that without Internet they still have access to them.”
Delivery +	I7: “Just to emphasise different points, blue ones were important points and red points were ones you needed to watch out for, you know just highlighting. I still do that with PowerPoint. If I want to emphasise something, I will embolden it or put it in italics, or put it in a different colour or something.”
Interest +	I7: “It acts as an inspiration, because it shows the students what can be done with very very simple graphs ... without the technology it wouldn’t work, we just would not be able to do it.”
Repeatability	I7: “Some students have recorded the lecture in the past but then you miss the visuals, especially the slide build, and so all of that is on these lectures that the kids have got access to on Moodle. They’ve also got a copy of it, and the thing is that they can play it over and over and over again. I tell them to take it to bed with them and put it under their pillow and let it roll all night on a loop.”
Ubiquity	I6: “I also tend to make my Powerpoint, and I make them into audio lectures with Powerpoint, and that way students have a repeatability option and they can look at it when they have time, hopefully not when they are driving their car. So they have that full capacity to be able to learn at their [own] timing, I firmly believe in that as an option is any time learning.” I20: “They want to access material in their own time, whether that's in replacement of or in support of is varied.” I22: “At one extreme, just look what technology has enabled for Stephen Hawking). People can study essentially whatever they want at any time of day or night.” I23: “This is great for two reasons. So, one, any student, regardless of on campus or off, can go ahead and obviously watch at any time. “

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.3.2 Constraints

Constraints include IT academics' reflections and examples of technology limiting their teaching practice.

In phase one, this axial code contained four properties; *bandwidth*, *complexity*, *culture*, and *fear and apprehension*. See Section 5.3.3.2 for phase one descriptions and sample quotes. In phase two the *complexity* property was renamed *complexity and time* to reflect its expanded nature (see Table 6–13). In addition, two new properties emerged. These included; *barrier and distraction* and *support services*. The finalised phase two axial is made up of the following six properties: *bandwidth*^{1}, *barrier and distraction*^{2}, *complexity and time*^{12}, *culture*^{12}, *fear and apprehension*^{12}, and *support services*^{2}. Descriptions for the phase two new and updated properties follow.

- The *complexity and time* property describe IT academics' negative perceptions around software complexity in terms of labour, and the length of time taken to master. These act as inhibitors to adoption and integration, for example the time and effort taken to learn complex software.
- The *barrier and distraction* property represent obstacles or hindrances that arise from technology adoption and implementation, for example students playing with their mobile phones during class.
- The *support services* property describes IT academics' thoughts and frustrations regarding IT hardware and software support at a university level, for example limitations on what software can be accessed.

Table 6–15 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the phase one properties; *culture* and *fear and apprehension,* and the phase one renamed property; *complexity and time*.

Table 6-15 Sample Quotes Representing Constraints

Property	Sample Interview Quotes
Barrier and distraction	I16: "When they're sitting there with a laptop in front of them there I can't tell whether what they're doing is responding to the email they've just read from, you know because they're looking on their laptop, or whether they're responding to what I've done and what I'm saying."

Property	Sample Interview Quotes
	I17: “I come up behind them and I have a look, and you know, they're on Facebook, they're Googling, they're Twittering, they're doing all sorts of things that has got absolutely nothing to do [with the lesson].” I18: “Some students play with their mobile, SMS, whatever, and then I call him to bring him back, and ask him easy questions and help him to answer the question. Then once he’s back thinking “Hey, actually I can answer it with some help”, then he’s back. He’s no longer playing with his mobile. Yeah, so that’s why I don’t use Twitter.”
Complexity and time +	I5: “I’m not rushing out to the shop to buy it, to get it, but I thought then I’ll have to learn how to use it and I don’t have the time.” I6: “I just sort of worked through trial and error. It took a long time, it took an awful long time to do them. There was just Saturday afternoons, and Sundays you’d come up and just slog away at it.” I8: “I’m not sure how to use it, and how it can relate it to my teaching, if I knew it better, like the quiz … database, there is a little bit of extra work and I need to understand how it can help to engage students, so that we can use it 100%.” I14: “Like I’d like to be able to do a lot more investigations into other different software modes for my lectures but I just don't honestly have the time for it and the energy for that, the bigger the change.” I17: “Facebook confuses me. Twitter I find absolutely worse than useless, although I was able to help an academic in psychology just this morning because of a Twitter feed that I got.”
Culture +	I14: “I think a lot of people are waiting for it to basically be told [what to do], you know, but we get told conflicting things like the past head of school said at a certain time in a certain year all our courses would have to be online in a certain fashion and state, and then that never actually happened and there’s just all these stops and starts but nothing ever gets done or finished there.”
Fear and apprehension +	I7: “Well I get a bit cranky when things don’t work. I am sort of figuring at this stage of the game, everything should work, but obviously, that’s a bit pie in the sky. Look the teaching environment out here is pretty good really, I mean, I bitch and groan and complain about not being able to log onto the system and stuff like that, which I couldn’t do the first two weeks of the semester.” I14: “I think we lack a central organisation or a unit within the university which is strong in this area who are showing good, clear examples of modern technology and software and hardware options.” I15: “So I’m not one to move towards anything like, have some sort of interactive thing where people give me answers and I write them up on a whiteboard. I won’t ever do that. And I don’t do that because I avoid my fear.”
Support services	I9: “How can there be support if the Friday before we start up a new semester these clowns from ICT come and install new software that requires a total change to your lab sheets. What sort of support is that? Come on.” I14: “Well, I use all the software dictated by the school which is supported by the uni because I know that there’s support there and it works and it’s functional.”

+ denotes additional quotes from phase two interview added to a phase one property

6.3.3.3 Examples of use

Examples of use represents examples of technologies used to support learning and teaching.

In phase one the *examples of use* axial code was named *exemplars* (see Table 6–13) and contained four properties; *student learning*, *teaching administration*, *teaching preparation* and *teaching research*. See Section 5.3.3.3 for phase one descriptions and sample quotes. In phase two, the *teaching preparation* property was renamed *content preparation and delivery*, the *student learning* property was renamed *learning engagement*, and the *teaching administration* and *teaching research* properties were merged into one property *teaching administration and research*, while one new property emerged called *educator entertainment and engagement* (see Table 6–13). The finalised phase two axial code is made up of the following four properties: *content preparation and delivery*^{12}, *educator entertainment and engagement*^{2}, *learning engagement*^{12}, and *teaching administration and research*^{12}. Descriptions for the phase two new and updated properties follow.

- The *content preparation and delivery* property provides examples and rationale for using technology to develop and deliver teaching and learning materials, including; best practice approaches, such as developing a social presence (using technology to promote thought provoking discussion in order to engage students with new and contested ideas).
- The *educator entertainment and engagement* property describe IT academics enjoying technology for entertainment and motivation purposes, for example game playing, technology creation, and the use of emerging technologies such as wearable devices.
- The *learning engagement* property describes IT academics using technology to promote participation, interest and involvement amongst students. For example providing assignment help (use of technology to assist students with understanding and completing assessment tasks), engagement and motivation, group work (use of technologies to facilitate group work amongst IT students), and providing questions and feedback (using technology to promote student questioning and to provide feedback).

- The *teaching administration and research* property describes IT academics use of technology to perform administrative, management and research functions of the job, for example conducting teaching research (ways and types of technology used in resource development), and teaching administration (IT academics using technology to perform data analysis (accessing LMS analytics to access statistical information regarding student learning).

Table 6–16 contains sample interview quotes for the phase two properties, including the re-named phase one properties.

Table 6-16 Sample Quotes Representing Examples of Use

Property	Sample Interview Quotes
Content preparation and delivery	I6: "I have learned over the years because of the level of technology I work with to have a plan: a, b, c, and d. Sometime I've had to go to 'd', it's not that far down. In the early days when we had overhead projectors you always carried a spare blub. Now you carry, I carry an iPad and a laptop to presentations, I carry multiple connectors just in case it doesn't work, and if push comes to shove I put a copy in the cloud so I can actually get to it on their computers if I need to." I7: "Integrating clips, movie clips and stuff like that, going onto the web to find stuff, really useful for that." I25: "I do a lot of hand gestures and looking and using second person language and that sort of stuff, because I've tried to develop some sort of sense of social presence through it, and I've found that to be reasonably effective. People feel like they have some sort of stronger relationship with me than they actually do as a result of them, which is kind of nice. Not sort of a movie star level thing, but some people are 'Hey, I watched your video, and what do you think about this?', or want to get into an argument with me or something."
Educator entertainment and engagement	I6: "I am just hanging out for the nano technology stuff to come out so I can have a wrist watch that is also a mobile phone you know the Dick Tracey thing." I10: "I play games. I have multiple consoles, no one is allowed to touch them." I12: "I love games, I'm a computer gamer. I like, I love computers." I15: "I'll often write software to provide a particular example of the technique or an effect, … something that shows a particular thing. So yeah, develop my own technology essentially to be able to do that." I19: "I have lots of games consoles, I like video games ... I'd love to write video games, you know that would be fun, wouldn't that be amazing, just write, you know work on a project that you love, do that for six months, sell it, work on something else." I21: "I use Flash because that's what I'm teaching to develop the games. I use them creating games for their learning now. So, for example, we might have an activity where we're looking at making decisions about if structures, right, so if something is true then do this, else do that. So, I get them to actually create a game that will help them use those structures."

Property	Sample Interview Quotes
	I23: "I play games pretty much every day. Then I love developing as well, of course. IT is my life, basically. I'm always developing apps or software or playing games or reading stuff on the Internet. Yeah, it's basically who I am I25: "I'm a pretty big gamer as well. A whole range of games, probably first-person shooter games is a part of it, but not sort of violent, wary sort of ones, more cartoony, interesting community stuff, so a game called Team Fortress II I play a lot. Yeah, so not necessarily keeping up with the latest games, but more games that have a really solid online community."
Learning engagement	I8: "I think Facebook, what I was thinking Google + might be a better option than Facebook, because in the Google + what I read [is] that you can have different categories of the networking groups. So like... you can create a group of students, and you can have discussions going on." I12: "I have quizzes. I have forums. I have the week by week, that the thing that everyone has. The glossary, although I'm not going to use that again, this year. And, just the file system. I have you know, that's where I put all my, like all the exams for the last ten years or whatever. They've got you know uploaded there. All the tutorials, every week they get you know the lecture, the tutorials, the solutions, the whatever." I18: "And blog, I don't make it compulsory, but actually some students really write really comprehensive blogs, and they actually put their feelings on how, while they are learning this, which one is kind of using, which ones they like. I know well some, for some students it works really well because … they were summarising what they've learnt and it's actually a good way of us as a lecturer to see which part is it they really like."
Teaching administration and research	I23: "I can go ahead and see … obviously it's assignment marks and stuff but if I go resources I can see all the resources that this person has accessed on this website. So all these links, clicked on there, how many times visited." I25: "I was one of the early people to experiment with a few learning analytics, things on those as well, and with Blackboard originally way back when that was basically downloading the logs and running some Excel stuff, and some Pearl code over the top of that. So that sort of learning management system stuff."

6.3.3.4 Repertoire

Repertoire provides a list of hardware and software used by IT academics. The finalised *repertoire* axial is made up of the following two properties; *hardware*[12] and *software*[12]. These have not changed from phase one, see Section 5.3.3.4 for descriptions and sample quotes. Table 6–17 contains additional sample quotes gathered from phase two interviewees.

Table 6-17 Sample Quotes Representing Repertoire

Property	Sample Interview Quotes
Hardware +	I6: "Mobile phones, iPad, iMac, Apple TV, Nintendo Wii, and tablet PC, cloud." I21: "iPad, laptops." I22: "laptop, calculator, phones, 3D printing."

Property	Sample Interview Quotes
	I25: "Interactive whiteboards, and Video Conferencing."
Software +	I6: "Windows, Linux, LMS, Office, Podcasts, Facebook, Twitter, Delicious, Skype, Google Docs, Second Life." I7: "Camstudio, Virtual Dub, Audacity, PowerPoint." I8: "Office, Moodle (Forums), Audacity, Acrobat, Google Docs, Skype, Facebook, PDF writer" I9: "Email, MSN, Skype, Flash, Adobe Master Suite, Paintshop Pro, Powerpoint, Second Life, Google Docs, Facebook" I15: "Powerpoint, Youtube, Animations, Camtasia, Moodle, Dropbox" I18: "Camtasia, :Powerpoint, Moodle (Quizzes, Blogs), Twitter" I20: "Minitab, SPSS." I21: "Flash." I22: "PowerPoint, Facebook, Cahoot, 3D SMax." I25: "Moodle (Database), Youtube, Google Hangouts, Elluminate"

+ denotes additional quotes from phase two interview added to a phase one property

6.3.4 Techno-pedagogical practice category

The ***techno-pedagogical practice*** category describes technologically-driven, philosophically-based teaching and learning environments which enable contemporary digitally enhanced student-centred learning approaches.

Table 6–18 provides a summary and rationale for coding changes made to the ***techno-pedagogical practice*** category from phase one to phase two. Two new axial codes emerged during phase two, the original two were renamed and a number of additional properties were identified while, some existing properties were renamed and refined.

Table 6-18 Phase 1 to 2 Code Changes – Techno-Pedagogical Practice Category

Axial Code	Phase 1 Name(s)	Phase 2 Name	Reason for Change
Learning environment[2]	N/A	Learning environment[2]	New axial code
	N/A	Immersive[2]	New property
	N/A	Interactive[2]	New property
	N/A	Online eLearning[2]	New property
	N/A	Simulation[2]	New property
	N/A	Student-centred[2]	New property
Contemporary learning strategies[1]	Contemporary learning strategies[1]	Learning strategies[2]	The contemporary learning strategies axial code has been renamed to learning strategies. The label contemporary was incorrectly used as an adjective and strayed from goal of using gerunds as coding labels. In this case its removal also allows for additional depth and flexibility amongst the quotes.
	N/A	Flipped classroom[2]	New property
	N/A	Gamification[2]	New property
	N/A	Problem based[2]	New property
	N/A	Social learning[2]	New property
	Technology enhanced[1]	N/A	Property deleted. Quote moved to learning environment axial, interactive property a better match.
Convergence[1]	Convergence[1]	Technology convergence[12]	The convergence axial code has been renamed to technology convergence this label fits better with the properties within this axial.
	N/A	Environment[2]	New property
	Student learning and technology[1]	Learning and teaching[12]	The student learning and technology property has been renamed to learning and teaching accommodating the expansion to encompass both learning and teaching examples.
	N/A	Metaphor[2]	New property
	Pedagogy and technology[1]	Pedagogy[12]	The pedagogy and technology property has been renamed pedagogy to maintain consistency with the other properties.
	N/A	Society[2]	New property
	N/A	Students	New property
Technology relationships[2]	N/A	Technology relationships[2]	New axial code
	N/A	Emotional[2]	New property

Axial Code	Phase 1 Name(s)	Phase 2 Name	Reason for Change
	N/A	Mastery^{2}	New property
	N/A	Physical^{2}	New property
	N/A	Thinking and problem solving^{2}	New property
	N/A	Tool^{2}	New property

Figure 6–4 provides a visual representation of the finalised ***techno-pedagogical practice*** category code structure. Note the shading and superscript characters adopted in Table 6–1 are continued here for ease of identification. The dark grey background denotes phase two properties while updated phase one properties are shaded with a light grey and no shading for those which remain the same.

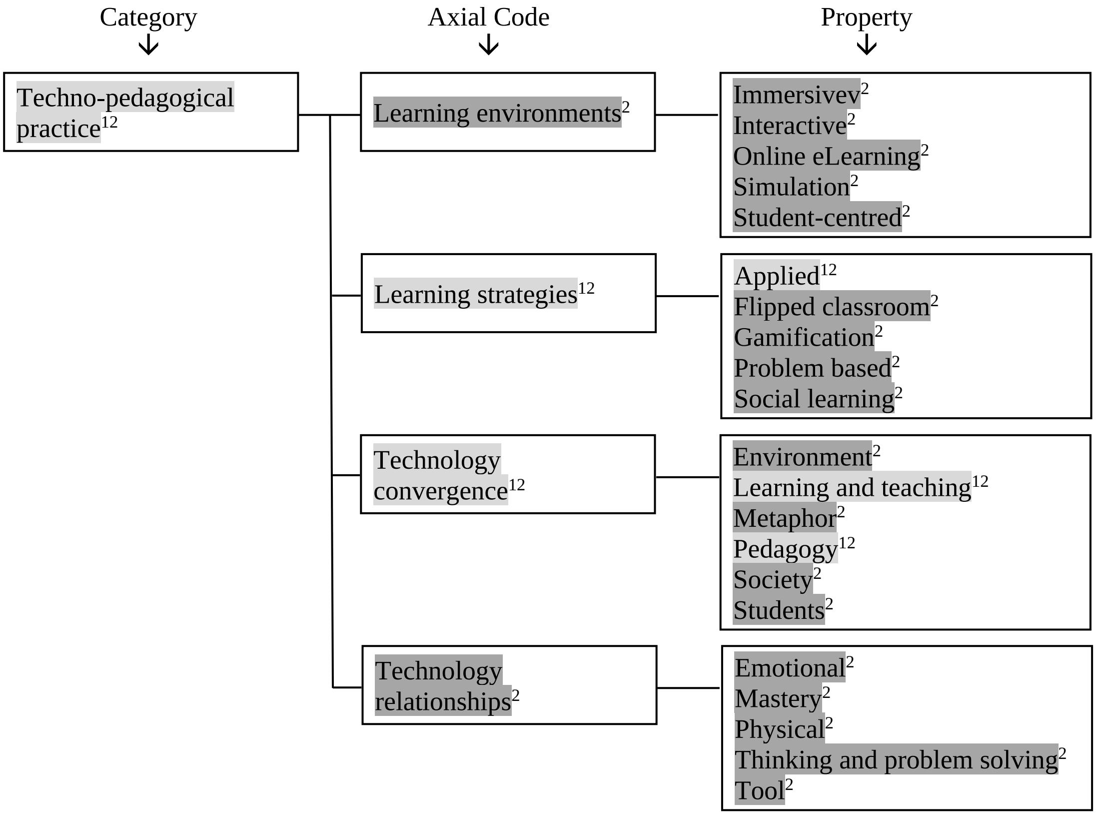


Figure 6-4 Phase 2 – Visual Summary of Finalised Techno-Pedagogical Practice Code Structure

The finalised ***techno-pedagogical*** category for phase two contains four axial codes: *learning environment*^{2}, *learning strategies*^{12}, *technology convergence*^{12}, and *technology relationships*^{2}. New and updated descriptions and sample quotes follow.

6.3.4.1 Learning environment

Learning environments describe attributes and features of technology-enhanced learning settings.

This axial code and its associated properties are new in phase two. The finalised version is made up of the following five properties: *immersive*^{2}, *interactive*^{2}, *online eLearning*^{2}, *simulation*^{2}, and *student-centred*^{2}. Descriptions of the phase two properties follow.

- The *immersive* property describes a learning environment composed of three-dimensional images that appear to surround the user (Dede, 2009), for example second life (a three-dimensional virtual world where users, called residents, create virtual representations of themselves, called avatars, and interact with other avatars, places or objects (Linden Research Inc., 2016)).
- The *interactive* property describes types of computer-assisted instruction that include some degree of learner participation and feedback (Innocent, 2010), for example online quizzes.
- The *online eLearning* property describes content and instructional methods delivered on a computer whether on CD-ROM, the Internet, or an intranet, and designed to build knowledge and skills related to individual or organisational goals (Clark, 2002) for example, Moodle (a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments (Dougiamas, 2016)).
- The *simulation* property describes the technique of representing the real world by a computer program (Farlex Inc., 2011), for example drivers’ tests.
- The *student-centred* property includes methods of teaching that shift the focus of instruction from the teacher to the student (Jones, 2007), for example using Khan Academy (personalised learning resource for all ages, offering practice exercises, instructional videos, and a personalised learning dashboard that empower learners to study at their own pace in and outside of the classroom (Khan Academy, 2016)) to facilitate differentiated activities.

Table 6–19 contains sample interview quotes for the phase two properties.

Table 6-19 Sample Quotes Representing Learning Environment

Property	Sample Interview Quotes
Immersive	I9: "Second Life for communications, in whatever form. I have not taught in Second Life, although that was on the cards this semester if my health situation deteriorated I would have done the PowerPoint presentation the same way but in Second Life." I14: "When we looked into the virtual worlds at [university] so we built an online campus and we got classrooms there, everything there; we can show PowerPoints, videos, the web-based stuff etc." I22: "You've got virtual reality environments where you can get people prepared for scenarios before they actually get to them."
Interactive	I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds." I5: "What used to be a walkthrough of the museum and you read the placard next to each exhibit is now a more interactive thing, where you can go ... you go to an exhibit wearing an interactive device and you hear stories or information about that exhibit to the extent that you want, and if you want to sit in front of an obscure exhibit and hear hours of stories, great then exhibits themselves are much more interactive." I18: "So I always have quiz every week and the quiz is only open for one week to … midnight the day prior to the next lecture." I18: "So interactive, interactive is my main goal, at the beginning, right. So I want the students to get involved, because otherwise they fall asleep. So with my PowerPoint I really try to achieve that goal, to give student every opportunity to pipe up. For every lecture, at the beginning I always put pictures that are pertinent to the topic ... It's always a picture so they get it, I think." I23: "I never see them face-to-face. The lectures are recorded, which is fantastic. We have … once a week we have [an] online interactive session where we have a tool that they can use called [software]." I23: "I'm trying to teach. How do I feel they're going to learn best? If they love games, for instance, or sometimes they play them, so maybe just playing a game is the best way to teach game design or something like that, interactive."
Online eLearning	I9: "… one of the most difficult things I find about online learning is that I can't see student's eyes. Eyes always tell me whether they've understood something or not. And there only needs to be one student who sort of goes a bit like that, or 'Ah, I don't think I understand', sort of thing, and I try and find another way of explaining what I've just explained." I15: "I actually wanted to provide online videos of lectures, kind of running out of time to do that [laughs] but it's something I've been wanting to do and particularly for this subject, because this subject's heavy, … there's too much content and it's too heavy so I was going to provide a lot of the content online and then just go through the important bits in lectures." I17: "The off-campus students did not like the idea of having to be online at a particular time. Their idea of a conversation online was post a message, go away, and forget about it. So, I actually had to teach them how to have a conversation amongst themselves. Really challenging." I25: "The online students versus the face-to-face ones. The online ones just, I never got the sense of critical analysis out of them, never got the sense of really engaging deeply with the stuff. They still did good enough, but it just

Property	Sample Interview Quotes
	wasn't, it wasn't as good in terms of the learning. And that's not a sort of data set I can draw any strong statistical conclusions from, that's a bit of a hunch."
Simulation	I5: "[course] we explore simulation systems and one of the simulation systems is that the students get to perform knee surgery online. Simulated knee surgery, it's a great way to learn." I22: "They use some of that for driver's tests and, well, simulation stuff and rather virtual reality, but they'll use the simulations for driver's tests."
Student-centred	I5: "It's what technology is giving students now is that freedom to do more of what they want to do, when they want to do it, the way they want to do it." I6: "It's about giving learners options, and I think technology can do that. So I don't look at technology and say oh I'll find a way to jam that into my teaching. I look at my teaching and say look at this new social bookmarking tool [that] could be really useful because I can create a list so the students can see what all the options are." I13: "I've spoken with a lot of people about teaching a long time, you know, and it's like a little club. The people who are in the club understand that the club exists, and they understand that there are people who are born to teach. The people who are outside the club kind of don't understand it and they tend, in my mind they tend to be the ones who either don't, so they don't value teaching particularly, and that's usually because they've had poor feedback about the teaching, or they think they're outstanding teachers and can't understand why everybody else doesn't see it that way, and they tend to, so they tend to focus on themselves and not on the students." I22: "The student is central to everything, everything should be everything should focus on the student and what they need to learn." I23: "I'm very student-focused. That's essentially what my job is, teaching students."

6.3.4.2 Learning strategies

Learning strategies describe changes in thoughts and behaviours and learning approaches resulting from technology adoption which influence how learners process information.

In phase one the *learning strategies* axial code was named *contemporary learning strategies* (see Table 6–18) and contained two properties; *applied* and *technology enhanced*. See Section 5.3.4.1 for phase one descriptions and sample quotes. The *technology enhanced* property has been discontinued in phase two (see Table 6–18). Four additional properties were identified including; *flipped classroom*, *gamification*, *problem based*, and *social learning*. The finalised phase two axial is made up of the following five properties: *applied*^{12}, *flipped classroom*^{2}, *gamification*^{2}, *problem based*^{2}, and *social learning*^{2}. Descriptions of the phase two properties follow.

- The *flipped classroom* property describes a teaching and learning approach where the lecture and homework aspects of a course are reversed. Students gain exposure to new material outside class, typically by reading or lecture videos, while in-class time is devoted to collaborative activities, problem solving and discussion (Rutherfoord & Rutherfoord, 2013), for example making readings and lecture notes available to students ahead of classes.
- The *gamification* property is a teaching and learning approach used to motivate students to learn by using video game design and game elements in learning environments. The goal is to maximise enjoyment and engagement through capturing the interest of learners and inspiring them to continue learning (Bennedsen & Caspersen, 2007; Fokkens-Bruinsma & Canrinus, 2014), for example, using games to teach programming.
- The *problem based* learning property is a hands on active learning approach where students are given realistic problems to solve (Watson & Li, 2014), for example, assigning a problem based activities to replace traditionally delivered scheduled classes.
- The *social learning* property describes learning that takes place in a social context, where students learn from each other in informal ways, for example using Facebook as a communication tool in capstone projects.

Table 6–20 contains sample interview quotes for the phase two properties. Additional quotes have also been provided for the phase one property; *applied*.

Table 6-20 Sample Quotes Representing Learning Strategies

Property	**Sample Interview Quotes**
Applied +	I6: "I tend to embed a lot of examples in, because I was in industry for so long I can usually come up with some useful examples." I8: "I give them examples [of] what’s happening in industry, how they can be better, how you can be a better programmer, so that’s interactivity and engaging." I21: "They actually learned media studies by actually doing it. And we had a screening at the end.
Flipped classroom	I20: "I'm a big fan of the flipped classroom approach where they can access the basic readings beforehand. It's probably in essence what we've been doing for quite some time, probably 10 years or something along those lines, in that we've always given them the ability to have the lecture notes ahead of time."

Property	Sample Interview Quotes
	I25: "I guess alongside all of this the whole flipped classroom thing was happening, and I have engaged with that literature a little bit. Actually, an interesting thing is one of the student assignments from that class, we ended up turning into a paper on the flipped classroom, which is a paper that's had a little bit of impact out there, people have read it. So I guess I did some reading in that whole space."
Gamification	I2: "Everyone's played a lot of games. I can throw a fairly abstract idea in say a games design, or even in the engine unit we talk about shadowing effects and I can ask well can anyone think of a game where they have seen this sort of thing." I12: "I do use it a lot for things like, human/community interaction, for interfaces, for strategy [and] intelligence, [and] for data structures. I do a lot of my examples with games." I21: "I get them to actually create a game that will help them use those structures. So Dice Wars was one, so they had two dice [sic], they pushed a button, animated the dice, they pushed the button again and it stopped on two values. It compared the two values, so if Player 1's value was higher they would win, and they would then combine both values and score that, otherwise Player 2 would win and get the combined value."
Problem-based	I5: "So what do they do, what do most of them need to do here is to work as much as they can, so that they can reduce the burden that they are on their families. So they are not going to go to lectures when there is a shift at work to be done, so attendance at lectures is going to be very difficult for them. I thought what I would try [is] to remove lectures and replace them with problem-based exercise so that there was never a formal delivery of the concept, its only delivered through problems that are assigned. So each lecture was replaced with a workbook. My gut feeling was that this kind of workbook way fit their constraints better, because they could skip the lecture and work through the workbook themselves. All the material is available on the Internet. There is a lot of watch this You Tube video and stuff."
Social learning	I9: "We're using Facebook with a project this semester, so all our communication happens via Facebook. A group that only has a few people associated with it. Which is an interesting sort of place to be as far as students are concerned because I'm beginning to realise that students feel that they're invisible. And they do say much more on Facebook than they do anywhere else." I22: "Facebook has power for learning - I reached out to teacher friends of mine over Facebook one evening to find current resources used for teaching about a particular area of Australian history; within an hour or so I had received several replies pointing me to different resources that were used including pdfs of actual textbook content that was being used."

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.4.3 Technology convergence

Technology convergence describes the merging of technology and other learning influences, pioneering an innovative technology-based learning culture, for example the convergence between technology and environment (green computing), and technology and pedagogy (techno-pedagogy).

In phase one the *technology convergence* axial code was named *convergence* (see Table 6–18) and contained two properties. These included; *student learning and technology*, and *pedagogy and technology*. See Section 5.3.4 for phase one descriptions and sample quotes. In phase two, the *student learning and technology* property was renamed *learning and teaching*, and the *pedagogy and technology* property was renamed *pedagogy* (see Table 6–18). Four additional properties were identified; *environment*, *metaphor*, *society* and *students*. The finalised phase two axial is made up of the following six properties: *environment*^{2}, *learning and teaching*^{12}, *metaphor*^{2}, *pedagogy*^{12}, *society*^{2} and *students*^{2}. Descriptions of the phase two properties follow.

- The *environment* property describes the connection between technology and building a greener world, for example the creation and storage of digital teaching records.
- The *learning and teaching* property reflects on the connection between student learning and ET used in teaching and learning process, for example the use of software such as MS Project to teach project management theory and skills.
- The *metaphor* property represents teachers' abstract representations which are symbolic of omnifarious learning relationships, for example students as a flower, the water representing the teaching and the fertilizer the technology.
- The *pedagogy* property represents the reflective impact of technology on the teachers approach to teaching and learning, content delivery and resulting student learning, for example the decision whether to use augmented technologies to teach educational concepts.
- The *society* property describes reflections on perceptions of the impact of technology on society's changing expectations of teachers, for example the use of iPhones to enable communication.
- The *students'* property represents teachers' views of the transformative impact of technology on students, for example teachers seeing students as cyborgs.

See Table 5–17 for a sample of interview quotes describing the *technology convergence* axial code.

Table 6-21 Sample Quotes Representing Technology Convergence

Property	Sample Interview Quotes
Environment	I6: "Sustainability is a big one for me. I don't have paper. I have an iPad, and two iPhones and two iMacs and a Mac book air, and in there is everything - [every] single paper I have has been digital scanned in. I don't do paper, so when someone walks into my office, I have in front of me my iPad usually, and when I go into a meeting I have an iPad, and its actually been a real focus of mine in the university to get committees to go paperless because I think we can save a huge number of trees and water and so on and so forth." I6: "So pretty much my teaching environment is paperless as well, and [students' assignments] get marked online and they get returned to them that way."
Learning and teaching +	I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds." I4: "I don't understand how much overlap there is between education and technology. Because the technology is there we used it, so on one hand I might under estimate the amount of overlap, on the other had I might also overestimate the overlap, when I consider the potential." I6: "I try to come up with assessments that either engage them or challenge them in some way, which is why a lot of times my assessment include technology, because it forces them to get outside that comfort zone, and they learn a lot. And they come back and say I learned a lot about say emerging tech as a result of having to learn how to do slideshare on the Internet or play a Youtube video, so its sort of incidental learning of the technology, but it forces them to learn the material as well." I8: "The audio [feedback] I only did for three or four students, that was my trial. It's an audio option through the pdf. I used Audacity, then embed to the pdf file."
Metaphor	I15: "Firstly this would need a strong base such as a cookie base to provide a good foundation to build on. Then I would add a sponge cake to ensure good absorption. Ideally, I would avoid having any lumps of significant substance (preconceived incorrect ideas), like orange rind, that you have to pull out or work around to avoid breaking teeth. When mixing the cake, I would add some saffron (this is probably not possible in a real cake, but anyway) just add a bit of flavour and colour so that the cake has something interesting to contribute. I would avoid any icing as I would not want anything blocking the absorption of the sponge cake." I16: "Well the best, yeah the best metaphor I can come up with is the, that old saying which I'm sure you've heard of the, you know the kind of that, that kind of thing about education of, you know, I give you some food then I feed you for a day, I teach you how to get food then I set you up to look after yourself for the rest of your life kind of thing. So that kind of philosophy of don't hand people things, teach them how to look after themselves." I18: "Yeah, so that's so it's like you want to water your plants. What's the best device to water your plants? So there are different cans, there's different nozzles. If the plant is in the pot, students are not plants of course, in the pot if you use this splattering big thing nozzle, then it doesn't go to the pot, so you need a small nozzle to put in the pot. But if it is big, big [like] a garden bed, you want a bigger nozzles so that it covers [everything], so that can is my technology but the students are not the flower. But I think the shape of the flower will be the way they learn. For example, the pot that's the way they learn so you need to use different nozzle. But they're not plants, they're more, they're live. They interact, plants are passive. Things like that but that's to achieve the goal of the plants flourishing." I20: "If I was to use the garden, let's think about that. Does that fit in nicely because I always see it … it's creating the right environment? For some

Property	Sample Interview Quotes
	students you need a lot of shade and there are other ones that are happy to be out in the sun and it's all about achieving everything that they're capable of.”
Pedagogy +	I7: “I think around the outside I hope that there’d be a personal aura thing, where your spirit and your essence it is sort of, is there, your enthusiasm, your love, your passion all of that is there, you as a person. But then you are comfortable to pull in, anything, that is going to enhance the presentation ... of what you are presenting and whether that’s technology or other people, or a funny incident that might have happened up the back.” I14: “Technology and pedagogy are closely intertwined and will continue to be until the end of time. Pedagogy will drive technicality and technology will drive pedagogy. Both are entwined though and are not dependent on each other. But perhaps pedagogy is not dependent and being led a lot more by technology. But the forcefulness and push of the pace of the advancement of technology is starting to weigh the favour for technology being a more dominant driving force pedagogically.”
Society	I6: “It is just the most amazing influencer of society that I have ever seen. I do get excited, because I have goose bumps now. But it was amazing in [place] to watch people function, and I had an iPhone with me and I actually turned it on because people were so worried about us, and so from [place] where we were sort of trapped at one point I could actually text and phone people to let them know we were ok. And the text messages that came through on my phone, there were hundreds of them, including from you, and it was just like are you ok, what’s happening, what’s going on, blah blah blah. It’s an amazing thing technology, and I get frustrated because people don’t see it. They see the bad stuff, they hear about the bad stuff.” I14: “Educators are being forced to adapt to changing social environments and the technological push. Students are rising up through the ranks being highly dependent on technically and also somewhat competent. Adolescents are used to a high dependence on social media and web technologies and expect education to follow suit. Educators must follow suit and embrace technology to aid, enhance and supplement their teaching practises.”
Students	I9: “I think there is a very blurred idea about, you look at their mobiles. If they’re not with their ears on their mobiles, they feel lost. It worries me actually because you take the electricity away and their whole world comes tumbling down for most of them. It’s like television. It’s an extension of themselves.” I12: “They take the laptops everywhere.” I14: “Technology is advancing at such a frightening rate and the youth are natives within this environment. Born purely as cyborgs entwined and dependent in technology to survive socially and attempting to fill the need of a constant technological appetite makes the emerging student [a] foreign force to contend with. But most educators are not from these generations and still have much of their teaching practices grounded within the conventional face-to-face and book style teaching. Such educators must be assimilated with technology and rush to catch-up and understand the system.”

+ denotes additional quotes from phase two interviews added to a phase one property

6.3.4.4 Technology relationships

Technology relationships describes various meaningful connections between IT academics and technology, for example the emotional connection.

This axial code and its associated properties are new in phase two. The finalised version is made up of the following five properties: *emotional*^{2}, *mastery*^{2}, *physical*^{2}, *thinking and problem solving*^{2} and *tool*^{2}. Descriptions of the phase two properties follow.

- The *emotional* property describes IT academics' relationships with technology on a psychological level, arising spontaneously rather than through conscious effort, for example expressing excitement when thinking about technology.
- The *mastery* property describes views, thoughts and perceptions of the level of technology skill of other IT academics for example the assumption that all IT academics are IT savvy.
- The *physical* property describes IT academics' relationship with technology on a physical level, in terms of touch, and connectedness, for example the symbiotic nature of technology.
- The *thinking and problem-solving* property describes examples of IT academics using IT to solve problems, for example writing programs to solve problems.
- The *tool* property describes IT academics' perception of technology use, some see it as a tool while others see it as more than that, for example describing technology as being like a lawn mower or car, conversely seeing technology as an inspiration.

See Table 6–22 for a sample of interview quotes describing the *technology relationships* axial code.

Table 6-22 Sample Quotes Representing Technology Relationships

Property	Sample Interview Quotes
Emotional	I6: "Emotional connection, that's interesting. If you took away my technology I would struggle, because the other piece to the technology that's around today is social media, I am very involved in social media. I'm involved in Internet activism and politics. I'm involved with Facebook and Twitter and that's how I communicate with people. I do have a very strong emotional attachment. And if I don't have it, like I went up to the rainforest a couple of weeks ago and there was no technology, and I really struggled. I had a good time, but I really struggled."

Property	**Sample Interview Quotes**
	I7: “The technology of using the computers and PowerPoint and so forth, Excel, and Mini tab and SPSS, I find it’s exciting to be able to do that. Just before you came in, [name] was in here and we did a chi-squared goodness of fit test, and there was a little graph produced, I think she got a bit excited about it, I certainly did because it felt it was something that was useful, I mean it’s just a simple bar graph.” I9: “I just, I love computers. That is the first thing. I also feel that to a lot of people, and that has been my experience with old and young, computers are things, for want of a better word, that are not like humans. They don’t talk back, they don’t scold you, they don’t get angry with you, they just serve things up the way they’re supposed to serve up, and that’s it. You can’t get angry with a thing like that, although I do, and I show them that all the time.” I10: “I play games. I have multiple consoles, no one is allowed to touch them.” I12: “I am very comfortable with it, but also I sometimes hate it with a passion, because sometimes it doesn’t work, and you know that is a little key, a little file on a little thing, if you just knew how to do it, a monkey could it. But you just, don’t. And it drives me insane. Sometimes I’d like to get the computer and throw it out the window. But, I love games, I’m a computer gamer. I like, I love computers.” I14: “At an emotional level, it is a somewhat uneasy… I don't know, hang on, let me think. This is a hard one actually. It’s a relationship of dependence from my point of view somewhat now. I could not work without, of course because I work in IT, I use computers, I must send emails, Word documents, etc.” I15: “I get very upset if anything goes wrong with my computer and it doesn’t work. No, I get withdrawn if I’m away from the computer; I find it hard. So, each year we often go camping. I’ve gone to the lengths of buying a device that I can plug into the car so that I can plug the computer in.”
Mastery	I10: “I think as a rule IT educators may think about things more from the technology perspective and look at where it could be applied, whereas I guess less IT literate folk would come more from an educational or a problem perspective and look for guidance on what might help.” I12: “There’s some people here who are incredibly early, like [name] and those kinds of people. There’s some people who are incredibly old fashioned in the way that they teach, absolutely not technology orientated. And then there’s [people] they’re kind of in the middle. Probably compared to all the parts of the University they are way technological. We all teach with you know technology. Most of us record lectures, use forums, use quizzes.” I17: “I think it is because you have a better of understanding of how - I'll come back the infrastructure. How the infrastructure works - you're better able to force it to do what you want.” I22: “I guess the difference with IT is they’re more open to using IT, but I guess where the difference might be is how adventurous they’re willing to be with their use of IT. I don’t think there’d be an IT lecturer who wasn’t willing to use a PowerPoint slide and a projector, or comfortable with doing that.” I25: “Look, I think it gave me an overall orientation towards computing of “I can do this”. If you think of a computing self-efficacy, studying computer science gave me a high computing self-efficacy. I believe I am able to get things done and learn new things with computers, and therefore I do.”

Property	Sample Interview Quotes
Physical	I6: “In a physical level I have a very symbiotic relationship with technology. I use technology in every aspect of my life, and its just sort of emerged that way I’m a bit of a geek.” I12: “I play games lots. When my kids go to bed. From … 8:30 when my kids go to bed until you know 2:00 in the morning or something like that.” I21: “I’d be lost without my physical attachment to technology” I23: “Quite connected. Obviously, I live on my computer, basically. I've got my smart phone that I use all the time. I'm quite up to date with software as well, so anything [university] has as well, the systems like Cloud [university], Echo Recordings, Blackboard Collaborate. It's all quite natural to me now.” I25: “I found it really difficult to do this, that I’ve set my phone up so that I am only able to access work stuff, so work e-mail et cetera between 7:00 am and 7:00 pm, and only on weekdays. And only on days that I’m actually working, and outside of those I actually can’t access it. So, I am aware that I’m very attached to it, and I’ve had to take steps to sort of stop it from taking over my life in certain ways in terms of the work stuff. And I guess the other thing is I’m a pretty big gamer as well.”
Thinking and problem solving	I15: “I have a problem. I do tend to always look for solutions through technology to whatever an issue might be. So when there’s an issue, I’m going to solve that issue, I almost end up thinking, I could develop a program that does this or I could something like that.” I21: “I love it. It’s fun. People don’t get that. How can programming be fun? Well, it’s intellectually challenging, it’s solving problems that other people can’t do, it’s taking something that I see or hear or watch.” I22: “I want them to be thinking, so things that allow me to customise it or to work with it so that the kids are actually thinking, actively thinking about what they’re doing and where they’re learning. I don’t want it to just be question/answer sort of stuff. When I’m stuck with that I try to make it more interesting, but I really want them to be thinking about it and interactive, and trying new things.”
Tool	I1: “I think it’s more than just a tool, I think it’s an inspiration not just a tool. Because some of the things I do, I couldn’t do I wouldn’t do I wouldn’t of thought of doing without the affordance of the technology.” I9: “This technology is, yes, the technology, and I’ve said that before, it’s just like a lawn mower, and just like a car, just like anything else, but it is a creative tool.” I9: “The software with which to create webpages for instance. I use that as a tool, so to create the product and to teach about the product. But in my private life I use it for communication, I use it for my creative expression, and I’m beginning to use it for banking, that sort of, well I have been using it for banking, but reluctantly because I’m not all that switched on about the security of things. It is, yeah, I make a distinction between what I use it for in my work and what I use it for at home. But it is a multiple tool.” I25: “And also I guess I bring the toolset of things I had from computing to bear on education quite a bit. So, some examples there, I published a paper on exam hacking, because I have a set of skills around computing and doing interesting stuff with systems that I can apply to assessment research, which is my current field. And another thing I’m working on now is I’ve got a script running grabbing lots of bibliometric data and indexing that against social media and whatever. So, it’s a skill set that I keep up with. Yeah, so I don’t know, I think they do affect each other, but I think it’s more of a disposition and self-efficacy than any particular skill set with particular computing tools.”

6.4 Phase 2 – Paradigm model

The paradigm model is a component of Strauss' axial coding that presents the categories in a contextual format as opposed to the previous hierarchical coding structure. The contextual view includes details of each category's conditions, interactions and emotions, and consequences (see Chapter 3.5.4.5). The paradigm model provides an alternative lens for viewing and interpreting the data (see Chapter 4.6.2.1). Details of the paradigm model for all four categories is shown in Table 6–23.

Table 6-23 Paradigm model

Phenomenon (Category)	Conditions	Interactions and Emotions	Consequences
Pedagogical development	**Factors influencing underpinning philosophy of teaching approach:** • Specific techniques (signatures) tailored to sub-discipline areas of computing. • Counselling and guidance of others. • The use of educational and technical language. • Obstacles and fears limiting philosophical development. • Perceived characteristics of quality teachers. • Relationships with students and understanding of their needs.	**Reactions and responses to influencing factors:** • Triggered strong positive feelings of admiration, awe, and optimism when reacting to the influence of others, and ideas around what constitutes quality teaching. • Negative feelings of disapproval and vigilance when considering students' attitudes toward learning and being mindful of their needs.	**Changes and development of underpinning philosophy.**
Teaching practice	**Development of practical teaching approach:** • Assessment strategies and approaches including assignments, tests and examinations. • Expert technical knowledge and specialties in computing. • University management and imposed legislative requirements. • Various instructional methods and teaching approaches.	**Reactions and responses to practical teaching approaches:** • Strong positive feelings of admiration and optimism in relation to assessment approaches adopted, development of technical knowledge and instructional teaching models utilised. • Negative feelings of frustration in relation to	**Application of practical teaching strategies and approaches.**

		negative and restrictive teaching experiences.	
Technology adoption	**Availability and use of educational technologies:** - Affordances facilitating technology integration. - Constraints limiting technology integration. - Catalogue of ET's in use. - Range of skills in software and hardware application.	**Reactions and responses to use of educational technology:** - Strong positive feelings of admiration and optimism when considering affordances and use of ET. - Negative feelings of frustration around constraints and disadvantages of ET integration.	**Integration of new and emerging technologies to facilitate learning and teaching.**
Techno-pedagogical practice	**Technology, pedagogy and teaching practice:** - Technology enhanced learning and teaching environments. - Range of technology enhanced learning and teaching strategies. - Technology converging with other influences. - Relationships with technology.	**Reactions and responses to technology enhanced teaching practice:** - Sense of awe and optimism in relation to using pedagogical based technology enhanced teaching practices.	**Innovative teaching and learning approaches.**

6.5 Summary and conclusion

Data gathered in phases one and two was presented in this chapter. The finalised detailed code structure, a descriptive narrative, and accompanying sample quotes were provided, along with the contextualised paradigm model.

The detailed coding structure described in this chapter, presents the finalised phase one and two data in a format ready for review and analysis. Once analysed the coding structure provided answers to the research questions under investigation (see Chapter 8.2). The finalised codding structure was modelled and developed into a substantive theory (see Chapter 8.4).

The next chapter provides an analytical discussion of the finalised coding structure. It offers a detailed analysis of each category, associated axial codes, and properties. The detailed analysis of each category contains details on the importance of understanding each code, details of the current literature and a discussion and comparison with the relevant interview data. Implications and answers to the research questions are provided in Chapter 8.

7 Analysis and Discussion

7.1 Introduction

The previous chapter presented data gathered during phases one and two. Data from 25 interviewees was coded using a Straussian grounded theory approach, with four categories emerging. A finalised summary and detailed description of the coding structure for phase two (including phase one) was presented along with sample interview quotes. The aim of this chapter is to present an analytical discussion on each of the four categories providing details of purpose, comparable literature and a comparative analysis of the interview data. Implications and research questions answers are detailed in Chapter 8.

This chapter contains six sections; introduction, a separate section for each of the four categories, and a summary and conclusion. Each of the four category sections commence with a diverging radial diagram which illustrates the category and its related axial codes. This is followed by an analytical narrative of each category, associated axial codes and properties. The focus of the discussion is on a comparison of ideas from the existing literature. Then defining the purpose and importance of each axial code and a discussion incorporating relevant interview quotes. These quotes offer support and extend our knowledge of this phenomena. The end of each section contains a summary, conclusion, and a set of recommendations. A full set of recommendations is available in Appendix E.

In the following sections, codes relating to phase one are identified with a superscript one ^{1} character, and codes created during phase two are identified with a superscript two ^{2} character.

7.2 Pedagogical development

This section provides an analysis of the ***pedagogical development*** category and a model illustrating this category along with its associated axial codes. This is followed by a discussion of each axial at the properties level. Each property is examined in terms of its connection to the literature and the phase one and two data, a brief conclusion and recommendations for each are offered.

The ***pedagogical development*** category describes factors influencing the formation, development and growth of IT academics' pedagogy, and provides underpinning support upon which IT academics reported in this study build their practice.

The model illustrated in Figure 7–1 represents the ***pedagogical development*** category, its associated axial codes, and property codes. The diverging radial diagram functions as a visual representation illustrating connections between the axial codes and properties to the central theme (pedagogical development).

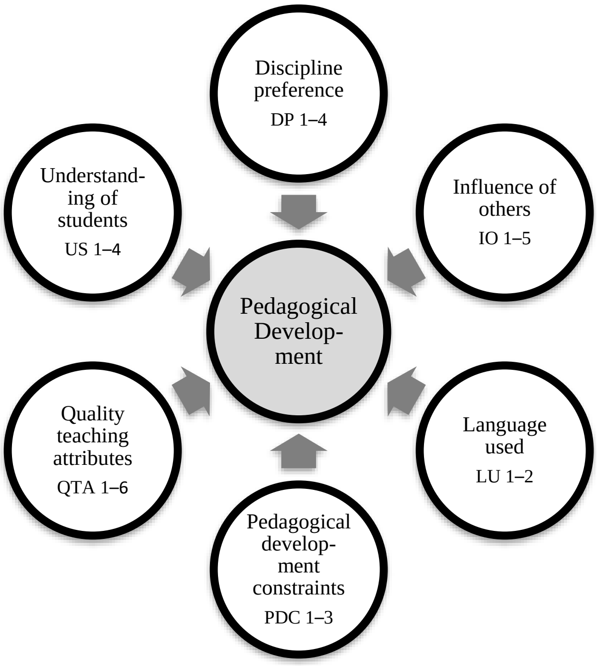


Figure 7-1 Phase 2 – Pedagogical development radial diagram

See Table 7–1 for a list of the ***pedagogical development*** radial diagram property codes and labels. This should be read in conjunction with Figure 7–1.

Table 7-1 Pedagogical development properties

Axial Code	**Property Code**	**Property**
Discipline preference	DP1	Creative outlet
	DP2	Educational successes
	DP3	Logic based
	DP4	Skills based
Influence of others	IO1	Family
	IO2	Industry
	IO3	Mentors and teachers
	IO4	Scholarship
	IO5	Society
Language used	LU1	Educational
	LU2	Technical
Pedagogical development constraints	PDC1	Generation gap
	PDC2	Industry experience
	PDC3	Self-confidence
Quality teaching attributes	QTA1	Approachable
	QTA2	Caring
	QTA3	Communicator
	QTA4	Entertaining
	QTA5	Honest
	QTA6	Passionate
Understanding of students	US1	Attendance
	US2	Engagement and motivation
	US3	Learning approach
	US4	Learning highlights

7.2.1 Discipline preference

Discipline preference represents the identification of learning and teaching techniques tailored to various sub-discipline areas of IT, and how these emerge from educators' own experiences and choices. The *discipline preference* axial code contains four properties: *creative outlet*[2], *educational successes*[2], *logic based*[12], and *skills based*[1].

Analysing this axial code provides information about academics' preferences for discipline specialisations. Understanding the *creative outlet* of ET provides information about aspects that motivate and excite its selection and application by IT academics. The *educational successes* property provides information about areas of computing that IT academics enjoyed studying as students and wish to teach. Understanding *logic-based* preferences provides insight into IT academics teaching preferences, which require learning processes of questioning, reasoning and deduction. Understanding *skills-based* preferences provides insight into the practical disciplines, which encourage a kinaesthetic or hands on, experimental learning approach.

A study by Goodwyn, Protopsaltis and Fuller (2009) reported primary and secondary teachers enjoying teaching with technology because of the varied teaching and learning approaches it affords, not often possible using traditional approaches. Flexible working conditions is reported as the primary reason for becoming an academic (Acker, 2003; Strasburger, 2010), along with a love of teaching students (Strasburger, 2010). This focus on students is evident in some sub-discipline areas of CS/IT teaching, such as computer programming, where much has been written regarding high student failure rates (Bennedsen & Caspersen, 2007; Sheard & Hagan, 1998). From a student point of view, there is much research trying to understand why some find programming easier than others (Ramalingam, LaBelle, & Wiedenbeck, 2004). Why computing academics appear to enjoy teaching programming is not clear in the literature. However some have reported passion, driven by learning something new and the ability to help people as appealing characteristics (Harbottle, 2013). Findings from this research add to the literature, suggesting IT academics enjoy the capacity to build or create something with the use of technology. Interviewee 15 reported loving the inventive aspects of ET particularly programming which facilitates the creation of something.

> *I15: "I've been into programming since I was a kid, since computers were new, so that goes back to Commodore 64 days, programming games on that in machine language. And I always loved programming. So my two loves were film and programming, probably for much the same reason: you're making something. I like to make things."*

Teachers enjoy teaching what they know and what they have experienced as students (Ramanathan, 2008). Kowalski and Weaver (1988) found teachers have typically been reported as being good students. Interviewees 4, 5, 7 and 13 reported on past educational successes. Findings from this research are consistent with the literature. Interviewees, 7 and 13 reported being good at school and enjoying learning.

> *I7: "I enjoyed school because I was good at it I suppose. I wasn't one of the ones that got into trouble, or never understood what was going on."*
>
> *I13: "I've always known I didn't have any trouble with [learning]."*

Data from interviewee 5 extends the literature indicating a sense of achievement in learning difficult concepts.

> *I5: "I was doing a Graduate Diploma in Computing and they had just started the course, and there was 120 of us or something enrolled, and I think 25 finished. There was a dramatic drop out and the 25 of us that finished, really felt that we had achieved something because it was a tough course."*

Computers help people generate solutions to problems (Saeli, Perrenet, Jochems, & Zwaneveld, 2011), In particular learning programming helps individuals to develop problem solving skills (Koppensteiner, Vittori, Miller, & Goodgame, 2015), and logic and high order thinking skills (Casey, 1994). The literature reports the contribution of computers and programming in developing logic and problem-solving skills however; it does not recognise the desire and attraction of IT academics in wanting to pursue this type of thinking. Interviewees 2, 3, and 13 reported enjoying logical pursuits. Adding to the literature, interviewees reported loving the challenge, the logical high order thinking, and the skills and creativity required to program.

> *I2: "Very much skills based."*
>
> *I3: "I've taught that in Java, C and C++. I enjoy that one, I find it a challenge, because the students come in, and to me programming is a completely different way of thinking, it's very logical and you have to follow steps, and there [are] rules."*

7.2.2 Influence of others

The *influence of others* represents the development of IT academics' teaching philosophy resulting from counselling, guidance and lessons learned from various teaching role models. The *influence of others* axial code contains five properties: *family*^{2}, *industry*^{2}, *mentors and teachers*^{12}, *scholarship*^{12}, and *society*^{2}.

The *influence of others* provides an important understanding of factors reported by IT academics' when reflecting on their relationships with people who have inspired their thinking and approaches to teaching. The *family* property provides details of the impact of parents, uncles and children in shaping thinking about teaching and ensuing approaches to teaching. The *industry* property provides some insight into professional standards and gives teachers some exposure to examples and stories of real workplace practices and requirements. The *mentors and teachers*' property provides details of teaching experiences and strategies shared with other academics, as well as preference for developing relationships and working with others. The *scholarship* property provides insights into concepts and ideas identified through reading the research of other academics, as well as insight into the type of literature consulted; educational or discipline based. This deeper insight provides interesting information around IT academics' motivation and preference for improving teaching approaches and/or course content. The *scholarship* property also provides information about the type of information and preferred professional educational activities IT academics seek. The *society* property provides information about the influence of the wider community for example, sporting clubs, places of worship and the media, on teaching thinking and approaches.

Family environments where educational achievement is valued and expected promote positive and powerful academic outcomes (Israel, Beaulieu, & Hartless, 2001). Hoffman, Charles and Goldsmith (1992) found fathers are a key influence over their children in undertaking suitable occupations. Women in particular have been found to be influenced to undertake CS/IT studies by their parents (in particular their father), also by their teachers, employers and co-workers, family and friends (Turner, Bernt, & Pecora, 2002). Much research has been conducted on why individuals choose teaching as a career. Interviewees 7, 8, 9, 13, 15, 16 and 21 reported on the influence of family on teaching. Findings from this research are consistent with the literature in recognising the influence of family particularly fathers. This is reflected in interviewees 8, 13, 15, 16 and 21 comments. Interviewee 9 extended the idea of teaching as a career choice to promoting the influence of family on encouraging considered or reflective thinking. Much literature has been published on reflection, from defining reflection, reflective thinking (Dewey, 1933), reflective strategies (Larrivee, 2010; Stingu, 2012), the depth of teacher reflection, models for teacher reflection (Lee, 2005), and more, however this is limited evidence of the influence of family on teacher's reflective thinking. This research reports the impact of family on IT academics.

> *I8: "My uncle was a lecturer at the university in [place]. That has influenced me a bit in my teaching. He is a chemistry lecturer. So at home I have a connection with those academic people, and also the students coming at home, and he has been writing papers. So that has influenced a little bit I guess, why I got into teaching. At home also my parents."*
>
> *I9: "My father was a big influence on me. My mother not so much. My mother was the typical housewife who knew her crafts incredibly well, but my father was a thinker. And my father expected, not deep thinking but considered thinking from his children."*
>
> *I13: "My kids have profoundly influenced the way I think about teaching and the way, mostly because of the way, they influence the way you think about life."*
>
> *I21: "I think perhaps the fact that my parents allowed me to be creative and didn't say, 'No, you're going to be a doctor,' or, 'No, you're doing to do this.' I wanted to be a teacher and Mum said, 'Well, you know, if you want to do that you're going to have to make sure you meet these goals at school so you can get into teacher's college."*

Teachers with industry experience have been found to positively motivate students' interest (Gentelli, 2015), relate their experiences to the theoretical aspect of their teaching, act as role models (Matthews, 2007), improve student work readiness, and provide industry links for learning (Levine, 2015). In addition, industry experience and was found to promote the use of experiential learning amongst Engineering academics (Johan, 2015). Industry experience improves teachers' skills and knowledge (Perry & Ball, 1998), however, teachers with industry experience have been found to lack focus on the research and publishing requirements of their positions (Fairweather & Paulson, 1996). Interviewees 8, 14, 17, and 19 all reported the value of having worked in industry prior to becoming academics. Interviewees reported providing contextualised learning through the use of real case studies (see interviewee 14), integrating work practices and standards, such as coding standards (see interviewee 8) and integrating problem solving approaches (see Interviewee 8).

> *I8: "I worked in the industry as an analyst/programmer, I worked in an e-Commerce company where I used to maintain a wine company, we had a C++ database, so what we did is keep track of all the transactions. So we had our own programming practices, for example we had coding standards, and then when you have a problem like how to communicate with team members, those sort of things. Those explanations I gave to them."*
>
> *I14: "In the multimedia course I'm probably at an advantage because I've worked in [multimedia], I've done certain things in it so I can easily talk about, you know, 'I've worked on this and I've done this."*

Much literature has been written regarding conducting effective mentoring and peer review of teaching in a higher education context. Blackmore (2005) found peer reviews lead to encouragement of reflective practice amongst academics. Mentoring relationships are reported to work both ways with the mentor and mentee benefiting from ways of thinking and shared teaching approaches (David, 2000). Critical awareness of learning and teaching issues shared through mentoring relationships can lead to innovation and good practice and ultimately improved student satisfaction (Carbone, Wong, & Ceddia, 2011). However, not all studies have found the process of peer review a positive one. Peer review conducted by work colleagues can lead to prejudice, collusion and compromise (Ingvarson & Chadbourne, 1994). Other problems include, inadequate training of the reviewers, overcoming suspicion and a lack of trust (Marsh, 2008). Interviewees reported mentoring from other academics, through a range of activities, including sitting in their class as a student, through formal and informal mentoring sessions such as peer reviews. A strong relationship with mentors from early on instils a sense of collegiality and a preference for discussing teaching and learning issues. Interviewees 2, 3, 4, 6, 7, 18 and 25 reflected on the influence of mentors and teachers. Interviewee 4 reported discussing teaching approaches with a mentor consistent with the literature (see David, 2000). Interviewee 2 relates the practice of peer review to good teaching, suggesting good teachers seek to improve their practice. This extends ideas reported in the literature. Interviewee 25 reports teaching and mentoring peers on their teaching practice as being a catalyst for improving their own teaching.

> *I2: "We have the policy of a couple of times a year sitting in on someone else's lecture and getting them to do the same thing for you, and that's what I noticed some of the good teachers doing."*
>
> *I4: "We used to discuss various ways of doing things. And as a young teacher it was also good to have a senior person, who was, not so much a protector, that [is] to strong a word but a supporter with some strength and some credibility."*
>
> *I25: "I come from a pedagogical background in peer learning, so the peer assisted study sessions, or [name] or [name] programs that exist in various places. I've had a fair bit to do with them, I've trained a lot of people to run those programs at different unis, and I guess that was a really formative thing for me as a teacher."*

Bain (2004) believes it is important for academics to explore existing literature in order to develop research–based teaching initiatives. Green (2010) found academics are reported to read a variety of literature including; books, journal articles and textbooks for students. Academics that spend time reading professional journals were found to be more effective teachers and better prepared for scholarly activity (Ferman, 2002; Green, 2010; Woods-Quinn, 1994). Woods-Quinn (1994) reported some academics question the usefulness of reading as a way of developing their pedagogy, while others report not having time to read beyond their discipline area. Interviewees 1, 3, 4, 6 and 7 reported on the influence of research on their pedagogy. Results support the literature that academics undertake reading of educational literature as a way of soliciting new ideas to inform their practice and pedagogical thinking. Literature consulted by interviewees was consistent with that reported by Green (2010), this included textbooks (see interviewees 3 and 6), and published research (see interviewee 1). Interviewees indicated a self-professed interest in teaching and learning, this is consistent with Green's (2010) findings that academics are more likely to consult pedagogical literature if they are interested in teaching. Although the thoughts of both interviewees 1 and 3 appear similar, there is a subtle difference in the intellectual thought and intent, behind each comment. Interviewee 3 appears pragmatic, reviewing textbooks for ideas on practice, while interviewee 1 consults pedagogical research literature as a way of investigating underpinning educational ideas.

> *I1: "The educationally critical aspects. Somehow, they need to be determined. Often it's by reading the research of other people."*
>
> *I3: "So I went through and decided, ok, what are the topics that we need to go through. What's a good order, I looked in text books, and online and I looked at other courses that people had delivered."*
>
> *I6: "I started to read things like Freire and his work in radical pedagogy."*

Academics rate conference attendance and participation as a preferred way of maintaining professional currency and gaining exposure to new ideas (Ferman, 2002; Ling, 2009). Not all academics report finding value in professional development activities. Nicholls (2001) findings suggest imposed professional development activities can have the opposite effect leading to greater alienation from teaching, and encourage academics to play the system. Interviewees 3, 4 and 7 reported on the influence of conferences. Data gathered supports findings in the literature, where educators found they assimilated valuable techniques, which enhanced their teaching practice through attendance at conferences (see interviewees 3 and 7), in addition to observing others, and, participating in peer review sessions (see interviewee 4).

> *I3: "I went to a conference and they highlighted the idea of early assessment."*
>
> *I4: "I watched her give a presentation one day, I watched her pause, and I thought ah yes that's effective."*
>
> *I7: "I went to a conference last year in [place] ... there was a guy [name] from [place] and he's got these graphs that he uses ... and he portrays graphically five or 6 dimensions in his graphs, and they are just fabulous, and I have shown them to different groups of students and that just blows them out of the water to see just what can be done, and just how interesting it is to see what happens."*

There is much literature reported of the impact of society and culture (sport, religion and media) on students and their learning, while there is less reported of the impact on teacher's pedagogical development. A study by Wadsworth (2015) investigated the impact of teacher's religious beliefs on their teaching. Wadsworth (2015) found religious beliefs impacted teacher's classroom management, lesson plan development, handling parents and colleagues, approaches to discipline and attitude. Alabdulkareem (2015) found that teachers and students perceived the use of media (social media) to enhance their educational experiences, in addition, Florescu (2014) found the media (radio, television, press, Internet) to be a useful teaching resource. Marsh (2015) reported on the importance of teachers staying fit to help reduce anxiety and boost concentration. A report by the World Health Organisation (2006) recommended the importance of physical activity for teachers. These studies report impact of society and culture on teaching practice rather than pedagogical development and thinking. Interviewees 7 and 8 reported on the influence of society. This research introduces new ideas into the literature. Interviewees 7 and 8 reported the impact of society and culture on their pedagogical thinking. Interviewee 7 talked about the influence of his church and preacher, and the curiosity they inspired. Also, the importance of belonging to a sports club and emulating leadership behaviours in teaching as a natural extension of the experience. Interviewee 8's responses confirmed the literature regarding the value of media in assisting students' to form their ideas and opinions. Interviewee 8 also reported reflecting on the value of media to enhance students' basis of knowledge and ideas.

> *I7: "One guy was a lay preacher in the church and it was interesting to hear him preach and hear him teach in school, and then I also partnered him in tennis when we played doubles in tennis they would often put me with this guy."*
>
> *I7: "It was through sport on the weekend. We had a couple of teachers that would play football on the weekends for the local team. And you'd see them go in and get crunched, and they earned the respect of people ... It was good and that had a positive impact on me, and I just went into teaching naturally."*
>
> *I8: "I think students can understand what's happening around them, if I talk about [news item], they want to participate, what it is, because they have been listening to the news and reading those things and they are very quick to give their opinion."*

7.2.3 Language used

The *language used* axial code provides examples of IT academics' using educational and technical language. It includes IT academics' describing teaching and learning experiences using colloquial or folk language consistent with educational frameworks and theories presented in the literature. It also includes technical language adopted by IT academics, related to IT discipline specialisations. This axial code contains two properties: *educational*[1] and *technical*[1].

Analysing this axial code provides an understanding of the language used by IT academics in both educational and discipline-based contexts. The language encompasses terms and phrases used, and their meaning and application. The terminology associated with learning and teaching theory provide a picture of the IT academics' professional educational language set, educational research, and a view of the way they integrate language into their teaching practice. Investigating IT academic's approach to the use of technical language provides an understanding of the educational importance placed on the development and adoption of such language.

The literature suggests that most academics (apart from those in education schools) do not have a background or formal training in education theory to be able to apply pedagogical based terminology (Harris, 2005). In addition, Yayli (2012) found that prior to any formal training teachers were not able to use professional educational language. Interviewees 1, 3 and 4 reported on the influence of language on pedagogy. Consistent with the literature interviewees described a range of teaching frameworks and theories but were not able to use the formal educational language required to connect their descriptions to identifying educational labels. For example, problem-based and applied learning, student-centred learning, constructivism (see Chapter 2.3.4), and learning styles were all described using everyday language. This is consistent with observations of other researchers (see Harris, 2005). For example, interviewees 1 and 3 described the attributes of constructivist learning theory without providing the label.

> *I1: "They go to a lecture maybe do the homework problems build up that foundation build on it for the next portfolio. So it's a building process."*
>
> *I3: "I would try and design it so that they could work on small parts each week and encourage them in the class."*

Educational language is the language of professional educators, discipline-based language is also important. The use of technical language is essential for communicating specialist ideas (Zobel, 1997), particularly relevant in technical disciplines, such as IT. Zeidler and Lederman (1989) found that when science teachers used technical language it improved students' understanding of concepts. Alternatively Zobel (1997) recommends specialised vocabulary or professional language should be used carefully as it limits accessibility of the audience. According to Windschuttle and Elliott (1994) academics use inaccessible language as a convenience even though it is known to exclude others. Interviewees 3 and 4 understood the need for applied real world problems, but without providing the education labels. Interviewee 3 encouraged students to explore technical language underpinning their discipline speciality, while interviewee 4 saw a need for commercial experience as a source of applied knowledge.

> *I3: "Generally with programming units I try and have and an early assessment task ... I had them working on terminology, because I'm a firm believer in that they understand what the terms are and that they can talk about them."*

> *I4: "A well rounded lecturer will have research interests and research experience, will have commercial experience, to get good understanding of the way in which IT is used in the world, as well as a good theoretical knowledge of IT."*

7.2.4 Pedagogical development constraints

The *pedagogical development constraints* axial code describes IT perceived obstacles and fears constraining or limiting the development of IT academics' pedagogical philosophy. The *pedagogical development constraints* axial code contains three properties. These include; generation gap[2], industry experience[12], and self-confidence[12].

Analysing this axial code provides a deeper understanding of the potential reason's IT academics feel constrained in the development of their pedagogy. These factors led to frustration and act as deterrents to natural pedagogical development. Analysing the generation gap aids understanding of the differences in attitudes between teachers and their students. The lack of industry experience provides information about the importance placed on practical knowledge and applied examples used in teaching. Understanding a lack of self-confidence provides insight into the pressure and responsibility felt in association with not making any errors while teaching.

The term *generation gap* was first used in the 1960's (Hernandez, 2010), and is used to describe sociological (structure and functioning of society) and psychological (mind, mental and emotional) differences between members of different generations (Bengtson, 1970), for example, members of younger generations when compared to members of older generations. There are known generation gaps and various impacts between teachers and their students. Krotov (2015) reported a generation gap hindering effectiveness of students' learning in higher education, while Aalai (2016) reported a difference between experiences and varied frame of references between academics and their students, for example, when using pop culture references. A large study by Wotring and Bol (2011) suggested there are significant differences among generations in values, attitudes and patterns of behaviour. A technology generation gap has also been reported in schools (Cohen, 2013), and a survey found that generation gaps in the workplace are really wide with many differences when it comes to what constitutes appropriate use of technology (cited in Perez, 2009). However, a meta-review of 20 studies examining the generation gap found only minor and inconsistent variations in between baby boomers, Gen X and the Millennials (Constanza, Badger, Fraser, Severt, & Gade, 2012), suggesting the generation gap may not exist (Nash, 2019). Interviewees 6 and 7 reported experiencing generation gaps. The notion of a generation gap existing between teachers and students requires further research. The literature is conflicted and there is not a clear view of the existence or not of the generation gap. Interviewee 6 believes students see teachers as being from a different generation, in the same way they see their parents or grandparents. Interviewee 7 believes first year students are better taught by younger academics. These academics recommended that students can be educated to limit or remove the impact of the generation gap. Given the conflicting views, this idea requires further investigation.

> *I6: "I think age is an issue, I think it is. I think students start to perceive you as being a different generation, you know you're like my father or you're like my grandfather [laughing] or whatever."*
>
> *I7: "I've given up on 1st years. I'm too old for first years. Seriously. I mean, I'm just so far removed from the current thinking, mentality, of first years. They just annoy me now. But once they've been groomed by our younger staff I'm more than happy to take them on in second year."*

Universities have been increasingly criticised for their lack of relevance to industry (Jarvik, 2009). In a bid to provide real world experiences for students, business schools have been employing business practitioners as faculty members (Clinebell & Clinebell, 2008), while IT schools are utilising capstone projects with industry based clients (Gorka, Miller, & Howe, 2007; Isomottonen & Karkkainen, 2008). Consistent with the literature, a lack of real-world commercial experience was reported as a concern. Interviewees 4 and 6 reported no real-world commercial IT experience with which to enrich teaching and learning experiences.

> *I4: "I have never been involved, apart from minor projects, with the commercial and business side of IT."*
>
> *I4: "I just think that a well-rounded lecturer will have research interests and research experience, will have commercial experience, to get good understanding of the way in which IT is used in the world, as well as a good theoretical knowledge of IT."*
>
> *I6: "I've given up on 1st years. I'm too old for first years. Seriously. I mean, I'm just so far removed from the current thinking, mentality, of first years. They just annoy*

> *me now. But once they've been groomed by our younger staff I'm more than happy to take them on in second year."*

Another constraint is a reported a lack of self-confidence. Secondary teachers of Science, Technology, Maths, and pre-service and primary school teachers, reported they lack understanding, and the competence to teach when delivering subject content (Appleton, 1995; Brady & Bowd, 2005; Harlen & Holroyd, 1997; Holroyd & Harlen, 1996). Despite these studies, little is reported in the literature regarding self-efficacy of higher education academics. Interviewees 3, 8 and 18 reported a lack of self-confidence and feeling under pressure when teaching students and claimed that this affected the quality of the students' learning. Although a lack of self-confidence has been reported in the literature with primary school teachers and pre-service teachers, there is little reported regarding higher education academics' lack of self-confidence constraining their pedagogy. This is possibly because it is not a frequently reported constraint amongst higher education academics. This research indicates that a lack of self-confidence is potentially a problem for some IT academics, particularly when teaching different or new courses.

> *I8: "I think it's much easier if, to teach students in your area, you can teach in other but you won't be that confident and you need to practice and you need to prepare and it takes a lot of time."*

7.2.5 Quality teaching attributes

The *quality teaching attributes* axial code describes thoughts, reflections and comments by IT academics which describe qualities of good teaching, and key traits of great teachers. The *quality teaching attributes* axial code contains six properties. These include; approachable^{2}, caring^{12}, communicator^{12}, entertaining^{2}, honest^{12}, and passionate^{1}.

Analysing this axial code provides information detailing quality teaching characteristics of IT academics. Understanding these provides a profile of desired qualities for great teaching. Approachability is an important aspect in developing positive learning environments for students (Hagenauer & Volet, 2014). Being aware of the importance of empathy helps IT academics to share and understand the experiences and emotions of their students. This provides a better sense of the students' journey including their hardships and successes. Appreciating the importance of effective two-way communication can assist IT academics to do a better job of teaching by interacting skilfully with their students, identify problems and meet individual student needs. The importance of engaging students is vital in a world where they are immersed in technology, and their attention is no longer held by drab or monotonous presentations (Collier, 2011). Embracing the value of honesty is essential to teachers earning the respect of their students (Palmer, 1962). Understanding teacher passion is important because passion is a key driver to capturing students' interest and inspiration in a topic. A passionate teacher has a big impact on students' learning experiences (Levoy, 2015).

Approachability in university teaching is reported to be an important quality of good teaching (Hagenauer & Volet, 2014; Sander, Stevenson, King, & Coates, 2000). Pitney and Ehlers (2004) found approachability to be important in developing mentoring relationships with athletics students, while Reid and Johnston (1999) found that approachability in academics promoted interaction and deep thought in unengaged students. Consistent with the literature interviewees 2, 3, 6 and 12 all reported the importance of approachability. Extending this idea, interviewee 6 suggested teachers need to combine normality and approachability to facilitate improved student learning. Interviewee 12 suggested teachers keep a balance between setting students at ease, while not being overly friendly as being important.

> *I3: "So I think that sort of friendliness, and approachability, is what came across with some of the staff."*
>
> *I6: "Someone who is able to make mistakes and admit it not have to know everything all the time because they are approachable and if you are approachable then you'll learn more."*
>
> *I12: "You need someone who, or has the time of course but is, not – yeah friendly I guess, approachable enough. They cannot feel scared or you know, distant, too distant. I mean it's good to keep a certain respect distance, but it cannot be that they're not willing to come and talk to you."*

It is well reported in the literature that effective teachers care about their students (Stronge, 2007). Caring teachers are encouraging and nurturing towards their students (Lumpkin, 2007). Caring teachers are the key to student learning and take an interest in the students as individuals (Shulman, 2004). Biggs and Moore (1993) list “treating students as individuals” and “empathising with students” as numbers two and six on their list of the top 15 characteristics of what makes a great teacher (Biggs & Moore, 1993). Findings supported the literature. Interviewees 1, 2, 4, 6, 7, and 19 identified caring as the topmost important feature of great teaching. Extending the literature are interviewee 19’s thoughts that caring teachers not only care about the student but also the student’s career and their ability to be successful in life.

> *I1: “The most important feature of a good teacher is that they care about their students.”*
>
> *I2: “Try to be as sympathetic as you can be.”*
>
> *I4: “An interest in students as people.”*
>
> *I6: “Compassion, you have to really actually care or else, you have to have compassion for students.”*
>
> *I7: “They have also got to have compassion they have got to be compassionate. I think that is really important they have got to understand that some students are scared stiff by not knowing something, and to be able to handle that in a nice, non-threatening way.”*
>
> *I19: “I think that comes through in my teaching that I do care, and I do want them to get better, or I certainly hope it does. And that came through in the best teaching from the teachers that I had, that they cared about my education, about where it would take me, about what I would do in my life.”*

Diverse effective communication skills are really important to teachers (Prozesky, 2000). Communication skills are considered one of the most neglected aspects of educators preparation for teaching (Morgan, 1989). Teachers require a variety of tools, such as images, posters, demonstrations, diagrams and projectors in order to communicate effectively (Prozesky, 2000). Teachers need to communicate with a wider audience of students with different interests and backgrounds (Marsh, 2008). Tools such as those suggested by Prozesky (2000) can facilitate and improve communication. Findings build on this research, where interviewees 3 and 13 reported a need to communicate with students at different levels, in different ways.

> *I3: “They have to be a good communicator, and to different levels, so it can’t just be, being able to, they have to be able to explain things in ways that various different people understand. So, you can’t just be at the high level, with the higher students, especially here because we have such a range, you have to be able to deliver it in a number of different ways and look at it from different perspectives.”*

> *I13: "She was one of the clearest communicators I think I've ever met; she had a way of simply being able to lay out very complex ideas in very easy to grasp stages, and she was able, through that she was able to expose the structure of Maths which had not been exposed to me before."*

The notion of teachers as entertainers has been well debated. Some academics believe that teachers who entertain compromise their credibility as educators (Weimer, 2002), because these teachers see themselves as being engaged in a serious endeavour (Ben-Peretz, Mendelson, & Kron, 2003). Harris (1989) suggests that humour and joke telling by teachers is not funny. Harris (1989) believes joke telling is disrespectful, and jokes about women, men, ethnic or racial groups, handicapped or aged people are discriminatory and hurtful. Alternatively some teachers pride themselves on being entertaining, and believe that being an entertainer is part of being a teacher (Stanley, 2004). Entertainment is said to make learning more interesting, by helping both students and teachers enjoy class, motivating and energising them (Korobkin, 1988; Lundberg & Thurston, 2002), and is a useful teaching tool for establishing a relaxed classroom favourable to learning (Bryant, Comisky, & Zillmann, 1979; Kher, Molstad, & Donahue, 1999). Interviewees 3, 7, 12, 13 and 20 reflect on the importance of teachers as entertainers. Findings suggest that IT academics link entertaining with student engagement. This is not about pride as suggested by Stanley (2004), but a subtle suggestion of using entertainment as a tool for generating desire, motivation and engagement in order to expand students' thinking and ideas. Interviewee 13 provides a unique perspective regarding the use of humour, the idea of not taking oneself to seriously. Interviewee 13 believes it important to present as relaxed and approachable, and is attempting to set students at ease, using laughter to improve the learning and teaching environment.

> *I3: "Keep it entertaining, so you will engage the students, so not entertainment for entertainment sake, but keep it so that it's interesting, and you do things differently and you bring in different ideas."*
>
> *I7: "I used to play little jokes on the kids, like you might have ... when you are giving them a spelling test you usually put the word in a sentence so there is a context with it. Like 'bird', I saw a bird down the street' or, a 'bird up in the tree', you know. Occasionally I'd go 'bird' 'b i r d spells bird', and you'd see the kids giggle, just a bit of fun."*
>
> *I13: "Humour is very important, mostly to keep myself sane. I can't take myself that seriously for that long, so, and you know, I laugh at my own jokes; I do it a home too. I laugh at my own jokes; nobody else laughs at them."*

> *I20: "There's a lot of humour. It only takes a week or two for students to know this guys on our side. Do you know what I mean, he's supportive and ... I don't know what the magic element is but quickly at the end of a week students are coming to see us to say, "This is all right." I don't know what it is, if it's the humour or ... I mean, I think it's knowing your audience that's in front of you and being able to pitch at that sort of a level and have a laugh."*

Teachers' honesty and attitudes toward the truth are central to their character and professional integrity (Fallona, 2000). Students' reportedly prefer and respect educators who are honest (Shah & Inamullah, 2011), and report honesty as their number one preferred characteristic of any effective teacher (Kelly, 2007). Students also believe teachers who are honest, have more credibility and create a positive impact on their learning. Findings advance the literature where educators espouse the importance of honest teachers, particularly in situations where they are potentially out of their depth, and their credibility is potentially in jeopardy (see interviewees 2, 3 and 14).

> *I2: "One of my key philosophies is never being afraid to say I don't know."*
>
> *I3: "Admitting to something when you are out of your depth, so that if a student asks a question that you are not sure of, don't bluff your way out of it."*
>
> *I14: "Honesty. I think students love that. I think when you're totally upfront and honest to the student about the course itself, the content, even yourself... because I'm even upfront in some areas that I'm not actually strong on so I'll say "Look, we're going to be covering this course this week in this subject matter. To be honest, I'm not very strong in this area."*

Passionate teachers have an enthusiasm and a love of their content, and are able to communicate this (Day, 2004; Furnham, 2001). This is consistent with the findings. Interviewees 2 and 4 talked about an interest in the topic being taught and an interest and a passion for the students they teach.

> *I2: "Enthusiasm an absolute must. If the teacher doesn't seem to be interested in the topic it is very hard to expect the students to be enthused about it either."*
>
> *I4: "A love of what you are teaching, the content. Passion and demonstrating a passion for my students and for what I am teaching."*

7.2.6 Understanding of students

The *understanding of students*' axial code describes IT academics' reflections and perceptions of student learning approaches, engagement and motivational triggers for learning. The *understanding of students*' axial code contains four properties: *attendance*^{2}, *engagement and motivation*^{12}, *learning approach*^{12}, and *learning highlights*^{2}.

Analysing this axial code provides an understanding of the perceived impact of attendance on students' learning. It also provides insight into the underpinning rational for adoption, and application of various successful motivational approaches implemented by IT academics, to inspire students. As well as an appreciation for techniques employed by IT academics catering for a variety of student learning approaches and the importance of key learning moments.

The importance of student attendance has been reported as a major concern for educators in the literature (Devadoss & Foltz, 1996). Rodgers (2001) found attendance to have a small but statistically significant effect on academic performance in business and economics university students. Paisey and Paisey (2004) reported a clear and positive relationship between attendance and academic performance, while Massingham and Herrington (2006) suggested changes to learning teaching will be required to reverse the trend. Interviewees 5, 9, 17, 18 and 19 all reported on the importance of attendance. This was consistent with the literature and confirms some traditional notions of student attendance and its impact on learning and teaching, however a couple of interesting ideas surfaced. Interviewee 18 suggested recording attendance can be used to encourage students to attend, even when it is not compulsory. Interviewee 19 provided a clue as to the kind of change required to engage students (see Massingham & Herrington, 2006), a move away from teacher-centred learning to a student-centred approach. This is an interesting and potential conflict of ideas as a student-centred approach is a ubiquitous style of learning, where attendance is not necessarily important.

> *I9: "The end results always match up what they've done in class, the attendance that they have shown, it's that whole coming together."*
>
> *I18: "I use, actually another thing is that attendance, tutorial attendance, so you mark the tutorial attendance on model right, and students see that you actually see them, I'm not saying attendance is compulsory. I just show them that we take attendance."*

> *I19: "One guy I talked to didn't turn up to anything but the first class and maybe one lab. He said I don't like being in lectures, don't like sitting still, just nothing against you."*

There is much literature reported on techniques for motivating and engaging students (Good & Brophy, 2007). Teaching strategies such as question and answer techniques, collaborative learning approaches, conceptual problems (Fencl & Scheel, 2005), development of critical thinking skills (Williams & Williams, 2011), using praise and encouraging language (Bain, 2004), providing interesting content (Marzano, 2010), and use of ET (Stosic, 2015) are just some of the techniques reported to have been found the most effective for building engagement and motivation in students. To enable deeper engagement with difficult content, Perrone (1994) suggests linking topics to students' everyday activities. Learning from everyday experiences is a way of constructing knowledge (Schulte, 1996; Schunk, 2008), this is an aspect of a learning theory known as constructivism (Cobern, 1993; Crowther, 1999). Constructivism views knowledge as being shaped by experiences, and as new experiences are encountered, these are related to previous knowledge and understanding (Pelech & Pieper, 2010). Interviewees 1, 3, 5, 6, 14, 15 and 22 reported techniques for increasing motivation and engagement in their students. Interviewee 3 mentioned using examples from a novel to illustrate concepts. Findings are consistent with the literature (see Perrone, 1994). Reading a novel represents an everyday life experience and is an example of existing knowledge. Students make connections with these experiences and this helps develop deeper engagement. Similarly, interviewee 1 reflects on students' drawing on life experiences, while interviewee 15 uses aspects of games students' play to illustrate concepts. These examples suggest the adoption of a constructivist style approach to engage and motivate learning. Interviewees 5 and 6 and suggest it is about capturing students' interest and curiosity, through content, examples and technology. Interviewee 14 suggests reading the body language of students to determine their nonverbal cues (see Benzer, 2012).

> *I1: "I encourage them to get involved with their learning. The best students are mature age students, who have had some experience of life, and are aware of how much they are paying for it, and want to make, and want to get their money's worth."*
>
> *I3: "Keep it entertaining, so you will engage the students. I can remember one year I was reading a book, like just a fiction book as I was doing my hair, and there was a bit in there where they were doing some stuff on Unix. So that day I photocopied that and put that up as an overhead."*

> *I5: "How you engage people's natural curiosity is by not telling them too much, if you there and that kind of teaching from the [?] you giving them too much and you are taking from the fun of figuring it out. But not giving too little, so there's how much content is there. Probably the biggest thing is stories, if you wrap the concepts around some stories, and sometimes it's harder than others, that sort of seems it."*
>
> *I6: "I had showed them a lot of examples of technologies and then I let them go and investigate. I think students are curious, I think that technology can encourage that if that makes sense."*
>
> *I14: "It's looking at the hierarchy of students, where they're sitting and why they're sitting and where they commonly sit and then working out where to focus in the future, who's focused, who's not focused, who's understanding, who's talking a lot."*
>
> *I15: "I connect everything to games that they've played. So, if you're talking about a particular technique, they're doing some graphical thing, you identify where they've seen that in games, so "It's such-and-such game where you've seen this connect to that" and start answering the questions, sit behind their head."*

There are many models of learning styles published (Cassidy, 2004). Some of the well-known versions include Kolb's Experiential Learning Model (Kolb, 2015), and Honey and Mumford's Learning Styles (Honey & Mumford, 1982), and Fleming's Visual, Aural, Read/Write and Kinesethic (VARK) model (Fleming & Mills, 1992). Models like these are used to determine students' natural or preferred learning approaches, with a view to enhancing their learning potential. The literature is conflicted as to the usefulness of these models. Weaknesses reported include confusion with variations in approaches, issues with validity and reliability of tools, irrelevant characteristics being included (Hadfield, 2006; Lemire, 2000), and teachers' cognitive overload when attempting to integrate multiple media approaches simultaneously (Lethaby & Harries, 2016). The literature is uncertain around the usefulness of learning styles, findings from this work suggest that IT academics make assumptions about student learning approaches and make an effort to accommodate students' different preferences. Interviewees 1, 2, 4, 6, 8, 20, and 23 all reported on various student learning approaches. For example, interviewee 1 talks about delivering concepts from multiple approaches. Interestingly both interviewees 1, 4 and 8 use language which is indicative of the VARK model, however this appears to be more at a subconscious level rather than a conscious application and knowledge of the model. Interviewee 6 reflects on a need to challenge students' through the use of technology, while interviewee 23 reflects on students familial intrinsic connection to technology, using language direct from the literature (see Prensky, 2001).

> *I1: "I change things a lot and approach concepts from a number of different directions, so that it picks up on the different sorts of learners in my classroom, and in that I gotten in mind the visual learner, the audio learner."*
>
> *I4: "The lab work is wonderful for the kinaesthetic students. I think the PowerPoint has probably [satisfied visual learners rather] than the auditory learners. The auditory learners have always had somebody speaking to them."*
>
> *I6: "The students want to be taught how to do these things I think, and they want to be challenged, and I think technology is a natural challenger."*
>
> *I23: "So it's just about providing for these different mindsets they have these days. They're digital natives these days, so we fill this ... it's right up their alley anyway. They're always watching videos."*

Pivotal teaching moments (PTM) have been discussed in the context of teachers' noticing and capitalising on key moments in a lesson where a teacher has the opportunity to improve students' mathematical understanding (Stockero & Van Zoest, 2013). While Kohler-Evans (2006) call these best teaching moments. Labercane, Last, Nichols and Johnson (1998) categorise these moments in terms of teachers' various critical relationships with other teachers, parents and students. Consistent with the literature interviewees 1, 2, 4 and 7 all reflected on critical moments in terms of student learning. These comments suggest reflection on key moments is about the nature of the teacher's relationship with their student (see interviewee 4). Interviewee 2 extends this idea further suggesting the strength of the emotional connection is important.

> *I1: "I've just recently had a female student who said all of that, not especially good student ah kind of ... above average, but not a really really good student, but saying things like "now I know how I'm going to teach."*
>
> *I2: "I think conversations that I have with students, quite often the ones you have outside of the formal class material. It is where the student is infused enough about something to want to talk to you about it, and obviously has a high enough opinion to think that you are the right person to talk to about this subject."*
>
> *I4: "The happy relationships I've had with so many students, has been a highlight. Particularly a student whom I had a run in with at one stage, and the relationship has turned around and become a positive relationship."*

7.2.7 Conclusions and recommendations

The ***pedagogical development*** category and its associated axial codes represent factors, which influence the development and growth of IT academics' pedagogy. The axial codes include: *discipline preference, influence of others, language used, pedagogical* *development constraints*, *quality teaching attributes*, and *understanding of students*. Conclusions and recommendations offered are based on the analysis of combined phase one and two data.

Discipline preference:

Technology affords varied teaching and learning approaches, while the flexible conditions are an attraction for academics, along with a love of students. High failure rates in programming have been of much interest. Findings extend the literature. The creative appeal, academics' prior learning successes, the pursuit of logical higher order thinking, the development of practical skills and the sense of achievement at learning difficult concepts attract IT academics to teaching, specifically teaching programming.

Recommendation 1: Encourage IT academics to foster their creative development, such as developing their own educational software, while pursuing practical and logical thinking skills. In addition, workload IT academics with courses they are familiar with, and have confidence in teaching.

Influence of others:

IT academics' pedagogical thinking is influenced by family and friends. Findings extend the literature indicating the influence of family encouraging reflective thinking in IT academics. Industry experience for IT academics provides role models and improves students' work readiness; at the same time these academics can lack a research focus. Findings extend the literature suggesting industry experience provides IT academics with credibility, the ability to contextualise students' learning experiences, and an understanding of industry standards and various problem-solving approaches which inform pedagogical practice. IT academics interested in teaching and learning enjoy discussing ways of teaching with peers and mentors and can benefit from peer review and observation of other teachers in action (see Carbone & Kaasboll, 1998). Adding to the literature findings indicate IT academics who are already good teachers look to improve their practice through peer review, using it as a way of improving their teaching. IT academics investigate various types of literature looking for practical suggestions as well as pedagogical insight. IT academics encouraged to consult pedagogical literature are likely to become more effective teachers (see Green, 2010), with a practice based on a research informed teaching pedagogy. Partaking in professional development activities such as conferences is an avenue for IT academics to keep their teaching skills and knowledge current. New to the literature is an understanding of the influences of society and culture (sport, religion and media) inspiring curiosity, leadership behaviours in IT academics, and providing a source of knowledge and ideas to improve student learning.

Recommendation 2: Support IT academics to develop and maintain healthy relationships with family and friends in social environments. Provide opportunities for IT academics to engage in industry release programs, develop industry partnerships, and where possible employ IT academics with some previous industry experience. Encourage IT academics to share ideas and expertise and develop strong relationships with their peers. Nurture a culture which encourages and rewards participation in teaching and learning development activities for IT academics. Encourage participation in sport and culture groups, as well as provide mechanisms for IT academics to embed media in their daily experiences, for example, social media.

Language used:

IT academics' separate education and discipline-based language in their thinking and speaking. There is a relationship between educational based research and the adoption of professional educational language. The use of discipline based language is important for communicating specialist ideas (see Zobel, 1997), it has also been found to improve student learning (see Zeidler & Lederman, 1989).

Recommendation 3: Encourage IT academics to benefit from using contemporary educational language making conscious decisions to access a range of teaching and learning strategies.

Pedagogical development constraints:

There are many inhibiting factors which restrict IT academics' ability to enact their preferred pedagogy. A perceived generation gap between teachers and students requires further investigation. IT academics thrive in an environment where they can access career long connections with industry enabling currency and embedding of real-life experiences in their teaching. Stress in educational situations can lead to a lack of self confidence in teaching some aspects of course content, particularly when working with new material.

Recommendation 4: Encourage industry interaction and limit stressful teaching environments for IT academics.

Quality teaching attributes:

Attributes reported by IT academics as those being important to great teaching include being approachable, caring, a good communicator, entertaining, honest and passionate. These attributes appear as functions of great teachers (see Biggs & Moore, 1993; Manuel & Hughes, 2006). Being approachable promotes a positive learning environment for students. Findings extend the literature with IT academics combining normality and approachability to improve student learning. The attributes of empathy and caring enable IT academics to understand and relate to students' experiences. Findings extend the literature with IT academics also caring about their students' careers and success in life in general. Being a good communicator is essential to teachers. Teachers need to communicate with different audiences, extending the literature IT academics need to communicate at different levels in different ways. Some educators believe in entertaining students while, others believe humour compromises the teachers' credibility. Findings recommend IT academics use humour carefully and respectfully to create a relaxed learning and teaching environment. Students prefer honest teachers. Findings extend the literature suggesting students respect IT academics who admit when they are out of their depth. Passionate teachers have enthusiasm and a love for teaching. Biggs and Moore (1993) emphasise that these attributes (approachability, caring, a good communicator, entertaining, honesty and passionate) are consistent with the social side of teaching and the connection to students.

Recommendation 5a: In our modern area of student-centred pedagogy, it is essential learning and teaching environments foster and encourage growth of great teaching attributes (approachability, caring, a good communicator, honesty and passionate), helping to shape teaching in student focussed way.

Recommendation 5b: IT academics should take care when considering the use of humour, and should avoid using humour which is disrespectful and views women, men, ethnic or racial groups, handicapped or aged people in a discriminatory fashion (see Harris, 1989).

Understanding of students:

Some IT academics' reported students attending classes and its perceived relationship to learning as being important. IT academics suggest recording attendance as a way of encouraging participation. However, students have reported having a very good reasons for not attending (see Massingham and Herrington, 2006). Students can be engaged in the learning process by incorporating ideas and techniques which connect to their everyday life experiences. This approach is considered part of the constructivist learning theory. IT academics could improve student engagement and motivation by actively fostering a constructivist learning environment. IT academics could also benefit from developing a knowledge and conscious awareness of student learning styles to avoid limiting student learning options.

Recommendation 6: It should be noted that some IT academics still have a traditional view of student attendance and its relationship to student learning. Encourage an understanding and application of constructivist learning theory to improve engagement and motivation in students. Encourage identification of key or pivotal teaching moments. These allow teachers to direct learning toward these moments and improve student learning.

7.3 Teaching practice

This section provides a recap of the ***teaching practice*** category and a model illustrating this category along with its associated axial codes. This is followed by a discussion of each axial at the properties level. Each property is examined in terms of its connection to the literature and the phase one and two data. A brief conclusion and recommendations for each are offered.

The ***teaching practice*** category describes strategies, techniques and the implementation of practical teaching approaches. This category is about how IT academics manifest their teaching in hands-on or practical ways.

The model illustrated in Figure 7–2 represents the ***teaching practice*** category and its associated axial codes. The diverging radial diagram functions as a visual representation illustrating connections between the axial codes to the central theme (teaching practice).

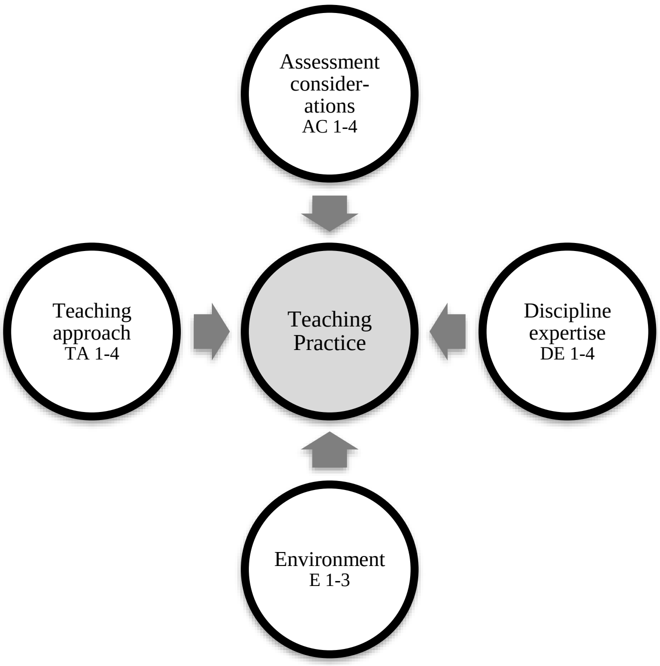


Figure 7-2 Phase 2 – Teaching practice radial diagram

See Table 7–2 for a list of the ***teaching practice*** radial diagram property codes and labels. This should be read in conjunction with Figure 7–2.

Table 7-2 Teaching practice properties

Axial Code	Property Code	Property
Assessment considerations	AC1	Assignments
	AC2	Examinations
	AC3	Feedback and marking
	AC4	Tests
Discipline expertise	DE1	Computer Science
	DE2	Information Systems

Axial Code	**Property Code**	**Property**
	DE3	Information Technology
	DE4	Mathematics and Statistics
Environment	E1	Imposed policy
	E2	Imposed process and practice
	E3	Collaboration
Teaching approach	TA1	Classes
	TA2	Completion and rewards
	TA3	Content knowledge
	TA4	Delivery

7.3.1 Assessment considerations

The *assessment considerations* axial code describes IT academics' approach to assessment tool development and application, as well as marking and feedback to students. The *assessment considerations* axial code contains four properties: *assignments*^{12}, *examinations*^{1}, *feedback and marking*^{2}, and *tests*^{1}.

Analysing this axial code provides acuity around development, implementation and evaluation of assessment approaches. An understanding of the *assignment's* property provides guidance into the unique composition and perceived broader efficacy of this technique. An understanding of the *feedback and marking* property provides teachers' thoughts on the speed, type, amount and purpose of feedback, in addition to an understanding of students learning. An understanding of the *examination's* property supplies information about IT academics' beliefs regarding the educational value of exams, also their viability as a preparatory tool for students' future professional endeavours, and finally the development choices around content selection and style. An understanding of the supervised *test* property provides information regarding the rationale around its selection, application and utility.

Creating assignments is reported to be a difficult and time consuming task (Parlante et al., 2002). Cleverly constructed assignments have the ability to make learning and teaching more engaging and relevant (Dougherty, 2012). Students have been found to respond positively to hands-on style assignments (Daniels, 2010), and those constructed with a view to acquiring content knowledge and specific skills (Dougherty, 2013). Parlante et al (2002) reported a series of case studies describing assignments used in CSE courses. Interviewees 1, 4, 5, 6 and 9 all reflected on assignments. An analysis shows the educators to be focussed on the structure and content of the assignment. This approach appears consistent with the thoughts of interviewee 1 who focused on the style and administration of the assignment. Contrary to that, interviewee 4 appeared more pedagogically driven, focussing on the experiences the assignments provide to students. Further research is required to better understand these inconsistencies. Of interest were interviewee 6's comments which suggest the need for assignments to challenge and engage students, using technology as a conduit.

> *I1: "I introduced a portfolio assignment which involved every two weeks working individually on two or three questions from the text. Then swapping them around so they did a peer review of other peoples' work."*
>
> *I4: "With assignments I try and think about the experiences that I think that the students should have when they are doing a particular course. So, giving them a chance to do things, assignments they'll actually learn quite a lot from."*
>
> *I6:" I think about what assessments might challenge those students, and I try to come up with assessments that either engage them or challenge them in some way, which is why a lot of times my assessment include technology, because it forces them to get outside that comfort zone, and they learn a lot."*

There has been much literature reported about the apparent usefulness of examinations in higher education (Williams, 2004). Traditional examinations have not been found to consistently test deep conceptual understanding of ideas (Entwistle & Entwistle, 1991), or identify those students capable of assimilating new ideas (Laurillard, 2005). The summative nature of examinations has been reported as being less effective than formative style assessments, such as assignments (Hsu, Chou, & Chang, 2011). Alternatively examinations have proved useful for ranking students (Laurillard, 2005), and testing rote memory concepts (Williams, 2004). Student grade results from open book examinations appear to fluctuate as reported in the literature, with some students doing better and some doing worse (Gharib, Phillips, & Mathew, 2012; Mahmoudzadeh, Heidari, & Mohammadi, 2015). However open book examinations have been found to be preferred by students, primarily due to less stress and anxiety associated with examination study and preparation (Gharib, et al., 2012; Mahmoudzadeh, et al., 2015). Interviewees 1 and 4 reflected on examinations. Analysis of the results shows that interviewee 1 reported a preference for formative assessment (evaluate student performance during the learning). This is consistent with findings reported in the literature. The summative (evaluate student performance at the end of the learning) nature of examinations has made them less beneficial educationally, interviewee 1's testimony provides additional insight into why this is the case, reporting that waiting until the end of a course or semester to assess students' knowledge is too late to assist those who have failed to understand key concepts. Interviewee 4 reported a preference for open book examinations, this is consistent with students' preferences reported in the literature (see Gharib, et al., 2012; Mahmoudzadeh, et al., 2015). In addition, interviewee 4 highlights the usefulness of open book examinations, for students by emulating future professional career practices, extending ideas currently reported in the literature.

> *I1: "You must have a fifty percent exam. [pause] and that changes assessment from being formative to being summative, and when it is summative it is too late to fix [pause] and so I would, I would prefer to have portfolio sessions, mid semester test, and a final test, and have the final test not actually worth very much at all."*
>
> *I4: "I see advantages of having open book exam, is that it forces you to think carefully about what questions you want to ask. The second reason I don't have a problem with open book exam, when somebody during there working life has got a problem, they have their resources in front of them to deal with that problem."*

Teachers' feedback and marking is considered an important facet of pedagogy, however the literature differs on what makes good feedback (Li & Barnard, 2011). Black and William (1998) found quality detailed feedback leads to increased engagement and higher quality learning. Crisp et al (2009) found that students expect their assessment to be marked and returned within a week, while Agius and Wilkinson (2013) identified four themes important to written feedback; quality, quantity and location of feedback, feed-forward and timeliness. Crisp (2012) also proposed that teachers incorporate different types of assessment and reward mechanisms. Interviewees 8, 12 and 18 all reflected on feedback and marking. Interviewee's 8 and 18's responses were consistent with Crisp et al (2009) and Agius and Wilkinson's (2013) research regarding timeliness. Interviewee 8 also commented on the importance of feedback to learning and engagement, as well as providing different mediums of feedback. Interviewee 18 commented on the value of providing solutions. Interviewee 12's comments provide insight regarding the computing discipline, suggesting usefulness in analysing student's written programming code, to determine a snapshot of the student's current programming capacity at the same time expressing frustration at not having sufficient resources to provide one-to-one support for students.

> *I8: "Giving students prompt feedback is very important, last semester what I did was in [course], I marked the assignments and I used PDF writer, when I was marking I put all the comments, and also I added some audio comments as well. The students liked that. Some of the students think that I was a hard marker, they were happy that I did give them good feedback. Feedback is an important part, for their learning progress. So we need to give feedback, so engaging students."*
>
> *I12: "From marking, and seeing same the same patterns of code and from, knowing that they don't get enough feedback about their work and that we don't have the capacity of having one to one, we then through the code and going, "No that's wrong."*
>
> *I18: "I always have feedback on, I put the right answer and explanation about why it is the right answer. So students get feedback before the next lecture so then I can see which questions students get, most students get it wrong, which question is easy, how they right, and then after the quiz is closed."*

Tests have been reported as a tool for ranking and evaluating students' learning in a higher education context (Ewell, 2001), and to evaluate the quality of teaching and the education institution particularly in the primary and secondary systems for example NAPLAN (Victorian Curriculum and Assessment Authority, 2015). However there is much loathing by teachers against the use of testing (Phelps, 1999). Interviewee 1 reported using testing to motivate students to attend classes and engage with the learning process. This would suggest this academic was in favour of using testing as a motivational tool to persuade students to attend classes i.e. no attendance, no marks. This extrinsic approach is not known to facilitate deeper conceptualised learning (Smith & Miller, 2005).

> *I1: "Every second week, they had a test, and because it was worth four marks each time, they came to class for those sessions. I think that was a very successful innovation that I trialled."*

Two additional assessment considerations not raised in the interviews include peer assessment and automated assessment.

"Peer assessment is an arrangement for learners to consider and specify the level, value, or quality of a product or performance of other equal-status learners" (Topping, 2009, p. 20). Some advantages of peer assessment reported include development of skills (Topping, 2009), students gain insight into their performance and gain the necessary skills to make judgements (Brown, Rust, & Gibbs, 1994). Peer assessment also encourages deep learning (Vastani, 2004). However, peer assessment does not work for all students (Asikainen, Virtanen, Postareff, & Heino, 2014), and some teachers have concerns regarding its reliability and validity (Bouzidi & Jaillet, 2009). Peer assessment has been used in a number of CSE courses, for example in introductory database though the creation of a bank of self-assessment questions (see Paterson, et al., 2010), and in introductory computer programming classes to evaluate other students work (see Sitthiworachart & Joy, 2004).

Automated assessment refers to the use of computers to assess students (Skalka, Drlik, & Obonya, 2019). Automated assessment has been reported to provide critical, rich and timely feedback (Liang, Liu, Xu, & Wang, 2009). In addition, automated assessment saves time and money, and provides the opportunity for repeated testing and personalised feedback (Barana, Marchisio, & Rabellino, 2015). However, there are some disadvantages. Educators worry whether it is possible to test a student's ability to use their knowledge and problem solve in this type of environment (Barana, et al., 2015). In addition, online testing can impose specific solutions, which can limit student creativity (Laß, Krusche, von Frankenberg, & Brügge, 2019). Automated marking has been utilised in a number of CSE courses, for example, programming courses (see Higgins, Gray, Symeonidis, & Tsintsifas, 2005; Laß, et al., 2019).

7.3.2 Discipline expertise

The *discipline expertise* axial code defines expert technical knowledge and specialities of computing academics. The *discipline expertise* axial code contains four properties: *Computer Science*^{12}, *Information Systems*^{2}, *Information Technology*^{12}, and *Mathematics and Statistics*^{1}.

Analysing this axial code provides an overall view of IT academics’ specialities and sub-discipline teaching areas. It also affords a picture of historical teaching experience and future teaching capability and gives some insight into preferred teaching specialities.

Academics typically choose university careers for many reasons. Such as to benefit from interstate and international travel, to be able to work with others from diverse cultures, and the ability to influence the future innovations through research (Symonds, 2013). Those who choose to work as computing professionals enjoy using new technologies and the accompanying pay (Malone, 2008). There appears little literature published on why and how academics' elect to develop skill sets or select sub-discipline specialisations. Although it has been reported CS/IT educators require computational thinking skills (Wang, 2016), and an in-depth understanding of computing concepts in order to teach CS/IT courses (Yadav & Korb, 2012). The findings of this research show CS/IS/IT/Maths academics enjoy teaching a diverse variety of sub-discipline areas and have backgrounds in teaching technical courses such as programming, in multiple computer languages. For example, interviewees 1, 2 and 22 reported teaching a wide range of sub-discipline areas.

> *I1: "I have a longitudinal overview of the development of IT in schools and in universities. My sessional experience has meant that I've become very flexible in my teaching areas and [I] teach the gamete across IT, Maths and Stats."*
>
> *I2: "I have taught a fairly broad range of things, Multimedia a little bit of databases, some networking, and software quality assurance."*
>
> *I22: "I've done it across the board, like, well as far as, well face-to-face teaching here has been the tutorials for project management, health infomatics, professional communications and network operating systems. And then I've had database management systems as a tutor, and then I've had e-commerce, contemporary challenges for IT managers, software engineering design and analysis, and mobile computing platforms and introduction programming. I like variety."*

Interviewee 2 reports having a programming teaching background, which would suggest a need for longevity and a deep level of content knowledge required to teach CS/IT courses (see Yadav & Korb, 2012). Interviewee 3 reports teaching multiple programming languages including Java, C and C++ to first year students. This suggests IT academics are drawn to concepts which require in deep content knowledge in specific contexts.

> *I2: "Teaching background is primarily in the programming side of computer science."*
>
> *I3: "It's predominantly that first-year programming unit. I've taught that in Java, C and C++."*
>
> *I19:" Definitely multimedia and programming."*

Interviewees 6, 16 and 18 report teaching IS and related courses. Interviewee 6's response suggests selecting the IS major area stemmed from interest and content knowledge developed through a combination of practical work experience and education.

> *I6: "Information Systems, Emerging Technology and e-Commerce."*
>
> *I6: "I had skills in the information systems area from being in industry. I had the right qualifications and so they hired me, and so I ended up as an information systems teacher."*
>
> *I16: "IS development and IT management and strategy."*
>
> *I18: "I teach project management, information systems, networking, that kind of stuff."*

7.3.3 Environment

The *environment* axial code describes the influence of university management, administrative, legislative imposed requirements and the cooperative requirements of the educational environment including learning spaces and associated resources. The *environment* axial code contains three properties: *imposed policy*[1], *imposed process and practice*[1] and *collaboration*[2].

Analysing this axial code provides a picture of the type and the extent of imposed policy, process and practices in a higher education context. In addition, it provides an understanding of the impact of these policies, processes and practices on educators, their teaching and associated quality. As well as information about how educators feel and respond to these imposed policies, processes and practices, in additional to an understanding of the required collaborative nature of the educational environment.

A policy is a principle or guideline devised and adopted by an organisation which acts to guide the behaviour of its people. A procedure functions as the approach outlining actions to implement organisational policies (Campbell, 1998). Policies are designed to influence all major decisions, actions and activities that occur in organisations (BusinessDictionary.com, 2016). All universities have policies and procedures which mandate the process and practice of teaching and learning amongst other activities.

Coherent policies are vital to the quality of good teaching and learning in universities, unfortunately this is not always the case (Ramsden, 2003). For example inappropriate policies can direct staff toward teacher-centred strategies, surface approaches to learning, and discourage change (Ramsden, 2003). A lack of funds for conference travel (Smart, 1997) and a lack of scholarship associated with teaching (Weimer, 1992) have also been reported. University policy and processes can have an obligatory or imposed effect on educators. Interviewees 1, 2 and 4 reported on imposed policy, process and practice. Findings support ideas outlined in the literature. Interviewee 1 discusses imposed policy which restricts changes to course descriptions. This suggests a sense of inflexibility at traditional teacher-centric teaching and learning policies as not accommodating contemporary pedagogy. Interviewee 4 discusses imposed processes which discourage changes to resources and ultimately restrict the educators' ability to trial new and innovative teaching practices. There is a strong sense of frustration exhibited by these interviewees, this feeling is supported in the literature (see Lynch, et al., 2005).

> *I1: "Course descriptions are automated we have very little impact. Indeed, the only thing that I get to put in it is the assessment tasks [pause] and what they are allowed to use in the exam."*
>
> *I4: "Courses [that] have been developed by other people and the first contact with the course you are encouraged strongly to present the course as it has been presented previously."*

Lieberman (1988) talks about the importance of building a collaborative culture amongst educators, while Giroux and Myrsiades (2001) suggest a need for university culture to change. Damrosch (1995) reported that academics are often isolated and divided by specialisations, resulting in alienation and lacking general discussion. Interestingly interviewee 14 suggested that the culture of the learning environment is what inspires students and not the individual educators. By this comment interviewee 14 is emphasising the cultural environment at universities is not about individuals (Damrosch, 1995), but about the collective.

> *I14: "I think it's the environment, which is the inspiring point, not the people individually here, if that makes sense."*

7.3.4 Teaching approach

The *teaching approach* axial code describes teaching strategies, techniques and informal instructional models adopted and implemented by IT academics in various learning contexts. The *teaching approach* axial code contains four properties: *classes*^{12}, *competition and rewards*^{2}, *content knowledge*^{2} and *delivery*^{2}.

Analysing this axial code provides an understanding of how IT academics go about teaching labs, lectures and tutorials. The stories told by IT academics here illustrate intuitive and innovative teaching practices which can be modelled and trialled by other educators. Viewed holistically these form the beginnings of a profile of discipline specific strategies, or an IT signature teaching strategy. Examining *competition and rewards* provides an understanding of the various extrinsic motivational approaches IT academics believe to be successful in encouraging student participation and engagement. Understanding *content knowledge* provides details of IT academics learning and teaching priorities, i.e. what they deem to be most important and needy of their time and effort. Lastly investigating the *delivery* approach provides an understanding of the innate teaching enhancement strategies IT academics believe to be successful in engaging student learning.

Laboratory classes are considered essential for delivering discipline specific, practical hands-on learning experiences for students (Biggs, 2007; Gupta, 2001). Laboratory teaching is considered a low-priority job for many academics, due to its boring repetitive nature (Gupta, 2001). Laboratories are expensive to run and often poorly resourced (Ramsden, 2003). A lack of purpose and often poor pedagogical design are also reported shortcomings (Biggs, 2007; Gupta, 2001; Ramsden, 2003). Alternatively, laboratory classes are thought to improve student knowledge retention (Azer, Hasanato, Al-Nassar, Somily, & AlSaddi, 2013), facilitate interaction, participation and support timely completion of assignment work (Gupta, 2001). Students are also known to prefer laboratory classes over the traditional lecture format (Corritore, Hickman, Grandgenett, & Hitchcock, 1999). Laboratories work best when the content follows the theory introduced during lectures (Mackechnie & Buchanan, 2012). Interviewees 2, 3, and 4 reported on laboratories. Findings of this research support and build upon the ideas presented in the literature. Interviewee 4 discusses following the same approach by introducing concepts in the lecture and further developing them in the laboratory (see Mackechnie & Buchanan, 2012). Interviewee 4 also talks about students developing resilience and independence. Interviewee 3 uses lab tasks to develop and practice skills, while interviewee 2 builds upon existing skills by offering students more challenging extension activities.

> *I2: "I tend to do is to have an extension section at the end of the lab. So, ok you've got to this point, you've got the basics of this game working, now try adding this function to it."*
>
> *I3: "I think you can go back and work on the lab sheets, spend time, more time practising, because it's important that they practice their skills on a computer."*
>
> *I4: "I might introduce some lab work in lectures, but I regard that time as student time, normally the content of the lab sheet will be more than say the fifty minutes which is assigned to the students, so I want them to get on with it, and to get to the stage on the lab sheet they feel reasonably confident they should be able to finish it off on their own."*

Lectures are the principal and preferred method of teaching in most universities (Laurillard, 2005; Ramsden, 2003). Lectures have been reported for being effective for transmitting information (Bligh, 2000), motivating students, modelling reasoning (Pritchard, 2010), provide a sophisticated pedagogical practice in mathematically intensive subjects (Fox & Artemeva, 2012) and are favoured by the majority of academics (Ramsden, 2003). However lectures have been widely criticised as a method of teaching (Pritchard, 2010). Some issues reported include; too expensive to change, likely to reduce educational standards (Ramsden, 2003), can be ineffective for developing higher order thinking (Biggs, 2007), facilitate a one way narrative of ideas, and place an enormous burden of the educational process on students (Laurillard, 2005). Interviewees 1, 2, 3, 4, 5 and 7 reported on lectures. Findings are supported by the literature. Interviewee 1 reported lectures as being an inefficient way of learning. By using the term inefficient, interviewee 1 is referring to lectures as lacking productive learning or failing to make the most use of time available for learning. Interviewees 4 and 5 confirm lectures as being a one way transmission of ideas, although interview 4's comments are unintentional (see Laurillard, 2005). Interviewee 4 unknowingly highlights additional issues with lectures such as being tied to the console and relying on presentation software for memory prompts.

> *I1: "I don't think lectures are a very efficient way of learning [pause] and I try and run my lectures more like classrooms, where I say something, they do something."*

> *I4: "I tend to stick pretty close to the console, because I do rely on the PowerPoint slides for recall for me during the lecture ... I like to be physically close ... so that I'm part of the group it's not just a narration from afar."*

> *I5: "The lecture material on PowerPoint slides is a very passive kind of thing to do, they download the slides and then read through the slides, and then when you find that at the end of a semester that if you ask a question that's even vaguely deeper than the bullet points on the PowerPoint slides you don't get an answer."*

The role of tutorials is to complement lecture classes (Biggs, 2007). Lectures are considered the dominant and coveted teaching in higher education, tutorials are considered less time consuming and less appealing to academics and are typically taught by sessional staff as opposed to ongoing (tenured) academics (Ramsden, 2003). A poorly delivered tutorial does not achieve its aims and objectives (Biggs, 2007), and can have a negative impact on learning effectiveness (Kamp, Domans, Van Berkel, & Schmidt, 2013). However tutorials are said to represent a superior learning environment for students (Beck, Skinner, & Schwabrow, 2013). Students report supportive tutors with good communication skills, and content expertise as being important aspects of successful tutorials (Ravens, Nitsche, Haag, & Dobrev, 2002). In addition, tasks set should be rich, challenging, promote problem solving and generate active learning (Biggs, 2007). Interviewees 1, 2 and 4 reported on tutorials. Findings are consistent with the literature, interviewee two reported facilitating interactive tutorials (see Biggs, 2007) and extended this idea by focussing on the development of team work and cooperative learning. Interviewee 4 reported the importance of preparing quality materials for students (see Biggs, 2007).

> *I2: "Tutorials I tend to still be more interactive. So, I might give the students a few minutes to work through a couple of questions, then we'll get together as a group and compare answers."*

> *I4: "With the lab and tutorial my expectation is that I have the materials prepared, so programs for the tutorials and labs for students to follow, and that I have actually tested."*

The literature is divided on the value of competition and rewards used by teachers. An environment where teachers encourage competition and rewards is said to reduce motivation of other students (Slavin, 1982), is often destructive (Kohn, 1993) and results in less effective learning strategies (Ames, 1992). Conversely Biggs and Moore (1993) suggest social reinforcement or verbal praise can be useful in boosting student confidence. Ames (1992) recommends that rewards can be used to enhance achievement directed behaviour in students when used in private, recognising the individual student's effort. Good and Brophy (2007) recommend the use of rewards to be for everyone and not just the high-ability students. Interviewees 12 and 18 reflected on the use of competitions and rewards. The teaching and learning context is important here as suggested by Good and Brophy (2007), for example open access versus G8 universities. Group of Eight (G8) are Australia's elite universities (The Group of Eight Ltd, 2019). Interviewee 12 and 18's comments suggest the rewards and incentives being available to everyone, however they do seem aimed at the high achieving students which may result in the less capable students being de-incentivised. However they are being used for menial or boring, repetitive tasks as recommended by Good and Brophy (2007).

> *I12: "They were telling me that they wanted more, so I made it kind of a, hall of fame question in which rather getting points, the game is the name, the best – so it's kind of a competitive one. Rather than getting points it's whoever is the best of the people who have done that. And I get my tutors to rank the best, and the name goes into the Moodle page and, every week it will say who has been the hall of fame person and if they get twice their name up there."*

> *I18: "I always publish saying 'Hey, the winners for this week's quiz is', I say first place, second place, third place. The good students got recognised, and then it's, and these ten quizzes for ten weeks it's worth 3% bonus mark."*

> *I18: "To increase unit evaluation participation, the response rate, to actually have chocolates at the end of, in the last tutorial". At the beginning of the last tutorial, week 12".*

Content or subject matter knowledge includes information needed to present the content (Good & Brophy, 2007). Good and Brophy (2007) also suggest a need for action-system knowledge, that is skills for planning teaching and learning. Shulman (2005a, 2005b) says teachers must keep specific methods in mind when teaching a course content combining content with pedagogy, called pedagogical content knowledge (Mishra & Koehler, 2006; Shulman, 1987). An analysis of interviewees 13, 15 and 18 suggest that content knowledge is very important. Interviewee 13 also suggests IT academics need un understanding of course content in a big picture sense, in order to provide a connected framework or scaffold for students. Of interest are interviewee 15's comments, which suggest IT academics also require an emotional confidence, or self-belief in their content knowledge.

> *I13: "You need really good sound subject knowledge, so you can only unpack those things if you understand how they all go together in the first place. And in order to*

> *understand how they go together in first place you really need to understand the subject you're teaching."*

> *I15: "There needs to be a level of confidence in the teaching, you've got to go in there with, 'I know what I'm talking about. I can prove and justify anything that I'm saying' and really understanding your material. It allows you to stop worrying about the material. I know when I've struggled as a teacher it's always been when I wasn't confident about the material."*

Chunking is the breaking down of a collection of elements which are strongly connected (Gobet et al., 2001). Interviewees 7 and 19 reported using the technique of chunking (breaking down information into smaller pieces) when teaching difficult complex content.

> *I19: "The art and the skill of teaching comes in explaining complicated things in a simple way and that's what the best teachers can do and that's what I strive to do. To take something which is very hard and break it down into components, so you can then work on each component at a time".*

Concept learning broadly refers to learning by example or forming representations to identify characteristics, generalise them to new examples, and separate examples from non-examples (Schunk, 2008). Concept learning is said to simplify the learning process and promote deeper thinking. Providing solutions to students is an example of concept learning (learning by example). Hattie and Timperley (2007) suggest one way for teachers to provide feedback on simple tasks is through distribution of the solutions. Interviewees 12 and 18 indicated they provide solutions to students. Interviewee 18 indicates these are for tutorial questions, which are relatively simple tasks. This is consistent with the literature, however there is limited literature on this topic in a university learning and teaching context. However, there are many computing texts with "Learn by example" in their title, suggesting it is a common approach used by computing professionals. Interestingly interviewee 18's comments also suggest disagreement with colleagues regarding this approach.

> *I18: "I always give solutions to the tutorial questions. Some like say 'I don't give solutions because I want you to find it for yourself'. I think it's [language]. They learn from your solutions, why won't you give them solutions".*

Stories are not only useful for entertainment (Koening & Zorn, 2002) but are also a valuable instruction and pedagogical tool (Blaustone, 1992). Storytelling is known to facilitate thinking, enhance imagination and visualisation, develop appreciation for language, support context based learning (for example, Nursing and Law), strengthens caring communities, provide links between theory and practice (Koening & Zorn, 2002), and is a powerful tool for communication (Davidhizar & Lonser, 2003). Storytelling has been reported as being useful to motivate students learning object-oriented programming (Kelleher & Pausch, 2007). Computer games designers use the art of storytelling to control characters, heroes, adventures and quests in games (Ma, Williams, Prejean, & Richard, 2007). Interviewee 5 suggests using storytelling as a way of providing background context and drawing students attention and interest, while interviewee 13 suggests using storytelling as a way of navigating course content when teaching.

> *I5:" But instead of that is to cut it back so that you leave out the technical, sort of details but instead spend more time in telling stories around who developed it in the first place. The context of the development, who's working with these things now, what are they doing with these things now?"*
>
> *I13: "I always try and build a course as a story, so start and an end, and it can jump around a little bit, but you should always know where you are in the story".*

7.3.5 Conclusions and recommendations

The ***teaching practice*** category and axial codes represent practical implementation of IT academics' teaching strategies and techniques. The axial codes include: *assessment considerations*, *discipline expertise*, *environment* and *teaching approach*. Conclusions and recommendations offered are based on the analysis of combined phase one and two data.

Assessment considerations:

IT academics apply a range of considerations when creating assignments, examinations and in-class tests. Inconsistences were reported with some favouring a focus on the structure and content of assignments, and others focusing on the learning experience for students. IT academics reported the summative nature of examinations make them less beneficial educationally, this is supported by the literature. In addition, adding to the literature IT academics reported a preference for open book style examinations in order to reflect real life work experiences. Feedback and marking are important components of pedagogy. There are different views on what constitutes quality feedback. Timeliness of feedback is considered important by IT academics to facilitate student learning and engagement. Adding to the literature, feedback and marking can be used to illustrate student's current skills capacity, for example, programming skills. Testing is used as a ranking and evaluation tool for higher education students. IT academics believe compulsory testing is useful for ensuring students attendance however, this approach is a form of extrinsic motivation and does not facilitate deep learning in students (see Smith & Miller, 2005).

Recommendation 7: Focussing on style, administration and pedagogy of assignments created will help to improve quality, however additional research is required to better understand inconsistencies around ideas reported by interviewees and the literature. IT academics may benefit from the fostering of a learning and teaching environment which supports the use of formative assessment to identify student progress, and the use of open book examinations in order to facilitate student professional career readiness. IT academics should provide students with timely marking and feedback in order to improve student learning and engagement. IT academics believe the use of marked in-class testing encourages students to attend class. However, they should be aware that this approach is not known to facilitate deep learning.

Discipline expertise:

Academics choose university careers for reasons including a desire to travel, diversity, and research opportunities. Findings suggest IT academics teach a variety of major computing areas including CS, IT, IS (see Shackelford, et al., 2005), Maths and Statistics. With a wide range of speciality areas including programming, multimedia, quality assurance, database, networking and others. New to the literature, IT academics like teaching courses which require a deep level of content knowledge in specific learning contexts, for example, multiple programming languages and first year courses. IT academics are drawn to the creativity required to learn and teach technical courses, for example, programming.

Recommendation 8: IT academics are comfortable teaching a diverse variety of sub-discipline areas and are driven in an environment which facilitates a long and deep association with their chosen speciality area.

Environment:

University teaching and learning policies and processes guide the philosophy and practice of IT academics in higher education. A reliable technology infrastructure is essential to solicit and maintain educator confidence and encourage explorative practice. A move from teacher-centric policy to learner-centred policies will provide IT academics with the flexibility to develop innovative practice. This is supported by Tutty, Sheard and Avram (2008) who found many IT academics are constrained by current governance and institution policy resulting in unsatisfying teaching and learning experiences for both teachers and students. Findings extend the literature suggesting a collaborative academic environment in which IT academics work to achieve a united collective culture is an important aspect in inspiring students.

Recommendation 9: When developing teaching and learning policies university management and educators should be encouraged to work collegially in order to develop policies and processes which support shared values (see Ramsden, 2003), and ultimately work to improve the quality of learning and teaching.

Teaching approach:

IT academics adopt a range of techniques and strategies when teaching laboratory, lecture and tutorial classes. Laboratory classes are considered boring, expensive and often lack purpose. However, they can be used to improve student knowledge, and should follow on from lectures. Findings suggest laboratories can be used to build upon existing skills and develop resilience and independence in students. Lectures are an effective way to transmit information to students, however they can be ineffective in developing high order thinking skills in students. Findings support the literature, however new is an understanding that the use of lectures can restrict academics to an enforced immobile pedagogy, developed from the stationary layout of lecture rooms. Tutorials complement lectures and can provide a superior learning environment if well facilitated. Tutorial tasks should be challenging and promote problem solving. Findings extend the literature recommending tutorials be used to focus on team-work and cooperative learning. The literature is divided on the value of competition and rewards. They can reduce motivation and alienate students while at the same time be used to enhance achievement. Findings suggest IT academics aim towards sorting the high achieving students (context should be taken into account i.e. open access versus G8 universities), which is inconsistent with the literature. IT academic content knowledge is important. Findings extend the literature suggesting IT academics also require emotional confidence. Consistent with the literature IT academics use the technique of chunking, extending this concept IT academics use chunking for not only connected ideas, but for the teaching of complex ideas. Concept learning or learning by example is often used by professional technical computing authors. Findings suggest releasing solutions for simple tasks is a way of promoting concept learning (learning by example). Storytelling has been reported as motivating and engaging students. Findings suggest it can also be used as a navigation tool for teachers when delivering complex ideas.

Recommendation 10a: When facilitating laboratory classes IT academics should be encouraged to extend the ideas presented in lectures, helping students to develop their skills, and foster resilient, independent thinking. When delivering lectures IT academics should be encouraged to trial new and innovative approaches in order to avoid the transmission style teaching which has long been a cause of much frustration by students. Similarly, when teaching tutorials, IT academics benefit from support to create quality materials, and foster active, cooperative learning environments.

Recommendation 10b: The use of competition and rewards should be used with great care. IT academics should be aware of the range of student abilities, and that rewards are more effective for increasing effort than producing quality learning and thus afford an extrinsic motivation. In addition, Good and Brophy’s (2007) recommendations suggest focussing rewards to increase participation in boring, unpleasant or routine tasks. IT academics need to develop deep content knowledge as well as an emotional confidence in their teaching. IT academics should use chunking when teaching complex ideas. IT academics can encourage students to learning by example by releasing solutions for simple tasks. IT academics can use storytelling as a way of navigating through complex content.

7.4 Technology adoption

This section provides a recap of the ***technology adoption*** category and a model illustrating this category along with its associated axial codes. This is followed by a discussion of each axial at the properties level. Each property is examined in terms of its connection to the literature and the phase one and two data. A brief conclusion and recommendations for each are offered.

The ***technology adoption*** category describes the array of technologies used in student learning, teaching administration, preparation, and research also the associated advantages and disadvantages of technology, and examples of its use.

The model illustrated in Figure 7–3 represents the ***technology adoption*** category and its associated axial codes. The diverging radial diagram functions as a visual representation illustrating connections between the axial codes to the central theme (technology adoption).

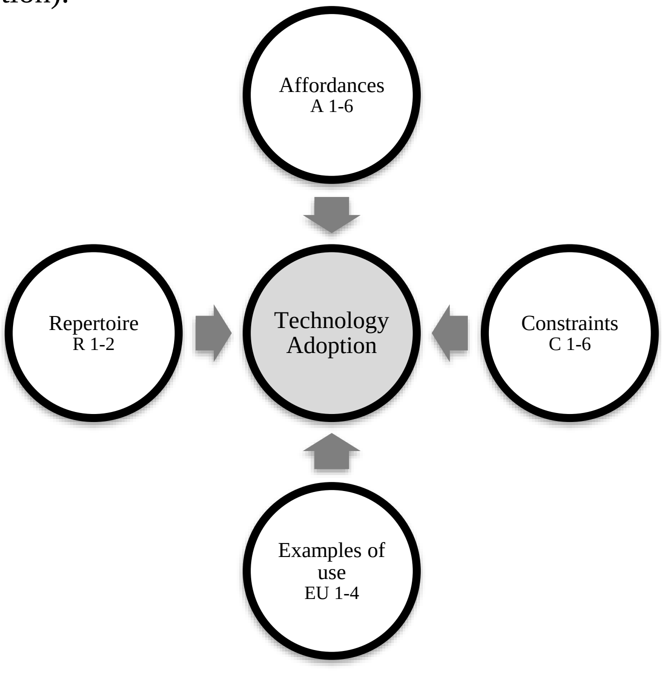


Figure 7-3 Phase 2 – Technology adoption radial diagram

See Table 7–3 for a list of the ***technology adoption*** radial diagram property codes and labels. This should be read in conjunction with Figure 7–3.

Table 7-3 Technology adoption properties

Axial Code	**Property Code**	**Property**
Affordances	A1	Communication
	A2	Convenience
	A3	Delivery
	A4	Interest
	A5	Repeatability
	A6	Ubiquity
Constraints	C1	Bandwidth
	C2	Barrier and distraction
	C3	Complexity and time
	C4	Culture
	C5	Fear and apprehension
	C6	Support services
Examples of use	EU1	Content preparation and delivery
	EU2	Educator entertainment and engagement
	EU3	Learning engagement
	EU4	Teaching administration and research
Repertoire	R1	Hardware
	R2	Software

7.4.1 Affordances

The *affordances* axial code describes IT academics' reflections and stories of technology improving and adding benefit to teaching and learning. The *affordance* axial code contains six properties: *communication*^{1}, *convenience*^{2}, *delivery*^{1}, *interest*^{1}, *repeatability*^{2} and *ubiquity*^{2}.

Analysing this axial code provides a profile of IT academics' perceived benefits or affordances of ET. This insight illustrates the aspects of technology that IT academics are particularly interested in this appears to be about improving motivation and technology customisation.

Many benefits of ET have been reported in the literature. ET has been used to improve student learning (Thornton, 2014), and impart knowledge in easier more flexible ways (Shah & Murtaza, 2012; Smith, 2013). ET can be used to assess learning (Biggs, 2007) and provide instant feedback (Faizi, Shakil, & Muntaha, 2013). ET promotes individualised learning (Johnson et al., 2013), and suits different styles of learners (Usun, 2003). ET helps protect the environment for example; the use of electronic text books (Smith, 2013). ET aids knowledge construction, and functions as a social medium to support learning (Jonassen, et al., 2008), amongst other benefits including improving communication, convenience, increasing motivation, repeatability and ubiquity.

ET is said to improve the effectiveness of communication. It enables many different forms of communication, and provides students with the opportunity for well managed useful contact with lecturers (Steel & Hudson, 2001). ET is known to facilitate an increased communication between teachers and students (Sivin-Kachala & Bialo, 1994). ET provides time and labour-saving benefits to educators (Steel & Hudson, 2001), and students allowing them to use their time more efficiently (Usun, 2003). ET acts as a motivational tool for both educators and students (Biggs, 2007; Li, 2007). ET is said to enable students to become more active and independent (Perrotta, 2013). ET makes learning more interesting providing enriched experiences (Sharma, 2008; Steel & Hudson, 2001), and more student-centred (Sivin-Kachala & Bialo, 1994). ET allows students to flip back and reverse through content repeatedly (Sharma, 2008; Steel & Hudson, 2001), and ubiquitously (Shah & Murtaza, 2012; Usun, 2003). Interviewees 1, 6, 7, 20, 22, and 23 reported on the affordances of ET. Findings support the literature, interviewee 1 provides details of using technology to make teaching easier (see Shah & Murtaza, 2012), through the use of laser pointers and the customisability of presentation software. Interviewee 1's testimony also suggests a reduction in teaching stress levels through the use of ET as a memory aid. Interviewee 6 uses technology for communication.

> *I1: "The laser pointer thing which also moves the slides on. My slides are animated, one step of at a time, no matter what I'm doing, and I can animate those from anywhere in the room. I have been trialling is online delivery of my lectures, and I've been using iSpring. It is an open source software which chunks my audio up according to mouse clicks, and matches each mouse click with a sound byte. Using PowerPoint keeps me on track, I don't get side-tracked, I don't forget what it is I want to talk about, I actually go with my plan, rather than go someplace else. I think that is a really important aspect of using PowerPoint."*
>
> *I6: "Computers are fantastic in a lot of ways, for things like being able to stay in touch."*

Interviewees 1 and 7 also reported feeling motivated and inspired through exploration and application of educational technologies (see Biggs, 2007).

> *I1: "It also gives me an increased level of interest in what I am doing. To be constantly trying out new things is interesting."*
>
> *I7: "It acts as an inspiration, because it shows the students what can be done with very very simple graphs ... without the technology it wouldn't work, we just would not be able to do it."*

Interviewee 7 emphasises the value of repeatability, with students benefiting from recorded lectures that can be viewed over again, in any location that suits them. Also highlighted is the use of animation to capture more complicated concepts in a step-by-step fashion (see Chapter 7.3.4). This approach can help to reduce the cognitive load on students, and aids repeatability. However, a study by Naps et al (2002) found that no matter how well an animation is designed it is of little educational value if the students are not engaged in an active learning process, suggesting animations should be used in conjunction with active learning tasks.

> *I7: "Some students have recorded the lecture in the past but then you miss the visuals, especially the slide build, and so all of that is on these lectures that the kids have got access to on Moodle. They've also got a copy of it, and the thing is that they can play it over and over and over again. I tell them to take it to bed with them and put it under their pillow and let it roll all night on a loop."*

Interviewees 6, 20, 22 and 23 highlight the importance and value of students being able to learn in their own time. This sense of ubiquity (anytime anywhere) comes across as an important theme to IT academics. These academics appeared primarily motivated by what is best for their students' learning, this suggests an intrinsic motivation to adopt ET (see Birch & Burnett, 2009).

> *I6: "I also tend to make my PowerPoint, and I make them into audio lectures with PowerPoint, and that way students have a repeatability option and they can look at it when they have time, hopefully not when they are driving their car. So, they have that full capacity to be able to learn at their timing, I firmly believe in that as an option is any time learning."*
>
> *I20: "They want to access material in their own time, whether that's in replacement of or in support of is varied."*
>
> *I22: "At one extreme, just look what technology has enabled for Stephen Hawking). People can study essentially whatever they want at any time of day or night."*

> *I23: "This is great for two reasons. So, one, any student, regardless of on campus or off, can go ahead and obviously watch at any time. "*

7.4.2 Constraints

The *constraints* axial code describes IT academics' reflections and examples of technology limiting their teaching practice. The *constraints* axial code contains six properties: *bandwidth*^{1}, *barrier and distraction*^{2}, *complexity and time*^{12}, *culture*^{12}, *fear and apprehension*^{12}, and *support services*^{2}.

Analysing this axial code provides an understanding of IT academics' perceived disadvantages or constraints of ET. This knowledge highlights aspects of technology that IT academics' find particularly confronting.

ET is not the universal answer to all educational problems (Rushby, 2013), and has been found to limit teaching thinking (Aldunate & Nussbaum, 2013). Some critical constraints on ET use include a lack of human resources, a lack financial capital (Ebersole & Vorndam, 2002; Johnson, et al., 2013; Li, 2007), a need for training and professional development (Buchanan, Sainter, & Saunders, 2013), and the need for clear institutional policies and planning (Birch & Burnett, 2009; Gülbahar, 2007). Slow download times (Buchanan, et al., 2013) and bandwidth issues are reported as frustrating for both academics and students (Smith, 2001). Mobile devices have been reported as a source of distraction by students and educators (Campbell, 2006). Students using technologies are said to suffer from cognitive overload which distracts them from their performance (Birch & Burnett, 2009; Wood et al., 2012). Time to learn new technology is one of the most important barriers to adoption reported by educators (Ebersole & Vorndam, 2002). It takes too long to become proficient in new ET (Buchanan, et al., 2013). In addition, many educators report fears and anxiety when working with new technologies (Birch & Burnett, 2009; Butler & Sellbom, 2002; Johnson, et al., 2013; Kelsey & D'souza, 2004). Finally, a lack of technical support has been found to limit ET use (Buchanan, et al., 2013; Kelsey & D'souza, 2004; Li, 2007).

Findings support the literature, interviewee 1 reported limitations implementing ET due to limited bandwidth (see Buchanan, et al., 2013). Significant increases in bandwidth have been reported due to advances in technology and government policy, anecdotal evidence from students suggests they have limited funds and are unwilling or unable to pay expensive download costs, making this an ongoing limitation.

> *I1: "One of the problems is the file that you end up with is fairly big, and so download bandwidth issues matter."*

Interviewees 16, 17 and 18 all reported student distraction issues associated with the use of mobile devices. Interviewees 16 and 18 reported not knowing if students were using technology to complete tasks associated with learning or with other social pursuits. Educators have reported a sense of frustration at technology as a barrier (see Kelsey & D'souza, 2004), however this work extends the literature. Interviewee 18 suggests something deeper and interesting about students using technology as unconscious protection when struggling with ideas.

> *I16: "When they're sitting there with a laptop in front of them there I can't tell whether what they're doing is responding to the email they've just read from, you know because they're looking on their laptop, or whether they're responding to what I've done and what I'm saying."*
>
> *I17: "I come up behind them and I have a look, and you know, they're on Facebook, they're Googling, they're Twittering, they're doing all sorts of things that has got absolutely nothing to do [the lesson]."*
>
> *I18: "Some students play with their mobile, SMS, whatever, and then I call him to bring him back, and ask him easy questions and help him to answer the question. Then once he's back thinking "Hey, actually I can answer it with some help", then he's back. He's no longer playing with his mobile. Yeah, so that's why I don't use Twitter."*

Interviewees 1, 5, 6, 8, 14, and 17 reported complexity and time issues associated with ET use. Findings of this research support the literature. Interviewees 1, 5, 6, 8 and 14 reported overlooking technologies in which the perceived complexities and high time investment outweighed the educational benefits (see Buchanan, et al., 2013). Interviewee 17's response is interesting indicating while they are using technologies to assist other educators (or benefit their own learning), they have not yet made a connection as to its potential usefulness for their own students' learning.

> *I1: "I looked at Adobe Captivate, but that's exceedingly labour intensive."*
>
> *I5: "I'm not rushing out to the shop to buy it, to get it, but I thought then I'll have to learn how to use it and I don't have the time."*

> *I6: "I just sort of worked through trial and error. It took a long time; it took an awful long time to do them. There was just Saturday afternoons, and Sundays you'd come up and just slog away at it."*
>
> *I8: "I'm not sure how to use it, and how it can relate it to my teaching, if I knew it better, like the quiz the database, there is a little bit of extra work and I need to understand how it can help to engage students, so that we can use it 100%."*
>
> *I14: "Like I'd like to be able to do a lot more investigations into other different software modes for my lectures, but I just don't honestly have the time for it and the energy for that, the bigger the change."*
>
> *I17: "Facebook confuses me. Twitter, I find absolutely worse than useless, although I was able to help an academic in psychology just this morning because of a Twitter feed that I got."*

Extending the literature is the influence of culture. Interviewees 4 and 14 reported a general apathy for the integration of ET into their teaching. Interviewee 4 appeared to base their impression that other educators were not using ET either, suggesting a culture of indifference. This notion was not prevalent in the literature. Interviewee 14 appears pessimistic suggesting a lack of policy direction and follow-up as reasons for non-adoption.

> *I4: "Apart from PowerPoint and the programming language, which is Python, that nobody else is using a lot of different technology either, I mean there are things going on in the school, but there not widely being used."*
>
> *I14: "I think a lot of people are waiting for it to basically be told, you know, but we get told conflicting things like the past head of school said at a certain time in a certain year all our courses would have to be online in a certain fashion and state and then that never actually happened and there's just all these stops and starts but nothing ever gets done or finished there."*

Interviewees 2, 4, 7, 14 and 15 reported fear and apprehension when considering the integration of new technologies (see Johnson, et al., 2013). When technology fails academics', fear looking incompetent. This is consistent with findings where interviewee's 2 and 4 reported a lack of confidence in technology reliability, useability and prior negative experiences when using technology. These interviewees illustrate a deeper impact as a result of a fear of technology. Pedagogy can be constrained through the avoidance of technology use. A consideration of the diffusion of innovation (DOI) theory (see Rogers, 2003), suggests that these IT academics are likely to be in the late majority category. This indicates they realise they need to adopt technology but are unwilling to take a risk or invest the time.

> *I2: "I'm too afraid of everything going wrong. I didn't buy a CD player until they had been on the market for four or five years, I a generation behind in my game's consoles, I just never been the person to go out and grab the technology straight away. I let someone else find all the problems first then adopt it."*
>
> *I4: "I haven't' investigated podcasting* or lots of the you know, all the other things *that people have got themselves involved in. I'm not exactly a luddite but I'm not one of the leading figures in that area."*
>
> *I14: "I think we lack a central organisation or a unit within the university which is strong in this area who are showing good, clear examples of modern technology and software and hardware options."*
>
> *I15: "So I'm not one to move towards anything like, have some sort of interactive thing where people give me answers and I write them up on a*

A lack of technical support is a widely reported barrier to technology adoption. This was not a strong theme, however interviewee 9 reported a sense of frustration with support services. Interviewee 14 reported following protocol, this might suggest a lack of ability and support to explore new technologies, or the existence of constraining policies.

> *I9: "How can there be support if the Friday before we start up a new semester these clowns from ICT come and install new software that requires a total change to your lab sheets. What sort of support is that? Come on."*
>
> *I14: "Well, I use all the software dictated by the school which is supported by the university because I know that there's support there and it works and it's functional."*

7.4.3 Examples of use

The *examples of use* axial code describe examples of technologies used by IT academics to support teaching and learning. The *examples of use* axial code contain four properties: *content preparation and delivery*^{12}, *educator entertainment and engagement*^{2}, *learning engagement*^{12} and *teaching administration and research*^{12}.

Analysing this axial code provides information regarding the range and application of technologies IT academics prioritise to support teaching and learning activities.

Technology has significantly changed student learning. Educational technologies have been integrated into learning environments for the purpose of producing educational resources and also to aid student learning, for example iPads, scanners, cameras, smart pens and others (Ramey, 2013). Interviewees 1, 6, 7 and 25 reported on the use of technology for content preparation and delivery. Interviewee 1 reported using technology in preparation for teaching, including the use of a scanner and animation software to develop learning materials. Interviewee 6 discusses having a technology backup plan as part of teaching preparation, this confirms what is reported in the literature, when planning lessons options are important (Corn, Tagsold, & Patel, 2011), uniquely interviewee 6 uses variations of technology to facilitate back-up plans, rather than non-technology options discussed in the literature. Interviewees 7 and 25 mention using video. Interviewee 25 uses video in an interesting and unique way, to connect with students through the development of a social presence (the degree to which a person is perceived as real and present in a given mediated communication (Short, Williams, & Christie, 1976)) using personalised gestures and promoting vibrant discourses in YouTube educational videos.

> *I1: "I use the scanner a great deal. I use it to turn the written word into editable text. I use it to put diagrams into my work. I use it a lot in the process of animating solutions."*
>
> *I6: "I have learned over the years because of the level of technology I work with to have a plan a, b, c and d. Sometime I've had to go to d, it's not that far down. In the early days when we had overhead projectors you always carried a spare blub. Now you carry, I carry and iPad and a laptop to presentations, I carry multiple connectors just in case it doesn't work, and if push comes to shove I put a copy in the cloud so I can actually get to it on their computers if I need to."*
>
> *I7: "And integrating clips, movie clips and stuff like that, going onto the web to find stuff, really useful for that."*
>
> *I25: "I do a lot of hand gestures and looking and using second person language and that sort of stuff, because I've tried to develop some sort of sense of social presence through it, and I've found that to be reasonably effective. People feel like they have some sort of stronger relationship with me than they actually do as a result of them, which is kind of nice. Not sort of a movie star level thing, but some people are 'Hey, I watched your video, and what do you think about this?', or want to get into an argument with me or something."*

Playing video games is reported as being good for students' brains, particularly in developing the STEM subject areas (Posso, 2016). Playing two hours of games a week can make individuals more employable by helping to develop key skills (Barr, 2017). Little is reported in the literature about academics as game players and the influence gaming has on their approach to learning and teaching. Interviewees 6, 10, 12, 15, 19, 21, 23 and 25 indicated they were motivated by technology. Interviewees 2, 10, 12, 14, 15, 19, 21, 23 and 25 all indicated they were gamers. A passion for games and gaming by IT academics appears a strong theme in this research. IT academics reported loving games, collecting consoles, playing games, reading about games, enjoying the gaming social community, developing games, and creating and using games for learning and teaching purposes. Gaming appears a strong part of the IT academic psyche (soul, mind and spirit), and is a strong motivator for IT academics, suggesting their love of technology and developing a sense of community is connected to their game playing.

> *I15: "I'll often write software to provide a particular example of the technique or an effect, so bring up that whatever that is, so kind of something that shows a particular thing. So yeah, develop my own technology essentially to be able to do that."*
>
> *I19: "I have lots of games consoles, I like video games ... I'd love to write video games, you know that would be fun, wouldn't that be amazing."*
>
> *I21: "I use Flash because that's what I'm teaching to develop the games. I use them creating games for their learning now. So, for example, we might have an activity where we're looking at making decisions about if structures, right, so if something is true then do this, else do that. So, I get them to actually create a game that will help them use those structures."*
>
> *I25: "I'm a pretty big gamer as well. A whole range of games, probably first-person shooter games is a part of it, but not sort of violent, warry sort of ones, more cartoony, interesting community stuff, so a game called Team Fortress II I play a lot. Yeah, so not necessarily keeping up with the latest games, but more games that have a really solid online community."*

Many technologies have been used to promote student learning in computing courses in recent years, these span across web 2.0 and 3.0 technologies. Some examples of these include robotics, social media, wikis, virtual worlds, Massive Open Online Courses (MOOCs), games and more. Robots have been utilised to teach programming and artificial intelligence concepts (Akin, Mericli, & Mericli, 2013). Social media has been used as tool to promote improved communication amongst computing students (Charlton, Devlin, & Drummond, 2009). Wiki's have been used to support collaborative learning activities (Thomas, King, & Minocha, 2009). Virtual worlds have been used as a development environment, as a collaboration tool, and to provide an environment for simulation (Crellin, Duke-Willams, & Chandler, 2009). MOOC's have been used to teach programming courses on a massive scale, producing thousands of solutions from learners (Glassman, Scott, Singh, Guo, & Miller, 2014). Games have been used to improve participation and proactivity (Barata, Gama, Jorge, & Goncalves, 2013).

Technologically sophisticated PowerPoint presentations have been used to facilitate positive learning experiences for students across a variety of disciplines, including Computer Science (Edge, Savage, & Yatani, 2013; Guadagno, Sundie, Hardison, & Cialdini, 2011). Results from phase one indicated a limited use of technology to promote student learning, when compared to the new and emerging technologies reported in the literature. However, there was consistency around the use of presentation software. Interviewees one and four both reported the use of PowerPoint to deliver lectures. Interviewee one also indicated the use of the more technologically advanced aspects of PowerPoint using animation to present step by step solutions to problems.

> *I1: "In class I use PowerPoint to present solutions one step at a time. On the screen they will see the next step of a solution and I will be explaining that solution."*
>
> *I4: "Well PowerPoint for lectures."*

Learning Management Systems (LMS) have been used for student learning, but also for academic administrative tasks such as; record keeping, planning, communication general data administration (Henrick & Holland, 2015; Reigeluth, 2008), and for assessment (Biggs, 2007). Interviewees 1, 2, 3, 4, 23 and 25 all reported on teaching administration and research. Findings are consistent with the literature with interviewee 1 reporting using the LMS for communication purposes (reportedly unsuccessfully). Interviewee 4 reported utilising Microsoft products for administrative tasks. Interviewee's 2 and 3 reported using software developed in-house to manage student grades. Interviewees 23 and 25 discussed using learning analytics features of the learning management system to understand and facilitate student learning.

> *I1: "I have posted discussion points each week based on some higher education research findings, and it didn't get off the ground, it worked for about the first two weeks, and then people where either too busy, or didn't see the need."*
>
> *I2: "They get their marks back through Blackboard and [software]."*
>
> *I3: "I provide the students marks and put them online and then for example we've been using Blackboard, so I'll enter the marks there, get the tutors to enter the marks there as well export it from there and directly import into [software] to eliminate data entry errors."*
>
> *I4: "In an administrative way I use things like Excel."*

> *I23: "I can go ahead and see ... obviously it's assignment marks and stuff but if I go resources, I can see all the resources that this person has accessed on this website. So, all these links, clicked on there, how many times visited."*
>
> *I25: "I was one of the early people to experiment with a few learning analytics, things on those as well, and with Blackboard originally way back when that was basically downloading the logs and running some Excel stuff, and some Pearl code over the top of that. So that sort of learning management system stuff."*

The Internet has been reported as a resource for educators to support their learning and teaching (Jonassen, et al., 2008; Ribeiro, Politis, & Culum, 2015). Findings were consistent with the literature, with interviewee's 3 and 4 both reporting using the Internet to research teaching resources and concepts. Interviewee 3 also reported using books, manuals or online help. The idea of using online help manuals is not widely reported, particularly as reported by interviewee 3 who used it without pre-preparation or planning while teaching. This technique teaches students unique problem-solving approaches.

> *I3: "I'll look at the books, or you know look online, or if it's something in class that we are doing I might say I'll look at the manual or check out the help."*
>
> *I4: "[I am] making increasing use of the Internet."*

7.4.4 Repertoire

The *repertoire* axial code provides a list of hardware and software used by educators. The *repertoire* axial code contains two properties: *hardware*[12] and *software*[12].

Analysing this axial code provides not only a list of software used by IT academics, but also an understanding of their priorities and the inferred importance they attribute to each technology selected. There are examples of IT academics using technology reported in the literature. These are infrequently accompanied by a reflection of the underpinning philosophy around their adoption however they provide insight into what IT academics are doing with educational technologies, and the choices they are making.

Thompson (2014) suggests educators require the following technology skills; the ability to search the web (Google), familiarity with the MS Office Suite (Excel, Outlook, Word and PowerPoint), social media, sharing and collaborating tools (YouTube), mobile devices, and cloud computing software (Dropbox). IT professionals require a range of technical and people skills including architecture, programming and application development, project management, big data, business intelligence/analytics, help desk support, database administration, security, compliance and governance, cloud and Software as a Service (SaaS), and web development (Pratt, 2015). Combining Thompson (2014) and Pratt's (2015) skills lists might provide a picture of the type of software skills needed by IT academics. All phase one interviewees reported having some MS Office skills, and appeared to focus on software used for student learning, and teaching preparation. It appears that the phase one interviewees likely reported the minimum mandated software skill set, given that anecdotal evidence would suggest that IT academics use a larger selection of software than that reported. Interviewee 3 mentioned the use of Google, while none of the phase one interviewee's mentioned using social media or collaborative tools, mobile devices or cloud software. Phase two interviewees reported many additional technologies some of which were not university supported, indicating IT academics enjoy exploring different technologies. For simplicity software used is catalogued by purpose. Software appears to be used for a range of reasons including; administration, teaching and teaching preparation, student learning and student learning support, communication and research. IT academics appear to provide lists of software which relate to their innate interest areas.

Table 7-4 Software catalogue

Interviewee	Software	Purpose
I8	Acrobat	Teaching preparation
I9	Adobe Master Suite	Teaching preparation
I7	Audacity	Teaching preparation
I2, I3	Blackboard	Teaching and student learning support
I22	Cahoots *	Student learning
I7, I15, I18	Camtasia Studio	Teaching preparation
I6	Delicious *	Social communication
I15	Dropbox	General administration
I3	Eclipse	Student learning
I1	Eggshell	Student learning
I25	Elluminate	Student communication
I9	Email	Work related communication
I6, I8, I22	Facebook	Social communication
I9, I21	Flash	Teaching preparation and student learning
I2	GL and Ogre graphics libraries	Student learning

Interviewee	**Software**	**Purpose**
I3	Google	Research and teaching
I6, I8	Google Docs	Research
I25	Google Hangouts	Student communication
I1	Inspiration *	Student learning
I1	iSpring *	Teaching
I1	Java Maths World *	Student learning
I3	Latex	Research
I6	Linux	General administration
I6	LMS	Student learning
I20	Minitab	Student learning
I8, I15, I18, I25	Moodle	Teaching and student learning support
I2	MS Excel	Teaching administration
I1, I2, I3, I4, I7, I15, 18, I22	MS PowerPoint	Teaching
	MS Word	Teaching
I9	MSN	Communication
I3	Notepad	Student learning support
I9	Paintshop Pro	Student learning
I8	PDF Writer	Student learning and feedback
I6	Podcast	Student learning support
I6	Second Life	Research and student learning
I6, I8, I9	Skype	Work communication
I20	SPSS	Student learning
I22	Studio 3D Max	Student learning skill and knowledge
I6, I18	Twitter	Social communication
I7	Virtual Dub	Teaching preparation
I2	Visual Studio	Student learning
I3	WebCT	Teaching and student learning support
I6	Windows	General administration
I15, I25	YouTube	Teaching and student learning

* software which is not supported by the university

Interviewee 1 reported using hardware which aided the practice of learning and teaching, such as a scanner to capture images, or convert books to digital text and others. Other interviewees reported a range of hardware technologies used for various purposes including administration, entertaining, teaching and communication.

Table 7-5 Hardware catalogue

Interviewee	Hardware	Purpose
I1, I22	Calculator	Teaching and student learning
I1	Laser pointer	Teaching
I1	Microphone	Teaching
I1	Scanner	Teaching
I6, I22	Mobile phone	Communication
I6, I21	iPad	General administration
I6	iMac	General administration
I6	Apple TV	Entertainment
I6	Nintendo	Entertainment
I6	Wii	Entertainment
I6	Tablet PC	General administration
I21, I22	Laptop	General administration and student learning
I22	3D printer	Teaching and student learning
I25	Interactive white board	Teaching
I25	Video conferencing	Communication

7.4.5 Conclusions and recommendations

The ***technology adoption*** category and axial codes represent technologies used by IT academics, the related benefits, issues and instances of use. The axial codes include: *affordances*, *constraints*, *examples of use* and *repertoire*. Conclusions and recommendations offered are based on the analysis of combined phase one and two data.

Affordances:

There are range of advantages in using technology to improve learning and teaching. Some reported in the literature include; flexibility, facilitation of assessment, accommodation of individualised learning and learning styles, provision of protection for the environment, aids knowledge development and enables communication, amongst other benefits. Those reported by IT academics include facilitating communication, convenience, improving delivery, motivation, repeatability and ubiquity. IT academics used technology to facilitate communication with their students and to make social connections. IT academics reported being inspired by the potential of technology. IT academics used technology to aid learning through the production of reusable, duplicatable resources, and through animations which facilitated the reduction of complicated concepts into a series of smaller steps, however findings from the literature suggest animations should only be used in conjunction with active learning tasks, in order to aid retention of learning. In addition, technology was used to provide pervasive learning resources for students.

Recommendation 11: IT academics will benefit from being encouraged to adopt technologies which help reduce their cognitive load while teaching. IT academics should use animations in conjunction with active learning tasks (see Naps, et al., 2002), to aid retention of learning. In additional IT academics will benefit from access to technologies that can help spark their imagination and increase their intrinsic motivation.

Constraints:

The literature reports a range of constraints in using technologies some of these include; a lack of university supporting infrastructure, funds, training and policy, as well as unreliability. In addition, IT academics reported constraints including; limited bandwidth, complex time-consuming software, poor cultural environment, and fear of technology failure. IT academics reported frustration with bandwidth limiting options on file sizes. IT academics also reported student distraction issues when using technology. Extending the literature findings suggest students used technology as a subconscious barrier when they failed to understand concepts, perhaps to avoid being embarrassed. IT academics reported overlooking technologies which were complicated and potentially required a large time investment to master. IT academics indicated a lack of policy direction for non-adoption of technology. In addition, extending the literature IT academics reported participating in a culture of indifference for technology adoption amongst peers, a fear of technology failure and a lack of technical support.

Recommendation 12: IT academics should think about avoiding or limiting the use of external resources which require large and costly downloads to students. University management and administration could benefit from fostering resourced and supported environments which promote independence and self-efficacy, where IT academics willingly and hastily learn and adopt new technologies.

Examples of use:

ET has been used to prepare learning resources and aid student learning. IT academics interviewed in phase one showed a limited use of technology to support student learning, with PowerPoint being reported as the favoured software. Extending the literature phase two interviewees reported using technology facilitated back-up plans rather than non-technical options for technology teaching failures. IT academics reported a unique use of video to develop a social presence through personalised gestures and the promotion of discourse with students utilising educational videos. New to the literature, IT academics reported a strong passion for game playing, which suggests their love of technology is based on strong links with gaming culture. IT academics reported using LMS's for teaching, communication, administration and to conduct learning analytics aimed at facilitating and understanding student learning. IT academics reported using google as a resource for teaching and learning. IT academics reported the use of online help manuals used spontaneously when solving programming issues in class, as a way of demonstrating best practice. This was not widely reported in the literature.

Recommendation 13: When developing educational resources with software such as PowerPoint, IT academics will benefit from being encouraged to utilise the high-end features of the software, to aid engagement and motivation amongst students. IT academics should use technological back-up plans in the event of technology failure when teaching. IT academics can increase student participation and promote discourse by personalising resources. Development of a strong gaming culture can also increase IT academic propensity to access and implement technologies aimed at improving learning and teaching. IT academics can better understand student learning behaviours by conducting LMS data analytics. The Internet can be used to illustrate unique problem-solving approaches to students.

Repertoire:

Educators require technology skills in MS Office, Google, social media, sharing and collaboration software, and cloud technologies. IT professionals require a range of specialised technical skills. IT academics interviewed in phase one reported relatively limited software skill sets. The use of MS Office to prepare lecture materials was indicated by all interviewees. Phase two interviewees reported many additional technologies, which were used for many purposes including; administration, teaching and teaching preparation, student learning and student learning support, communication and research.

Recommendation 14: IT academics are known to be technological experts and require access and support for a range of specialised, new and emerging software applications including required hardware. This will aid motivation and ensure currency of knowledge and skills for IT academics and facilitate better learning outcomes for students.

7.5 Techno-pedagogical practice

This section provides a recap of the ***techno-pedagogical practice*** category and a model illustrating this category along with its associated axial codes. This is followed by a discussion of each axial at the properties level. Each property is examined in terms of its connection to the literature and the phase one and two data. A brief conclusion and recommendations for each are offered.

The ***techno-pedagogical practice*** category describes changes in teaching and learning philosophy and practice resulting from technology adoption, facilitating digitally enhanced teaching promoting a student focussed approach.

The model illustrated in Figure 7–4 represents the ***techno-pedagogical practice*** category and its associated axial codes. The diverging radial diagram functions as a visual representation illustrating connections between the axial codes to the central theme (techno-pedagogical practice).

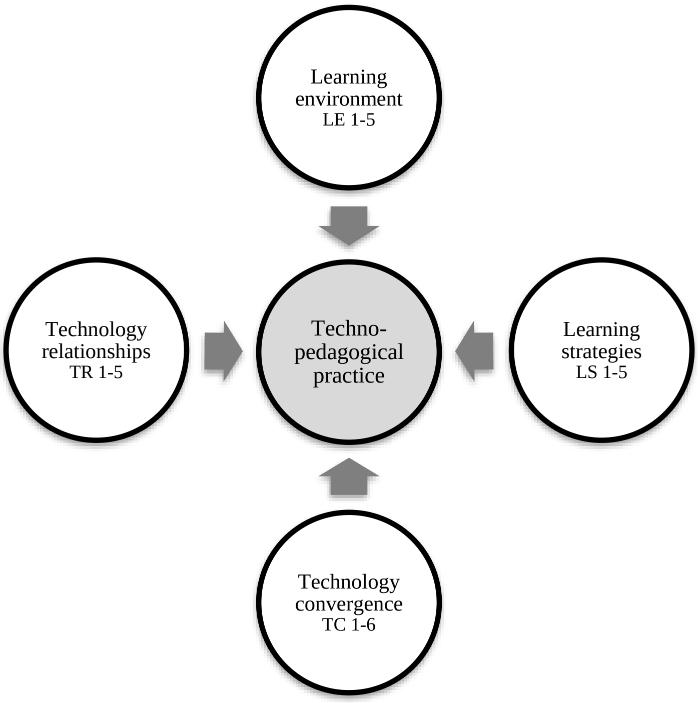


Figure 7-4 Phase 2 – Techno-pedagogical practice radial diagram

See Table 7–4 for a list of the ***techno-pedagogical practice*** diagram property codes and labels. This should be read in conjunction with Figure 7–4.

Table 7-6 Teaching practice properties

Axial Code	**Property Code**	**Property**
Learning environment	LE1	Immersive
	LE2	Interactive
	LE3	Online eLearning
	LE4	Simulation
	LE5	Student-centred
Learning strategies	LS1	Applied
	LS2	Flipped classroom
	LS3	Gamification
	LS4	Problem based
	LS5	Social learning
Technology convergence	TC1	Environment
	TC2	Learning and teaching
	TC3	Metaphor
	TC4	Pedagogy
	TC5	Society

Axial Code	**Property Code**	**Property**
	TC6	Students
Technology relationships	TR1	Emotional
	TR2	Mastery
	TR3	Physical
	TR4	Thinking and problem solving
	TR5	Tool

7.5.1 Learning environment

The learning environments axial code describes attributes and features of technology enhanced learning environments. The learning environments axial code contains five properties: *immersive*^{2}, *interactive*^{2}, *online eLearning*^{2}, *simulation*^{2} and *student-centred*^{2}.

Analysing this axial code provides information about the contemporary university learning spaces. Investigating learning spaces helps to us to understand the impact and contribution they make to student learning. Of interest is their influence on the accumulation of knowledge and skills and the emotional and physical connections between students and their learning environment.

Immersive learning environments provide greater opportunities for experiential learning, increased motivation/engagement, improved contextualisation of learning richer/more effective collaborative learning tasks (Dalgarno & Lee, 2010), purposeful and focussed communication, and development of higher order thinking skills (Falloon, 2010). Immersive worlds allow for more complex social interactions and encourage learning empowerment for students (De Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, & Poulovassilis, 2010), provides learners with a safe and repeatable learning environment, and exposes them to real situations and is a bridge between learning and life (Cheng & Wang, 2011). However, constraints including technical difficulties (Quintana & Fernández, 2015), kinaesthetic limitations and character misrepresentations (Dickey, 2003) have been reported with regards to immersive learning spaces. Interviewees 9, 14 and 22 reported on immersive learning environments. Findings are consistent with the literature, interviewee 9 reports on the use of immersive environments for communication purposes. Interviewee 22 highlights a key affordance of immersive learning environments, the ability to practice practical and/or dangers activities in a safe virtual environment. Interviewees 9 and 14 also exhibit signs of horseless carriage thinking (see Chapter 1.1).

> *I9: "Second Life for communications, in whatever form. I have not taught in Second Life, although that was on the cards this semester if my health situation deteriorated, I would have done the PowerPoint presentation the same way but in Second Life."*
>
> *I14: "When we looked into the virtual worlds at [university] so we built an online campus and we got classrooms there, everything there; we can show PowerPoints, videos, the web-based stuff etc."*
>
> *I22: "You've got virtual reality environments where you can get people prepared for scenarios before they actually get to them.""*

Interactive software allows learning experiences that are simultaneous and fun (Armstrong & Georgas, 2006). In interactive learning environments students demonstrate more positive attitudes and higher levels of performance (Durrington, Berryill, & Swafford, 2006), they are more active learners (Awedh, Mueen, Zafar, & Manzoor, 2014), and can communicate from different locations and times (Stafford & Faber, 2005). Constraints of interactive learning environments include an increased cognitive load (Homer & Plass, 2014), a hesitancy to participate, and significant teaching expertise is required (Cook, Dow, & Hammer, 2017). Interviewees 5, 8, 18, 23 and 25 discussed interactive learning environments. Findings support the literature. Technology enhanced learning describes the application of technologies to improve learning and teaching (Kirkwood & Price, 2014). Interviewee 1 reports an example of using basic interactive technology, to encourage exploration and facilitate improved learning, particularly for students who are struggling to understand course concepts. Interviewee 18 mentions using interactivity to engage students, and to facilitate self-confidence to question and offer ideas. Here the IT academic is talking about interactivity engaging students and promoting communication in a face-to-face environment. Interviewee 23 mentions communication benefits in an online environment. Extending the literature is interviewee 25's response, suggests it is important to focus on how the students will learn best, and using interactivity is useful in achieving that.

> *I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds."*
>
> *I18: "So interactive, interactive is my main goal, at the beginning, right. So I want the students to get involved, because otherwise they fall asleep. So with my PowerPoint I really try to achieve that goal, to give student every opportunity to pipe up. For every lecture, at the beginning I always put pictures that are pertinent to the topic ... It's always a picture so they get it, I think."*
>
> *I23: "I never see them face to face. The lectures are recorded which is fantastic. We have ... once a week we have online interactive session where we have a tool that they can use called [software]."*
>
> *I23: "I'm trying to teach. How do I feel they're going to learn best? If they love games, for instance, or sometimes they play them, so maybe just playing a game is the best way to teach game design or something like that, interactive."*

Students value teaching and learning resources made available online (Sher, Williams, & Northcote, 2015). A key advantage of online eLearning is that it centres on the students or learners (Holmes & Gardner, 2006). Some other reported benefits include focuses on the needs of the individual, flexibility, promotes discussion between learners, cost effective, helps compensate for scarce resources, allows for self-paced learning (Arkorful & Abaidoo, 2015), being able to access recordings at any time, avoid and travelling to and from university (Sher, et al., 2015), and geographical reach (Urh, Vukovic, Jereb, & Pintar, 2015). Conversely a key limitation of online eLearning environments includes the absence of vital interpersonal interactions (Young, 1997). Some other disadvantages include additional workload and skills required for academics, difficulties catering for diverse cohorts (Sher, et al., 2015), requires strong student motivation and time management skills, and it is more difficult to clarify concepts (Arkorful & Abaidoo, 2015). Interviewees 9, 15, 17 and 25 reported on online eLearning environments. Consistent with the literature interviewees 9, 17 and 25 reported limitations while interviewee 15 discussed a potential benefit. Interviewee 9 mentions the inability to read students' body language while teaching online, here the IT academic was referring to a non-video environment associated with online eLearning. Young (1997) eluded to this problem when he reported the absence of interpersonal interaction. Interviewee 17 reported communication challenges while interviewee 25 talked about online students failing to reach the same level of critical analysis as the face-to-face student. Interestingly interviewee 25 does not give any real evidence as to why this might be the case rather indicates that it is a hunch upon reflection. Interviewee 15 mentioned the benefit of preparing online eLearning materials for complicated heavy content courses. Interviewee 15 felt giving students' access to additional audio and video resources as a technique for easing students' learning burden.

> *I9: " With online learning one of the most difficult things I find about online learning is that I can't see student's eyes. Eyes always tell me whether they've understood something or not. And there only need to be one student who sort of goes a bit like that, or 'Ah, I don't think I understand', sort of thing, and I try and find another way of explaining what I've just explained."*
>
> *I15: "I actually wanted to provide online videos of lectures, kind of running out of time to do that [Laughs] but it's something I've been wanting to do and particularly for this subject, because this subject's heavy, and I wanted to be able to provide, there's too much content and it's too heavy so I was going to provide a lot of the content online and then just go through the important bits in lectures."*
>
> *I17: "The off-campus students did not like the idea of having to be online at a particular time. Their idea of a conversation online was [to] post a message, go away, and forget about it. So, I actually had to teach them how to have a conversation amongst themselves. Really challenging."*
>
> *I25: "The online students versus the face to face ones. The online ones just, I never got the sense of critical analysis out of them, never got the sense of really engaging deeply with the stuff. They still did good enough, but it just wasn't, it wasn't as good in terms of the learning. And that's not a sort of data set I can draw any strong statistical conclusions from, that's a bit of a hunch."*

Simulation is used extensively in medical education (Scalese, Obeso, & Issenberg, 2008; Weller, Nestel, Marshall, Brooks, & Conn, 2012), with much of the simulation research being conducted by medical and health care researchers. Simulation-based environments can lead to improved effectiveness when compared to traditional teaching and learning approaches (Milkins, Moore, & Spiteri, 2014), simulation amplifies real experiences (Gaba, 2004), can lead to increased confidence in collaborative approaches, addresses issues of safety, and is used to conduct consistent assessment tasks (Gaba, 2004; Weller, et al., 2012). Simulations improve student memory, enhance engagement with the material and are widely used to improve students' negotiation skills (Druckman & Ebner, 2008). Constraints of simulation environments include high costs (Gaba, 2004), difficult to design (Hazen & Hazen, 1984), and technical issues (Guise, Hansen, Lambert, & O'Brien, 2017). Issues reported specifically in terms of gaming simulations include efficiency mindset (a phenomenon where one needs to find a strategy that will consume relatively few resources and yet offer maximum yield (Waddington, 2015)) and technocratic thinking (the impression that effective social reform is a matter of choosing and implementing the correct rule set (Waddington, 2015)). Interviewees 5 and 22 mentioned simulations. Findings are consistent with the literature. Interviewee 5 mentioned using simulations to practice complicated or serious tasks without the potential dangers (see Weller, et al., 2012). Interviewee 22 suggests the use of simulations for assessment and testing (see Scalese, et al., 2008).

> *I5: "[course] we explore simulation systems and one of the simulation systems is that the students get to perform knee surgery online. Simulated knee surgery, it's a great way to learn."*
>
> *I22: "They use some of that for driver's tests and, well, simulation stuff and rather virtual reality, but they'll use the simulations for driver's tests."*

Student-centred learning is said to improve students' learning, teaches them how to learn, develops skills including critical thinking, problem solving and reflective thinking, and helps students set their own learning goals (Cubukcu, 2012). It also assists knowledge and skills to be absorbed in an effective and lasting way (Lont, 1999), and accommodates individual learning needs (Hannafin & Land, 2000). Conversely limitations of student-centred environments have been reported. Students have difficulties discerning relevant from irrelevant information (Roth, 1995). Students require a working knowledge of concepts to build upon, if their base knowledge is inaccurate or incomplete they further develop these inaccuracies which in the future can be difficult to rectify (Hannafin & Land, 2000). Other limitations include student-centred environments often utilise team based learning, and students dislike working in teams (Pedersen & Liu, 2003). Student-centred learning requires teachers with specialist skills, and takes longer to prepare and achieve learning outputs (Garrett, 2008). Farrington (1991) poses a question in relation to student-centred environments, "Students are at the heart of any educational activity, but how much individual choice, how much teacher involvement, how much freedom we give to individuals is problematic for all of us" (p. 20). Findings not only support the literature but strengthen it. Analysis suggests IT academics feel strongly about students being at the centre of the learning, this is supported by comments from interviewees 5, 6, 22 and 23. Interviewee 5 suggests IT academics use technology to afford these beliefs. Interviewee 13 provides interesting insight suggesting good teachers are part of a club who focus on their students, and not on themselves as teachers.

> *I5: " It's what technology is giving students now is that freedom to do more of what they want to do, when they want to do it, the way they want to do it."*

> *I6: "It's about giving learners options, and I think technology can do that. So I don't look at technology and say oh I'll find a way to jam that into my teaching. I look at my teaching and say look at this new social bookmarking tool could be really useful because I can create a list so the students can see what all the options are."*
>
> *I13: "I've spoken with a lot of people about teaching a long time, you know, and it's like a little club. The people who are in the club understand that the club exists, and they understand that there are people who are born to teach. The people who are outside the club kind of don't understand it and they tend, in my mind they tend to be the ones who either don't, so they don't value teaching particularly, and that's usually because they've had poor feedback about the teaching, or they think they're outstanding teachers and can't understand why everybody else doesn't see it that way, and they tend to, so they tend to focus on themselves and not on the students."*
>
> *I22: "The student is central to everything; everything should be everything should focus on the student and what they need to learn."*
>
> *I23: "I'm very student focused. That's essentially what my job is, teaching students."*

7.5.2 Learning strategies

The *learning strategies* axial code describes changes in thoughts and behaviours and learning approaches resulting from technology adoption which influence how learners process information. The *learning strategies* axial code contains five properties: *applied*^{12}, *flipped classroom*^{2}, *gamification*^{2}, *problem based*^{2} and *social learning*^{2}.

Analysing this axial code provides details of the impact of technology on student learning strategies. This information allows anticipation and planning for required resources, new skills and knowledge of educators, infrastructure requirements (for example, learning space construction), software and hardware needs amongst others.

Applied learning describes the further development of a student's existing skills through experiences gained in a workplace setting (Gilbert, 2010). Blended learning is an education program in which students learn through a combination of face-to-face and web based delivery (Akkoyunlu & Soylu, 2008). Applied learning is pedagogically innovative and applied approaches have risen in importance (Dare, 2000). Applied learning aims at bridging the gap between university and the workplace and is reported to provide better support for students than traditional work placement approached. In addition applied learning provides an opportunity for students to utilise and extend their existing skills while working with an experienced workplace mentor (Gilbert, 2010). Limitations of applied learning reported include, a need for extensive support and resources to be effective, and unsatisfactory outcomes from poorly managed programs (Harrison, 2006). Interviewees 3, 6, 8 and 21 reflected on applied learning. Interviewee 3 provided an example of a combined applied learning and blended learning approach. Students typically develop skills in a university blended learning environment which are then extended and enhanced through workplace training. There are different types of applied learning models reported (see Harrison, 2006). Findings are consistent with the literature, with interviewees 6 and 8 using applied examples to provide context for student learning, and interviewee 21 highlights the value of work-based placements, learning by doing.

> *I3: "The professional practice degree combines university blended learning with real world experience. The degree is spread over a 4-year period to give students time to complete hours for their scholarship in years 2 and 3, and then to be employed for a semester in their final year. Many students are able to complete their final year project as a part of their work placement as well."*
>
> *I6: "I intend to embed a lot of examples in, because I was in industry for so long. I can usually come up with some useful examples."*
>
> *I8: "I give them examples what's happening in industry, how they can be better, how you can be a better programmer, so that's interactivity and engaging."*
>
> *I21: "They actually learned media studies by actually doing it. And we had a screening at the end."*

There is much controversy among educators on the value of flipping the classroom (Rutherfoord & Rutherfoord, 2013). Flipping the classroom is reported to enable superior learning outcomes and enhanced critical and analytical thinking skills in students (Towle & Breda, 2014). It also encourages students to take responsibility for their own learning, and explore additional course concepts (Rutherfoord & Rutherfoord, 2013). Flipping the classroom has some limitations. Educators must prepare media enhanced course materials ahead of time, for example, podcasts. This is a very time-consuming process (Maher, Latulipe, Lipford, & Rorrer, 2015). Teaching and learning tasks need to be creative and accommodate students higher-level critical thinking needs (Rutherfoord & Rutherfoord, 2013). Students can feel isolated, as viewing online resources is an individual activity (Maher, et al., 2015), and students are required to attain the prerequisite knowledge prior to coming class (Towle & Breda, 2014). Interviewees 20 and 24 reported on using a flipped classroom approach. Findings support the literature. Interviewee 20 reported the benefit of students being able to access learning materials ahead of time. This also suggests empowering students to take responsibility for their own learning. An analysis of interviewee 25’s comments is very interesting. Interviewee 25 indicates IT academics are engaged with educational literature and publishing research articles based on their teaching experiences. Given pressures on universities to publish in specific discipline-based fields of research (FoR) codes, this suggests a prevailing interest and motivation to pursue teaching excellence.

> *I20: “I'm a big fan of the flipped classroom approach where they can access the basic readings beforehand. It's probably in essence what we've been doing for quite some time, probably 10 years or something along those lines, in that we've always given them the ability to have the lecture notes ahead of time.”*
>
> *I25: "I guess alongside all of this the whole flipped classroom thing was happening, and I have engaged with that literature a little bit. Actually, an interesting thing is one of the student assignments from that class, we ended up turning into a paper on the flipped classroom, which is a paper that’s had a little bit of impact out there, people have read it. So, I guess I did some reading in that whole space.”*

Gamification in education has dramatically increased over recent years (Kankanhalli, et al., 2012). Gamification has been reported to improve student loyalty and innovation (Kankanhalli, et al., 2012). The most reported affordance of gamification is its ability to increase student motivation and engagement (Barata, Gama, Jorge, et al., 2013; Dominquez et al., 2013; Kankanhalli, et al., 2012). Conversely Hanus and Fox (2015) found that students in a gamified course showed a reduction in motivation. Hanus and Foxes (2015) findings recommended educators using gamification techniques need to apply individual gaming aspects with care, for example, avoid badge systems. Interviewees 2, 12 and 21 mentioned gamification aspects. Interviewees 2 and 12 did not report specifically using gamification in the traditional sense i.e. adding technological games elements to their teaching and learning environments but used games ideas to provide a context for theoretical concepts. In the same way an educator using a constructivist approach might. Findings from interviewee 21s comments extend the literature. Interviewee 21 uses a unique approach, getting students to create their own game to learn theoretical programming and logic concepts. This approach is perhaps unique to the computing discipline due to the technical knowledge and skills required.

> *I2: “Everyone’s played a lot of games. I can throw a fairly abstract idea in say a games design, or even in the engine unit we talk about shadowing effects and I can ask well can anyone think of a game where they have seen this sort of thing."*
>
> *I12: "I do use it a lot for, things like, human/community interaction for, interfaces for strategy, intelligence for data structures. I do a lot of my examples with games."*

> *I25: "I get them to actually create a game that will help them use those structures. So, Dice Wars was one, so they had two dice [sic], they pushed a button, animated the dice, they pushed the button again and it stopped on two values. It compared the two values, so if Player 1's value was higher they would win, and they would then combine both values and score that, otherwise Player 2 would win and get the combined value."*

Problem based learning has been used widely and successfully (Taplin, 2000). PBL is reported to motivate students (He, Kinshuk, & Patel, 2002; Keane & Keane, 2005; MacDonald & Isaacs, 2001), improve student retention of concepts (Azer, et al., 2013), develop higher-level thinking skills (Taplin, 2000), robust mental models, and improves self-reflection and peer collaboration (Askell-Williams, Murray-Harvey, & Lawson, 2007). Conversely PBL requires teachers to undertake specialised training (He, et al., 2002), involves significant effort in terms of planning and ongoing facilitation (He, et al., 2002; Kilroy, 2004), and setting assessment is challenging (Keane & Keane, 2005). In addition, students require a certain level of computing skills and maturity to use PBL successfully (So & Kim, 2009). Some students have reported a sense of frustration with PBL (He, et al., 2002). Interviewee 5 reported on a PBL approach. Interviewee 5 abandoned traditional lecture classes in favour of students working through a series of problems while utilising Internet based resources as support. The interesting aspect of interviewee 5's comments were in relation to the importance of the student cohort and context (students working with families). This was not specifically mentioned previously in the literature.

> *I5: " So what do they do, what do most of them need to do here is to work as much as they can, so that they can reduce the burden that they are on their families. So, they are not going to go to lectures when there is a shift at work to be done, so I attendance at lectures is going to be very difficult for them. I thought what I would try to remove lectures. And replace them with problem-based exercise so that there was never a formal delivery of the concept, its only delivered through problems that are assigned. So, each lecture was replaced with a workbook. My gut feeling was that this kind of workbook way fit their constraints better, because they could skip the lecture and work through the workbook themselves. All the material is available on the Internet. There is a lot of watch this You Tube video and stuff."*

The use of social media has experienced exponential growth in recent years (Faizi, El Afia, & Chiheb, 2013). The are many benefits of social media in education. Some of these benefits include, new opportunities for self-expression (Alabdulkareem, 2015; Wan, 2015), personal development (Wan, 2015), enhanced learning opportunities (Vervaart, 2012; Wan, 2015), increased motivation and engagement (Alabdulkareem, 2015), improved communication. Social media can improve communication between students and teachers, and also between students (Alabdulkareem, 2015; Faizi, El Afia, et al., 2013). Conversely there are disadvantages associated with social media learning. Some of these disadvantages include content generated by students requires close monitoring (Kist, 2008), the digital divide (see Chapter 1.1) may mean not all students have equal access in their various learning environments (Bynum, 2011), with information overload students may find it difficult to determine relevant concepts (Berner, 2002), and students identities may need protection (Weisman, 2012). Interviewees 9 and 22 mention social media learning. Findings of interviewee 9 confirm the literature, with social media being used as a communication tool in capstone project classes. An analysis of interviewee 22 response extends the literature, with social media being used from educator to educator, improving communication and resources sharing.

> *I9: "We're using Facebook with a project this semester, so all our communication happens via Facebook. A group that only has a few people associated with it. Which is an interesting sort of place to be as far as students are concerned because I'm beginning to realise that students feel that they're invisible. And they do say much more on Facebook than they do anywhere else."*
>
> *I22: "Facebook has power for learning - I reached out to teacher friends of mine over Facebook one evening to find current resources used for teaching about a particular area of Australian history; within an hour or so I had received several replies pointing me to different resources that were used including pdfs of actual textbook content that was being used."*

According to Hannafin (2000) "the challenge is not so much to invent new teaching-learning models as to understand and optimize those models that have emerged" (p. 22).

7.5.3 Technology convergence

The *technology convergence* describes the merging of technology and other learning influences, pioneering an innovative technology-based learning culture. The *technology convergence* axial code contains six properties: *environment*[2], *learning and teaching*[12], *metaphor*[2], *pedagogy*[12], *society*[2] and *students*[2].

Analysing this axial code provides an understanding of the powerful relationships between technology and other phenomena. This information affords insight into new territories, new ways of living, new ways of learning, new ways of teaching, new ways of thinking, and new ways of understanding in a new society. This assists IT academics to be better prepared, to take full advantage of the benefits of these new phenomena and be better equipped to handle any associated limitations.

There are advocates of paperless learning in schools (Slowinski, 2000), particularly given the high costs of paper and printing (Johnson, 2011). In additional, students are reported as being more motivated (Katz, 2002) and exhibit a preference for paperless learning (Tan, 1992), at the same time saving trees and protecting scarce storage space in universities (Lim, 1999). Price and Petre (1997) conducted a study of a paperless classroom while teaching programming. Findings suggested administration was more efficient, and the quality of feedback improved. Drawbacks of paperless classrooms include student eye strain (Rangel, 2014), technical issues, download issues, time consuming to use, and is impacted by the digital divide as not all students have equal access to technology (Craven, 2017). Interviewee 6 mentioned the convergence of the environment and technology. Findings support the literature with interviewee 6 indicating use of paperless assignments (see Price & Petre, 1997). Additional analysis of interviewee 6's comments extend the literature, suggesting a deeper appreciation and advocacy of paperless living, with interviewee 6 promoting paperless committees in universities.

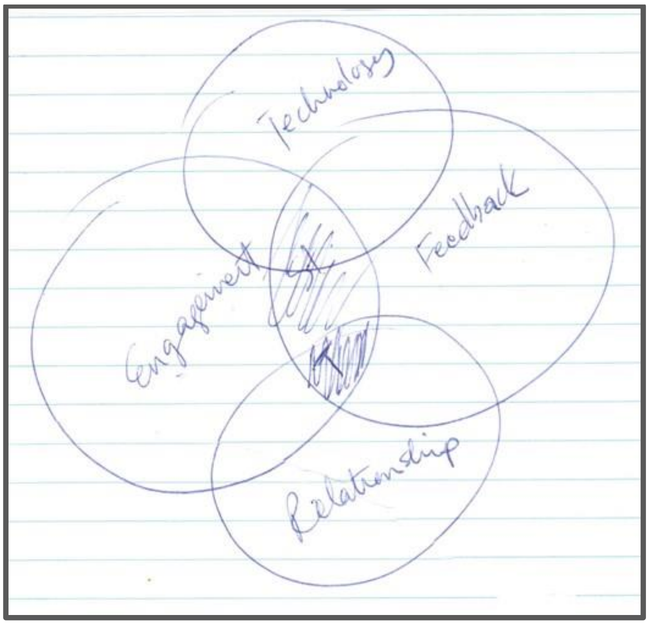
> *I6: "So pretty much my teaching environment is paperless as well, and they get marked online and they get returned to them that way."*
>
> *I6: " Sustainability is a big one for me. I don't have paper. I have an iPad, and two iPhones and two iMacs and a Mac book air, and in there is everything single paper I have, as been digital scanned in. I don't do paper, so when someone walks into my office, I have in front of me my iPad usually, and when I go into a meeting I have an iPad, and its actually been a real focus of mine in the university to get committees to go paperless because I think we can save a huge number of trees and water and so on and so forth."*

The real power in technology is the way it facilitates change in student learning (Anderson, 2005). Most educators are only willing to integrate technology when they are certain there will be significant benefits to student learning, as its implementation requires considerable effort (Means, 2010). Interviewees 1, 4, 6 and 8 mentioned the convergence of learning and teaching, and technology. Interviewees 1 and 4 report educational reasons for the use of technology. Interviewees 6 and 8 show how embedding of technology within assessment and feedback is a way of improving student learning. Findings in relation to interviewees 6 and 8 suggest that IT academics have a more liberal view of the use of technology to facilitate student learning than is reported in the literature.

> *I1: "I think about the use of technology. For instance, I use CAS calculators in the Maths to allow students to explore and support their often not very strong Mathematical backgrounds."*
>
> *I6: "I try to come up with assessments that either engage them or challenge them in some way, which is why a lot of times my assessment include technology, because it forces them to get outside that comfort zone, and they learn a lot. And they come back and say I learned a lot about say emerging tech as a result of having to learn how to do SlideShare on the Internet or play a YouTube video, so it's sort of incidental learning of the technology, but it forces them to learn the material as well."*
>
> *I8: "The audio one I only did for three or 4 students, that was my trial. It's an audio option through the pdf. I used Audacity, then embed to the pdf file."*

Interviewees were given an option to draw a Venn diagram, which represented learning and teaching, and ET. Not all the interviewees elected to draw a diagram however, interviewees 8, 11, 12, 16 and 23 provided the following sketches representing their view of the intersection of technology and teaching and learning.

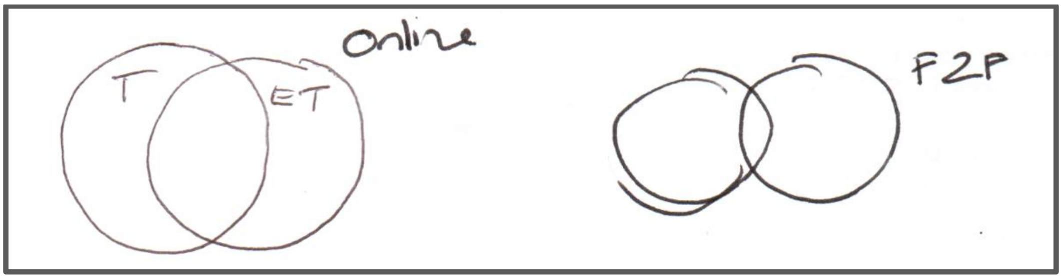
I8



When drawing this diagram interviewee 8 indicated engagement as a key element, along with feedback and relationship. Students were mentioned as being at in the centre or converging aspect. Interestingly the interviewee was prompted to add technology. This might suggest something about the order or relevance this interviewee placed on critical aspects of learning and teaching, suggesting technology is not at the heart of it for this educator. Also the relationshp is given its own bubble, this is interesting. Relationship might best describe the connection between the elements (or phenomena).

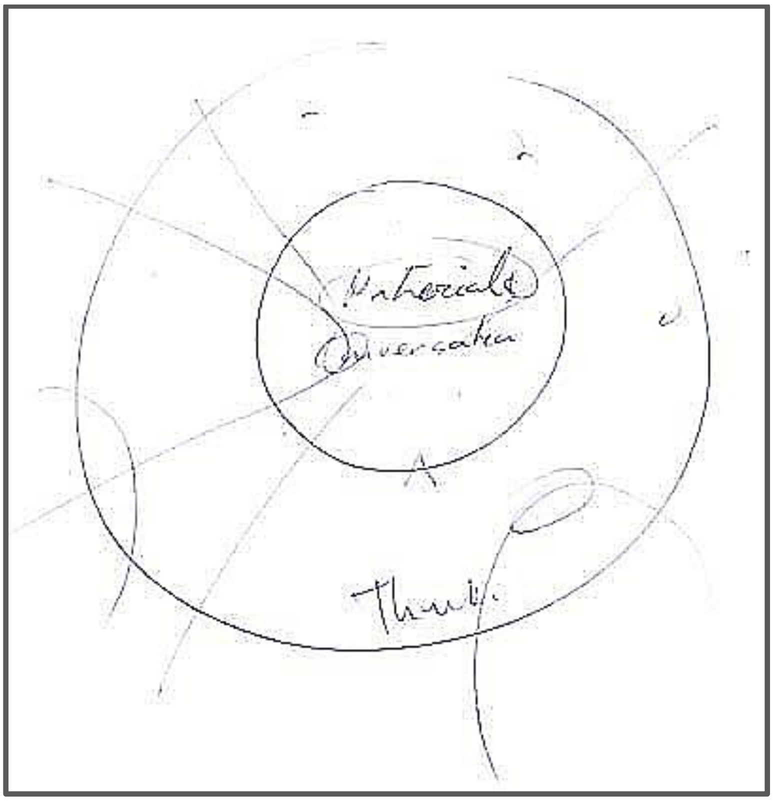
> *I8: "Ok I'll draw the diagram. So, I'll just put to my view what are the important things. 'Engagement', would be there, and here I would say this is 'Feedback', this would be 'Relationship', relationship in the sense that a good mutual understanding, sometimes when you have command in a course, and when they listen to you, everything goes smooth, but sometimes it doesn't happen. I can see that some of the students struggle and then they find it a bit hard to catch up. So those sorts of things can be avoided by starting earlier. And the other thing is students who come for help, when they need it they don't so if they come regularly and see you for half an hour the problem they are having the problem can be avoided. I see the 'Students' could be somewhere here, the student's and the teaching staff maybe I would say that this would be 'Student's' and this is 'Teacher's' here."*

I11



Interviewee 11, provided a diagram without associated commentary. Investigation suggests when drawing this diagram interviewee 11 kept the ideas fairly simple. An analysis of the two images suggests interviewee 11, saw a difference between online teaching and learning and face-to-face teaching and learning. Interviewee 11 saw the centre or converging aspect as being significantly larger for online teaching and learning. This is interesting with university policy suggesting students get the same experience regardless of the delivery.

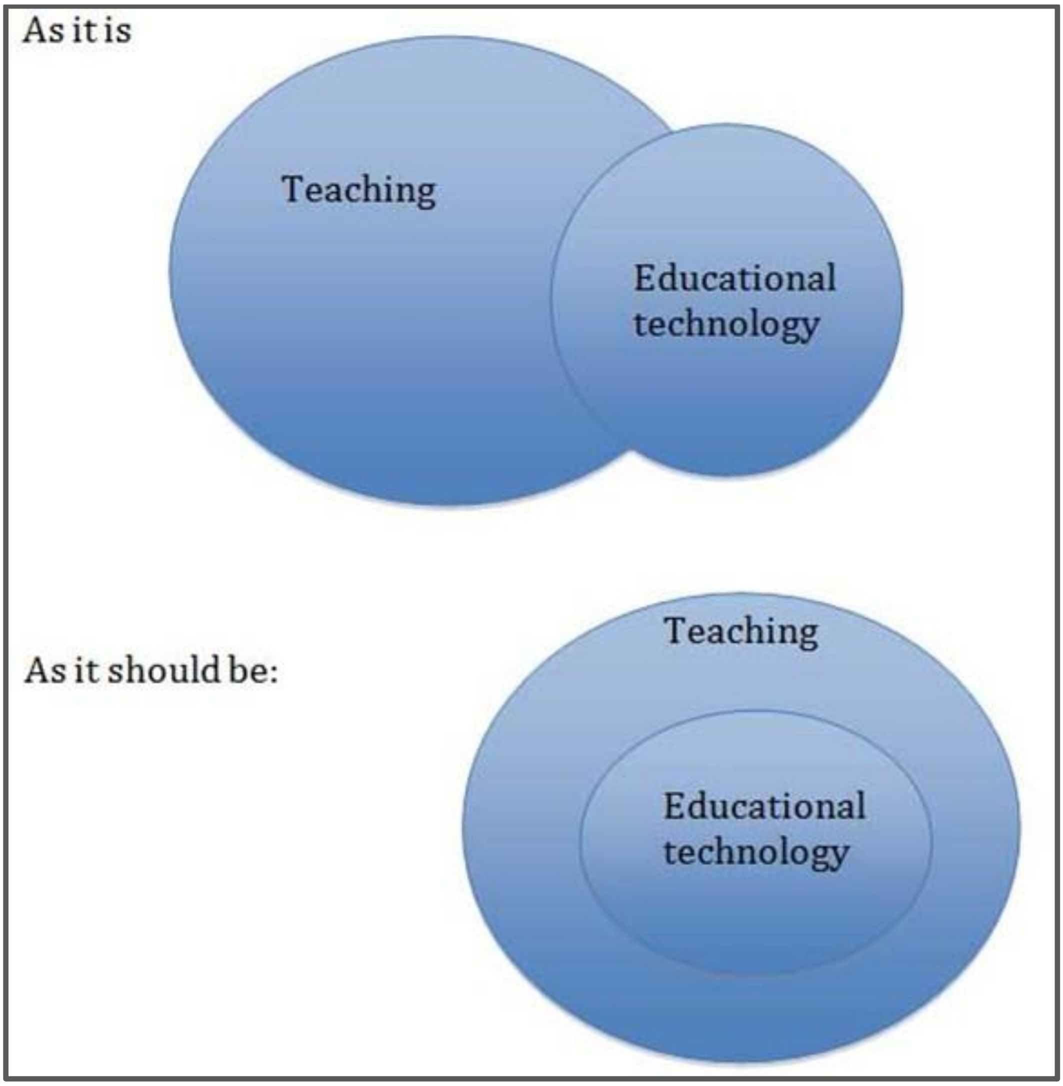
I12



When drawing this diagram interviewee 12 described course materials and conversations with students as being at the centre. This might suggest a teacher focussed pedagogy. The overlapping lines (or half circles) on the edges represent the students. Interviewee 12 suggests technology is the connector, not the main aspect but an important and necessary faciliator of communication between educators and students.

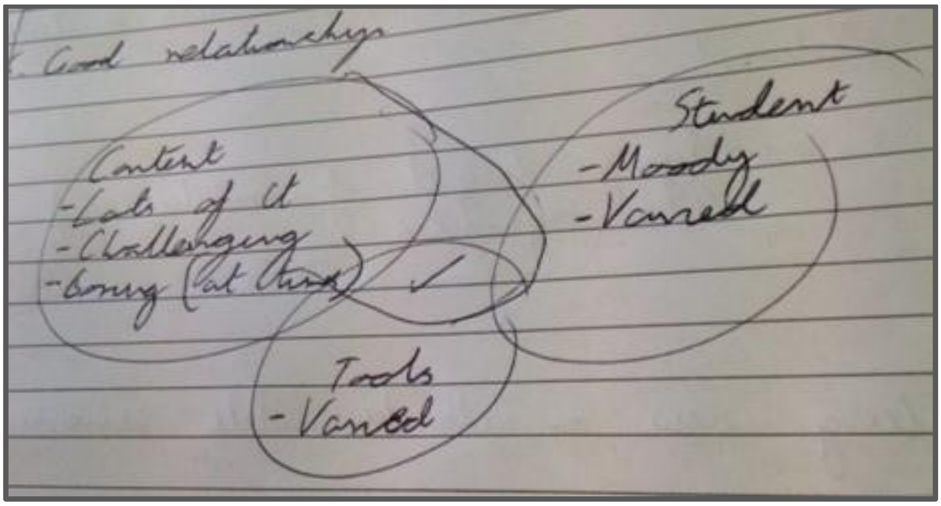
> *I12: "For me it's kind of in the middle. So, if the is all the thinking time right, so it's just that in the middle I'm helping everyone to have all the materials and have all the conversations right. So, you have my – I'm not writing very well. Materials and the conversations, through it. So, this is the thinking of different people right, that they are there and they can – so this is kind of the thinking space of people. They connect through, this but they also can connect through that. They don't need to have the technology to actually connect, or to me. They can come and talk to me through another place, but you know this is a very, it's kind of the nexus. They have to access this to have it. It's not, the main thing but it's definitely a connector, a main connector of all things that, we do, for sure. It's at the centre. I could not do without the technology. And it enhances a lot of the things. It makes things possible. But it makes things possible. It's not the technology that is important. And sometimes it's a downer. PowerPoint goodness me, click it and worse. It's really a pain in the butt but, having it online is a real need.*

I16



Like interviewee 11, interviewee 16 did not provide a commentary associated with the diagram. However analysis suggests interviewee 16 sees the relationship of the two as being different between practice and in theory. In practice interviewee 16 indicates the relationship has an overlapp, but in theory ET is represented as a subset of teaching. This is an interesting distinction. In a ideal world the relationship between the two would be seamless and represent a default or subconcious teaching approach.

I23



Interviewee 23 describes the intersection of three phenomena (students, content and tools). This model is somewhat similar to the TPACK model (see Chapter 2.4.3), both having content and technology as a focus however, there is a subtle difference with technology being the practical implementation of teaching, rather than representing a theoretical knowledge of technology. Interviewee 23 provides and articulate description to accompany the model, with great examples to illustrate each aspect. Student is mentioned as the first phenomena which might suggest this educator is student focussed, with the tools and content supporting the students' learning.

> *I23: It's just to jog my memory but essentially, I see it as three different forces. Sometimes they're interacting and sometimes they're against each other. So, you have the student who is on a huge spectrum. I've got the word moody but, you know what I mean, just different emotions. Sometimes they're really eager, sometimes just can't be bothered, whatever. They're very varied as well. We have a lot of content to try and squeeze in 11 weeks. It changes every week. It's very fast moving. Every week leads on to the next one. It can be quite challenging as well. Again, this does … that's why it relates to the students, I guess. Content does relate to the student and then the student relates back to the content. Again, you can have really easy or challenging content. The last one is tools. That's where technology comes into play and it's quite expensive. We've got the projectors in lectures. They're recorded. We've got video tutorials. We've got instruction forums. We've got the technologies they're using to learn the content as well, so if they're learning. see are the three different forces and if you meet in the middle that's when you have a good mix between … you can't control your students, of course. You can control your content and your tools. If you have content that's delivered in … try to make an exciting way or obviously a way that makes sense and flows nicely and if you've got tools that help support the content, so you develop your content nicely.”*

Metaphors have been used at a conceptual level to help develop our understanding of ways to improve the learning and teaching process (Tiberius, 1986). Saban (2006) suggested metaphors are a way of structuring our perceptions, thoughts and actions and can be used as a blueprint of professional thinking. By this Saban (2006) meant metaphors can be used to provide insight into teachers' reflections on personal thoughts, beliefs and feelings. Tiberius (1986) reported the most common metaphor in education is transmission (a transference of information from teacher to students, with the teachers seen as a primary vehicle for transmission). Interviewees 15, 16, 18 and 20 provided interesting examples. Interviewees provided metaphorical descriptions of the relationship between learning and teaching, and technology. Interviewees 15 used a cake metaphor, interviewee 16 used a food and feeding metaphor, while interviewees 18 and 20 used a plants and garden metaphor. Research on metaphors is not new, these results add to the literature. These metaphors share a common theme of growth and development. This might suggest that technology has the power to move learning and teaching from a metaphorical transmission state to a growth state.

> *I15: "Firstly this would need a strong base such as a cookie base to provide a good foundation to build on. Then I would add a sponge cake to ensure good absorption. Ideally, I would avoid having any lumps of significant substance (preconceived incorrect ideas), like orange rind, that you have to pull out or work around to avoid breaking teeth. When mixing the cake, I would add some saffron (this is probably not possible in a real cake, but anyway) just add a bit of flavour and colour so that the cake has something interesting to contribute. I would avoid any icing as I would not want anything blocking the absorption of the sponge cake."*
>
> *I16: "Well the best, yeah the best metaphor I can come up with is the, that old saying which I'm sure you've heard of the, you know the kind of that, that kind of thing about education of, you know, I give you some food then I feed you for a day, I teach you how to get food then I set you up to look after yourself for the rest of your life kind of thing. So that kind of philosophy of don't hand people things, teach them how to look after themselves."*
>
> *I20: "If I was to use the garden, let's think about that. Does that fit in nicely because I always see it … it's creating the right environment? For some students you need a lot of shade and there are other ones that are happy to be out in the sun and it's all about achieving everything that they're capable of."*

Combining pedagogy and technology helps improve the quality and flexibility of learning (Anderson, 2005; MacKeogh & Fox, 2009). The relationship between pedagogy and technology is known to be complex and essential (Smth-Autard, 2003), and is better understood by those who think about the application of technology

(Koehler & Mishra, 2005). Interviewees 4, 7 and 14 reflected on the convergence of pedagogy and technology. Interviewee 4 reports being confused about the connection between pedagogy and technology, although, the final part of the quote suggests the interviewee is motivated by the potential of technology but has not yet been empowered by it. Interviewee 14's comments are very interesting, suggesting that technology will soon drive teachers' pedagogy, that is a monumental shift in traditional teaching thinking.

> *I4: "I don't understand how much overlap there is between education and technology. Because the technology is there, we used it, so on one hand I might underestimate the amount of overlap, on the other had I might also overestimate the overlap, when I consider the potential."*
>
> *I14: "Technology and pedagogy are closely intertwined and will continue to be until the end of time. Pedagogy will drive technicality and technology will drive pedagogy. Both are entwined though and not are dependent on each other. But perhaps pedagogy is not dependent and being led a lot more by technology. But the forcefulness and push of the pace of the advancement of technology is starting to weigh the favour for technology being a more dominant driving force pedagogically."*

According to Morley (2015) computing technology is integrated virtually everywhere in society including the home, work, school, university and on the go. With most devices (for example, televisions, smart phones etc) incorporating Internet capabilities. Some of the positive impacts on society include the instant availability of information (Tavani, 2016), improved communication, increased business growth, increased access to educational information and enhanced learning experiences (Vermatt, Sebok, Freund, Campbell, & Frydenberg, 2016). Negative impacts include computer crime and an increase in cyber related crime (Tavani, 2016). Some education disadvantages include high infrastructure costs and cyber bullying (Vermatt, et al., 2016). Interviewees 6 and 14 reflected on the convergence of technology and society. Findings support the literature with both interviewees' comments presented a positive belief regarding the benefits of computers to society. Interviewee 6 focuses on the benefits to communication and instant information availability while interviewee 14 mentions students being digital natives (see Chapter 2.4.2), and the need for educators to meet the societal technological expectations of their students.

> *I6: "It is just the most amazing influencer of society that I have ever seen. I do get excited, because I have goose bumps now. But it was amazing in [place] to watch people function, and I had an iPhone with me and I actually turned it on because*

> *people were so worried about us, and so from [place] where we were sort of trapped at one point I could actually text and phone people to let them know we were ok. And the text messages that came through on my phone, there were hundreds of them, and it was just like are you ok, what's happening, what's going on, blah blah blah. It's an amazing thing technology, and I get frustrated because people don't see it. They see the bad stuff; they hear about the bad stuff."*
>
> *I14: "Educators are being forced to adapt to changing social environments and the technological push. Students are rising up through the ranks being highly dependent on technically and also somewhat competent. Adolescents are used to a high dependence on social media and web technologies and expect education to follow suit. Educators must follow suit and embrace technology to aid, enhance and supplement their teaching practises."*

Students' lives are saturated with digital media (Thompson, 2013), and have been found to use technologies for a wide diversity of purposes both academically and privately (Corrin, 2010). Students adapt technologies to support their learning (Sánchez, Salinas, Contreras, & Meyer, 2011), and manage their work on the computer in sophisticated ways (Sánchez, et al., 2011). Prensky (2001) calls these students digital natives (see Chapter 2.4.2). Kennedy (2007) argues that universities need to change teaching practices to accommodate these students using students' personal technologies as learning technologies. Conversely a study by Margaryan, Littlejohn and Vojt (2011) found that students adapt to the teaching approach, conforming to traditional pedagogy and are not drivers of change in approaches to learning and technology use. In addition, Thompson (2013) found that the popular belief regarding the relationship between technology and learning was overstated by researchers. Interviewees 9, 12 and 14 reflected on the convergence between students and technology. Findings extend the literature, with interviewees mentioning the mutual dependent relationship between students and technology. Both interviewee 9 and 14 elude the psychological and physical nature of the interdependence between students and their technology. Interviewee 14 uses strong language, labelling students as cyborgs, and describing teachers as barely keeping pace.

> *I9: "I think there is a very blurred idea about, you look at their mobiles. If they're not with their ears on their mobiles, they feel lost. It worries me actually because you take the electricity away and their whole world comes tumbling down for most of them. It's like television. It's an extension of themselves."*
>
> *I14: "Technology is advancing at such a frightening rate and the youth are natives within this environment. Born purely as cyborgs entwined and dependent in technology to survive socially and attempting to fill the need of a constant technological appetite makes the emerging student foreign force to content with. But most educators are not from these generations and still have much of their teaching practises grounded within the conventional face-to-face and book style teaching.*

> *Such educators must be assimilated with technology and rush to catch-up and understand the system."*

7.5.4 Technology relationships

The *technology relationships* axial code describes various meaningful connections between IT academics and technology. The *technology relationships* axial code contains five properties: *emotional*^{2}, *mastery*^{2}, *physical*^{2}, *thinking and problem solving*^{2}, and *tool*^{2}.

Analysing this axial code provides an understanding of IT academics cognitive and psychological relationship with technology, this provides information on how IT academics think about technology and how they respond to technology. It also provides information on how IT academics ways of thinking about technology differs from to non-technical users. It provides an understanding of the physical relationship with technology, enabling better utilisation of technologies, and pushing the boundaries of technology use. It also provides insight into computers as enablers of problem solving, cognitive thinking, and generation of self-efficacious attitudes.

Emotional attachment to a technology has been shown to be an important predictor of intention to use that technology (You & Robert, 2017). Mobile devices have been found to engender an emotional and spontaneous reaction in people, which is different from their other technology devices (Meschtscherjakov, 2009; Turner & Turner, 2011; Vincent, 2005). Research by Vincent and Harper (2003) found people express emotional panic when separated from their mobile phone, and exhibit irrational behaviour in regards to their phone usage, for example, driving while texting. McReynolds (2010) suggests IS/IT professionals have a strong brand attachment for their technology choices. You and Robert (2017) suggest there is a need for further research to understand the link between emotional attachment toward a technology and its impacts on the performance of individuals or teams using that technology. Interviewees 6, 7, 9, 10, 12, 14 and 15 reflected on their emotional attachment to technology. Findings extend the literature. IT academics appear to be infatuated with all their technology beyond just mobile phones, as opposed to the general population (see Meschtscherjakov, 2009; Turner & Turner, 2011; Vincent, 2005). Interviewee 6 suggests a strong need for the social attachment afforded by technology. Interviewee 7 is excited by the usefulness of technology to support learning and teaching. Interviewees 10 and 15 show strong emotional connections, displaying irrational behaviour (see Vincent & Harper, 2003). Interviewee 12 indicates a love/hate relationship with technology.

> *I6: "Emotional connection, that's interesting. If you took away my technology I would struggle, because the other piece to the technology that's around today is social media, I am very involved in social media. I'm involved in Internet activism and politics. I'm involved with Facebook and Twitter and that's how I communicate with people. I do have a very strong emotional attachment. And if I don't have it, like I went up to the rainforest a couple of weeks ago and there was no technology, and I really struggled. I had a good time, but I really struggled."*
>
> *I7: "The technology of using the computers and PowerPoint and so forth, Excel, and Mini tab and SPSS, I find it's exciting to be able to do that. Just before you came in, [name] was in here and we did a Chi-squared goodness of fit test, and there was a little graph produced, I think she got a bit excited about it, I certainly did because it felt it was something that was useful, I mean it's just a simple bar graph."*
>
> *I10: "I play games. I have multiple consoles, no one is allowed to touch them."*
>
> *I12: "I am very comfortable with it, but also I sometimes hate it with a passion, because sometimes it doesn't work, and you know that is a little key, a little file on a little thing, if you just knew how to do it, a monkey could it. But you just, don't. And it drives me insane. Sometimes I'd like to get the computer and throw it out the window. But I love gamer, I'm a computer gamer. I like, I love computers."*
>
> *I15: "I get very upset if anything goes wrong with my computer and it doesn't work. No, I get withdrawn if I'm away from the computer; I find it hard. So, each year we often go camping. I've gone to the lengths of buying a device that I can plug into the car so that I can plug the computer in."*

Mastery is a comprehensive knowledge or skills in a particular subject or activity (Oxford University Press, 2018a). Australian academics must have a qualification one Australian Qualifications Framework (AQF) level higher than the course they are teaching (Australian Qualifications Framework Council, 2013). This could be considered a mastery level. Graduates at this level have expert specialised technical and research skills and knowledge (Australian Qualifications Framework Council, 2013). The typical base level qualification for an Australian academic is a doctoral qualification. Some universities in Australia will employ level A academics without a PhD, however there will be restrictions placed on what they are able to teach in line with the AQF. Little else is published in the literature regarding specific skills required for IT academics, however the Australian Computer Society's core body of knowledge for ICT professionals (CBOK), has detailed requirements of essential core knowledge areas for IT professionals, these include hardware and software fundamentals, data and information management, networking, technology building, and ICT management (Australian Computer Society, 2015). Little is reported in the literature regarding IT academics' technology skill levels in comparison to the general population. Interviewees 10, 12, 17, 22 and 25 reflected on IT academics' mastery skills in computing. An analysis of the affordances and constraints of ET (see Chapter 7.4.1 and 7.4.2) with regards to IT academics found no or little difference to those reported in the literature, however here there is a strong impression that IT academics have a different view of technology. This is very interesting. Analysis of the interview data suggests this difference might be considered a cognitive or psychological difference. Interviewee 10, 22 and 25 mention differences in the way academics think about technology, while interviewee 17 indicates it is about the mastery or expert knowledge IT academics have in commanding technology use.

> *I10: "I think as a rule IT educators may think about things more from the technology perspective and look at where it could be applied, whereas I guess less IT literate folk would come more from an educational or a problem perspective and look for guidance on what might help."*
>
> *I17: "I think it is because you have a better of understanding of how - I'll come back the infrastructure. How the infrastructure works - you're better able to force it to do what you want."*
>
> *I22: "I guess the difference with IT is they're more open to using IT, but I guess where the difference might be is how adventurous they're willing to be with their use of IT. I don't think there'd be an IT lecturer who wasn't willing to use a PowerPoint slide and a projector, or comfortable with doing that."*
>
> *I25: "Look, I think it gave me an overall orientation towards computing of "I can do this". If you think of a computing self-efficacy, studying computer science gave me a high computing self-efficacy. I believe I am able to get things done and learn new things with computers, and therefore I do."*

Physical means relating to the body as opposed to the mind (Oxford University Press, 2018b). There is limited understanding of physical relationships with technology reported in the literature, however there is research regarding wearable technologies. A wearable device is a technology that is worn on the human body (Techopedia Inc, 2018) providing a direct physical relationship. Although understanding in the literature of the impact of wearable technologies requires further investigation (Deng & Christodoulidou, 2015). Wallace (2012) reports ICT opens the possibility of new forms of relationships with technology, here Wallace (2012) is referring to the benefits to society's social relationships. Interviewees 6, 21, 23 and 25 reflected on their physical relationship to technology. Findings support Wallace's (2012) claim. Interviewees 23 and 25 refers to using technology as a communication enabler. Interviewee 25 further reflects on the dangers of too much technology. Interviewee 6's comments suggest an irrational need for a physical relationship with technology. As with emotional relationships IT academics appear to have an obsessive almost addictive relationship with technology.

> *I6: "In a physical level I have a very symbiotic relationship with technology. I use technology in every aspect of my life, and it's just sort of emerged that way I'm a bit of a geek."*
>
> *I12: "I play games lots. When my kids go to bed. From eight at night, from 8:30 when my kids go to bed until you know two in the morning or something like that."*
>
> *I23: "Quite connected. Obviously, I live on my computer, basically. I've got my smart phone that I use all the time. I'm quite up to date with software as well, so anything [university] has as well, the systems like Cloud [university], Echo Recordings, Blackboard Collaborate. It's all quite natural to me now."*
>
> *I25: "I found it really difficult to do this, that I've set my phone up so that I am only able to access work stuff, so work e-mail et cetera between 7:00 am and 7:00 pm, and only on weekdays. And only on days that I'm actually working, and outside of those I actually can't access it. So, I am aware that I'm very attached to it, and I've had to take steps to sort of stop it from taking over my life in certain ways in terms of the work stuff. And I guess the other thing is I'm a pretty big gamer as well."*

Computers solve problems in all areas of human life (Rus, 2016), this combination is essential in the modern age (Martin, 2017). Li (2016) suggests there is a need for a relationship between people and computers to enable thinking and problem solving. In education computers assist many students to learn more, better, and faster (Richard, Cobo, Fortuny, & Hohenwarter, 2009). Students use computers to access information, validate, organise, synthesise to solve problems and formulate new ideas (Gershner & Snider, 2001), and develop lateral thinking (Pickover, 2012). Computers have the capability to affect how people think, learn and understand (Hokanson & Hooper, 2000). Interviewees 15, 21 and 25 reflected on thinking and problem-solving using computers. IT academics appear to have a high level of self-efficacy when solving problems with computers. This appeal draws IT academics to the discipline.

> *I15: "I have a problem. I do tend to always look for solutions through technology to whatever an issue might be. So, when there's an issue, I'm going to solve that*

> *issue, I almost end up thinking, I could develop a program that does this or I could something like that."*
>
> *I21: "I love it. It's fun. People don't get that. How can programming be fun? Well, it's intellectually challenging, it's solving problems that other people can't do, it's taking something that I see or hear or watch."*
>
> *I22: "I want them to be thinking, so things that allow me to customise it or to work with it so that the kids are actually thinking, actively thinking about what they're doing and where they're learning. I don't want it to just be question/answer sort of stuff. When I'm stuck with that, I try to make it more interesting, but I really want them to be thinking about it and interactive and trying new things."*

Many people see computers as problem solving tools (Blakeman & Taylor, 2017; Rus, 2016). Hokanson and Hooper (2000) suggest seeing computers as tools limits our vision. Vallance and Towndrow (2016) argue that in modern educational technology can no longer been seen as tool but part of who we are. Interviewees 1, 9, and 25 reflected on computers as tools. Findings support Vallance and Towndrow's (2016) assertion, that computers are more than tools. Interviewee 1 reported seeing computers as being inspirational. Interviewee 9 suggested computers provide an opportunity to develop creative expression. Interviewee 25 indicated computers engender a sense of inherent belief in ones-self. IT academics who are techno-pedagogues have made a transition to a world where technology has invisible yet omnipresent qualities, engendering a strong sense of self-efficacy.

> *I1: "I think it's more than just a tool, I think it's an inspiration not just a tool. Because some of the things I do, I couldn't do I wouldn't do I wouldn't of thought of doing without the affordance of the technology."*
>
> *I9: "This technology is, yes, the technology, and I've said that before, it's just like a lawn mower, and just like a car, just like anything else, but it is a creative tool."*
>
> *I9: "The software with which to create webpages for instance. I use that as a tool, so to create the product and to teach about the product. But in my private life I use it for communication, I use it for my creative expression, and I'm beginning to use it for banking, that sort of, well I have been using it for banking, but reluctantly because I'm not all that switched on about the security of things. It is, yeah, I make a distinction between what I use it for in my work and what I use it for at home. But it is a multiple tool."*
>
> *I25: "And also I guess I bring the tool set of things I had from computing to bear on education quite a bit. So, some examples there, I published a paper on exam hacking, because I have a set of skills around computing and doing interesting stuff with systems that I can apply to assessment research, which is my current field. And another thing I'm working on now is I've got a script running grabbing lots of bibliometric data and indexing that against social media and whatever. So, it's a skill set that I keep up with. Yeah, so I don't know, I think they do affect each other, but I think it's more of a disposition and self-efficacy than any particular skill set with particular computing tools."*

7.5.5 The core category

The core category identified in this study was ***techno-pedagogical practice***. Dey (2008), Holton (2010) and Corbin and Strauss' (2008) criteria provided guidelines for the selection of the core category in this study. These criteria included, connectedness, frequency, logical and consistent, longer saturation timeline, implications for formal theory, and explanatory power (see Chapter 4.6.2.2). A brief discussion of each of these criteria follows.

- Connectedness: the core category (techno-pedagogical practice) emerged as the central theme with the other three categories (teaching practice, pedagogical development and technology adoption) connecting to it via a series of four relationships. These relationships vary in strength and purpose. Details, descriptions and examples of all relationships are provided (see Chapter 8.2.3.2).
- Frequency: the techno-pedagogical practice category was composed of four axial codes each containing 4 or more properties, with more than 100 quotes classified in total for this category.
- Logical and consistent: the techno-pedagogical practice category is sound, rational and well-reasoned. Data was collected, examined and analysed over an extended period. Analytical memos were written to ensure detailed logical and reasoned thoughts using a methodical and consistent approach (see Chapter 4.5.3).
- Longer saturation timeline: data was gathered and analysed over a six-year period (see Chapter 4.2). Phase one was conducted over one year, and phase two over a five-year period. During phase one an open sampling approach was adopted (see Chapter 4.5.1). During phase two a theoretical sampling approach was adopted narrowing the search for potential interviewees (see Chapter 4.6.1). The theoretical sampling focussed data collection on *great IT technology using teachers*. Phase two took longer and it took until interviewee 19 to first reach theoretical saturation (see Chapter 4.6.4).
- Implications: from this research the substantive theory (see Chapter 3.5.4.10) of techno-pedagogical practice emerged. The substantive theory applies within the context of great IT technology using teachers. To be considered as a formal theory

this substantive theory would need to be applied in disciplines outside IT. This will be considered in future work (see Chapter 9.4).

- Explanatory power: analysis of the categories resulted in the development of 18 recommendations, with four of these relating specifically to the core category (techno-pedagogical practice). Analysis of the data resulted in the emergence of a model and theory of techno-pedagogical practice. For the purpose and application of the theory (see Chapter 8.2.4).

7.5.6 Conclusions and recommendations

The ***techno-pedagogical practice*** category and axial codes represent changes in teaching and learning thinking and practice resulting from technology adoption. The axial codes include; *learning environment*, *learning strategies*, *technology convergence* and *technology relationships*. Conclusions and recommendations offered are based on the analysis of combined phase one and two data.

Learning environment:

There are many benefits in immersive learning environments. Key aspects reported in the literature include; motivation, contextualisation, collaboration, communication and social interaction, higher order thinking skills and student empowerment. Key constraints include; technical issues, kinaesthetic limitations, and misrepresentation. Findings reported suggest IT academics use immersive learning environments as a communication tool and to provide a safe practice environment. One constraint observed was the existence of horseless carriage thinking. Key benefits of interactive software include; increased motivation, activity and communication. Key constraints include; heavy cognitive load, skills required to teach. Findings support the literature that interactive software engages students and helps to improve communication. In addition, it allows the educator to focus on how the student will learn best. Key advantages of eLearning resources include; student focussed, flexible, and ubiquitous. Key limitations include; impersonal, high workload and skills required by academics, and students need to be self-motivated. In addition, IT academics reported the benefit of diverse resources for students, but had difficulty reading students’ body language, communication challenges, and issues with students reaching the same level of critical analysis. Key benefits with simulation environments include effective, collaborative, safe, and improve student confidence and memory. Key constraints include, high costs and specialist skills required. IT academics reported using simulation for testing and as a safe environment to practice skills. Key benefits of student-centred learning include; it develops critical thinking and problem-solving skills and accommodates individuals. Key limitations include; students require a base knowledge, and is often team based. IT academics reported strong feelings of the importance of student centeredness and use technology to achieve it.

Recommendation 15: IT academics should be encouraged to utilise immersive environments as a way of improving student's motivation, collaboration and as a way of utilising practice and drill type skills. IT academics should be encouraged to explore and experiment with immersive environments and move toward new ways of delivery. IT academics should be encouraged to use interactive software to increase student motivation and improve communication and focus on how students learn best. IT academics should be encouraged to adopt the diverse learning and teaching opportunities afforded by eLearning environments, and utilise video options where appropriate. Simulation environments can be used to practice and repeat skills in a safe and interesting way for students. IT academics should continue their focus on students using technology as a lens.

Learning strategies:

Applied learning bridges the gap between university and the workplace. Students can utilise and extend their skills. A key limitation is that it requires significant resources to administer. IT academics reported using applied examples to improve context in learning and teaching. Key benefits of flipping the classroom include development of enhanced critical and analytical thinking skills, and self-reliance in students. Key limitations include; time consuming preparation for teachers, and pre-reading required by students. IT academics reported using a flipped approach, in addition to engaging with educational literature on the topic. Key benefits of gamification include; improved student loyalty, and increased motivation and engagement. Care needs to be taken when applying individual aspects of gamification. IT academics reported using gamification to teach programming logic and concepts. PBL is said to improve student motivation, retention of concepts and higher order thinking skills. Conversely PBL takes significant effort and specialised training. IT academics reported using PBLs to benefit cohorts of students who reported competing responsibilities requiring flexibility. Social media learning provides enhanced learning opportunities, and improved communication. However, it does require close monitoring, and the digital divide can mean it is not available to all students. IT academics reported utilising social media learning to improve communication, while also improving sharing and collaboration of resources with other educators.

Recommendation 16: IT academics should consider using applied learning techniques to improve learning context for students. A gamification approach can be used to increase student engagement and motivation however, caution is advised when applying competitive elements. Social media learning can be used to improve communication and collaboration skills.

Technology convergence:

Paperless learning is on the increase. Students are reported to be more motivated and prefer paperless learning. Limitations include eye strain, technical issues, and time consuming. IT academics reported using paperless assignments and advocated for paperless workplaces. Technology facilitates a change in student learning; however, its implementation requires effort. IT academics use technology for assessment and feedback. IT academics appear to prioritise the use of technology differently to that suggested in the literature (see Means, 2010), placing more emphasis on its selection and application. IT academics reported students and their engagement as key aspects in their relationship with technology. Also, course materials, communication and tools. Some IT academics see a difference between online and face-to-face technology use, and practice and theory. Metaphors help develop understanding, structure thoughts and can provide insight into learning and teaching. Findings extend the literature. IT academics’ metaphors illustrate themes of growth and development, suggesting technology ameliorates positive change. The relationship between technology and pedagogy is complex. Its combination is reported to improve flexibility. IT academics reported a lack of understanding about the complex relationship between pedagogy and technology, with comments suggesting IT academics believe it has potential for transformational teaching thinking. Technology is integrated is almost every aspect of society. Key impacts include; availability of information, communication, growth and improved learning experiences. Negative aspects of technology integration in society include; high infrastructure costs, and cybercrime. IT academics report the benefit of improved communication and the need for educators to meet student societal expectations. Students use technology to support their learning, some use the term digital natives to describe technologically able students. Conversely the relationship between students and technology has been found to be overstated. IT academics believe students have a psychological and physical interdependence with technology.

Recommendation 17: IT academics should be encouraged to utilise technology to enable paperless learning. In focussing on technology integration IT academics should consider students, engagement, learning materials, communication and tools as key aspects of the relationship. IT academics could benefit from a deeper awareness of the nature of this relationship, likely to improve the quality and flexibility of student learning (see Anderson, 2005). IT academics should focus on the power of technology for growth and development in improving student learning experiences and acknowledge students' psychological and physical interdependence with technology.

Technology relationships:

Research suggests people express emotional panic and irrational behaviour when separated from their mobile phones as opposed to other technology devices. There is a need for further research to better understand this phenomenon. Findings extend the literature while IS/IT professionals are said to be savvy around their technology brand attachment. IT academics reported an infatuation to all technology beyond just their mobile phone. In Australia academics require a mastery or expert knowledge in their discipline area to be employed. Having mastery level IT skills, IT academics report a different view of technology. Findings suggest IT academics demonstrate cognitive or psychological differences in their thinking about technology. Little research is reported on physical relationships with technology, although there is specific research on wearable devices. As with emotional relationships with technology IT academics appear to have an obsessive addictive physical relationship with technology. Technology aids thinking and problem solving in students. IT academics reported a high level of self-efficacy when solving problems with computers. Some see computers as tools however, research suggests in modern education computers are much more than a tool. IT academics reported seeing them as being an enabler of inspiration, creativity and developing ones self-believe.

Recommendation 18: To function at an expert level, problem solve and develop a sense of self-efficacy IT academics require significant and persistent access and engagement with a range of technologies.

7.6 Summary and conclusion

This chapter presented a descriptive analysis of the four categories, their associated axial codes and properties. The dialogue focussed on the purpose and rationale for each code, a comparison of ideas with the literature, and an analysis of the interview data. Conclusions and recommendations were offered for each category.

Findings of the pedagogical development category suggest that if IT academics can be encouraged to develop their pedagogical philosophy using a range of strategies, such as developing their own educational software, reading educational literature, expanding knowledge and application of educational language, and focussing on continuing to improve their values, the quality of learning and teaching is likely to improve. At the same time limiting the impact of constraining factors and continuing to develop their understanding of their students' needs so IT academics can better meet their needs.

Findings of the teaching practice category suggest that by modifying assessment approaches, IT academics can better assess progression and improve the work readiness of students. In addition, teaching a diverse range of sub-discipline areas, and developing a deep association with chosen specialities will help improve teacher skills, knowledge and motivation. The development of progressive collegial teaching and learning policies will help improve the academic and emotional environment. While trailing innovative teaching and learning approaches and developing quality learning materials and will likely improve teaching and learning standards.

Findings of the technology adoption category suggest utilising technology to reduce teacher cognitive load, sparking interest and promoting self-efficacy amongst IT academics will likely improve interest and motivation amongst IT academics. Also, encouraging the use of high-end features of technologies is likely to support student engagement. Limiting constraints such as costly large downloads, is important to students. Also, the fostering of self-efficacy when using are range of ET amongst IT academics, will aid production of reusable, repeatable quality learning resources likely to improve learning outcomes for students.

Findings of the techno-pedagogical practice category suggest that the use of technology enhanced learning environments such as immersive, simulations etc can increase engagement, support struggling students, and aid learning experiences. Using a range of technology supported learning strategies such as applied, flipped, and PBL can improve student motivation, communication and collaboration. Better understanding the relationship between technology and other converging factors such as the environment, pedagogy and students etc is likely to improve problem solving strategies, creativity and self-efficacy in students.

The next chapter contains contributions to new knowledge in the form an expanded definition of techno-pedagogy, a definition of techno-pedagogue, the profile of a techno-pedagogue, accompanying model and categorisation tool. Identification of elements which might contribute towards an IT signature pedagogy, and a description of the substantive theory of techno-pedagogical practice and accompanying model.

8 Models of Techno-Pedagogical Practice

8.1 Introduction

The previous chapter provided a detailed analysis of the coding structure produced in Chapter 6. The discussion composed an analysis of the relevance, importance and impact of codes with existing knowledge presented in the literature. Also a detailed analysis of each code and accompanying quotes. The aim of this chapter is to present models and details of theory which support and extend our knowledge of the phenomenon of techno-pedagogy.

This chapter commences with an outline of the components of the substantive theory of techno-pedagogical practice. The theory components are then explained in separate sections. A discussion and an expanded definition of techno-pedagogy is provided. This is followed by a definition of a techno-pedagogue and an accompanying profile, and the theory of techno-pedagogical practice and accompanying model. The final section of the chapter provides a description of elements which may contribute towards an IT discipline signature.

8.2 The substantive theory of techno-pedagogical practice

A key outcome of this research project is the substantive theory of techno-pedagogical practice. The theory is composed of the following components:

- a discussion and expanded definition of the phenomenon of techno-pedagogy;
- a definition and model profiling techno-pedagogues;
- a questionnaire used to determine a teacher’s strengths in each category in order to ascertain the existence of techno-pedagogy; and
- a model and description of techno-pedagogical practice.

The substantive theory of techno-pedagogical practice states that:

> An IT academic must be working in all three identified categories (teaching practice, pedagogical development, and technology adoption) to be classified as a techno-pedagogue who is demonstrating techno-pedagogical practice.

Elements which may contribute towards an IT discipline signature emerged during data analysis. It is not offered as a formal part of the substantive theory. However, it is an outcome of this research.

8.2.1 Expanded definition of techno-pedagogy

This research commenced with a definition of techno-pedagogy presented in the literature (see Chapter 2.4.4). *Techno-pedagogy* is the "various models of teaching and learning associated with instructional technologies" (Newson, 1999, p. 56). As a result of this research, Newson's definition can be updated and extended to reflect advances in thinking and understanding of IT academic's techno-pedagogical practices. This includes an emphasis on the impact of pedagogy and quality learning and teaching, a shift from instructor driven to student-centred thinking, and an expanded view of the practice of teaching.

Newson's original definition inferred the pedagogy aspect of the term techno-pedagogy. A study of IT academics' pedagogies suggests it is a much deeper relationship. IT academics place a strong emphasis on developing the underpinning philosophy of their teaching. The outcomes of this research suggest pedagogy is influenced by many factors. Mentors and teachers, industry experiences, research, society and family influences encourage reflective practice in IT academics. Other influences include a preference for creative pursuits, and practical and logical thinking skills. The quest to build and expand educational language, which helps to develop understanding and communication. Values such as approachability, caring, communication, honesty and passion, influence the way IT academics perform as teachers. Values also influence their decisions, actions and behaviour. Traditional notions of pedagogy typically associate it with quality teaching and learning (see Chapter 2.2.1). IT academics place an emphasis on their understanding of their students including aspects of attendance, engagement and motivation, learning approach and learning pivotal moments. This understanding helps teachers meet the diverse and individual learning needs of their students. There are some aspects which limit pedagogy which should be noted, these are constraining factors. Some of these include the perception of a generation gap, a lack of applied knowledge and a lack of self-confidence. These constraints can limit teachers' creativity and diminish the quality of the learning and teaching.

Newson's original definition included the term *instructional technologies*. This term is associated with a teacher-focussed approach. Researching IT academics' pedagogies suggests technology can help to support a student-centred approach (see Chapter 7.5.1), this is also supported in the literature (see Gibson, 2001). An updated term replacing instructional technologies is *educational technology*. The term ET takes into account the applied nature of technology, it also encompasses the notion of systems which suggests the involvement of people (Luppicini, 2005). The applied nature of technology is reported by IT academics (see Chapter 7.5.2). Students play an important role in the development of an IT academics' pedagogy (see Chapter 7.2.6).

Newson's definition refers to *models of teaching and learning*. Models of teaching is a term associated with instructional design. Instructional design is commonly defined as "a systematic procedure in which educational and training programs are developed and composed aiming at a substantial improvement in learning" (Reiser & Dempsey, 2017). This research shows that IT academics place importance on improving the practice of their teaching aimed at improving students' learning. This practice is influenced by many factors. Assessment is an important consideration. Assessment is a key aspect of students' learning as it is a measure of understanding and can help to motivate students. The teaching environment is extremely important and has a big impact on students and teachers. The emotional environment is a very important part of creating positive learning and teaching experiences for students and teachers. IT academics' teaching improves through a long and deep association with their speciality area. Teachers and the teaching approach matters more than any other factor in student academic achievement (Hattie, 2003).

Offered is an expanded, updated definition of the term *techno-pedagogy*. This definition reflects a deeper reference to pedagogical thinking. The replacement of instructional technology with ET, places an emphasis on the practice of teaching, and has the student at the centre of the learning.

> Techno-pedagogy is the practice of great teaching and learning enhanced through the integration of educational technologies focussed on improving student learning experiences and outcomes.

8.2.2 Profile of a techno-pedagogue

Experts define *pedagogue* as a synonym for teacher. Historically pedagogues were thought to be pedantic (thefreedictionary.com), strict, formal and old-fashioned (vocabulary.com) while, contemporary notions of pedagogues focus on how students learn, how the teaching is conducted, and how the content is delivered. ET is about the use of technology to facilitate learning and improve teaching. There are limited references in the literature discussing the term techno-pedagogue. Balakrisnan (2015) wrote a compelling blog discussing the notion of a techno-pedagogue. Although this is not peer reviewed literature, the author focusses on the importance of technology as an enabler of student learning. Findings of this research suggest that techno-pedagogues focus on the student through the development of philosophy and practice of their teaching, and ET adoption.

Given the absence in the literature of a formal definition of the term *techno-pedagogue*, a definition is offered.

> A techno-pedagogue is a teacher whose teaching and learning practices are enhanced through the integration of educational technologies focussed on improving student learning experiences and outcomes.

A model representing the techno-pedagogue is presented in Figure 8–1. This model includes the outcomes of this research which suggest techno-pedagogues focus on the thinking behind their teaching, the practice of their teaching, technology adoption and techno-pedagogical practices. All three underpinning aspects (teaching practice, pedagogical development and technology adoption) must be present for techno-pedagogical practices to be present.

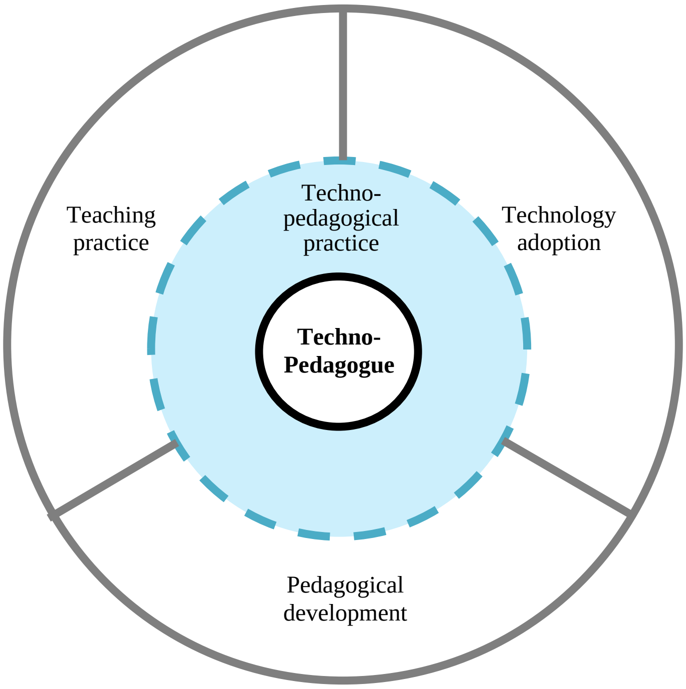


Figure 8-1 Profile of techno-pedagogue

See Chapter 6.2 for a description of each category. A questionnaire is available in Appendix F. Academics can use this questionnaire to determine their strengths in each category, and to ascertain their propensity to work as a techno-pedagogue. This profile can be used as a standalone tool or in conjunction with the model of techno-pedagogical practice (see Chapter 8.2.3).

The following statements represent factors which relate to each category.

The ***pedagogical development*** category represents individuals who are more likely to:

- prefer a creative environment, where they can pursue practical and logical thinking skills;
- feel a sense of achievement when learning difficult concepts;
- have confidence when teaching courses and content they are familiar with;
- engage with their family and the wider community, and these relationships contribute to their reflective thinking about their teaching;

- have a sense of credibility due to previous work experience in industry or use industry-based examples to illustrate key concepts;
- introduce students to industry inspired problem-solving approaches and industry standards e.g. programming standards;
- have strong relationships with peers and collaborate with other educators;
- read educational based literature;
- conduct education-based research;
- attend teaching based professional development activities e.g. conferences, training courses;
- participate in sport or culture groups and engage with the media e.g. social media;
- use learning and teaching language not just discipline-specific language;
- believe students can be educated to remove or limit the impact of the generation gap when taught by younger academics;
- provide an atmosphere of normality, appearing more approachable to students facilitating improved learning outcomes;
- care about students' learning, their careers and success in life;
- is a good communicator, communicating with students at different levels in different ways;
- display honesty, admitting when they don't know, and are prepared to find out;
- use humour carefully and respectfully to create a relaxed learning and teaching environment;
- exhibit great teaching attributes such as approachable, caring, a good communicator, entertaining, honesty and passionate;
- maintain a traditional view of a need for student attendance and its relationship to student learning;
- apply constructivist learning theory (views knowledge as being shaped by experiences, and as new experiences are encountered, these are related to previous knowledge and understanding) to enhance student learning;
- identify key or pivotal teaching moments to direct and improve student learning.

The ***teaching practice*** category describes individuals who are more likely to:

- prefer formative assessment as a means of identifying student progress;

- prefer open book examinations as this approach facilitates student professional career readiness;
- prefer a timely approach to feedback and marking in order to improve student learning and engagement;
- see feedback and making as a means of determining students' current skill capacity;
- use in class testing to encourage student attendance;
- enjoy teaching a diverse range of major and speciality areas;
- enjoy teaching courses which require deep level of content knowledge in specific learning contexts;
- feel constrained in their teaching approach by imposed university policy and procedures;
- desire a collaborative collective culture which is more likely to inspire student learning;
- use laboratory tasks to build upon existing skills and develop resilience and independence in students;
- believe lectures are effective in transmitting information to students, but can be ineffective in developing high order thinking skills;
- use tutorials to complement lectures and provide a superior learning environment when well facilitated;
- provide challenging tutorial tasks which promote problem solving, and focus on teamwork and cooperative learning;
- use competition and rewards for menial or repetitive tasks;
- require strong content knowledge and emotional confidence for the courses they teach;
- use chunking (breaking down of a collection of elements which are strongly connected) to teach connected ideas and complex ideas;
- use the technique of concept learning (learn by example), as a simple form of student feedback, e.g. release solutions for simple tasks; and
- use storytelling to motivate and engage students.

The ***technology adoption*** category describes individuals who are more likely to:

- facilitate communication with students using technology;

- use technology to make social connections with others;
- be inspired by the potential of technology;
- aid student learning through the creation of reusable, duplicatable resources;
- facilitate understanding of complicated concepts by breaking them into animated steps;
- provide pervasive learning resources for students;
- avoid or limit the use of external resources which are large and costly downloads for students;
- are self-reliant, independent users and creators of technologically based educational resources;
- use high-end features of software;
- display a strong passion for games and playing games;
- use LMS' for teaching, administration, communication and to conduct learning analytics';
- use the Internet as a resource and teaching research tool; and
- be known technological experts who require access and support for a range of specialised, new and emerging software applications including the required hardware.

The ***techno-pedagogical practice*** category describes individuals who are more likely to:

- engage with technology enhanced learning environments;
- engage with technology enhanced learning strategies;
- engage with technology enhanced ways of teaching;
- engage with new and emerging technologies;
- own and interact with lots of technology within and beyond the classroom;
- use paperless learning;
- have consideration for the environment;
- see technology as aiding thinking and problem solving in students;
- have a strong dependency on technology (bordering on addictive for some); and
- develop ET (software) for teaching and learning purposes.

8.2.3 Model of techno-pedagogical practice (TPP)

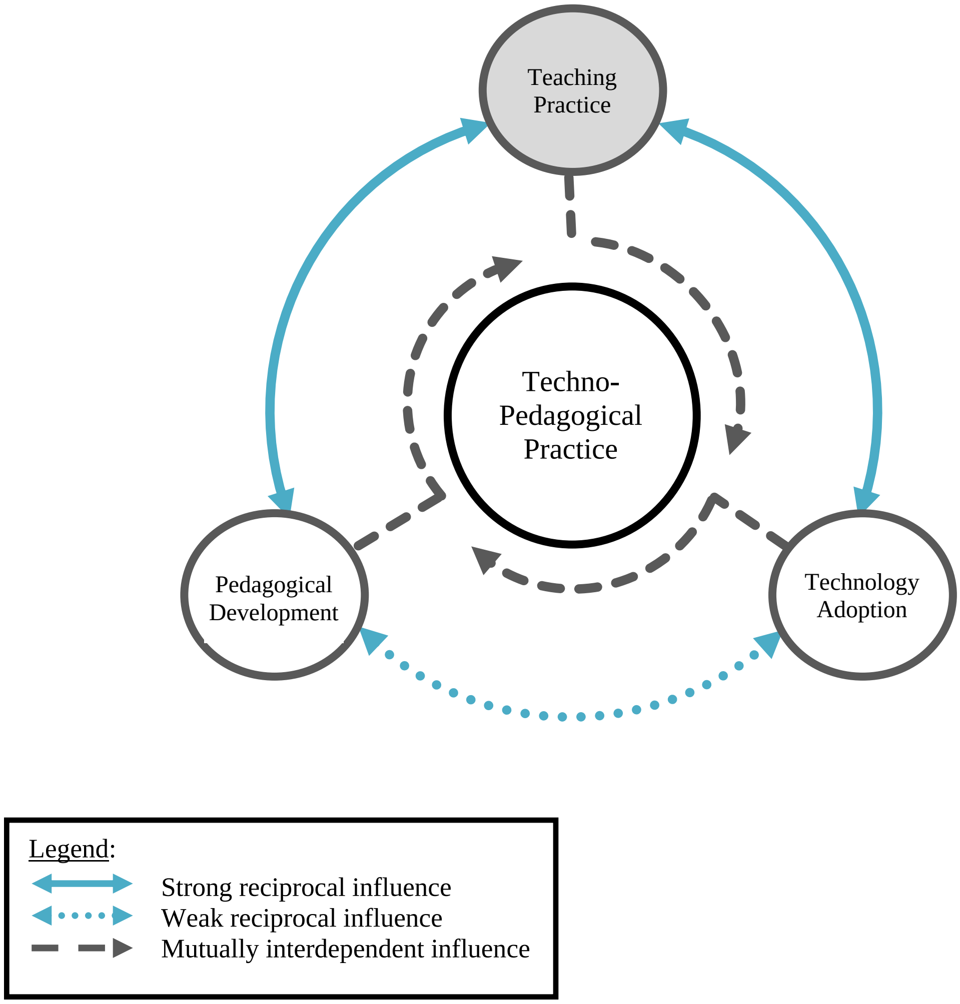


Figure 8-2 Phase 2 – Model of techno-pedagogical practice

8.2.3.1 Description of the model

The above model illustrates the phenomenon of techno-pedagogy. Techno-pedagogues are educators who work within the three categories: ***teaching practice***, ***pedagogical development***, and ***technology adoption***. These are represented in Figure 8-2 by the smaller rings. These categories are mutually interdependent upon each other (that is they benefit from each other). ***Teaching practice***, ***pedagogical development***, ***technology adoption*** must all be present for the core category ***techno-pedagogical practice*** to exist. The core category is presented as a larger ring and is held in place by the underpinning categories via relationships (or connections), these are denoted by the dashed **dark grey** lines. The grey shaded ring encompassing the teaching practice category indicates this category is common to all educators within this study and is persistent within the model. The solid **aqua blue** lines represent relationships between the underpinning categories. These are all two-way relationships, which suggest that each influence the other. The weaker relationship is represented with a dotted **aqua blue** line.

Teaching practice illustrates the “**how**” aspect of teaching. IT academics working in this space reflect on the way, or manner in which they teach. They ask the question: “**How will I teach that?**” This category is typically about the practical skills, techniques and knowledge required to teach. It includes the IT academic’s favoured approach to assessment, marking and feedback, the IT academic’s discipline expertise, imposed university policies, processes and practice, the IT academic’s approach to class structure and delivery, student motivation, rewards and incentives, and knowledge of subject content.

Pedagogical development illustrates teachers who are thinking about the “**why**” aspect of teaching. It is typically about the thinking and philosophy that influences their approach. They ask the question: “**Why do I teach the way I do?**” This category describes the IT academics underpinning philosophy of teaching. This includes factors, thoughts and experiences that influence the thinking behind the practice. It includes the agency of technology-based discipline preferences, and the impact of people such as family, industry, mentors etc. It also includes the teacher’s discourse and innate use of language, constraining factors (for example, a lack of industry experience, generation gap and a lack of self-confidence), perceived attributes of quality teaching and an understanding of students’ needs.

Technology adoption represents the “**what**” aspect of using technology. IT academics working in this space are typically thinking about what technology to adopt. They ask the question: “**What technology will I use?**” This category describes the types of technologies used to facilitate student learning, teaching preparation, research and administration. It includes the affordances (advantages) and constraints (disadvantages) of these technologies and rationalisation of their acceptance or rejection. Also details of the IT academic’s technology miscellany, and anecdotes describing technology use.

The techno-pedagogical practice category (core category) represents the combination of **how**, **why** and **what** aspects of teaching. IT academics working in this space are typically thinking about: **How will I teach that**? **Why do I teach the way I do**? and **What technology will I use?** This category describes the embodiment of IT academic's philosophy and teaching practice resulting from technology adoption, facilitated through the merging of technology and pedagogy. This includes flexible digitally enhanced learning environments and contemporary learning approaches. As well as the convergence of technology with the environment, learning and teaching, pedagogy, society and students teaching promoting student-centred learning practices.

If an educator works in the space of any two of the underpinning categories, the category and relationships of the remaining category will no longer exist. The core category will only be present while all three categories are present. Some IT academics may work between two of the underpinning categories, but without all three the academic is not working as a techno-pedagogue. This model can be used as a standalone tool or in conjunction with the profile of a techno-pedagogue (see Chapter 8.2.2).

8.2.3.2 Relationships between categories

Relationships represent links or connections between the categories (see Chapter 3.5.4.7). Possible combinations of relationships between any of the underpinning categories are illustrated in Table 8–1.

Table 8-1 Relationships between categories

Relationship	PD	TP	TA	TPP	Strength
1	•	•			Strong reciprocal
2		•	•		Strong reciprocal
3	•		•		Weak reciprocal
4	•	•	•	•	Mutually interdependent

The strength of the relationships between categories vary. A strong reciprocal relationship suggests a powerful, prevalent reliance between the categories. A weaker reciprocal relationship, while still being reliant is more fragile and less prevalent. The mutually interdependent relationships only exist while all other relationships are present, with each benefiting from each other.

The paradigm model (refer to Table 6–23) provides a mechanism for better understanding the nature of the relationships. The paradigm model is a component of Strauss' axial coding that presents the categories in a contextual format as opposed to the previous hierarchical coding structure. Relationships between the themes are illustrated and explained in the following sections.

Teaching Practice and Pedagogical Development

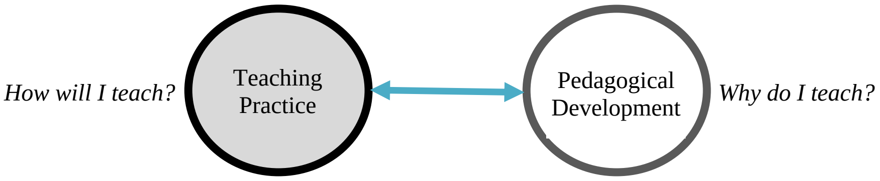


Figure 8-3 Phase 2 – Relationship 1 – TP and PD

Teaching practice and pedagogical development share a strong reciprocal influence. Both categories work together to achieve a shared purpose of improving learning and teaching. The relationship is represented by a double-headed arrow because it is a two-way relationship. Teaching practice can drive changes in pedagogical development and pedagogical development can drive changes in teaching practice.

From the paradigm model (see Chapter 6.4) any change in pedagogical development can drive a transformation in the teacher's underpinning philosophy of teaching. The consequences of any changes to pedagogical development may result in positive feelings regarding what constitutes quality teaching. These feelings can occur when specific teaching approaches unique to IT academics are formulated and utilised (IT discipline signature), when IT academics are guided in their approach by others, through understanding and using educational and technical language, focussing on quality teaching attributes and developing relationships with students. Negative feelings toward students' attitudes to learning can occur through obstacles and fears which can limit thinking.

Teaching Practice → Pedagogical Development

When a teacher focusses on their teaching practice they are driven by the **how** aspect of their teaching. There are many instances when this can occur, for example, a change in university policy, mandated software and hardware, or high failure rates. In these situations, and others like them, teachers driven by their practice will initially focus on how they will carry out the task or function, then they will think about why they might follow that approach.

For example, an IT academic was asked to explain their process for teaching a class (see Interviewee 2). In the first part of the quote (shaded text), the teacher mentioned preparing lab sheets with detailed instruction and then assists students with their queries as required. This is an indication of **how** the teacher teaches, and is an example from the *teaching practice*, *teaching approach*, *classes* category. In the second part of the quote (underlined text), the teacher mentioned their approach was to allow students to work independently at their own speed, and to encourage work beyond the lab time. This is an indication of **why** the teacher teaches the way they do, and is an example from *pedagogical development*, *understanding of students*, *learning approach* category.

> *I2: "Labs, my tendency has been to give very detailed written instructions and then to a large extent, leave the students to their own devices, circulate round the room, answer questions as they arise sort of thing. In particular the lab exercises are quite often larger than they can finish in the lab time, particularly when they have only one-hour labs. So, I am not trying to keep everyone in lock step, going through things at the same time, if someone needs longer to carry out a particular exercise then they can do it at their own speed."*

← how

← why

Pedagogical Development → Teaching Practice

The reverse is also true. Pedagogical development can drive changes in teaching practice. When a teacher focusses on their pedagogy they are driven by the **why** aspect of their teaching. There are many instances when this can occur, for example, when contemplating student motivation and engagement, when reading education-based literature, or when reflecting on the influence of peers and mentors. In these situations, and others like them, teachers driven by their pedagogy will initially reflect on why they need to do something, or why they will take an approach, then they will think about how they will go about carrying it out.

For example, an IT academic was asked to explain their approach to assessment (see Interviewee 1). In the first part of the quote (underlined text), the teacher mentioned they believe students will only complete learning tasks that have marks associated with them. This is an indication of **why** the teacher teaches the way they do, and is an example from the *pedagogical development, understanding of students, engagement and motivation* category. In the second part of the quote (shaded text) the teacher mentioned they introduced an assignment to be submitted for assessment every two weeks. This is an indication of **how** the teacher teaches, and is an example from the *teaching practice, assessment considerations, assignments* category. This example is an illustration of pedagogy driving teaching practice.

> *I1: "Well I think particularly at tertiary level that assessment drives the learning. If it's not assessed, they don't do it. I introduced a portfolio assignment which involved every two weeks working individually on two or three questions from the text. Then swapping them around so they did a peer review of other peoples' work.".*
>
> ← why
> ← how

Teaching Practice and Technology Adoption

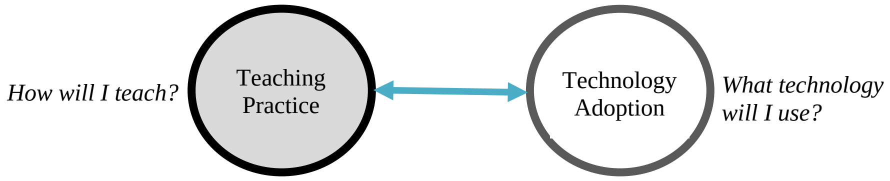


Figure 8-4 Phase 2 – Relationship 2 – TP and TA

Teaching practice and technology adoption share a strong reciprocal influence. Both categories work together to achieve a shared purpose of improving learning and teaching. The relationship is represented by a double-headed arrow because it is a two-way relationship. Teaching practice can drive changes in technology adoption and technology adoption can drive changes in teaching practice.

From the paradigm model (see Chapter 6.4) any change in teaching practice can drive a transformation in the teacher's practical teaching strategies and approaches. The consequences of any changes to teaching practice may result in positive feelings regarding assessment approaches, acquisition of technical knowledge and trialling of instructional teaching approaches. These feelings can occur when assessment strategies are tested, expert technical knowledge is developed, and various teaching methods are investigated. Negative feelings toward teaching experiences are restricted through imposed policy and process.

Teaching Practice → Technology Adoption

Teachers driven by their practice will initially focus on **how** they will utilise a given technology, then they will think about **what** technology they might use.

For example, a teacher was asked to explain qualities of good teaching (see Interviewee 8). In the first part of the quote (shaded text), the teacher noted the importance of providing prompt feedback to students. This is an indication of **how** the teacher teaches, and is an example from the *teaching practice, assessment considerations, feedback and marking* category. In the second part of the quote (**bolded text**) the teacher describes the software they used to provide that feedback (PDF writer). This is an example of **what** technology the teacher utilised, and is an example from the *technology adoption, repertoire, software* category. This example is an illustration of teaching practice driving technology adoption.

> *I8: "Giving students prompt feedback, is very important, last semester what I did was in [course], I marked the* ***assignments and I used PDF writer, when I was marking I put all the comments, and I added some audio comments as well****. The students liked that. Some of the students think that I was a hard marker, they were happy that I did give them good feedback. Feedback is an important part, for their learning progress. So, we need to give feedback, so engaging students"* ← how ← what

Technology Adoption → Teaching Practice

The reverse is true also. Technology adoption can drive changes in teaching practice. When a teacher focusses on technology they will think about **what** technology to adopt, and then they will think about **how** to use that technology. There are many instances when this can occur, for example, when a teacher is driven to utilise high end features of educational software, or when a new piece of software or hardware is released a teacher may be keen to incorporate the new technology into their teaching practice.

For example, an IT academic was asked to explain their approach to technology integration (see Interviewee 7). In the first part of the quote (**bolded text**), the teacher mentions they like to use the animations feature of PowerPoint. This is an indication of **what** technology the teacher utilised, and is an example from the *technology adoption*, *repertoire*, *software* category. In the second part of the quote (shaded text), the teacher described using this approach to teach concepts in a step by step fashion (chunking). This is an indication of **how** the teacher teaches, and is an example from the *teaching practice*, *teaching approach*, *delivery* category. This example is an illustration of technology adoption driving teaching practice.

> *I7: "**I use PowerPoint. I use animations a lot to bring in information.** So, a slide will start out simple with some words and then I'll bring in a diagram and I'll add to the diagram quite a lot, so things get built on top of each other quite a lot within the particular slides."*

← what

← how

Pedagogical Development and Technology Adoption

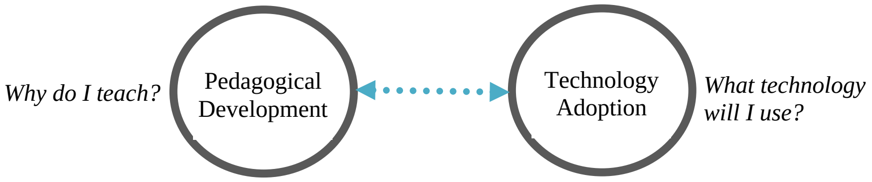


Figure 8-5 Phase 2 – Relationship 3 – PD and TA

Pedagogical development and technology adoption share a weaker reciprocal influence. This relationship was less prevalent in IT academics' thinking and responses when discussing technology integration. Both categories work together to achieve a shared purpose of using ET to improve learning and teaching. The relationship is represented by a double-headed arrow because it is a two-way relationship. Teaching practice can drive changes in technology adoption and technology adoption can drive changes in teaching practice.

From the paradigm model (see Chapter 6.4) any change in technology adoption can drive a transformation in the teacher's integration of new and emerging technologies to facilitate learning and teaching. The consequences of any changes to technology adoption may result in positive and negative feelings when considering the affordances and constraints of ET. These feelings can occur when affordances or constraints are emphasised, when the range and application of ETs is considered, and skills required are acknowledged.

Pedagogical Development → Technology Adoption

Teachers driven by their pedagogy will initially focus on **why** they might use a given technology then they will think about **what** technology they might use.

For example, an IT academic was asked to explain influences on their teaching (see Interviewee 18). In the first part of the quote (underlined text), the teacher talked about the influence of another teacher. This is an indication of **why** the teacher teaches the way they do, and is an example from *pedagogical development, influence of others, mentors and teachers'* category. In the second part of the quote (**bolded text**), the teacher describes using online quizzes as a learning tool for both students and the teachers. This is an example of **what** technology can be used to facilitate student learning and is an example from *technology adoption, repertoire* and *software* category. This example illustrates the pedagogy driving technology adoption.

> *I18: I heard, for example, [name] started using them. So, I thought, **I'll try out*** ← why
> ***online quizzes using Moodle**." After I started it I saw the value of it. It's actually a* ← what
> *learning tool both ways, for the students and for me. Yeah. And to make sure that*
> *the question is not trivial.*

Technology Adoption → Pedagogical Development

The reverse is true also. Technology adoption can drive changes in pedagogy. When a teacher focusses on technology they will think about **what** technology to adopt, then they will think about **why** to use that technology. There are instances when this can occur, for example, when a teacher is trying to meet the diverse needs of their students (on-campus students, and online students).

For example, an IT academic was asked to explain their approach to technology integration (see Interviewee 6). In the first part of the quote (**bolded text**), the teacher mentions they like to use Learning Management Systems and Skype (software used to make audio and video calls, exchange chat messages, files etc) This is an indication of **what** technology the teacher utilised, and is an example from the *technology adoption*, *repertoire*, *software* category. In the second part of the quote (<u>underlined text</u>), the teacher mentioned the approach was to allow students the opportunity to ask questions and provide them with a freedom in their learning. This is an indication of **why** the teacher teaches the way they do, and is an example from *pedagogical development*, *understanding of students*, *learning approach* category.

> *I6: "**I use technology tools like LMS systems. One of the things I do use for my students is Skype**, because then if I'm not have very many lectures they can actually Skype in and <u>talk to me about anything they want to ask questions and stuff, and so it gives them a certain freedom about their learning that they wouldn't get otherwise</u>.* ← what ← why

Teaching Practice, Pedagogical Development, Technology Adoption and Techno-Pedagogical Practice

Teaching practice, pedagogical development, and technology adoption share a mutually interdependent relationship. The categories work together to benefit one another and achieve a shared purpose. Teaching practice, pedagogical development, technology adoption must all be present for the core category techno-pedagogical practice to exist. The relationship is denoted by dashed dark grey lines, these lines don't connect, they rather suggest a gentle holding pattern, which demonstrate the fragile complex nature of the relationship.

From the paradigm model (see Chapter 6.4) any change in the underpinning categories can drive a change to techno-pedagogical practice. The consequences of any changes to techno-pedagogical practice result in positive innovative teaching and learning approaches. This occurs when IT academics have access to technology enriched learning environments, utilise a range of enhanced learning and teaching strategies, where technology converges with a range of influences results in various relationships.

For example, an IT academic was asked to explain their approach to technology integration (see Interviewee 22). In the first part of the quote (**bolded text**) the teacher describes multiple examples of hardware and software adopted including laptops, screens, calculators, phones (hardware), and PowerPoint, Facebook and Cahoots (software). This is an example of **what** technology was utilised, and is an example from the *technology adoption*, *repertoire*, *software* category and *technology adoption*, *repertoire*, *hardware* category. In the middle part of the quote (shaded text), the teacher mentioned empowering students to be transfer their technology knowledge gained non-learning settings (such as social computing—Facebooking) into learning settings. This is an indication of **how** the teacher teaches, and is an example from the *teaching practice*, *teaching approach*, *delivery* category. In the final part of the quote (underlined text), the teacher mentioned the approach was to encourage students to see technology beyond entertainment and social communication, but to see the learning power of technology. This is an indication of **why** the teacher teaches the way they do, and is an example from *pedagogical development*, *understanding of students*, *engagement and motivation* category.

> *I22: "They don't see it used like that. In classrooms they go through an education system where they might use a* ***laptop to type up notes or to do what the teachers are doing, they might see PowerPoint presentations projected on a screen, and they might use a calculator****.* ← what
> *But those, you walk into a classroom and most teachers would tell them to put their* ***phones*** *away, and if they get them out, they'll get confiscated. The teachers… they see is that the kids have got their* ***phones*** *and they're texting or they're* ***Facebooking or they're doing things that they shouldn't be doing in class****. I want to use technology in a way that they can use it in class.* ***Now, while they're doing a Cahoot quiz they're not off texting or Facebooking because the device*** *[laughs] is being used, and it's being used in a way that they're learning from it.* ← how
> *So, I really wanted to turn it around so that people don't see them just as entertainment devices, and they don't just see it as a social interaction tool. I want to be able to use tech in ways, so people actually can see, "Wow, there is so much power to learn new things and access information on this, that I can just, I can really use this to help me in all sorts of facets of life."* ← why

8.2.4 Purpose and application of the theory

There are many benefits to using the theory and accompanying model of techno-pedagogical practice. Firstly, it provides a visualisation of the story of contemporary higher education teaching as told by IT Academics. It also provides a mechanism to categorise the modern teaching practice of IT Academics, and for understanding the complex relationships between teaching practice, pedagogy and technology adoption. In addition, it provides a benchmark for acceptable or typical teaching practice and technology adoption of IT academics. It helps to identify and highlight the perceived influence of technology by IT academics and provides a basis of an IT discipline signature.

This model can be used by IT academics as a benchmark to evaluate their own practice, and as a tool for self-discovery. In addition, it can be used by university management to identify the type of educators needed in a 21st century learning and teaching environment. It can also be applied more general sense to similar academic disciplines in order to better understand teaching practice, pedagogy and technology adoption, and visualise the complex relationships that exist between this phenomenon.

The model should be used along with the profile of a techno-pedagogue, and the theory of techno-pedagogical practice questionnaire available in Appendix F. Teachers who work in all three categories are classified as techno-pedagogues. Teachers will typically have a strength or sub-conscious preference for one of the areas. Analysis of teacher's comments suggest the category they are drawn to will be mentioned as a priority.

8.2.5 Validation of the theory

Strauss and Corbin suggest eight conceptual questions for evaluating a formal or substantive theory. These questions related to concept generation, systematic relationships, linkages, variation, conditions, process, findings and enduring (see Chapter 3.5.4.10). A brief discussion of each of these follows.

1. Concept generation: ideas were abstracted directly from interview data (see Chapter 4.6.2). A total of 78 properties were generated via multiple iterations of three coding cycles.
2. Systematic relationships: four connections between categories emerged (see Chapter 8.2.3.2). These connections composed of three different types, strong reciprocal, weak reciprocal and mutually interdependent (see Table 8–1).
3. Conceptual linkages: each category is sufficiently dense, each composed of further axial codes and properties. A full coding structure is available (see Table 6–1) and associated descriptions (see Chapters 5.3 and 6.3).
4. Variation: variation became apparent during the theoretical sampling process. Theoretical sampling allowed a focus on actions, experiences, event and issues (Charmaz, 2014). In this study the focus was on great technology using IT teachers (see Chapter 4.6.1.1).

5. Conditions: conditions under which variation can be found include organisational policies, social movements, trends, culture, societal values, language, professional values and standards (Strauss & Corbin, 1998).
6. Process: a rigorous application of Straussian GT was followed (see Chapter 3.5.4).
7. Theoretical findings: theoretical outcomes include an expanded understanding and definition of techno-pedagogy, elements contributing towards an IT signature pedagogy and the substantive theory of techno-pedagogical practice. These findings are of significance to IT academics and contemporary educators.
8. Enduring: The theory of techno-pedagogical practice applies to IT academics and is the basis of understanding relationships between teaching practice, pedagogical development, and technology adoption for existing new and emerging technologies. Technologies change the theory deals with technology in persistent way, at the same time enabling growth and expansion.

8.2.6 TPACK model revisited

TPACK is a conceptual theoretical framework used by teachers to identify knowledge they require to competently teach with technology (Voogt, et al., 2013). TPACK has many strengths and weaknesses reported in the literature, it has some similarities and some points of difference with the model of techno-pedagogical practice (TPP).

Recapping the technological pedagogical content knowledge (TPACK) model is based on Shulman’s (1987) pedagogical content knowledge (PCK). Shulman suggested teachers have content knowledge (a knowledge of their subject) and a pedagogical knowledge (knowledge of how to teach it). Shulman referred to the intersection of these as pedagogical content knowledge (PCK). Koehler and Mishra (2009) extended Shulman’s model to include technology knowledge. The various sections and intersections of the diagram displayed in Figure 8–6. According to Harris et al (2009, pp. 397-398) and Kurt (2019):

- **Content Knowledge (CK**) describes a teachers’ own knowledge about the subject.
- **Pedagogical Knowledge (PK)** describes teachers’ knowledge of the practices, processes, and methods regarding teaching and learning

- **Technological Knowledge (TK)** describes teachers' knowledge of, and ability to use, various technologies, technological tools, and associated resources.
- **Technological Content Knowledge (TCK)** describes teachers' understanding of how technology and content can both influence and push against each other.
- **Technological Pedagogical Knowledge (TPK)** describes teachers' understanding of how particular technologies can change both the teaching and learning experiences by introducing new pedagogical affordances and constraints.
- **Technological Pedagogical Content Knowledge (TPACK)** emphasises the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers' understanding of technology-, pedagogy, and content can interact with me another to produce effective discipline-based teaching.

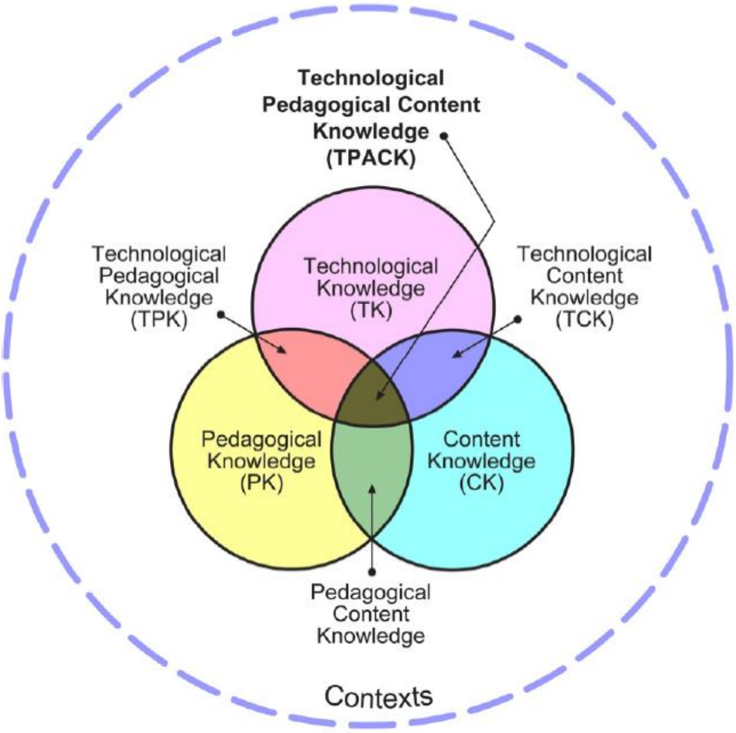


Figure 8-6 **The TPACK framework and its knowledge components (Koehler & Mishra, 2009, p. 63)**

The techno-pedagogical practice (TPP) is a model of **great practice** (see Figure 8-2, p. 288). It is a practical model for those teachers who aspire to improve their practice. TPP is grounded in the data and has been developed using extensive analysis and a process of continued abstraction applying Straussian Grounded Theory. TPP is accompanied by a questionnaire which allows teachers to determine:

- **How** will I teach that? (teaching practice)
- **Why** do I teach the way I do? (pedagogical development)
- **What** technology with I use? (technology adoption)
- A techno-pedagogue (a teacher whose teaching and learning practices are enhanced through the integration of educational technologies focussed on improving student learning experiences and outcome), will be thinking about all three questions.

TPACK is thought to be very easy to understand (Graham, 2011) and can be applied to any discipline (Kurt, 2019). It has been extensively implemented as a model for conceptualising the concerns regarding the introduction and use of technology in education with an enduring debate on details of its interpretation and application (Maclaren, 2018; Voogt, et al., 2013). It provides guidelines for implementing technology in mathematics teaching (Niess et al., 2009), and assists classroom teachers with support and application when implementing technology (Hartwell, 2020). TPACK can also be used to assist teachers in recognising content knowledge (CK) and pedagogical knowledge (PK) and identify links between disciplinary areas to support interdisciplinary task design (Hartwell, 2020). TPACK can act as a tool to build relationships with colleagues (Hartwell, 2020). It also helps to develop a culture of positive attitudes amongst teachers (Dweck, 2006).

Not all teachers have identical pedagogical, content, and technology knowledge (Kurt, 2019). There is much debate and varying descriptions amongst the literature for the different elements and boundaries of the TPACK model making it open for mis-interpretation (Graham, 2011; Voogt, et al., 2013). Teachers have trouble grasping the complicated relationships between the elements, as these are often taught separately in teacher education programs (So & Kim, 2009). A challenge is to develop a representation of TPACK in which the individual forms of knowledge are intersected in a way that provides a clearer view of an individual teacher's knowledge (Phillips, 2016). So and Kim (2009) found student teachers were able to understand their pedagogical approach but were not able to apply their pedagogy using technology in a practical way. The questions from the TPACK survey on content knowledge are discipline specific, including social studies, mathematics, science and literacy (Schmidt et al., 2009).

Similarities between both models is the epicentre of each. Harris (2009) suggests a truly effective and highly skilled teacher is at the centre of the TPACK model, similarly a great technology using teacher or techno-pedagogue is at the centre of the TPP model. Both models aim at trying to improve teaching. The TPACK model is a generalised model for teachers at any stage of their technological development. While the TPP model is aimed at improving teaching and making great teachers. It is a model of great practice. Each model appears to be aimed at different target audiences. The TPACK model appears to be aimed at primary and possibly secondary school teachers. While the TPP model is clearly for CS/IT and IS academics, the focus of this research project. TPACK is a framework that highlights the connections between the knowledge of content, pedagogy, and technology. Whereas, TPP is a model that provides a mechanism to categorise the modern techno-pedagogical practices of IT academics. The key difference here is with regards to the focus on knowledge (TPACK model) and techno-pedagogical practice (TPP model). The TPP model also includes teaching practice which is omitted by the TPACK model. TPACK is purported to be of use to all teachers even though the content questions appear to be discipline specific. Whereas TPP is a model for anyone wanting to determine their strengths and weaknesses in the areas PD, TP, TA TPP with a view to improving their teaching. TPACK is represented by a Venn diagram "A Venn diagram is an illustration of the relationships between and among sets, groups of objects that share something in common" (Rouse, 2005). While TPP is presented as a radial cycle diagram, used to illustrate relationships to a central idea in a cyclical like progression. Emphasises both information in the centre circle and how information in the outer ring of circles contributes to the central idea.

While there are similarities and points of difference both models have something to offer various audiences. Unlike the TPP model, the TPACK model did not appear to address the development of teaching practice or technology-based teaching practice or the development of techno-pedagogues.

8.3 Elements contributing towards an IT signature pedagogy

Pedagogies can differ across disciplines. Disciplines such as medicine and law have reported distinctive pedagogies. Shulman (2005a) terms these *signature pedagogies*. Signature pedagogies are the types of teaching that characterise the fundamental ways in which students are educated for their professions (Shulman, 2005b). A signature pedagogy provides a blueprint or model of good practice. Shulman (2005b) suggests signature pedagogies help shape the character, values, and hopes of a profession.

A descriptive list portraying some elements which may contribute towards an IT discipline-based signature pedagogy are provided below. This is based on an analysis of responses reported by IT academics interviewed and either extend or add new ideas to the existing body of literature. The list contains elements from each of the four categories identified: pedagogical development, teaching practice, technology adoption and techno-pedagogical practice. **It should be noted that not all IT academics display all characteristics**.

8.3.1 Elements which relate to Pedagogical Development

Recapping, this category describes factors influencing the formation, development and growth of IT academics' pedagogy, and provides underpinning support upon which IT academics reported build their practice.

Elements from this study which add or extend ideas presented in the literature include IT academics who:

- *Build or create using technology*. IT academics enjoy the capacity to build or create something with the use of technology.
- *Feel a sense of achievement:* IT academics feel a sense of achievement in learning difficult concepts.

- *Love the challenge of programming*. IT academics love the challenge, the logical high order thinking, and the skills and creativity required to programming.
- *Believe peer review improves teaching practice*. IT academics relate the practice of peer review to good teaching, and suggest good teachers seek to improve their practice.
- *Identify with society and culture*. IT academics talk about the influence of society and culture on their pedagogical thinking. For example, belonging to a sports club helps build leadership behaviours in teaching.
- *Are normal and approachable.* IT academics recommend combining normality and approachability help facilitate improved student learning.
- *Are caring.* IT academics not only care about the student but also the student's career and their ability to be successful in life.
- *Use various approaches to communicate.* IT academics communicate with students at different levels, in different ways.
- *Are honest.* IT academics espouse the importance of being honest, particularly in situations where they are potentially out of their depth, and their credibility is potentially in jeopardy.
- *Identify pivotal teaching moments (PTM)*. IT academics identify critical moments in terms of student learning and believe the strength of the emotional connection is also important.

8.3.2 Elements which relate to Teaching Practice

Recapping, this category describes strategies, techniques and the implementation of practical teaching approaches. This category is about how IT academics manifest their teaching in hands-on or practical ways.

Elements from this study which add or extend ideas presented in the literature include IT academics who:

- *Use open book exams to emulate work practices*. IT academics find open book examinations to be useful for students by emulating future professional career practices.
- *Enjoy teaching a variety of areas*. IT academics enjoy teaching a diverse variety of sub-discipline areas and have backgrounds in teaching technical courses such as programming, in multiple computer languages.
- *Are drawn to complex areas*. IT academics are drawn to concepts which require in deep content knowledge in specific contexts.
- *Use lab classes in variety of ways*. IT academics use labs to help students develop resilience and independence, also to develop and practice skills, and to build on skills by offering more challenging activities.
- *Use tutorials to focus on teamwork.* IT academics use tutorial to focus on the development of teamwork and cooperative learning.

8.3.3 Elements which relate to Technology Adoption

Recapping, this category describes the array of technologies used in student learning, teaching administration, preparation, and research also the associated advantages and disadvantages of technology, and examples of its use.

Elements from this study which add or extend ideas presented in the literature include IT academics who:

- *Use videos to create a social presence*. IT academics use video in an interesting and unique way, to connect with students through the development of a social presence (the degree to which a person is perceived as real and present in a given mediated communication (Short, et al., 1976)) using personalised gestures and promoting vibrant discourses in YouTube educational videos.
- *Have a passion for games.* IT academics reported loving games, collecting consoles, playing games, reading about games, enjoying the gaming social community, developing games, and creating and using games for learning and teaching purposes. Gaming appears a strong part of the IT academic psyche

(soul, mind and spirit), and is a strong motivator for IT academics, suggesting their love of technology and developing a sense of community is connected to their game playing.

- *Use technology to facilitate unique problem-solving approaches*. IT academics use the online help manuals, without pre-preparation or planning while teaching. This technique teaches students unique problem-solving approaches.
- *Experiment with technology*. IT academics use many additional technologies some of which are not university supported, indicating IT academics enjoy exploring different technologies.

8.3.4 Elements which relate to Techno-pedagogical practice

Recapping, this category describes changes in teaching and learning philosophy and practice resulting from technology adoption, facilitating digitally enhanced teaching promoting a student focussed approach.

Elements from this study which add or extend ideas presented in the literature include IT academics who:

- *Have a passion for games.* IT academics reported loving games, collecting consoles, playing games, reading about games, enjoying the gaming social community, developing games, and creating and using games for learning and teaching purposes. Gaming appears a strong part of the IT academic psyche (soul, mind and spirit), and is a strong motivator for IT academics, suggesting their love of technology and developing a sense of community is connected to their game playing.
- *Support student centred learning*. IT academics feel strongly about students being at the centre of the learning and use technology to afford these beliefs. IT academics believe good teachers are part of a club who focus on their students, and not on themselves as teachers.
- *Engage with educational literature.* IT academics who are engaged with educational literature and publishing research articles based on their teaching

experiences, suggests a prevailing interest and motivation to pursue teaching excellence.

- *Get students to create their own games*. IT academics get students to create their own game to learn theoretical programming and logic concepts. This approach is perhaps unique to the computing discipline due to the technical knowledge and skills required.
- *Use social media*. IT academics use social media from educator to educator, improving communication and resources sharing.
- *Support paperless learning*. IT academics show a deeper appreciation and advocacy of paperless living, promoting paperless universities.
- *Use metaphors*. IT Academics metaphors share a common theme of growth and development. This might suggest that technology has the power to move learning and teaching from a metaphorical transmission state to a growth state.
- *Believe students have a mutual dependent relationship with technology*. IT academics reflect that there is a psychological and physical nature of the interdependence between students and their technology.
- *Are infatuated with all their technology*. IT academics appear to be infatuated with all their technology beyond just mobile phones, as opposed to the general population

A signature pedagogy has three dimensions a). surface structure, b). deep structure and c). implicit structure (Shulman, 2005b). The surface structure consists of concrete and operational acts of learning and teaching, the deep structure is the set of assumptions about the best ways to impart the knowledge, and the implicit structure are the moral beliefs about the profession (Shulman, 2005b). The elements which contribute towards an IT discipline signature meet all three of Shulman’s dimensions. A discussion of each is provided.

Firstly, the surface structure made up of concrete and operational acts of learning and teaching. These are evidenced in the teaching practice and aspects of the technology adoption categories. The teaching practice category describes approaches, techniques and the implementation of teaching practice. It is about the practical aspects of teaching. It includes the IT academic's favoured approach to assessment, marking and feedback, the IT academic's discipline expertise, imposed university policies, processes and practice, the IT academic's approach to class structure and delivery, student motivation approaches, and knowledge of subject content (see Chapter 6.3.2). The axial code *examples of use* from the *technology adoption* category represents practical ways technologies are used to support learning and teaching.

Secondly, the deep structure is made up of assumptions about good practices in IT teaching. These assumptions represent the pedagogical development category. This describes the IT academics underpinning philosophy of teaching. This includes factors, thoughts and experiences that influence the thinking behind the practice. It includes the agency of technology-based discipline preferences, and the impact of people such as family, industry, mentors etc. As well as the teacher's discourse and innate use of language, factors constraining thinking, perceived attributes of quality teaching and an understanding of students' needs (see Chapter 6.3.1).

Thirdly, the implicit structure is made up of the moral beliefs about the profession. Examples of this dimension exist in all four categories however, are most prevalent in the techno-pedagogical practice category, specifically the technology relationships, and technology convergence axial codes. Technology relationships which represents various meaningful connections between IT academics and technology such as emotional dependencies. Whereas technology convergence represents IT academics beliefs regarding the merging of technology and other learning influences, for example the convergence between technology and environment (green computing), and the convergence between technology and society (social media). These represent IT academics self-efficacy in relation to their discipline (see Chapter 6.3.4).

8.4 Summary and conclusion

This chapter presented an overview of the substantive theory of techno-pedagogical practice. Each element of the theory was presented and explained including; an expanded definition of techno-pedagogy, a definition and profile of a techno-pedagogue, and a description and model of techno-pedagogical practice. The chapter concluded with a narrative of the IT discipline signature.

The definitions provide a basis for understanding the phenomenon of techno-pedagogy. The profile of a techno-pedagogue allows IT academics to identify with their strengths and analyse and categorise their teaching practice. It also allows identification of factors influencing pedagogy and technology adoption. The model of techno-pedagogical practice provides a mechanism for IT academics to visualise the complex relationships between pedagogy, technology and teaching practice. The IT discipline signature provides a characterisation of habits and teaching approaches unique to IT teaching.

The next chapter provides a conclusion to the research, details of outcomes related to each research question. Details of study limitations and future work.

9 Summary and Conclusion

9.1 Introduction

The previous chapter provided an overview and discussion of the theory of techno-pedagogical practice and its components, as well as an overview of the IT discipline signature. The aim of this chapter is to present conclusions and implications in response to each research question, limitations and directions for future research.

This chapter commences with a review of the research aim, followed by a table detailing the connection between categories, axial codes and research questions. This is followed by a summary discussion responding to each research question, the study limitations, future work and final concluding statements.

9.2 Research question outcomes

In this thesis, an investigation was conducted to explore factors impacting IT academics' pedagogy, the purpose of their technology adoption and the influence of technology on their pedagogy. This work has addressed the broad aims of the research proposed in Chapter 1:

> *Investigate ways IT academics develop their teaching practice, with a focus on experiences and influences of technology on philosophical development, and the emergence of new digitally based pedagogies.*

In this section responses to each research question are provided. Each response is composed of a brief review of the combination of appropriate axial codes which offer insight into each research question. The axial codes merge across categories. Table 9–1 provides a big picture outline of the connections between categories, associated axial codes and research questions.

For each research question a table is provided comprising the representative axial codes across categories and associated recommendations. A full list of recommendations is available in Appendix E, or within Chapter 7 in the conclusions and recommendations sections at the end of each category discussion.

Table 9-1 Phase 2 – Connection between categories, axial codes and research questions

Category	**Axial Code**	**Research Question 1 – How do IT academics develop their pedagogy?**	**Research Question 2 – For what purpose do IT academics adopt technology?**	**Research Question 3 – What role does technology play in shaping IT academics' pedagogy?**
Pedagogical development	Discipline preference	●	●	●
	Influence of others	●		
	Language used	●		
	Pedagogical development constraints	●		
	Quality teaching attributes	●		
	Understanding of students	●		
Teaching practice	Assessment considerations	●		●
	Discipline expertise		●	●
	Environment	●		
	Teaching approach	●		
Technology adoption	Affordances		●	●
	Constraints		●	●
	Examples of use		●	●
	Repertoire		●	●
Techno-pedagogical practice	Learning environment			●
	Learning strategies	●	●	●
	Technology convergence		●	●
	Technology relationships		●	●

9.2.1 Question 1 – How do IT academics develop their pedagogy?

This section provides an answer to research question one. The discussion is organised around the relevant individual axial codes, which provide insight and understanding of the factors that influence the development of IT academics' pedagogy. Results from the data indicate a range of factors play a part in the foundation and ongoing development of IT academics' pedagogy.

The axial codes (or factors) related to research question 1 are: discipline preference, influence of others, language used, pedagogical development constraints, quality teaching attributes, understanding of students, assessment considerations, environment, teaching approach and learning strategies. See Chapters 7.2, 7.3 and 7.5 for a discussion of the meaning of each axial code. See Table 9–2 for the axial codes and recommendations relevant to research question one. Grouped by category, these suggest that the thinking behind teaching, the practice of teaching and technological factors all have an impact on pedagogical development. Following is a summary analysis of each axial code related to research question one.

Table 9-2 Phase 2 – Categories and axial codes connected to research question 1

Category	**Axial Code**	**Research Question 1 – How do IT academics' develop their pedagogy?**	**Relevant Recommendation**
Pedagogical development	Discipline preference	●	1
	Influence of others	●	2
	Language used	●	3
	Pedagogical development constraints	●	4
	Quality teaching attributes	●	5a and 5b
	Understanding of students	●	6
Teaching practice	Assessment considerations	●	7
	Environment	●	9
	Teaching approach	●	10a and 10b
Techno-pedagogical practice	Learning strategies	●	16

IT academics' pedagogy is influenced by their **discipline preference**. IT academics enjoy teaching courses they are familiar with and when the content encourages creativity. Encouraging IT academics to develop their creativity fosters an environment of opportunities where they are more likely to test out new ideas and ways of thinking and problem-solving. Developing practical and logical thinking skills can enable reasoning and the ability to see greater potential. The sense of achievement IT academics feel when learning and teaching difficult concepts, encourages high achievement and motivation, leading to improved learning and teaching outcomes.

IT academics' pedagogical thinking is shaped by the **influence of others** including; family, friends, industry, peers, educational literature, professional development activities, society and culture (sport, religion and media). Family and friends provide encouragement and foster creative thinking and reflective practice. Working in industry and liaising with industry groups provides IT academics with experiences which can be used to contextualise students' learning and provides innovative problem-solving approaches which can be shared with students. Peer review and mentoring is a way of discussing and improving the quality of teaching and learning. Peers and mentors can influence IT academics' perceptions of good teaching, by providing an avenue for discussing, viewing and applying quality teaching practices. Reading educational literature is a way of developing both teaching practice and pedagogical philosophy. Reading professional literature such as textbooks can lead to a pragmatic approach focussing on classroom practice, whereas, those who consult research-based literature look to develop their philosophical foundation of teaching based on a theoretical understanding of teaching and learning. Participation in professional development activities such as conference attendance and observation of others, expose IT academics to skills, techniques and philosophies of quality teaching. Interacting with society and culture helps build IT academics' sense of curiosity and allows them to assimilate leadership behaviours, while engaging with media provides a source of knowledge and ideas which can be shared with students and others.

IT academics' pedagogy is influenced by technical and educational **language use**, its selection and application. IT academics' educational language base is informed by educational literature. This encourages a use of educational language which informs and facilitates pedagogical thinking. IT academics use technical language to communicate specialist ideas and encourage students to learn and expand their technical language use.

IT academics' pedagogy is **constrained** through factors including; a lack of industry experience and self-confidence. These constraints influence or limit thinking about learning and teaching, and IT academics' ability to connect with their students. A lack of industry experience can influence the teachers' credibility, and their perceived ability to enhance students' learning experiences with the use of real-world applications and events. A lack of self-confidence can be a problem. When IT academics are worried. they may make a mistake and potentially confuse less able students, and when they are less prepared, they may be less likely to try new content areas.

IT academics' pedagogy is influenced by **qualities attributes** which they believe define and shape great teaching. These include approachability, caring, good communicator, entertainer, honesty, and passionate. Fostering a friendly demeanour means that IT academics to are approachable and this puts their students at ease. Apart from caring about their students' learning, IT academics also care about their students' careers and their successes in life, this extends what is reported in the literature. Developing good communication skills enables teachers to meet the different needs of students, while entertaining students promotes a relaxed atmosphere and improves student learning however, care is needed to maintain respect for minority groups. Being honesty is central to a teachers' integrity, students report honesty as the key attribute of great teachers. Findings extend the literature suggesting students respect teachers who admit when they don't know. Having passion is an important to demonstrate enthusiasm and a communicate a love of the topic. These qualities provide a foundation of IT academics' relatability, communication with their students, how nurturing and caring they are toward their students, and how they entertain their students, fostering a desire and motivation for learning. Also, their honesty when teaching particularly when out of their knowledge depth, and passion and enthusiasm of the content and students they teach.

IT academics' pedagogy is influenced by an **understanding of their students**. This includes their students' attendance habits, learning theory and identification of key learning moments. IT academics reported a direct relationship between attendance and positive learning outcomes, and so have an expectation students' need to attend to learn (traditionalist view). IT academics are influenced by constructivist learning theory, in subtle, subconscious ways. This was evidenced by the introduction of activities and content representing everyday life experiences, aimed at motivating and engaging students. IT academics instinctively identified key learning moments, these prompted in class reflection and redirection of teaching approaches designed to maximise student learning opportunities.

IT academics' pedagogy is influenced by **assessment considerations** which favour the use of tools such as assignments and timely marking and feedback in order to improve student learning and engagement, and the use of in class testing to encourage student attendance.

IT academics' pedagogy is influenced by the academic **environment** and is constrained by teaching and learning policies of universities which are imposed and inadvertently promote teacher centred strategies, surface learning approaches and teacher resistance to change. IT academics believe a nurturing collaborative environment with a collective culture is important for inspiring students.

IT academics' pedagogy is influenced by their **teaching approach** including laboratory, lectures, tutorials, the use of competition and rewards, their content knowledge and delivery techniques (including the use of chunking, concept learning or learning by example and storytelling). IT academics use laboratory classes to build upon existing skills and help to develop resilience and independence in their students. IT academics use lectures to transmit information and can also feel restricted by immobile pedagogy facilitated through the stationary nature of lecture room layouts. IT academics use tutorial tasks to promote problem solving, teamwork and cooperative learning. IT academics use competition and rewards to motivate high performing students when completing menial tasks. This is different from the literature which suggests competition and rewards should be made available to all students. The context is important here (i.e. open access versus G8 universities). IT academics' content knowledge is important as well as their emotional confidence to teach course content. IT academics use chunking to teach complex ideas and use concept learning (learning by example) to promote feedback on simple tasks. IT academics use storytelling to navigate complex content.

IT academics' pedagogy is influenced by the range of **learning strategies** they have available, including; applied learning, flipped classroom, gamification, PBL and social learning techniques. By using applied learning IT academics bridge the gap between university and the workplace, enabling students' work readiness. IT academics flip the classroom as a way of developing critical and analytical thinking skills, and self-reliance in their students. IT academics use gamification as a motivating and engaging technique for students to learn programming logic and concepts. IT academics use PBL to benefit students who need flexibility in their learning. By using social media learning IT academics improve communication skills in students and develop collaborative opportunities with peers.

In summary IT academics' pedagogy is complex and appears to be influenced by many factors including; their discipline preference, others, language, values, and their students. In addition, assessment, the teaching environment, various teaching approaches and learning strategies. Pedagogy is constrained by generation gap, lack of industry experience and low self-confidence.

9.2.2 Question 2 – For what purpose do IT academics adopt technology?

This section provides an answer to research question two. The discussion is organised around the relevant individual axial codes, to develop an understanding of some of the factors which influence IT academics technology adoption preferences and intended use. Results from the data indicate a range of factors play a part in influencing technology adoption and usage habits of IT academics.

The axial codes (or factors) relevant to research question 2 are: discipline preference, discipline expertise, affordances, constraints, examples of use, repertoire, learning strategies, technology convergence and technology relationships. See Chapter 7.2, 7.3, 7.4 and 7.5 for a discussion of the meaning of each axial code. See Table 9–3 for the axial codes and recommendations relevant to research question two. Grouped by category, these suggest the thinking behind teaching, the practice of teaching, technological factors and aspects of techno-pedagogical practice all have an impact on technology adoption. Following is a summary analysis of each axial code related to research question two.

Table 9-3 Phase 2 – Categories and axial codes connected to research question 2

Category	**Axial Code**	**Research Question 2 – For what purpose do IT academics adopt technology?**	**Relevant Recommendation**
Pedagogical development	Discipline preference	●	1
Teaching practice	Discipline expertise	●	8
Technology adoption	Affordances	●	11
	Constraints	●	12
	Examples of use	●	13
	Repertoire	●	14
Techno-pedagogical practice	Learning strategies	●	16
	Technology convergence	●	17
	Technology relationships	●	18

IT academics’ purpose for technology adoption is influenced by their **discipline preference**. IT academics have a technological preference for courses they are familiar with and whose content encourages creativity. Encouraging IT academics to develop their creativity fosters an environment of opportunities where they are more likely to use technology to improve thinking and problem-solving. IT academics technology use also facilitates the development of practical and logical thinking skills enabling greater potential in technology use. IT academics feel a sense of achievement when learning and teaching complex technologies, this leads to further motivation to adopt these technologies adding depth to learning and teaching outcomes.

IT academics’ purpose for technology adoption is influenced by their **discipline expertise**. IT academics’ technology adoption rationale appears to be influenced by the choices of major and specialist areas of computing they are drawn to. Different specialities have different knowledge and skill bases which are typically associated with practical teaching approaches and the appropriate supporting learning technologies as well as technical software.

IT academics' purpose for technology adoption is influenced by the perceived **affordances** of that technology. IT academics are more likely to adopt technologies they view as beneficial to learning and teaching. IT academics adopt technology to reduce their cognitive load, for example the use of animations to build steps in complex operations, however in accordance with the literature animation should be used in conjunction with active learning tasks in order to retain concepts. IT academics also adopt technology to stimulate imagination and to feel motivation and inspiration. When IT academics are motivated and inspired, they are more likely to use technologies in ways which are unique and diverse leading to improved learning and teaching outcomes.

IT academics' purpose for technology adoption is influenced by the perceived **constraints** of that technology. IT academics avoid adopting technologies for any purpose they perceive will likely have a harmful impact on learning and teaching. For example, large files which take up precious bandwidth, mobile phones which may cause a barrier or distract students, or complicated technologies that potentially take too much time to master, and a lack of cultural encouragement for the adoption and use of a technology.

IT academics' purpose for technology adoption is influenced by their perceived **examples of use** of that technology. IT academics adopt technologies for teaching, communication, administration and to conduct learning analytics. IT academics use technology driven back-up options for technology failures rather than non-technology options favoured by other disciplines. IT academics use technology in unique ways, for example to develop a social presence online, or to access online technical help manuals as a means of problem solving, providing guidance and role models for students. IT academics exhibit a love of games and game playing and use technology to participate in game playing cultural groups. This provides a creative release, motivation, enjoyment and love for technology which impacts on the quality of learning and teaching.

IT academics’ purpose for technology adoption is influenced by their **repertoire** or their technology skillset inventory. IT academics are known technical experts and adopt technology software and hardware for a range of purposes including administration, teaching and teaching preparation, student learning and student learning support, communication and research. Having access to a range of specialised new and emerging software and hardware aids motivation and maintains currency of IT academics’ technical skills and knowledge, facilitating better learning outcomes for students.

IT academics’ purpose for technology adoption is influenced by the range of technology-supported **learning strategies** they enable. Some of these include applied learning, flipped classroom, gamification, PBL and social learning techniques. IT academics adopt technology to help bridge the gap between university and the workplace, enabling students’ work readiness through improved learning contexts. IT academics flip the classroom adopting technology resources for students to access online ahead of time. The impact results in the development of critical and analytical thinking skills, and self-reliance in students. IT academics use gamification to teach students programming logic and concepts. This results in motivated, engaged students. IT academics use PBL to benefit students who need flexibility afforded by the options technology provides in their learning. IT academics use social media learning to improve communication skills in students and develop collaborative opportunities with peers.

IT academics’ purpose for technology adoption is influenced by **technology convergence** with other learning influences. There are serendipitous benefits gained from convergence of technology with other learning phenomena. For example, when technology is combined with environmental concerns one impact of that marriage is paperless learning. When technology is combined with learning and teaching, IT academics place more emphasis on the selection and application of technology, leading to a strong focus on student learning needs. Technology provides an avenue for IT academics to express student relationships in the form of metaphors, illustrating themes of growth and development. The combination of technology and pedagogy although complicated provides potential for transformative teaching thinking, while the integration of technology and society provides opportunity for boundless information and communication. The convergence of technology and students is complex. Some researchers report students are born digital. IT academics believe students have a psychological and physical interdependence with technology, and so technology environments need to support the learning needs of these students.

IT academics' purpose for technology adoption is influenced by their **technology relationships**. IT academics are infatuated by all technologies (beyond their mobile phone). IT academics demonstrate a cognitive or psychological difference in their thinking about technology when compared to the general population. Some IT academics appear to have an obsessive physical and emotional need to connect with their technology. This would suggest part of the purpose for adopting technology is to soothe a psychosomatic need for closeness or a relationship to the technology.

In summary IT academics appear to adopt technology based on a number of factors including; specialist expertise, perceived affordances and constraints, examples of use, skills set, needs of new learning approaches, and the convergence of technology and philosophy.

9.2.3 Question 3 – What role does technology play in shaping IT academics' pedagogy?

This section provides an answer to research question three. The discussion is organised around the relevant individual axial codes, which provide an understanding of the impact of technology in shaping IT academics' pedagogy. Results from the data indicate there are many ways technology influences IT academics' pedagogy. The relationship between technology and pedagogy is complex and difficult to understand.

The axial codes (or factors) relevant to research question 3 are: discipline preference, assessment considerations, discipline expertise, affordances, constraints, examples of use, repertoire, learning environment, learning strategies, technology convergence, and technology relationships. See Chapters 7.2, 7.3, 7.4 and 7.5 for a discussion of the meaning of each axial code. See Table 9–4 for the axial codes and recommendations relevant to research question three. Grouped by category, these suggest the thinking behind teaching, teaching practice, technological factors and aspects of techno-pedagogical practice all have an impact on technology influencing pedagogy. Following is a summary analysis of each axial code related to research question three.

Table 9-4 Phase 2 – Categories and axial codes connected to research question 3

Category	**Axial Code**	**Research Question 3 – What role does technology play in shaping IT academics' pedagogy?**	**Relevant Recommendation**
Pedagogical development	Discipline preference	•	1
Teaching practice	Assessment considerations	•	7
	Discipline expertise	•	8
Technology adoption	Affordances	•	11
	Constraints	•	12
	Examples of use	•	13
	Repertoire	•	14
Techno-pedagogical practice	Learning environment	•	15
	Learning strategies	•	16
	Technology convergence	•	17
	Technology relationships	•	18

Technology shapes IT academics' pedagogy through their **discipline preference**. IT academics prefer to teach courses they are familiar with and whose content encourages creativity, logical thinking and problem solving. IT academics feel a sense of achievement when learning and teaching complex technologies, this leads to further motivation to adopt these technologies adding depth to learning and teaching outcomes.

Technology shapes IT academics' pedagogy through their **assessment considerations**. Assessment considerations are about how IT academics approach, develop, administer, mark and develop feedback for students. Technology availability, selection and deployment impacts the type and nature of assessment tasks, for example, the type of feedback provided, audio, or text based.

Technology shapes IT academics’ pedagogy through their **discipline expertise**. IT academics reported being drawn to computing speciality areas which require technical deep content knowledge in specific learning contexts, for example, teaching programming. Technology based pedagogical preference plays an important role for IT academics.

Technology shapes IT academics’ pedagogy through the **affordances** of that technology. These affordances have a positive influence on IT academics’ thinking. As a result, IT academics’ focus on the benefits of technology, its purpose, and usefulness in supporting learning and teaching. The academic’s underpinning philosophy becomes a positive view of ET use, for example, the use of Facebook to aid communication.

Technology shapes IT academics’ pedagogy through the **constraints** of that technology. These constraints have a negative influence on IT academics’ thinking. As a result, IT academics’ focus on the issues and problems surrounding technology and are less likely to adopt it for teaching and learning, for example, potential bandwidth restrictions.

Technology shapes IT academics’ pedagogy through **examples of use** of that technology. Like affordances and constraints, IT academics’ experiences of using technology shape their thinking, impacting on their pedagogical development. The depth of the impact likely varies depending on the technology adopted. In phase one Microsoft products were the main technology reported. Microsoft products are generic, well known everyday type technologies, which appear to have minimal impact on pedagogy. Phase two provided a large variety of diverse technologies impacting pedagogical development in a range of ways, for example, game playing, learning analytics, and online resources.

Technology shapes IT academics’ pedagogy through their **repertoire** of that technology. IT academics selected technical specialities are likely to impact their pedagogical philosophy. The choice of sub-discipline and associated software is likely to be influenced by personal preferences, experiences and opportunities. Similar to technology experiences, the depth of the impact likely varies depending on the skill set acquired. In phase one the skills reported were predominantly limited to generic software resulting in relatively little impact on pedagogy. However, during phase two the skills reported were diverse and varied, for example, administration, to experiential learning.

Technology shapes IT academics' pedagogy through the **learning environment**. Contemporary learning environments adopted by IT academics are technology supported for example immersive, interactive. In these technology rich environments IT academics see the positives to learning and teaching, outweighing the negatives. IT academics are drawn to these environments for the benefits to improved student learning, for example increased motivation, improved communication, etc.

Technology shapes IT academics' pedagogy through the **learning strategies** adopted. Contemporary learning approaches typically have a technology base, for example blended learning. When contemporary learning environments are supported by technology many variations in learning experiences are possible for students. The impact and spread of these experiences play an indirect part in shaping future IT academic pedagogies.

Technology shapes IT academics' pedagogy through **learning convergence**. The influence of technology on IT academics' pedagogy is shaped by the serendipitous impact of technology converging with other learning phenomena. For example, technology and student learning. IT academics use paperless learning approaches. Another example is technology and society. Technology has integrated into almost every aspect of society, this is a huge enabler to IT academics for a range of tasks, for example, information distribution, and communication.

Technology shapes IT academics' pedagogy through their **technology relationships**. IT academics reported infatuation with technology which demonstrated obsessive, addictive emotional and physical relationships. This would suggest a cognitive or psychological need for technology beyond that experienced by regular society.

In summary technology plays an important role in shaping IT academics' pedagogy. Examples of its influence include; technology discipline preferences, assessment considerations, discipline expertise, perceived affordances and constraints, examples of use, repertoire, the learning environment, learning strategies, the convergence of technology and other learning phenomena, and. IT academics relationships with technology.

9.3 Limitations

Several limitations were observed by the researcher. These included issues with interviews, theoretical sampling, complexity of the methodology, and production of a substantive theory.

Interviewee 24 decided not to be audio taped. Interviewees 12 and 19 had strong accents, making the transcription process difficult and time consuming. The audio files of interviews 10 and 11 were partially corrupted making some of the data irretrievable.

The application of a GT theoretical sampling approach was utilised for population selection in phase two. In order to obtain the theoretical sample a snowballing approach was used. The snowballing approach was not always an accurate means of identifying interviewees. With colleagues tending to overstate pedagogical depth and technology adoption of their peers. This resulted in a couple of interviews mid process which were not as rich in theoretical data.

Grounded theory is very difficult and complicated methodology. Therefore, it took a long time to understand the different variations and make a determination on the appropriate version for this research, eventually Straussian GT was selected. Once committed to this methodology the researcher was locked into following the processes carefully and diligently.

Outcomes of the research produced a substantive theory not a formal theory (see Chapter 3.5.4.10). This means the theory can only be applied in an IT teaching context. However, it was never the intention of the researcher to produce a formal theory that could be applied outside the IT discipline. This is consistent with the literature, which suggests most GT studies do not produce a formal theory (see Urquhart, 2013).

9.4 Future work

Several areas arising from the research reported in this thesis warrant further investigation. These include the development of an electronic tool which can be deployed in place of the paper-based questionnaire provided in Appendix F and used to determine the existence and intensity of techno-pedagogical practice, and the extension of the substantive theory to a formal theory.

A tool to automate the questions posed in Appendix F (the theory of techno-pedagogical practice questionnaire), requires development. This application will enable higher education academics of any discipline to answer a series of questions related to their pedagogy, teaching and technology use. The application will evaluate the academic’s responses and provide an analysis and accompanying pie chart which details their score in each of the categories; pedagogical development, teaching practice and technology adoption, and determine the applicant’s strength in each category and ascertain whether they are a techno-pedagogue.

Glaser and Strauss’ (1967) approach for evaluating a formal theory could be applied as a benchmark to extend the substantive theory to a formal theory relevant beyond a higher education IT context (see Chapter 3.5.4.10).

9.5 Thesis conclusion

This thesis has presented an investigation exploring factors impacting IT academics pedagogy, the purpose of their technology adoption and the influence of technology on their pedagogy. This research is of importance because developing an understanding of pedagogy helps to improve teaching practice. Understanding the innovative potential of technology aids knowledge of practices, benefits and constraints of technology, and provides a better understanding of the complex relationship between pedagogy and technology. Being aware of missed opportunities helps to mitigate their impact and provides a deeper awareness of the use of technology to support student-centred learning approaches. Key findings suggest a range of factors play a part in the foundation and ongoing development of IT academics' pedagogy and influence technology adoption and application. There are many ways technology influences IT academics' pedagogy, and the relationship between technology and pedagogy is complex.

A holistic approach to encouraging IT academics to reflect on the factors reported in this research is recommended. By adopting an integrated approach, the key elements can be systematically incorporated into educational support systems, policy and practice. IT academics, need to move from a subconscious doing to a conscious knowing (Firmin, et al., 2012).

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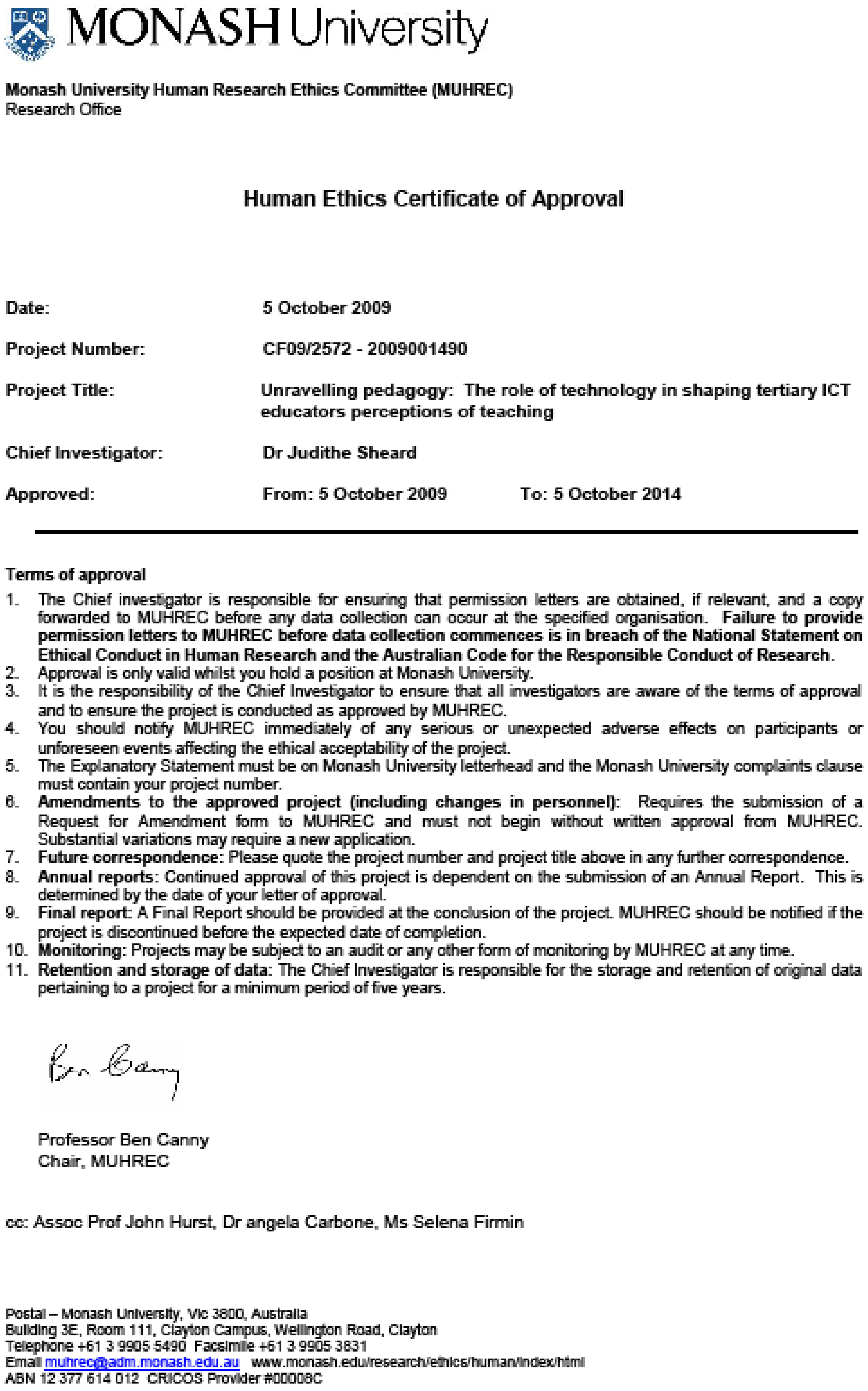
Appendix A Phase 1 – Data Collection and Analysis Documents

A.1. Phase 1 – Ethics Approval MUHREC



MONASH University

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

Date:	**5 October 2009**
Project Number:	**CF09/2572 - 2009001490**
Project Title:	**Unravelling pedagogy: The role of technology in shaping tertiary ICT educators perceptions of teaching**
Chief Investigator:	**Dr Judithe Sheard**
Approved:	**From: 5 October 2009 To: 5 October 2014**

Terms of approval

1. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, and a copy forwarded to MUHREC before any data collection can occur at the specified organisation. **Failure to provide permission letters to MUHREC before data collection commences is in breach of the National Statement on Ethical Conduct in Human Research and the Australian Code for the Responsible Conduct of Research.**
2. Approval is only valid whilst you hold a position at Monash University.
3. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must contain your project number.
6. **Amendments to the approved project (including changes in personnel):** Requires the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.
7. **Future correspondence:** Please quote the project number and project title above in any further correspondence.
8. **Annual reports:** Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.
9. **Final report:** A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.
10. **Monitoring:** Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.
11. **Retention and storage of data:** The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Ben Canny

Professor Ben Canny
Chair, MUHREC

cc: Assoc Prof John Hurst, Dr angela Carbone, Ms Selena Firmin

Postal – Monash University, Vic 3800, Australia
Building 3E, Room 111, Clayton Campus, Wellington Road, Clayton
Telephone +61 3 9905 5490 Facsimile +61 3 9905 3831
Email muhrec@adm.monash.edu.au www.monash.edu/research/ethics/human/index/html
ABN 12 377 614 012 CRICOS Provider #00008C

A.2. Phase 1 – Explanatory Statement

MONASH University

November 14, 2009

Explanatory Statement – IT Academics Pedagogy – Interview Group

Title: Unravelling pedagogy: The role of technology in shaping IT academics' perceptions and application of teaching philosophy

This information sheet is for you to keep
My name is Selena (Sally) Firmin and I am conducting a research project supervised by Dr Judy Sheard, Associate Professor John Hurst and Dr Angela Carbone from Caulfield School of Information Technology towards a Doctor of Philosophy at Monash University.

Why I chose this particular person/group as interviewees?
This group of teachers belong to the Graduate School of Information Technology and Mathematics (GITMS) with a varied experience incorporating technology into teaching. It will consist of four Information Technology (IT) academics, 2 male and 2 female, with experience in both undergraduate and postgraduate teaching. Contact details for these teachers are publically available on the University of Ballarat website.

The aim/purpose of the research
The aim of this project is to uncover the ways in which IT academics think about their teaching and develop their practice.

Possible benefits
This research will provide an understanding of how technology influences IT academics teaching philosophy and practice.

What does the research involve?
The research will involve interview style questions about your teaching, such as what do you like most about teaching, characteristics you feel make up a good teacher as well as your rationale how you go about teaching a course. The interview will be audio taped and is likely to last no more than one hour.

Can I withdraw from the research?
Participation in this study is voluntary. You are under no obligation to consent to participation. However, if you do consent, you may withdraw prior to the data analysis.

Confidentiality
Your participation in this research project will be kept confidential. The interview notes/audio/transcript will be kept in a locked drawer. If we publish the results of our research, no personally identifying information (names, university names) will be used in any publication. If a quote from the interview is used in the text of a publication, at most a research code (e.g. AB03) will be used.

Storage of data
Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. A report of the study may be submitted for publication, but individual interviewees will not be identifiable in such a report.

Use of data for other purposes
It is anticipated that further related studies will be conducted, based on the results of this study. If such studies occur, then we might use your anonymous data for the purposes of those studies. As in this study, no personally identifying information would be provided to anyone outside the research group or in publication.

Results
If you would like to be informed of the aggregate research findings, please contact Dr Judy Sheard on 03 9903 2701 or at judy.sheard@infotech.monash.edu.au .

If you would like to contact the researchers about any aspect of this study, please contact the Chief Investigator:	If you have a complaint concerning the manner in which this research **CF09/2572 20090014990** is being conducted, please contact:
Dr Judy Sheard 03 9903 2701 judy.sheard@infotech.monash.edu.au	Executive Officer Monash University Human Research Ethics Committee (MUHREC) Building 3e Room 111 Research Office Monash University VIC 3800 Tel: +61 3 9905 2052 Fax: +61 3 9905 3831 Email: muhrec@adm.monash.edu.au

Thank you

Sally Firmin

A.3. Phase 1 – Consent Form

Consent Form – IT Academics Pedagogy – Interview Group

Title: Unravelling pedagogy: The role of technology in shaping IT academics' perceptions and application of teaching philosophy

NOTE: This consent form will remain with the Monash University researcher for their records

I agree to take part in the Monash University research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records. I understand that agreeing to take part means that:

I agree to be interviewed by the researcher ☐ Yes ☐ No
I agree to allow the interview to be audio-taped ☐ Yes ☐ No
I agree to make myself available for a further interview if required ☐ Yes ☐ No

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project before data analysis begins without being penalised or disadvantaged in any way.

I understand that any data that the researcher extracts from the interview for use in reports or published findings will not, under any circumstances, contain names or identifying characteristics.

I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party.

I understand that data from the interview and audio tape will be kept in a secure storage and accessible to the research team. I also understand that the data will be destroyed after a 5 year period unless I consent to it being used in future research.

Participant's name

Signature

Date

A.4. Phase 1 – Interview Protocol

Interview Protocol

Preamble:

"I am interested in investigating the role of technology in shaping tertiary IT academics perceptions of teaching. From this I wish to devise 1. A framework of factors which influence IT academics approaches to teaching, and 2. An understanding of how technology influences IT academics teaching."

[Explain anonymity and confidentially, and that the interview will be recorded and a transcript produced.]

Questions:

1. Did you have a favourite teacher growing up or a mentor helping you through your early experiences of teaching?
   Probes:
   - *Why was that person particularly important to you?*
   - *Can you give examples of their practice?*
   - *Do you use any of their techniques in your own teaching?*

2. Can you describe some highlights of your teaching career?
   Probes:
   - *Why was that particularly important?*
   - *Can you give examples?*

[use questions 1 and 2 as lead-in's to question 3 …]

3. What are the most important characteristics you believe a good teacher must have (use words like; beliefs, truths, principles, and attitudes)?
   Probe for specifics:
   - *Refer to Biggs (1993, p487) "What makes a great teacher?"*
     - › *motivator*
     - › *treat each student as an individual*
     - › *subject content expert*
     - › *empathetic*
     - › *fair and flexible*
     - › *organised etc…*

4. How do you go about teaching a course?
   Probe for specifics:
   - *Course planning –*

    - *objectives*
    - *content*
    - *referencing*
    - *which parts of the course description spend most time thinking about working on? why?*
- *Course assessment –*
    - *types of tools, e.g. multiple choice, reports, tests etc … why selected?*
    - *structure of marking guides*
    - *approach to extensions*
- *Delivery –*
    - *lecturing style*
    - *techniques*
    - *approach*
    - *questioning*
- *Classroom management –*
    - *start time*
    - *breaks*
    - *discipline*

5. What technologies do you use in your teaching? And why did you choose these?
   Probes:
   - *Use in preparation*
   - *During class*
   - *Teaching administration*

6. Can you describe some of your experiences using technologies in your teaching?
   Probes:
   - *Why was that experience particularly important to you?*
   - *In what ways do you use technology? e.g. for teaching, displaying, simulating, for learning, for assessment*
   - *Did these experiences change your approach to using technology? Probe for reflective practice here.*

[link question 7 back to question 3 …]

7. Do you feel technology has enhanced your teaching? YES/NO/Not Sure

8. What is your general feeling regarding technology enhanced teaching? How if at all has technology influenced your teaching?
   Probes:
   - *If good/positive reaction: What is it that makes it good?*
   - *If bad/negative reaction: What is it that makes it bad?*

A.5. Phase 1 – Sample Memo

October 14, 2010

This memo contains thoughts, and reflections after coding phase one interview 3 data.

Interviews 2 and 3 got me thinking about how teachers use technology to engage students and to develop their love of learning, in addition to enabling a student-centred learning environment. Off the top of my head, technology allows students to work at their own pace, it allows students review, revise, and return to content over and over. It enables different mediums such as video, audio, animation etc. It enables development of problem solving, thinking and research skills. It enables independence. Is this the same with teachers? Why do they use technology? How is technology an enabler for teachers? Two codes, which emerged from phase one interviewees, prompted me to reflect more on these ideas. These codes were the teacher as a developer of new technology and teachers' knowledge of software.

"Teacher as a developer of new technology"

I want to know more about this one, it is an interesting notion. What motivates IT academics to develop technology, specifically educational software? I may investigate further in phase 2 as part of grounded theory's theoretical sampling process.

Interviewee 3 indicated motivation to use technologies, which were of interest, something that they liked and enjoyed. Is this the same with students? Are they motivated the same way? Will understanding this help with our selection and integration of technology?

Interviewee 2 reported developing new software for educational purposes when there was benefit to teaching and learning practices. Interviewee 2 talked about developing a plagiarism detection software algorithm written in Java. This tool enabled students to check their work prior to submission, and take responsibility and ownership of it. Interviewee 2 also developed a software application to utilise

VR 3D environment for teaching and learning purposes. Interviewee 2 was passionate and excited when retelling me about this software, I imagine students being motivated with this immersive style of learning.

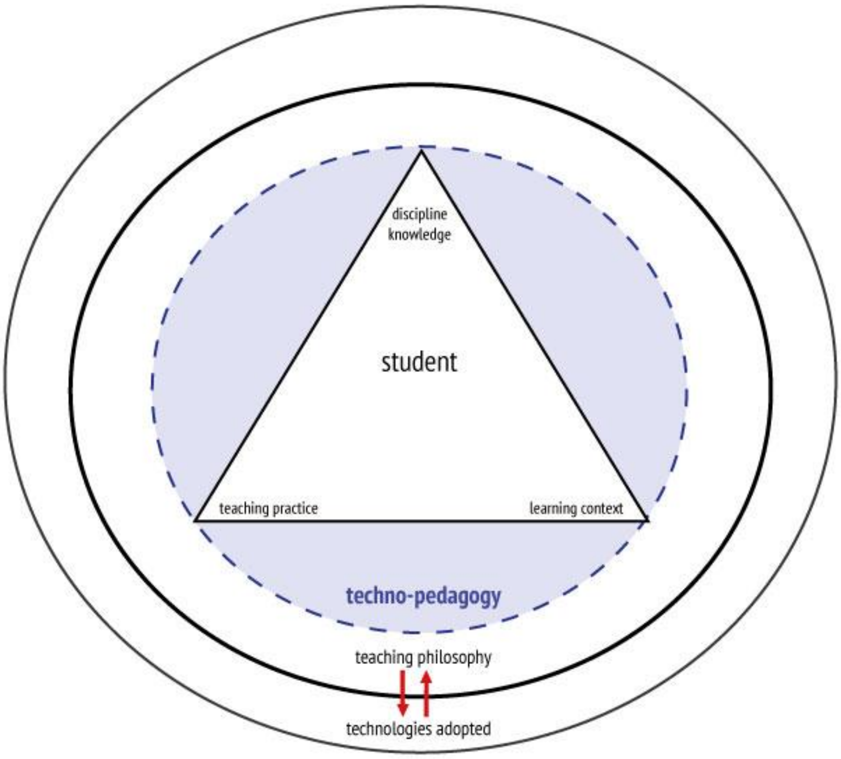
"Knowledge of software version"

Interviewees 2 and 3 both reported not knowing the version of MS Office they were using. This is of interest to me and I want to investigate this further. I would like to compare these responses to others particularly big technology users. For example, can they discuss the differences between software versions? Why don't they download the latest versions of software? Do they know when new versions will be available? Is there some relationship to explore here? Maybe, maybe not??

I tested my theory by anecdotally questioning a technology using academic. This teacher knew the versions of software from memory. Why is it that this extreme user of technology could recite this information off the cuff? Does this paint a picture of an IT academics' relationship or connection with technology? Does this suggest their likely use of technologies? Does this predict their approach and desire to work with new technologies? Is this an indicator of teachers who embrace technologies, which aid student learning? These are all questions I don't have the answers to YET!

A.6. Phase 1 – Sample Model

This is a sample model from phase one, it was set aside during phase two, however the diagramming process aided early conceptualisation of the data.



Model 8

Appendix B Phase 2 – Data Collection and Analysis Documents

B.1. Phase 2 – Ethics Approval MUHREC

From:	coral.lindupp@monash.edu on behalf of MRO Human Ethics Team (Adm) [muhrec@monash.edu]
Sent:	Wednesday, 22 December 2010 11:58 AM
To:	Judithe Sheard (Infotech)
Cc:	John Hurst (Infotech); Angela Carbone (Adm); sjfir1@student.monash.edu
Subject:	Monash Human Ethics - CF09/25723 - 2009001490

PLEASE NOTE: To ensure speedy turnaround time, this correspondence is now being sent by email only. MUHREC will endeavour to copy all investigators on correspondence relating to this project, but it is the responsibility of the first-named investigator to ensure that their co-investigators are aware of the content of the correspondence.

Dr Judithe Sheard
Caulfield Sch of Info Technology
Faculty of Information Technology
Caulfield

22 December 2010

CF09/2572 - 2009001490: Unravelling pedagogy: The role of technology in shaping tertiary IT educators perceptions of teaching

Dear Researchers,

Thank you for the Annual Report provided in relation to the above project.

This is to advise that the Monash University Human Research Ethics Committee (MUHREC) has noted your comments and the project may proceed according to the approval given on 5 October 2009.

Please continue to submit an Annual Report and submit a Final Report at the end of your research project.

Thank you for your assistance,

Professor Ben Canny
Chair, MUHREC
cc: Assoc Prof John Hurst; Ms Angela Carbone; Ms Selena Firmin

Human Ethics
Monash Research Office
Building 3E, Room 111
Monash University, Clayton 3800
Phone: 9905 5490
email: muhrec@monash.edu
http://www.monash.edu.au/researchoffice/human/

B.2. Phase 2 – Ethics Approval Time Extension

Subject:	CF09/2572 - 2009001490 - Unravelling pedagogy: The role of technology in shaping tertiary ICT educators perceptions of teaching
Date:	Fri, 3 Oct 2014 14:00:57 +1000
From:	MRO Human Ethics Team <muhrec@monash.edu>
To:	Judy Sheard <judy.sheard@monash.edu>

Dear Researchers

Thank you for the Annual Report / Request for Extension form provided in relation to the above project. This is to advise that the Monash University Human Research Ethics Committee (MUHREC) has noted the comments that you made on the form and research is approved until 3 October 2019.

Please submit a Final Report by 3 October 2019. To continue with human data collection after 3 October 2019, you will need a new submission to MUHREC.

Thank you for your assistance.

Professor Nip Thomson
Chair, MUHREC
Human Ethics
Monash Research Office

New forms are now available, please ensure that you use the most recent version.

Souheir Houssami, PhD - Executive Officer - Tel: +61 3 9905 2052
Coral Lindupp: - Tel: +61 3 9905 5490
Alison Woods - Tel: +61 3 9905 1478
Erica MacNally - Tel: +61 3 9905 2076

Our aim is exceptional service

Monash University
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Clayton VIC 3800, Australia
Email: muhrec@monash.edu

Website: http://www.monash.edu.au/researchoffice/human

B.3. Phase 2 – Explanatory Statement

MONASH University

December 9, 2010

Explanatory Statement – IT Academics Pedagogy – Interview Group

Title: Unravelling pedagogy: The role of technology in shaping IT academics' perceptions and application of teaching philosophy

This information sheet is for you to keep
My name is Selena (Sally) Firmin and I am conducting a research project supervised by Dr Judy Sheard, and Associate Professor John Hurst from Caulfield School of Information Technology, and Associate Professor Angela Carbone from the Office Pro Vice Chancellor (Learning and Teaching) towards a Doctor of Philosophy at Monash University.

Why did you choose this particular person/group as interviewees?
This group of teachers belong to Information Technology schools within various Victorian Universities with diverse experience incorporating technology into teaching. It will consist of approximately thirty IT academics, a mixed gender balance, with experience in both undergraduate and postgraduate teaching. Contact details for these teachers are publically available on University websites.

The aim/purpose of the research
The aim of this project is to uncover the ways in which IT academics think about their teaching and develop their practice.

Possible benefits
This research will provide an understanding of how technology influences IT academics teaching philosophy and practice.

What does the research involve?
The research will involve interview style questions about your teaching, such as what do you like most about teaching, characteristics you feel make up a good teacher as well as your rationale how you go about teaching a course. The interview will be audio taped and is likely to last no more than one hour.

Can I withdraw from the research?
Participation in this study is voluntary. You are under no obligation to consent to participation. However, if you do consent, you may withdraw prior to the data analysis.

Confidentiality
Your participation in this research project will be kept confidential. The interview notes/audio/transcript will be kept in a locked drawer. If we publish the results of our research, no personally identifying information (names, university names) will be used in any publication. If a quote from the interview is used in the text of a publication, at most a research code (e.g. AB03) will be used.

Storage of data

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. A report of the study may be submitted for publication, but individual interviewees will not be identifiable in such a report.

Use of data for other purposes

It is anticipated that further related studies will be conducted, based on the results of this study. If such studies occur, then we might use your anonymous data for the purposes of those studies. As in this study, no personally identifying information would be provided to anyone outside the research group or in publication.

Results

If you would like to be informed of the aggregate research findings, please contact Dr Judy Sheard on 9903 2701 or at judy.sheard@monash.edu.au.

If you would like to contact the researchers about any aspect of this study, please contact the Chief Investigator:	If you have a complaint concerning the manner in which this research CF09/2572 - 2009001490 is being conducted, please contact:
Dr Judy Sheard 9903 2701 judy.sheard@monash.edu.au	Executive Officer Monash University Human Research Ethics Committee (MUHREC) Building 3e Room 111 Research Office Monash University VIC 3800 Tel: +61 3 9905 2052 Email: muhrec@monash.edu.au

Thank you

Sally Firmin

B.4. Phase 2 – Pre-Interview Questionnaire

Pre-Interview Protocol

Preamble:

“I am interested in investigating the role of technology in shaping tertiary IT academics perceptions of teaching. From this I wish to devise 1. A framework of factors which influence IT academics approaches to teaching, and 2. An understanding of how technology influences IT academics teaching.”

Your pre-interview and interview responses will be completely anonymous and treated with strict confidentially, the interview will be recorded and a transcript provided for your review.

Questions:

1. Background and demographics: Please indicate your ...

- teaching experience – how long have you been teaching?

- qualifications

- tenure – contract, part-time, full time

- year level taught

- discipline specific expertise

2. Given a likert scale of 1 – 5 (one being not much to 5 being extensive), how would you rate yourself as a teacher using technology to support student learning?

B.5. Phase 2 – Interview Protocol

Interview Protocol

Preamble:

"I am interested in investigating the role of technology in shaping tertiary IT academics perceptions of teaching. From this I wish to devise 1. A framework of factors which influence IT academics approaches to teaching, and 2. An understanding of how technology influences IT academics teaching."

[Explain anonymity and confidentially, and that the interview will be recorded and a transcript produced.]

Questions:

[stress emphasis on technology integration and student learning]

1. Causal Influences:
   a. How did you get into teaching?
   b. Can you describe key moments, experiences or people that have influenced your teaching philosophy? For example mentors, professional development etc

      Probes:

      - *Why was that person particularly important to you?*
      - *Can you give examples of their practice?*
      - *Do you use any of their techniques in your own teaching?*

   c. Can you think of any other factors (e.g. circumstances) that have influenced your teaching?

2. Quality Teaching:
   a. What do you consider characteristics of a good teacher?
   b. Why do you believe these to be the most important?
   c. Which do you model in your own practice?
   d. Which do you think are the most important to students and their learning?

3. Teaching Practice:
   a. How do you go about teaching a course? (in particular course assessment methods and delivery approaches)
   b. Describe your teaching environment. How does it influence your approach?

4. Technology, Teaching, and Student Learning:
   a. What technologies do you use to facilitate student learning?
   b. Why these particular technologies?
   c. Can you describe some of your experiences using technologies in your teaching? (particularly those that have influenced your practice)

      Probes:

      - *Why was that experience particularly important to you?*
      - *In what ways do you use technology?*
      - *Did these experiences change your approach to using technology? Discuss reflective practice here.*

d. What do you think are the most important factors to consider around technology adoption to enhance student learning?
e. What is your general feeling regarding technology enhanced teaching? How if at all has technology influenced your teaching?

   Probes:

   - *If good/positive: What is it that makes it good?*
   - *If bad/negative: What is it that makes it bad?*

f. How would you describe your relationship with technology at a i).physical level, and ii). an emotional level

5. If I asked you to draw a Venn diagram, which represented learning and teaching, and educational technology, what would it look like?

B.6. Phase 2 – Sample Memo

November 16, 2012

This memo contains thoughts, reflections after conducting phase two, interview 18, conducted on Friday 16/11/12, at 12:30 pm. I have marked new ideas that I haven't had come up in an interview before in pink highlight, and some key concepts or reflections in blue highlight.

This IT lecturer was identified through application of a grounded theory theoretical sampling approach, with a focus on *great IT technology using teachers*. This interviewee was recruited using a snowballing technique, recommended by my primary supervisor as a reflective technology-using teacher.

This person reported commencing teaching through tutoring while completing a PhD. This interviewee reflected they had never considered becoming an academic. Interviewee 18 reflected that others knew before she did. She was offered a scholarship and an RA position. She reflected that teacher's in her home country are thought to be boring and stuffy (I think she didn't want to be like that, or appear like that). She reflected, that she felt teaching was her destiny or life path. She reflected on liking the flexibility and space to think as an individual in an academic position.

She indicated she always re-wrote materials when teaching a course for the first time. She placed a great emphasis on contextualisation of materials, and applied style learning materials. One interesting thing she said was when teachers lecture a course for the first time they are too preoccupied with their own learning, and don't always see the best way to do things.

She indicated she believed that technology needs to pass a certain threshold to be useful (here I think she meant threshold in the sense that the technology has to be useful). When I asked her about how she gauged that threshold she really said it was due to instinct (she appears to perform on gut instinct and her opening answer she indicated she was naturally a good teacher). Her instinct is gauged on the student's participation, for example, body language, and participating in discussions.

When I asked her what she thinks are good qualities in a teacher, she framed it in the information age. That quality teacher helps a student to learn, to guide them in sorting out what is good information and what is not. She indicated about helping the students acquire the knowledge. She indicated that the selection and breadth and depth of topics are important. She indicated that a strong foundation can help them to learn more. She feels that depth is more important that breath. She indicated acquiring knowledge she links material together, and reviews previous week's material, she never rushes it. She uses quizzes to help reinforce concepts. The quizzes (10 weeks) is worth 3% bonus marks. She chooses difficult or challenging questions and supplies answers. She believes in giving prizes to enthuse students. Students like to be recognised, she got this idea at an IBM camp. She believes in giving solutions to the tutorial questions as she feels students can learn from them. In the week 1 tutorial, she administers a pre-test (the idea came from another teacher who used this technique).

When I asked her about assessment, she indicated that her assessment was never outside the scope of the class. She believes this is in the philosophy of course work and not research. She spent quite a lot of time reflecting on plagiarism, and how she combated. Her main technique is through the technique of giving students lots of examples (e.g. gives previous year's submissions and examples from the Internet). She indicated she was trying to provide ideas, by showing them good materials and good examples. I think what she was trying to say that by providing lots of examples students don't really need to plagiarise.

Technologies used include the use of Moodle to record attendance. Each student can see which classes they have attended, so students know that attendance is important "you learning by being here". She indicated creating videos and having competitions e.g. she makes an error and asks the students to identify it. She got the idea of using short videos from the Khan Academy website. Also from watching videos on dog training. She selects topics through experience the course 2 or three times, by identifying the gems (when students get an ah hah moment). She uses echo 63, she also uses Camtasia. She would like to try technologies to annotate her slides and hasn't used it yet because it takes time at the commencement of class (each student has to install software). Currently she gets students to write answers on the board but would like to try a technology that could automate this. She trialled twitter but the students didn't like it because they had to create an account and didn't like the inconvenience of switching between applications. She has also introduced weblogs, but these are not compulsory because she feels some students don't learn well from this approach and will just go through the motions.

When I asked about experiences of technology, she reflected back to the use of the Moodle quiz tool. The quiz tool is used as a confirmation and elaboration learning tool. The idea of the quiz came from another lecturer who was doing it, also to ensure the question is not trivial. Her advice to other lecturers is that technology is a tool to enhance the student's learning. You need to see it from the student's point of view. Important things for IT lecturers vary on the content and type of the course, for example project management is theoretically heavy. Use pictures to illustrate ideas, and use animations (see video), to scaffold concepts. Incorporate students into the images. For example,e use a picture on the introduction slide so the students immediately know what the topic is about.

When I asked her about her connection to technology on a physical level and on an emotional level, I had to rephrase the question, so she could answer it. It is a difficult question if you haven't' thought about your connection to technology before. I wonder if this is linked to the fact that she see's technology as a tool, something separate, whereas some of the other technology using teachers see it as part of the learner. I think this is a kin to a tool that the learner uses as opposed to an appendage attached to the learner (a cyborg). See pictures below.

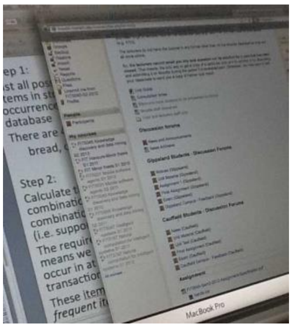
Picture 1

Picture 2

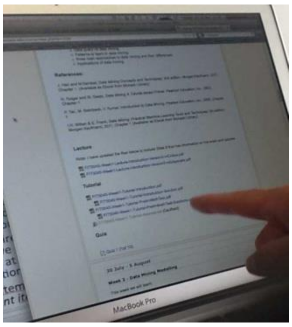
Picture 3

Pictures 1 and 2 are supposed to represent the cyborg style idea. I think this is like my daughter, she could not learn (or not easily) without her iPad. She uses it to type up assignments, create presentations, as a research tool, as a dictionary and thesaurus, calculator etc. It is an integral part of her learning. Whereas as picture 3 show the student using technology as a tool. It is separated from the learning; the learning can be done in other ways. This can be equated to teacher's thinking, and if they see technology as a tool, or as an integral part of their existence. For example, interviewee 15 said he would be very upset and couldn't function in his job without his email, whereas interviewee 18 indicated she wouldn't be too worried if she didn't have access to her email.

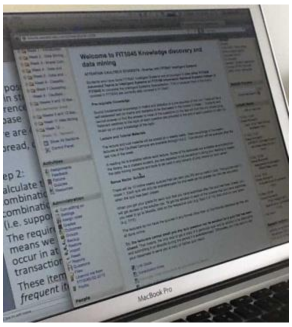
Here are some pictures of interviewee 18's Moodle shell:



Picture 4



Picture 5



Picture 6

There appears to have a lot of information, a lot of text and information, particularly in picture 6, and very linear, but I think this a symptom of Moodle.

At this university lecturers are assigned a course for a minimum of three years.

This teacher placed herself on the technology continuum at 4. Where 1 is not much use to 5 which is an extreme user.

1   2   3   4   5
| --|
X

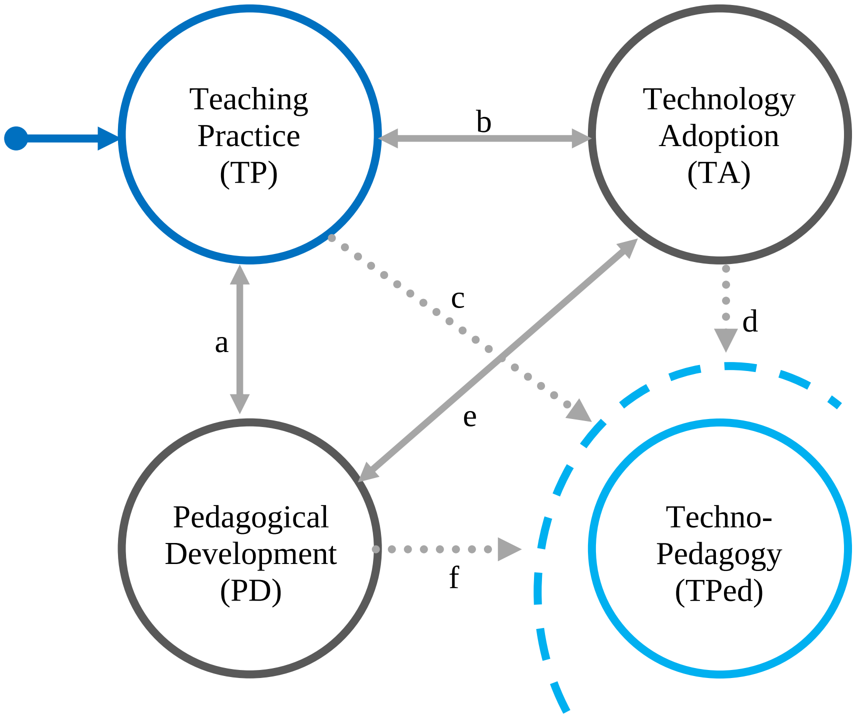
I think this fits with idea that this teacher feels technology is a tool for learning, a separate and distinct component.

This teacher's class seem a wonderful, supportive engaging environment, where the student's needs in focus at all times. When I reflect on this teacher, her self-reflection seems to be at a surface level, she knows and thinks about what she needs to do, but she does not really know why she needs to do it, or why a particular approach will work. She isn't able to use the educational language to talk about her approach e.g. scaffolding, or context based learning etc

When asked to draw a venn diagram or a metaphor which illustrates the connection between the teacher, technology and the student, this interviewee talked about the teacher being the watering can, and the student's learning (not the student), being the growth of a flower. She talked about how different nozzles on the watering can will provide a different amount of water, and strength of water, e.g. spray, stream etc. I like this, but interesting technology was omitted from the metaphor.

B.7. Phase 2 – Sample Model

This is an early version of a sample model from phase two, which after much iterations was modified into to the final model seen in Chapter 8.2.3. The diagramming process facilitated conceptualisation of the data and formation of the theory.



The above graph is known as a directed graph (note to self: see graph theory connectivity). The **dark blue** line with a beginning disc point represents a teaching starting point. The disc represents input data, representing teaching experiences and existing knowledge. All academics have a teaching practice. Teaching practice represents the “How” dimension of teaching. These academics ask ... How will I teach? How will I assess? How will I present the materials? etc.

The pedagogical development circle represents the “Why” dimension of teaching. In this space academics ask ... Why do I teach the way I do? Why am I influenced to teach this way? This is about the reasons, rational, philosophy, and the thinking behind my teaching.

The technology adoption circle represents the “What” dimension. In this space academics ask … What technologies are available? What technologies will I need? What technologies will I use? What technology will engage the students?

The **pale blue** circle represents the combination of all three circles. The lines connecting these are dotted to show that all three are required in order to have a techno-pedagogy. If either PF or TA are missing there is no TPed. Those academics who work in the techno-pedagogy space think about the “Why”, “How” and the “What” aspects of teaching.

Appendix C Phase 1 – Open Codes

List as at 18 September 2011

Open Code	**Description**
Assumptions about student learning	Teachers making assumptions about how students learn
Attributes of a quality teacher	Attributes of quality teachers
Constraints of traditional practice	Teachers discussing constraining university policies
Course materials	Teachers connecting development of materials presentation to student learning
Deep learning	Teachers reflections on student demographics and learning activities that are characteristic of deep learners
Discipline speciality	Teaching area (subject expertise or speciality)
Disciplined based pedagogy	Influence of discipline on the academic's teaching practice
Disciplines taught	Disciplines taught by academic includes those that are not necessarily their speciality
Examples of student discipline breaches	Teachers outlining examples of poor behaviour by students in class
Imposed pedagogy	Lecturer has pedagogical practices imposed upon them by management, university policy, government policy etc
Imposed process	Teachers discussing imposed university process which constrains assessment, and teaching practice
Lab approach	Teachers thoughts on the purpose of lab classes
Lacking industry experience	Reflection of academic's experiences in industry and the impact on their teaching
Lecture delivery style	Teachers practice regarding delivery style during lectures
Lecture delivery style reasons	Teachers reflecting on why they teach the way they do (in lecture situation)
Lecture preparation	Teachers details preparation and background regarding lecture materials
Mentor lessons	Teachers reflecting on colleagues, friends and confidants who have influenced and guided their teaching approach
Mentor was a former teacher	This academic's mentor was someone who had taught them in primary, secondary school or university

Open Code	**Description**
Outcomes of collaboration	Teachers outlining benefits and outputs of collaborative teaching partnerships
Pedagogy underpinning technology adoption	Teachers discussing their thinking behind the use of technology to facilitate student learning
Potential use of technology not utilised	Teachers identifying unexplored benefits of technology for student learning
Preferred speciality	Preferred discipline speciality. May or may not be the same as what the person actually teaches
Preferred speciality reasons	Reasons why the teacher prefers this particular subject or discipline area
Reflecting on student's approach to assessment	Teachers reflecting on student thinking around approach and completion of assessment tasks
Researching course materials process	Teachers outling learning material research sources
Researching teaching philosophy	Teachers discussing exploring ideas in the literature as an inspiration for their own practice
Self evaluation of teaching practice	Example of teachers critiquing their own practice
Self evaluation of technology use	Example of teachers critiquing their technology adoption
Speciality influences	Influences on teacher's speciality development
Student engagement	Teachers talking about ideas around engaging students in learning
Student reflecting on student learning	Teachers reflecting on students approach to learning
Surface learning	Teachers reflecting on the characteristics of surface learners
Teacher and student relationship	Teachers reflecting on the importance of the relationship between teacher and student
Teacher approach to security of materials	Teachers reflecting on their approach to the production and safety of learning resources
Teacher approach to web 2.0 technology use	Teachers reflecting of web 2.0 technology features
Teacher as a role model for students	Examples of teachers reflecting on situations where they are a role model to students, and so feel they must control behaviour in certain way
Teacher as developer of new technology	Examples of teachers developing software for learning and teaching purposes
Teacher as motivator	Teachers describing their approach to motivating students
Teacher attributes	Teachers describing attributes of quality or excellent teachers
Teacher comparing technology	Teachers making comparisons of features and uses of various educational technologies

Open Code	**Description**
Teacher constructivist approach	Teachers facilitating learning using real world examples and drawing on students existing experiences and knowledge
Teacher knowledge of copyright	Teachers reflecting on importance and knowledge of copyright
Teacher knowledge of software version	Teachers reflecting on knowledge of software versions installed on their computer
Teacher providing historical context of technology	Teacher providing historical description of technology use and development
Teacher reflecting on affordances of technology	Teachers reflecting on educational uses of technology
Teacher reflecting on applied concepts of course	Teachers discussing the importance of work based examples and scenarios to enhance student learning
Teacher reflecting on assessment	Teachers outlining approach and development of assessment tasks
Teacher reflecting on assessment feedback	Teachers approach to production and style of feedback on student assessment tasks
Teacher reflecting on class size	Teachers discussing the pedagogical limitations associated with large class sizes
Teacher reflecting on constraints of technology	Teachers reflecting on frustrations and disadvantages of educational technology use
Teacher reflecting on core versus elective courses	Teachers discussing student motivational approaches between teaching core versus elective courses
Teacher reflecting on fear of technology	Teachers discussing potential and actual problems experienced with using educational technology
Teacher reflecting on graduate attributes	Teachers discussing expected qualities of graduating students
Teacher reflecting on learning materials	Teachers outlining features of good quality learning materials
Teacher reflecting on lecture process	Teachers discussing the problems and limitations of lectures as a student learning tool
Teacher reflecting on link between technology and teaching	Teacher describing technology's role in supporting teaching
Teacher reflecting on link between technology and pedagogy	Teacher describing technology's role in influencing teaching practice
Teacher reflecting on own learning	Teaching describing their own learning approach and how it has influenced their teaching approach
Teacher reflecting on own skills and knowledge	Teachers analysing their own skills and knowledge
Teacher reflecting on pedagogy	Teachers discussing factors that influence their thinking and practice
Teacher reflecting on plagiarism	

Open Code	Description
Teacher reflecting on quality teaching	
Teacher reflecting on student approach to assessment	
Teacher reflecting on student comprehension	
Teacher reflecting on student demographic	
Teacher reflecting on student learning	
Teacher reflecting on student motivation	
Teacher reflecting on student team work	
Teacher reflecting on successful practice	
Teacher reflecting on technology adoption	
Teacher reflecting on the technology use of others	
Teacher reflecting on transferrable practice	
Teacher reflects on learning styles	
Teacher reflects on link between student learning and assessment	
Teacher reflects on link between student learning and technology	
Teacher reflects on online versus face-to-face teaching	
Teacher using educational terminology	
Teachers approach to assignments	
Teachers approach to blended delivery	
Teachers approach to course development	
Teachers approach to discipline	
Teachers approach to exams	
Teachers approach to labs	
Teachers approach to releasing course materials	
Teachers approach to student reading	
Teachers approach to tests	
Teachers approach to tutorials	
Teachers expectation of students	
Teachers feelings around technology use	
Teachers rationale for use of technology	
Teachers stress factors	
Teachers view on printing class materials	
Teachers views on technology	
Teaching a course first time or new course	
Teaching approach	

Open Code	**Description**
Teaching career choice	When did interviewee decide they wanted to be a teacher
Teaching career duration	Length of time interviewee has been teaching
Teaching highlights	
Teaching peer review	
Teaching practice contemporary	Example practice (philosophy) of contemporary teachers
Teaching practice non-contemporary	Examples of teaching practice in a non-contemporary environment
Teaching strategy origin	
Technology enhancing learning process	
Technology enhancing teaching process	
Technology used for online	
Technology used in teaching	
Technology used in teaching administration	
Technology used in teaching preparation and research	
Tutorial preparation	Teachers outline of tutorial preparation
Working with students	Examples and influences of teachers working with students

Appendix D Alignment of Research and Interview Questions

Table 10-1 Phase 1 – Alignment of Research and Interview Questions

Research Question	**Applicable Interview Question**	
	Phase 1 Interview Protocol	**Phase 2 Interview Protocol**
How do IT academics develop their pedagogy?	Questions 1, 2, 3, 4	Questions 1, 2, 3
What are IT academics experiences of using technologies in their teaching?	Questions 5, 6	
For what purpose do IT academics adopt technology?		Question 4
What role does technology play in shaping IT academics pedagogy?	Questions 7, 8	Question 4, 5

Appendix E List of Recommendations

Recommendation 1: Encourage IT academics to foster their creative development, such as developing their own educational software, while pursuing practical and logical thinking skills. In addition, workload IT academics with courses they are familiar with, and have confidence in teaching.

Recommendation 2: Support IT academics to develop and maintain healthy relationships with family and friends in social environments. Provide opportunities for IT academics to engage in industry release programs, develop industry partnerships, and where possible employ IT academics with some previous industry experience. Encourage IT academics to share ideas and expertise and develop strong relationships with their peers. Nurture a culture which encourages and rewards participation in teaching and learning development activities for IT academics. Encourage participation in sport and culture groups, as well as provide mechanisms for academics to embed media in their daily experiences, for example, social media groups.

Recommendation 3: Encourage IT academics to benefit from using contemporary educational language making conscious decisions to access a range of teaching and learning strategies.

Recommendation 4: Encourage industry interaction and limit stressful teaching environments for IT academics.

Recommendation 5a: In our modern area of student-centred pedagogy, it is essential teaching and learning environments foster and encourage growth of great teaching attributes (approachable, caring, a good communicator, honest and passionate), helping to shape teaching in student focussed way.

Recommendation 5b: IT academics should take care when considering the use of humour, and should avoid using humour which is disrespectful and views women,

men, ethnic or racial groups, handicapped or aged people in a discriminatory fashion (see Harris, 1989).

Recommendation 6: It should be noted that some IT academics still have a traditional view of student attendance and its relationship to student learning. Encourage an understanding and application of constructivist learning theory to improve engagement and motivation in students. Encourage identification of key or pivotal teaching moments. These allow teachers to direct learning toward these moments and improve student learning.

Recommendation 7: Focussing on style, administration and pedagogy of assignments created will help to improve quality, however additional research is required to better understand inconsistencies around ideas reported by interviewees and the literature. IT academics may benefit from the fostering of a learning and teaching environment which supports the use of formative assessment to identify student progress, and the use of open book examinations in order to facilitate student professional career readiness. IT academics should provide students with timely marking and feedback in order to improve student learning and engagement. IT academics could adopt the use of marked in-class testing in order to encourage students to attend class. However, they should be aware that this approach is not known to facilitate deep learning.

Recommendation 8: IT academics are comfortable teaching a diverse variety of sub-discipline areas and are driven in an environment which facilitates a long and deep association with their chosen speciality area.

Recommendation 9: When developing teaching and learning policies university management and educators should be encouraged to work collegially in order to develop policies and processes which support shared values (Ramsden, 2003), and ultimately work to improve the quality of teaching and learning.

Recommendation 10a: When facilitating laboratory classes IT academics should be encouraged to extend the ideas presented in lectures, helping students to develop their skills, and foster resilient, independent thinking. When delivering lectures IT academics should be encouraged to trial new and innovative approaches in order to avoid the transmission style teaching which has long been a cause of much frustration by students. Similarly, when teaching tutorials, IT academics benefit from support to create quality materials, and foster active, cooperative learning environments.

Recommendation 10b: The use of competition and rewards should be used with great care. IT academics, should be aware of the range of student abilities, and that rewards are more effective for increasing effort than producing quality learning and thus afford an extrinsic motivation. In addition, Good and Brophy's (2007) recommendations suggest focussing rewards to increase participation in boring or unpleasant or routine tasks. IT academics need to develop deep content knowledge as well as an emotional confidence in their teaching. IT academics should use chunking when teaching complex ideas. IT academics can encourage students to learning by example by releasing solutions for simple tasks. IT academics can use storytelling as a way of navigating through complex content.

Recommendation 11: IT academics will benefit from being encouraged to adopt technologies which help reduce their cognitive load while teaching. IT academics should use animations in conjunction with active learning tasks (see Naps, et al., 2002), to aid retention of learning. In additional IT academics will benefit from access to technologies that can help spark their imagination and increase their intrinsic motivation.

Recommendation 12: IT academics should think about avoiding or limiting the use of external resources which require large and costly downloads to students. University management and administration could benefit from fostering resourced and supported environments which promote independence and self-efficacy, where IT academics willingly and hastily learn and adopt new technologies.

Recommendation 13: When developing educational resources with software such as PowerPoint, IT academics will benefit from being encouraged to utilise the high-end features of the software, to aid engagement and motivation amongst students. IT academics should use technological back-up plans in the event of technology failure when teaching. IT academics can increase student participation and promote discourse by personalising resources. Development of a strong gaming culture can also increase IT academic propensity to access and implement technologies aimed at improving learning and teaching. IT academics can better understand student learning behaviours by conducting LMS data analytics. The Internet can be used to illustrate unique problem-solving approaches to students.

Recommendation 14: IT academics are known to be technological experts and require access and support for a range of specialised, new and emerging software applications including the supporting hardware. This will aid motivation and ensure currency of knowledge and skills for IT academics and facilitate better learning outcomes for students.

Recommendation 15: IT academics should be encouraged to utilise immersive environments as a way of improving student’s motivation, collaboration and as a way of developing practice and drill type skills. IT academics should be encouraged to explore and experiment with immersive environments and move toward new ways of delivery. IT academics should be encouraged to use interactive software to increase student motivation and improve communication and focus on how students learn best. IT academics should be encouraged to adopt the diverse learning and teaching opportunities afforded by eLearning environments, and utilise video options where appropriate. Simulation environments can be used to practice and repeat skills in a safe and interesting way for students. IT academics should continue their focus on students using technology as a lens.

Recommendation 16: IT academics should consider using applied learning techniques to improve learning context for students. A gamification approach can be used to increase student engagement and motivation however caution is advised when applying competitive elements. Social media learning can be used to improve communication and collaboration skills.

Recommendation 17: IT academics should be encouraged to utilise technology to enable paperless learning. In focussing on technology integration IT academics should consider students, engagement, learning materials, communication and tools as key aspects of the relationship. IT academics could benefit from a deeper awareness of the nature of this relationship, likely to improve the quality and flexibility of student learning (see Anderson, 2005). IT academics should focus on the power of technology for growth and development in improving student learning experiences and acknowledge students' a psychological and physical interdependence with technology.

Recommendation 18: To function at an expert level, problem solve and develop a sense of self-efficacy IT academics require significant and persistent access and engagement with a range of technologies.

Appendix F The substantive theory of techno-pedagogical practice questionnaire

Instructions

Use the substantive theory of techno-pedaogical practice to determine your teaching pracitce, pedagogical develoment, technology adoption, and techno-pedagogy scores by using the template provided (see Questionnaire). Rate the 63 factors listed below according to how important each is to you. Place a number on a scale of 0 to 2 on the line before each factor.

Scale

Descriptor	Score
Yes	2
Sometimes	1
No	0

Questionnaire

Score	Question
	1. I prefer a creative environment, where I can pursue practical and logical thinking skills.
	2. I feel a sense of achievement when learning difficult concepts.
	3. I have confidence when teaching courses and content you are familiar with.
	4. I engage with my family and the wider community, and these relationships contribute to my reflective thinking about my teaching.
	5. I have a sense of credibility due to previous work experience in industry or use industry-based examples to illustrate key concepts.
	6. I introduce students to industry inspired problem-solving approaches and industry standards e.g. programming standards.
	7. I have strong relationships with peers and collaborate with other educators.
	8. I read educational based literature.
	9. I conduct education-based research.
	10. I attend teaching based professional development activities e.g. conferences, training courses.
	11. I participate in sport or culture groups or engage with the media e.g. social media.
	12. I use learning and teaching language as well as discipline specific language.
	13. I believe students can be educated to remove or limit the impact of the generation gap e.g. when taught by younger academics.
	14. I provide an atmosphere of normality appearing more approachable to students facilitating improved learning outcomes.
	15. I care about students' learning, their careers and success in life.
	16. I am a good communicator, communicating with students at different levels in different ways.

17. I display honesty, admitting when they don’t know, and am prepared to find out.
18. I use humour carefully and respectfully to create a relaxed learning and teaching environment.
19. I exhibit great teaching attributes such as approachable, caring, a good communicator, entertaining, honesty and passionate.
20. I maintain a traditional view of a need for student attendance and its relationship to student learning.
21. I apply constructivist learning theory (view knowledge as being shaped by experiences, and as new experiences are encountered, these are related to previous knowledge and understanding) to enhance student learning.
22. I identify key or pivotal teaching moments to direct and improve student learning.
23. I prefer formative assessment (evaluate student performance during the learning) as a means of identifying student progress.
24. I prefer open book examinations as this approach facilitates student professional career readiness.
25. I prefer a timely approach to feedback and marking in order to improve student learning and engagement.
26. I see feedback and making as a means of determining students’ current skill capacity.
27. I use in class testing to encourage student attendance.
28. I enjoy teaching a diverse range of major and speciality areas.
29. I enjoy teaching courses which require deep level of content knowledge in specific learning contexts.
30. I feel constrained in their teaching approach by imposed university policy and procedures.
31. I desire a collaborative collective culture which is more likely to inspire student learning.
32. I use laboratory tasks to build upon existing skills and develop resilience and independence in students.
33. I believe lectures are effective in transmitting information to students, but ineffective in developing high order thinking skills.
34. I use tutorials to complement lectures and provide a superior learning environment when well facilitated.
35. I provide challenging tutorial tasks which promote problem solving and focus on team work and cooperative learning.
36. I use competition and rewards for menial or repetitive tasks.
37. I require strong content knowledge and emotional confidence for the courses they teach.
38. I use chunking (breaking down of a collection of elements which are strongly connected) to teach connected ideas and complex ideas.
39. I use the technique of concept learning (learn by example), as a simple form of student feedback e.g. release solutions for simple tasks.
40. I use storytelling to motivate and engage students.
41. I facilitate communication with students using technology.
42. I use technology to make social connections with others.
43. I am inspired by the potential of technology.
44. I aid student learning through the creation of reusable, duplicatable resources.
45. I facilitate understanding of complicated concepts by breaking them into animated steps.
46. I provide pervasive learning resources for students.
47. I try to avoid or limit the use of external resources which are large and costly downloads for students.
48. I am a self-reliant, independent users and creator of technologically based educational resources.
49. I use high end features of software.

50. I display a strong passion for games and playing games.
51. I use LMS' for teaching, administration, communication or to conduct learning analytics.
52. I use the Internet as a resource and teaching research tool.
53. I am a technological expert who requires access and support for a range of specialised, new and emerging software applications including the required hardware.
54. I engage with technology enhanced learning environments.
55. I engage with technology enhanced learning strategies.
56. I engage with technology enhanced ways of teaching.
57. I engage with new and emerging technologies.
58. I own and interact with lots of technology within and beyond the classroom.
59. I use paperless learning.
60. I have consideration for the environment.
61. I see technology as aiding thinking and problem solving in students.
62. I have a strong dependency on technology (possibly bordering on addictive.
63. I develop educational technology (software) for teaching and learning purposes.

Scoring

Fill in the scoring chart to determine your results for each category. Add up the numbers you recorded against each question, and calculate a sub-total for each category. Questions for each sub-category are noted in the questions column. Enter your sub-totals in the "Your Score" column. Each category is worth 25%. To calculate the value of each category use the following equation:

$$= (((x \div y) \times 100) \times 25 \div 100)$$

Where x is your score and y is the category sub-total. Use your calculator or computer to solve each equation. Enter your results in the "Calculations" column. A techno-pedagogue will have a score in each of the four categories. The greater the number of 2's the greater the academic is drawn to that category.

Scoring Chart

Questions	**Your Score (x)**	**Sub-Totals (y)**	**Calculations**	**Category**
1 – 23		**46**		Pedagogical development
24 – 40		**32**		Teaching practice
41 – 53		**24**		Technology adoption
54 – 63		**18**		Techno-pedagogical practice
Totals		**120**	**100%**	

11 Glossary

Active learning

Any teaching approach which gets students actively involved and reflecting on what they are doing (Keyser, 2000).

Andragogy

The art and science of helping adults learn (Knowles, 1970, p. 38).

Applied learning

Associated with hands on, or practical learning experiences which motivates and empowers students (Harrison, 2006).

Augmented learning

An on-demand learning technique where the learning environment adapts to the needs and inputs from learner (Huang & Wen, 2016; Klopfer, 2008).

Axial coding

a set of procedures whereby data are put back together in new ways after open coding, by making connections (Strauss & Corbin, 1990, p. 96).

Coding

The process of deriving and developing concepts from data, and defining what the data is about (Bryant & Charmaz, 2007; Corbin & Strauss, 2008).

Communities of practice

Groups of people who share a concern or a passion for something they do and learn how to do it better as they interact on a regular basis (Wenger, et al., 2002; Wenger & Snyder, 2000).

Constant comparison

The analytic process of comparing different pieces of data for similarities and difference (Corbin & Strauss, 2008, p. 65)

Constructivism

Views knowledge as being shaped by experiences, and as new experiences are encountered, these are related to previous knowledge and understanding (Pelech & Pieper, 2010).

Core category

A high impact dependent variable of great importance; it is hard to resist; it happens automatically with ease (Glaser, 2007).

Diagrams

Diagrams are visual devices that depict relationships between analytic concepts (Corbin & Strauss, 2008, p. 117)

Digital divide

The gap separating those individuals who have access to new forms of information technology from those who do not (Gunkel, 2003, p. 499).

Digital laggard

A true technology cynic (Luftman, 2004).

Digital native

Anyone too young to recall the arrival of digital technology (Prensky, 2001).

Dimensions

Specify the location of properties along a continuum (Strauss & Corbin, 1990).

Educational technology

The study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources (Januszewski, et al., 2008, p. 1).

e-Moderator

A person who presides over an electronic online meeting or conference (Salmon, 2005, p. 4)

Epistemology

The philosophy of knowledge (Byrne, 2001, p. 209).

Gamification

A learning and teaching approach used to motivate students to learn by using video game design and game elements in learning environments (Bennedsen & Caspersen, 2007; Fokkens-Bruinsma & Canrinus, 2014).

Grounded theory

A theory that is inductively derived from the study of the phenomena (Strauss & Corbin, 1990).

Guide on the Side

A phrase used to the teachers who provide occasional guidance to students, while encouraging them to play a more active and collaborative role in their learning (Palloff & Pratt, 1999).

Horseless-carriage thinking

Our tendency to use new technologies in exactly the same ways as we used earlier technologies (Horton, 2000).

Immersive learning

A targeted individual explorative interactive learning experience in a virtual world (Zender, et al., 2009).

Interpretivism

A view that cultures can be understood by examining what people believe about, their ideas, and the meanings that are significant to them. All knowledge is a matter of interpretation (McNabb, 2010).

Life-long learning

A continual process providing stimulation to empower individuals to acquire the knowledge, values, skills, and understandings required in life and apply these skills to give them confidence, creativity and enjoyment in all roles, circumstances and environments (Kearns, et al., 1999).

Memoing

Memos are written records of a researcher’s thinking during the process of undertaking a grounded study (Birks & Mills, 2011, p. 10).

Ontology

Aa holistic philosophy that knowledge is not independent of life experiences (Byrne, 2001).

Open coding

The process of breaking down, examining, comparing, conceptualising, and categorising data (Strauss & Corbin, 1990).

Open sampling

Identifies the interviewees using a broad set of criteria (Goulding, 2007).

Paradigm model

A perspective, a set of questions that can be applied to data to help the analyst draw out the contextual factors and identify relationships between context and process (Strauss & Corbin, 1990, p. 89).

Pedagogy

The art and science of how something is taught and how students learn it. Pedagogy includes how the teaching occurs, the approach to teaching and learning, the way the content is delivered and what the students learn as a result of the process (Fulks, 2004).

Problem based learning

PBL is a pedagogical approach for adopting substantial, real-world problems and providing the resources and support to learners as they cultivate the knowledge and skills necessary to solve the problem (Keane & Keane, 2005).

Properties

Attributes or characteristics pertaining to a category, and dimensions are the location of properties along a continuum (Strauss & Corbin, 1990, p.61).

Relationships

Linkages or connections between data concepts (Bazeley, 2009; Edhlund, 2008).

Selective coding

The name given to the practice of organising a structure to the data and ascertaining an order of significance of the conceptual categories (McNabb, 2010).

Signature pedagogies

The types of teaching that characterise the fundamental ways in which students are educated for their professions (Shulman, 2005b).

Storyline

A storyline is a conceptualisation of the central phenomenon or core category (Strauss & Corbin, 1990).

Student-centred learning

Shifts the focus of instruction from the teacher to the student (Jones, 2007).

Technology

The practical application of knowledge particularly in a discipline or specific field or area such as ET (Merriam Webster Inc., 2010).

Techno-pedagogy

The various models of teaching and learning associated with instructional technologies (Newson, 1999, p. 4).

Theoretical perspective

The philosophical view underpinning the methodology (Crotty, 1998).

Theoretical sampling

The process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides what to collect next and where to find them, in order to develop his theory as it emerges (Glaser & Strauss, 1967, p. 45).

Theoretical saturation

Is the point at which gathering more data about a theoretical category reveals no new properties, nor yields any further theoretical insights about the emerging grounded theory (Bryant & Charmaz, 2007, p. 611).

Theory

A set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena (Strauss & Corbin, 1998, p. 15).

Ubiquitous learning

An innovative approach that integrates wireless, mobile, and context-awareness technologies (Hwang, et al., 2009).

Web 2.0

The network as platform, spanning all connected devices; web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of web 1.0 to deliver rich user experience (O’Reilly, 2005).

Web 3.0

Semantic web technologies integrated into, or powering, large-scale web applications (Handler 2009).