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Professional Learning and School Leadership in a Digital Age

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December 2015

A thesis in fulfilment of the requirements for the degree of Doctor of Philosophy

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Abstract

In the digital age, technology is playing an important role in changing how, when, where and why educators learn professionally. Newer forms of professional *learning* stand in contrast to more traditional forms of professional *development*. This shifting paradigm has implications for educators in all contexts. While there are now many technology tools that promote learning beyond school and system contexts, many argue that the professional learning that takes place within these contexts remains largely imposed, defined by the twentieth century paradigms of print media and information scarcity, and rarely sensitive to the needs of the individual teacher. In the context of these realities, for school leaders seeking to leverage the affordances of technology there remains a challenge.

This study explores the changing nature of professional learning in a digital age. With recourse to models such as the Personal Learning Network (PLN), Participatory Cultures and the Technological, Pedagogical and Content Knowledge (TPaCK), the study employs a mixed research design that examines the dimensions of contemporary technology-enabled teacher professional learning and investigates its impact on the school community. Findings are drawn from three distinct samples of educators that include preservice teachers, classroom teachers, technology mentors and principals. These findings challenge educational leaders to build future capacity for professional learning that is autonomous, learner-centred and authentic.

Statement of Originality

This thesis has not been submitted for consideration for any other degree from any educational institution. It represents my original work, performed under the guidance and supervision of supervisors at Macquarie University. All instances where the work of others has informed the study and/or creation of this thesis have been referenced appropriately.

Approval to undertake the study informing this thesis has been provided by Faculty of Human Sciences Ethics under reference number 5201300264 and by the State Education Research Application Process (SERAP) under reference number 2013113 (for further details, see Appendix 3.

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Michael Eric Stevenson Date

Acknowledgements

I'm quite sure that no thesis – including this one – has ever been written in a vacuum. Over the past three years, so many intelligent minds and compassionate hearts have supported me and informed my thinking about the world. Without them, I could not have travelled the rough terrain of this PhD journey.

As the focus of my doctoral research suggests, our thinking is shaped our connections to the multitude of information sources and people in that vast network that surrounds us. Many, if not most, of my good ideas come from my Personal Learning Network. Whenever I pick up a piece of technology, I'm using it to connect to something out there. With each connection, I'm learning more about the world and hopefully becoming a better human being. I'm very grateful to be alive at such an exciting time and to have found my feet and voice as an educator in the twenty-first century, thanks in large part to the technology and ideas I use to transform my teaching.

Professor John Hedberg and Dr Kerry-Ann O'Sullivan have both been outstanding supervisors. Their expertise and experience have been the guiding lights at dark decision times, while their open-mindedness and open doors have meant that I always felt I could ask questions, seek advice and move my thinking on when it needed to move on. Both John and Kerry-Ann have helped me to realise what's possible and this thesis would not be what it is without them.

I'd also like to thank Cathie Howe at Macquarie ICT Innovations Centre. A passionate educator, Cathie treated me as a colleague and friend from Day 1. She has championed my professional learning and research at times when I lacked the confidence to be my own champion. It's because of Cathie's hard work that organisations such as MacICT exist, where the nexus between research and practice is strong.

I'm very grateful to Professor Lori Lockyer, who as Head of Department welcomed me as a staff member to the School of Education when I left the Secondary classroom at the end of 2012. Lori has provided me with challenging teaching opportunities have broadened my skills as an early career academic, while reminding me to find the right balance between the classroom and thesis. As a true educator, she has recognised my potential and created the right conditions in which I could reach this potential.

As I complete what will be my fifth degree, I doubt I ever would have made it to university without the unconditional love and support that Helen Stevenson has given me. In the words of the famous Indigenous writer Wayne King, “your mother’s story is your story”. It’s her intellect, sensitivity and creativity that I strive towards, while it’s her determination to go to university as a mature age student and raise me as a single mother is the same determination that I have to be the person I want to be.

To my beautiful wife, Felicity: your success in most things (not withstanding technology!) is meteoric and you are my greatest inspiration. Even to know you is an honour, while to be married to you is, and always will be, my finest achievement.

To my beautiful son, Zain: you remind me that one doesn’t need to have a degree – or even to have been to school – to be an excellent teacher. At two and a half years old, you’re one of the best teachers I’ve ever had, and you’ve helped me learn more about life that I would have ever thought possible.

Chapter 1. Introduction

The Post-Modern Professional

Professional learning has, until recently, largely taken place in face-to-face settings. The learning in these settings has followed a fairly common narrative throughout the twentieth century: educators sit in staff rooms, training centres and auditoriums, subjected to school- or system-led training through system leaders, their principal, visiting guest speakers or professional trainers. In this older face-to-face paradigm, the term *professional development* emphasises the capacity of the institution to "develop" its educators. With limited resources, access and cost issues, such development typically takes place on designated staff development days, or at other times when classroom teachers can be released from face-to-face teaching. This kind of *development* emphasises the role and agency of the institution – including its leaders and the wider system. With relative ease, the provision of professional development can be quantified and measured through such metrics as *days attended*, *hours completed* and *certificates issued*. School and system leaders can claim that staff have been "developed" and thus ready to practise professionally until further "development" is required.

In many contemporary educational contexts, however, technology has played an integral role in the shift to a newer paradigm of professional *learning* - one that now emphasises the individual educator's agency and autonomy. For a growing number of educators, learning also takes place through the use of technology tools to access a diverse range of information sources and people relevant to their needs and interests. These tools and the professional learning they enable in this newer paradigm are yet to be fully leveraged. Meanwhile, the older face-to-face paradigm of professional *development* continues to give rise to the financial limitations all-to-often associated with face-to-face teacher professional development, such as the costs of releasing teaching staff, paying guest speakers and sending staff to professional development programs during school time. Many of these constraints are, in turn, predicated on assumptions that learning needs to happen at certain sanctioned times and that educators need to wait to be "developed". Many contemporary educators are now challenging these assumptions, with implications that are likely to be far-reaching and hard to ignore.

Understanding the paradigm shift from *development* to *learning* is further possible when examining just how different professional learning has been for some during the last fifteen years than it was in the twentieth century. At the turn of the century, Hargreaves (2000) presented an incisive and somewhat prophetic analysis of professional learning reflecting the tension between older and new paradigms. In his article "Four ages of professionalism and professional learning", Hargreaves traces the history, developments and shortcomings of many professional learning initiatives across what he describes as four ages that span the twentieth century, highlighting recurring themes such as an overreliance on singular pedagogy, the lack of teacher agency, insularity and resistance to change. In spite of these common themes, however, each of the ages is distinctly recognizable.

In the first age – or what Hargreaves terms the *pre-professional age* (pre-1960s) – teaching was more commonly seen as "managerially demanding but technically simple" and teachers were "virtually amateurs" (p. 156). During this time, teacher development largely involved on-the-job apprenticing, resulting in relatively static learning that fell well short of being regarded as professional. In the second age of the *autonomous professional* (1960s to mid-1980s), professional identity slowly emerged, but teachers were largely left to their own devices – so much so that "most teachers taught in a box" (p. 160). By contrast, the third and fourth ages – the *age of the collegial professional* (1980s onwards, "still emerging") and the *post-professional* or *postmodern age* (not yet fully emerging at the time of writing) – underscore a marked shift in the way teachers learn through socially mediated interaction within communities of professionals.

Positioned in the present tense and situated at the time of writing, Hargreaves' third age reflects the increasing complexities of schooling that have since led "many teachers to turn to each other for professional learning, sense of direction and mutual support" (p. 162). In particular, "from the mid-1980s, evidence has accumulated that cultures of collaboration are not just a self-indulgent teacher luxury, but have positive and systematic connections to teachers' senses of efficacy about being able to make a difference with their students" (p. 163). In foreshadowing the fourth age of the "postmodern professional", Hargreaves predicts a professional learning context that may be "broader, more flexible and more democratically inclusive of groups outside teaching and their concerns than its predecessors" (p. 167). In particular, this fourth age represents a world where the "need for closer relations between professionals inside the school and people 'out there' beyond it, is especially pressing" (p. 172). In spite of these four ages symbolising some form of progress towards many of the goals highlighted in the article – most notably, connectedness, collaboration and shared practice – Hargreaves maintains that "current experiences and perceptions of teacher professionalism and professionalization draw on *all* these ages", with many of the assumptions and practices of earlier ages still in flux (p. 151, my emphasis).

While we may now claim that technology has played an important role in facilitating the shift from *development* to *learning*, this has not always been the case. Also at the turn of the century, Cuban (2001) presented a scathing critique of technology misuse in schools. With access to desktop machines the pressing issue of the day, *Oversold and Underused: Computers in the Classroom* challenges a common assumption amongst education reformers: "increasing access to computers in schools will lead to more classroom use which, in turn, will transform teaching and learning" (p. 34). Drawing attention to the fallacy of this assumption and misuse of computers in many of the classrooms observed, Cuban asserts that, "if anything, the *addition* of a computer centre to the array of centres already in common use in these classrooms means that teachers have adapted technologies to existing ways of teaching and learning" (p. 58). By exposing their tendency to use technology to fit existing practice, the author highlights what has become an all-too-common theme in the years since: when seen as an "add-on", many educators are unlikely to use technology to transform learning. Simply providing technology is a necessary but insufficient condition to ensuring that it is meaningfully used for learning.

However, part way into the twenty-first century, one may perhaps be cautiously optimistic about the use of technology to transform learning. Evidence is yet to show that technology has assisted in changing the more traditional structures of most education institutions, such as timetables and an emphasis on face-to-face instruction. There is evidence, however, to suggest that it has disrupted the lives of many learners. Indeed, the "world out there" so important to Hargreaves' fourth age is now an inseparable part of how many learn. In this digital age, there is now a myriad of options for personalising and tailoring learning to the needs and interests of the individual.

When we reflect on some of the many current tools now available, we see the breadth and depth of learning possible beyond the classroom walls. Websites like *Wikipedia* enable interaction, collaboration and information dissemination on a large scale, with at-times hundreds (even thousands) of authors and editors negotiating through a complex interplay of language, semantics, structure, time, place and meaning to produce free texts "that anyone can edit, use, modify and distribute" (Wikipedia contributors, 2013). Social media provides a platform for participating in online affiliations, connecting with, and following education professionals. Tools for collaborative authorship such as *Google Apps for Education* enable the real-time co-creation of multimodal content (Saito, 2014). Apps and mobile devices provide "just-in-time" access to content, people and ideas through always-on connectivity. Content aggregation tools such as *Feedly* enable syndication of information sources so that relevant content can be delivered and accessed on any device through personalised channels. Indeed, very few of these technologies existed in their current forms fifteen years ago, if they existed at all. The opportunities to learn through the combination of these and other tools underscores the importance of the Internet – that overarching network now connecting over four billion people – as "…a metaphor for pedagogy… [being] open, accessible and full of potential" (Brady & Kennedy, 2007, p. 79).

In the digital age, *autonomy* now has very a different, if not opposite, meaning to that of Hargreaves' second age. Far from teaching in a box, the autonomous professional can now employ technology tools to connect with people, information and ideas from around the world. Rather than waiting to be "developed", many of these educators can autonomously seek out information and people, pragmatically using these tools at their disposal – including learning how to use them if necessary. Such professionals might engage in formal learning such as further tertiary study (itself increasingly managed online through flexible modes of study) or attendance at a one-day course. However, they can also engage in informal learning experiences, many of which exist after hours and through the use of wide-ranging technology tools on laptops, smartphones, tablets and other devices. These informal learning experiences are now broadly recognised for their importance in professional learning. In the Organisation for Economic Cooperation and Development (OECD) report on non-formal learning, Werquin (2010) points to the organisation's recognition of informal learning as a "rich source of human capital", while at the same time identifying a pressing issue in need of further attention: that "recognition processes are often marginal, small-scale and not yet sustainable" (p. 7, 3).

We are also witnessing a time when face-to-face and online learning opportunities are more seamlessly blended, such as when educators attend conferences and continue discussion via social media "hashtags". While it may be difficult to measure the extent of their autonomy or the value of this kind of professional learning, it is often through the acts of play, experimentation, creation and sharing that the learning is most visible. Though difficult to quantify, it is through immersion in some of the many online professional learning communities and through professional dialogue with educators in school communities that we often find evidence of this kind of professional learning.

In a growing number of educational contexts, there is now an equal emphasis on both face-to-face and online settings. Broadly speaking, we are now moving away from an *either/or* view of face-to-face and online learning, seeing these two areas as more closely intertwined and less mutually exclusive. For example, as Whitehouse (2011) notes, it is the seamless use of current technology tools that denotes the shift from *blended* learning – with its relatively clear distinction between face-to-face and online environments – to "*blurred* learning", with learners "often working synchronously across distance and at the same time working face-to-face with a group" in an environment where "the meaning of being present blurs as one works across time and distance, and brings new dimensions of learning in networked learning environments" (p. 145). In harnessing this kind of learning, the digital age undoubtedly presents as many challenges as opportunities. How educators choose to engage with these challenges and opportunities plays a pivotal role in determining how they support their professional learning, and that of their colleagues, in the years to come.

About the Study

This study explores the nature of professional learning within three Australian educational contexts. The first of these was *Connected Communities 21* (CC21), a project that facilitated the face-to-face and online professional learning of school leaders from seventeen New South Wales Government schools as they worked together to respond to new curriculum demands. This context enabled the study to examine the nature of their professional learning and explore how these informed leadership decisions and the learning of colleagues in their school communities. School leaders in this sample ranged from relatively early career technology mentors to highly experienced principals. The second context was the *Macquarie ICT Innovations Centre* (MacICT), a professional learning centre located on campus at Macquarie University in New South Wales, providing a range of one-day technology training courses. This context enabled the study to investigate the role and relevance of face-to-face training in technology-enabled professional learning. The participants in this context were typically early career classroom teachers undertaking required formal training for ongoing accreditation purposes. The third context was the *Preservice Teachers Group* (PSTs), a cohort that included third year Education students from primary and secondary Teacher Education Program (TEP) units studying at Macquarie University. This context enabled the study to examine preservice teachers' professional learning and distinguish this learning, to some extent, from that typically required in most undergraduate Education programs.

All three contexts that are included in this study provide evidence that speaks to the nature, extent and impact of varying forms of professional learning. In particular, the study explores professional learning through the many decisions that educators – and especially school leaders – make about what, when, how and why they and their colleagues learn. These decisions are therefore integral to understanding learner autonomy, metacognition and effective school leadership as key aspects of professional learning in a digital age. Further, in examining the role of decision making, each of the contexts studied provides evidence of the diverse use of technology tools for information gathering and people-to-people networking. The relevance of Australian curriculum demands emphasising the use of technology tools for learner-led inquiry is also explored by considering how educators' use of tools for professional learning reflects their response to the curricula with which they work.

Given the many uses of technology tools to leverage learning in such seamless ways, one may well question whether or not Cuban's concerns of fifteen years ago – the overselling and underuse of technology in education and its incumbent status as an "add on" – are still valid. The author's critique of the inequity between classrooms where technology is used well and those where it not used at all still persists to this day. However, more recent evidence suggests that educators' use of technology *for professional learning* is playing a powerful role in informing its broader use in teaching and learning. Such evidence draws on examples of often highly connected educators that learn by doing, engaging in the acts of play, experimentation, creativity and sharing with digital tools.

This study critically examines the evidence in the literature and, empirically, among the three contexts. Stage 1 of the study explores the school community as an important context for shaping professional learning. The thesis argues that it is within this context that many of the discourses, support structures, leadership initiatives and mentoring needed for genuine *professional learning* can be observed. This context also provides a valuable area for generating insights about how educators perceive professional learning – both theirs and their colleagues. It also sheds light on the work of school leaders, their support for both older and newer forms of learning and how their philosophies and attitudes shape the learning of their colleagues. In Stage 2, the study measures the perceptions and reported actions of educators in relation to three constructs for which there is, to date, limited empirical research findings. These constructs include *Personal Learning Networks* (PLNs), *Online Participatory Cultures* and *Technological, Pedagogical and Content Knowledge* (TPaCK). As the thesis argues, operationalising these constructs goes some way to providing insights about how professional learning outside of traditional contexts enriches the work of educators in their school communities. The study thus examines professional learning as learner-led, inquiry-based, self-managed and highly personal. In short, the study explores the nature of professional *learning* as inherently distinct from professional *development.*

Defining Professional *Learning*

For a growing number of educators, the kinds of professional learning experiences that technology tools enable stand in contrast to the more traditional forms of teacher professional *development*, many of which are often predicated on the assumptions of "one-size-fits-all" approaches and the "information scarcity" of the print age. These assumptions continue to give rise to the financial limitations often associated with face-to-face teacher professional development, such as the costs of releasing teaching staff, paying guest speakers and sending staff to professional development programs during school time. Many of these constraints are, in turn, predicated on beliefs that professional development needs to happen at certain sanctioned times and through largely face-to-face modes of learning. While it may, to many, seem a minor semantic shift, the research that focuses on *learning* has, in contrast to the focus on *development*, emphasised the agency of the educator as a key component in the learning experience. This consideration has, in turn, highlighted the at-times lack of agency educators have when working within more traditional environments. Exploring the limitations of such environments and referring to the underlying problem of teacher passivity in relation to what at best constitutes "received information", Vrasidas and Glass (2004) find that, all too often, "teachers are treated as objects that must be changed, instead of agents with the intentions to work on their own professional development" (p. 251).

Ongoing, sustained professional learning is an essential component of any successful educational environment. As the digital age has evolved with the development of the Internet, educators can indeed use available tools to become agents in their learning. At the same time, there are few guarantees that this will happen. Innovation with technology has been inconsistent, as Hargreaves and Shirley (2009) point out when they state, "although teachers can be brilliant innovators, their collective record on *sustainable* improvement is little better than that of their governments" (p. 92, my emphasis). Furthermore, one may well question whether or not most educators have the opportunity to put into practice – that is, incorporate into *their* professional learning – some of the most basic tenets of good teaching and learning.

Brooks and Gibson (2012) assert that while professional development has been central to the teaching profession, traditional models "reinforce an externally-designed, stand-and-deliver non-participatory type of learning environment [that] does little to assist teachers in enacting constructivist, inquiry-based learning practices, commiserate with 21st century learning, in their classrooms" (p. 8). In a review that underscores the failure of many initiatives to move beyond these traditional models, they stress the need for professional learning to be different in the future. Such learning, they argue, should be *personal* (with considerable scope to choose and customise learning experiences through the flexible use of current technologies), *practice-focused*, mediated through both face-to-face and online *professional learning communities* (PLCs) and oriented around inquiry and reflection. It is this kind of future-oriented learning that this study explores.

Personal Learning Networks

While traditional models appear to hinder the autonomy and agency that are needed, there is evidence to suggest that newer models may be poised to radically alter the nature of professional learning. In particular, there is now increasing attention being given to the *Personal Learning Network* (PLN), an emerging model for technology-enabled professional learning that embodies learner-centred and self-managed networks (Couros, 2010; Richardson & Mancabelli, 2011; Warlick, 2009). As an emerging model, the PLN draws on two related concepts that are also reflected in literature: The Personal Learning Environment (PLE) and Personalised Learning. The PLE emphasises the combination of social and web tools that are employed outside of structured technology environments such as the LMS, sometimes regarded as "the sum of all tools used" in this way (Schaffert & Hilzensauer, 2008, p. 2). Marin, Negre and Perez (2014) discuss the difference in emphasis on the *environment* and *network* between the PLE and PLN. They refer to the PLE as the "as the set of tools, materials and human resources that a person is aware of and uses for life-long learning" while regarding the PLN as "the sum of connections with other people's PLE that make up knowledge environments and whose interaction produces the development and enabling of strategies for the actual PLE and, therefore, are central to learning and professional development" (pp. 2-3). Both the PLN and PLE have been used in educational research to inform Personalised Learning, a term that denotes the use of technology to foster more learner-centred experiences. Drawing attention to the different conceptions of

Personalised Learning in the literature, Looi, Wong, Seow and Chen (2014) have observed that the term "is defined differently by researchers, much of the interpretations converge along the lines of empowering the learners with more autonomy to chart their learning paths" (p. 214). In very recent literature, Personalised Learning has been closely linked to Mobile Learning, with particular emphasis given to the ways that mobile devices and software applications (apps) can be used to support different learning pathways (Michael Grant & Hsu, 2014; Rossing, Miller, Cecil, & Stamper, 2012; Stevenson, Hedberg, Highfield, & Ming-Ming Dao, 2015).

Accordingly, it is the *network* in the PLN that reveals the ways in which the tools have been used and the nature of the learning that has taken place. As Nussbaum-Beach (2013) elaborates, PLNs have the potential:

> to profoundly affect both professionalism and personal learning. Networking can help boost your energy, stimulate personal growth, and lead to a revitalised individual practice. Self-organised networks can also lead to opportunities to join or create powerhouse communities of inquiry and practice… with deeper levels of thinking, collaboration, and engagement (p. 26).

Similarly, exploring the practical applications of this model, Warlick (2009) defines the term as a vehicle for educators:

> to tap into connected and cultivated communities of interest to find information sources, suggestions for lesson plans, potential collaborators, current events and trends, new opportunities, resources, and a wide variety of other answers and solutions (p. 13).

In spite of its popularity amongst many in the broader online education community, there is a relative paucity of empirical research in the use of PLNs for teacher professional learning. However, a close examination of its attributes as reflected in recent literature reveals why this might be the case. Like the Internet itself, this network itself is not fixed, singular or linear. Rather, it is a loose affiliation of tools, information sources and people-to-people connections, a personally-referenced network wherein "the people, conversations and content… are distributed all over the web, glued together with the judicious use of links [shared] by the people you connect with" (Richardson & Mancabelli, 2011, p. 36).

The importance of human connections with other educators online is a theme shared by Couros (2010), who simply defines the PLN as "the sum total of all social capital and connections that result in the development and facilitation of a personal learning environment" (p. 125). Nonetheless, its diversity and magnitude that make the PLN difficult to define and measure beyond these kinds of summary statements.

Likewise, the development of a PLN does not require the use of specific tools in specific ways. Rather, educators are free to select and employ *any* tools that are relevant to their learning. Certain tools are, however, commonly employed. For example, the use of open social media tools such as *Twitter* allows educators to select (or "follow") other professionals and share relevant ideas, often in the form of links to online articles, media and educational resources that have been shown to support professional learning (Petrilli et al., 2011). Because the tools are employed freely, there is no "set formula" for cultivating a PLN, and because no formula exists, no two PLNs are identical. Accordingly, the learning that occurs through these networks is diverse, connected, personally meaningful and often informal. Given the considerable agency that the application of the PLN suggests, these qualities present implications for current research on professional learning. They also hold implications for teacher education in both pre- and in-service contexts and even the nature and legitimacy of professional learning in and around many educational institutions. As Huber (2010) notes, it is our increasing understanding of teacher professional learning with current digital tools, information sources and people-to-people connections that now encourages a radical rethinking of traditional models "that rely on false, yet culturally embedded assumptions about professional learning" (p. 42).

While not yet fully established in empirical research, the PLN and similar developmental models nonetheless reflect the paradigm shift from professional *development* to professional *learning*. In a relatively short amount of time, we have some evidence that speaks to the value of technology-enabled models of professional learning that promote, above all, the agency and autonomy of the learner. Such models clearly break away from traditional approaches to professional development, and with the wealth of examples that now exist online, they are hard to ignore. In the twenty-first century, therefore, exploring where this agency and autonomy might take us, and the profession, should be an important concern.

Positioning Teachers as Learners

The development of learner-centred, self-managed networks like the PLN nonetheless requires the application of emerging knowledge and skills that are, like the model itself, yet to be accurately reflected in the literature. While early critics such as Prensky (2001) saw technology skills and knowledge existing along a generational divide – with skilled, younger "natives" and relatively unskilled older "immigrants" (including, by implication, many teachers) – subsequent research has negated this conceptualisation, instead focusing on skills and knowledge acquired through exposure, experience, practice and reflection (Burhanna, Seeholzer, & Salem, 2009; Corrin, Lockyer, & Bennett, 2011).

One conceptual framework that aims to describe the attributes needed for self-managed online learning is the *Twenty-First Century Fluencies* framework, where skills such as collaboration and creativity with technology are seen as practices that need to be, like language, developed to the point of fluency in the digital age (Crockett, 2011). Similarly, the *Participatory Cultures* describe the attributes of successful technology-mediated learning, such as transmedia navigation, play and networking (Clinton, Purushotma, Robison, & Weigel, 2006). Importantly, both frameworks emphasise the role of the teacher as co-learner and underscore the importance of teacher professional learning through *doing* – that is, based on pragmatist and socio-constructivist theories of learning adapted to online contexts. Few, if any, such frameworks appear to stress the need for the teacher to be a pre-established "expert" in the skills described.

Further, many now accept the importance of the *Technological, Pedagogical and Content Knowledge* (TPaCK) framework (Koehler & Mishra, 2009). This framework extends on the Pedagogical Content Knowledge model (Shulman, 1986) to incorporate different knowledge dimensions of technology and how these can be applied in educational settings. At present, there remains an emerging body of research that seeks to measure TPaCK knowledge within professional learning settings. Earlier efforts have wrestled with issues of internal validity, small sample sizes and problems in replicating findings in other contexts

(Archambault & Crippen, 2009; Schmidt et al., 2009). More recent efforts have shown that with correctly loading factors, it is possible to measure knowledge in each of the distinct dimensions, thereby validating the framework in empirical research (Chai, Koh, & Tsai, 2011; Chai, Ng, Li, Hong, & Koh, 2013). Others have explored the TPaCK as a confidence measure among preservice teachers (Albion, Jamieson-Proctor, & Finger, 2010) and, more generally, in teacher evaluation (Chang, Jang, & Chen, 2014). Given its importance in the literature and in a growing body of empirical research, there is a need to understand the intersection between the TPaCK knowledge dimensions and the actions and perceptions of educators as they engage in professional learning. Measuring these dimensions therefore goes some way to providing insights on *what* kinds of learning work best and *for whom* and *when*.

In spite of attempts to explore and develop the skillsets needed for learning in a digital age, Fullan (2013) asserts that a "volatile push-pull dynamic intensifying in public schools" is simultaneously "pushing" teachers and students out of formalised, institutional learning and "pulling" them into an alluring digital world that "is not necessarily productive in the sense that it is largely ungoverned" (p. 24). Further, while the digital world that both teachers and learners inhabit is often far removed from institutional education, Fullan cautions "mere immersion in the land of information does not make one smarter". Advocating a "new pedagogy" founded on teacher-learner partnerships, the author underscores the importance of "teacher as *activator",* a pedagogical approach – in contrast to the teacher as guide or facilitator – that includes strategies like reciprocal teaching, teacher-student self-verbalisation, metacognition, challenging goals and frequent checks on teaching. Citing Hattie's (2008) meta-analysis that measures effect sizes of a very wide range of teaching and learning strategies, Fullan points out that:

> Hattie did not even examine the possible role of technology. Two items on his list are simulations/gaming and web-based. They were both in the weak impact category. I would surmise that the main reason is that they were used passively as the teacher as guide on the side. The new question by contrast is, with a strong teacher-learner partnership, how could technology be used to deepen and accelerate learning? (2013, p. 25)

The research on learning in a digital age highlights the important relationship between the technology tools, digital skills and learning outcomes for school leaders, classroom teachers and students. Accordingly, new skills like transmedia navigation, distributed cognition and collective intelligence (Clinton et al., 2006; Hague & Payton, 2010) need to exist alongside skills that predate learning in digital contexts like critical and creative thinking, negotiation, information literacy and collaboration. While there is yet to be clear consensus on what "twenty-first century skills" are, a growing body of research points to the importance of developing technology-based skills through the kinds of networked learning experiences now available online. Leveraging current tools to maximise emerging forms of teacher professional learning thus remains a challenge.

Research Questions

This study closely examines the professional learning in each of the three main contexts: *Connected Communities 21* (CC21), *Macquarie ICT Innovations Centre* (MacICT) and *Preservice Teachers* (PSTs). Focusing on school leaders in the CC21 group, Stage 1 explores the school context through one-on-one and focus group interviews with school leaders to understand how they engage, promote and support professional learning within their school community. Stage 2 measures the actions and perceptions of educators in all three contexts through the Teacher Professional Learning Questionnaire (TPLQ). Informed by relevant Stage 1 findings, this instrument seeks to operationalise important elements of Personal Learning Networks, Participatory Cultures and Technological, Pedagogical and Content Knowledge. Collectively, these constructs and their underlying elements provide a detailed account of how each participant views and responds to the technology-related professional learning challenges emerging in the literature and in their practice. Both Stages 1 and 2 explore examples of current tools commonly used in PLNs and as part of Participatory Cultures, including tools for content aggregation, blogging, media creation, online collaboration, communication and social media. The perceptions and actions in these areas speak to some of the diverse ways that educators learn professionally in the digital age. Both Stages of the study explore the following research questions:

1. How, in what ways, and to what extent do teachers use current technology tools to support their professional learning?

2. How, in what ways, and to what extent are professional learning outcomes for teachers shaped by the context in which the tools are used?

3. What principles and heuristics of twenty-first century learning are evident in the ways teachers use tools to support their professional learning?

4. How and in what ways might professional learning in traditional face-to-face contexts be better informed by the diversity of situated learning experiences in emerging and established online contexts?

These questions were developed to explore professional learning with a wide range of available technology tools in varying contexts. While Questions 1 and 2 explored relationships between current uses of the tools and professional learning outcomes, Questions 3 and 4 aimed to draw out implications for how professional learning principles, practices and support mechanisms might evolve to better align with current and future learning needs.

Sample and Method

The sample for this study is 205 educators drawn from a range of backgrounds, contexts and career stages, comprising the three main contexts. The *Connected Communities 21* (CC21) group (n=102) included current educators that participated in both stages of the study. The *Macquarie ICT Innovations Centre* (MacICT) group (n=47) included current educators that were invited to participate in the quantitative component during a professional learning program undertaken at Macquarie ICT Innovations Centre. The third and final group (n=56) included third-year preservice teachers from both primary and secondary Teacher Education Program (TEP) units that were recruited through the online Learning Management System, *iLearn*, at Macquarie University. All recruitment and data gathering took place during the period August 2013 to May 2014.

The study employed mixed methodologies that involved the sequencing of a small qualitative component (Stage 1) followed by a larger quantitative component (Stage 2). In Stage 1, interviews were conducted with principals and technology mentors. Interviews broadly explored how professional learning was evolving in the school community through current uses of technology for both professional learning and classroom teaching. Interview data then informed the design of the Teacher Professional Learning Questionnaire (TPLQ), delivered online in Stage 2 to the three samples of educators. This questionnaire measured the use of current technology tools for professional learning, leadership decisions and support structures as identified in both the Stage 1 interviews and, more broadly, in the literature. The TPLQ also aimed to operationalise constructs that are commonly linked to technology-enabled professional learning, including Personal Learning Networks (PLNs), Participatory Cultures and Technological, Pedagogical and Content Knowledge (TPaCK).

Limitations of the Study

Although the study explores an important and relevant topic, there are a number of limitations constraining the scope, instrumentation and nature of the reported findings. Most significantly, in all three samples, there are challenges in distinguishing professional learning that was required within the specific context from the professional learning that occurred through the agency and actions of the individual educator. The fact that learning seen as "optional" by many participants was also non-formal in nature is of significance. The problems of measuring non-formal learning in education and industry is one recognised on a global scale in recent OECD findings (Werquin, 2010). For the CC21 sample, this problem was evident in the attempt to separate project- and school-based learning from additional learning undertaken by the individual in their own time. The MacICT sample presented the problem in terms of the professional learning that new-scheme teachers must undertake – whether face-to-face or in their own time – for accreditation to work in New South Wales Schools. For the sample of preservice teachers, the problem exists in terms of the grey area between learning required for coursework and professional learning outside of study hours. To address these limitations, the study employed mixed purposeful sampling (B. Johnson & Christensen, 2008) and carefully worded items in the Teacher Professional Learning Questionnaire (TPLQ). However, it remains that drawing clear distinction between formal and non-formal – or between the "required" and "optional" – forms of learning remains a challenge for educational researchers as it was for the participants in the study.

The TPLQ examines the uses of wide range of technology tools for the purposes of professional learning, exploring the contexts in which they are used, the purposes underpinning their use and the perceived impact or benefit to the individual's professional learning. It was beyond the scope of this study to explore every facet of use, or every single tool that is used by each educator. The TPLQ categorises tools by utilising a range of labels, including Blogging, Social Media, Content Aggregation, Media and Learning Management Systems. Individual tools were offered as an example (such as using *Twitter* as an example of an open social platform) for each category, but the participant's response pertains to the category rather than a specific brand of tool. Further, the difficulties of measuring the breadth and depth of technology use were apparent when undertaking the research. In particular, measuring the size, scope, nature and impact of the individual's Personal Learning Network (PLN) was beyond the scope of the study. Similarly, comprehensively exploring every aspect of an individual's Participatory Cultures was not possible. The study was exploratory and tentative in its treatment of these two constructs, with findings that can be improved upon in future research.

Overview of Thesis

Chapter 2 reviews the literature that informed this study. It begins by critiquing the historical role of technology in professional learning over the two preceding decades before exploring the current digital age. The key trends of social media, mobility, Web 2.0 and Cloud Computing are explored in terms of their contribution to professional learning and how they have thus shaped the discourses in this field. The chapter also interrogates the theoretical paradigms of objectivism, socio-constructivism, and pragmatism, showing how the use of one theory informs both the focus of research undertaken and the nature of the professional learning that follows. The chapter concludes by arguing in favour of pragmatist epistemology as the most accurate theory for understanding technology-enabled professional learning at the present time. In drawing this conclusion, Chapter 2 references Dewey's (1938b) "social tools", as a term to best reflect the technology tools that educators can adapt, employ and even modify for their professional learning.

Chapter 3 explains the methodology informing the study. The chapter begins by examining pragmatism within mixed methodologies research. Citing complementarity and sequencing as guiding principles (Greene, Caracelli, & Graham, 1989), the design for the study's two stages are explained and discussed. The one-on-one interview in Stage 1 applies the Levels of Use (LoU) framework (Hall, Loucks, Rutherford, & Newlove, 1975) to measure teacher actions with technology within their school setting, while the focus group questions conducted during school visits employ semi-structured questions with the aim of exploring the breadth and depth of professional learning taking place in and around each school community. The rationale for both interview protocols is discussed. Chapter 3 also explains the design of the Teacher Professional Learning Questionnaire (TPLQ), an instrument that operationalises and measures key elements of Personal Learning Networks (PLNs), Participatory Cultures and Technological, Pedagogical and Content Knowledge (TPaCK). The chapter then explains how the TPLQ was designed with relevant findings from Stage 1 before describing data collection activities and the overall framework in which the data were analysed.

Chapter 4 presents the results of Stages 1 and 2. The chapter first describes, in detail, the nature of the case studies that embodied Stage 1, including interview data from both one-to-one and focus group interviews, highlighting pertinent findings. These are then discussed by identifying the key themes. Stage 2 quantitative findings are then explained through the combination of descriptive statistics, analysis of variance (ANOVA), discriminant analysis and principal components analysis (PCA). These analyses are employed to more fully understand the professional learning characteristics and unique features of educators across the three main contexts.

Chapter 5 provides a detailed discussion of both stages of the study in relation to the research questions and each of the three samples. Three overarching themes are presented that encapsulate the findings of the study as a whole. These include: first, the role of contextual factors; second, the roles of digital creativity and sharing; and, finally, the broader role of technology as an enabler. Chapter 5 explores the significance of these themes in shaping professional learning discourses, actions and outcomes for participants across the three samples.

Chapter 6 builds on the key findings from the study and critically explores how they inform possible future directions in professional learning. Key challenges that emerge from the study include problems with digital creativity and sharing, difficulties school leaders face in promoting and supporting autonomous professional learning in their communities, the need to comparatively and critically evaluate the strengths and weaknesses of professional learning in both face-to-face and online settings, and the detrimental effect of an underlying systemic culture of competition in preservice teacher education. These challenges are discussed in terms of further possible policy development.

Chapter 7 concludes by highlighting critical areas for future research.

Chapter 2. Literature Review

Professional Learning – What Role has Technology Played?

As Hargreaves' review of the four ages implies, the research field of teacher professional learning is very well established. Throughout this tradition, technology has played a multitude of roles as part of widely varying paradigms that include (but are not limited to) the more controlled and relatively contained environments of the Learning Management System (LMS) and the application of technology-based interaction through Computer-Supported Collaborative Learning (CSCL), as well as the more recent traditions of Web 2.0, Cloud Computing, Mobile Learning and Atomization. In addition to the research in each of these areas, there also exist sizable bodies of literature on technology's role in change management, educational leadership, preservice teacher training and evaluation. All of these research fields are entwined with many different technologies – past, present and future. Collectively, these fields explore the roles of key stakeholders like professional associations, governments, education bodies, school leaders and classroom teachers. In amongst these fields and in various ways, technology has played an important role in changing our perspectives on the agency and autonomy of the educator. An examination of the historical relationship between technology, leadership and professional learning since the early days of the mainstream Internet – what now represents the preceding two decades – thus reveals some important themes.

Lieberman (1995) examines professional learning at the point when Internet-based technologies of the 1990s were seen by many as the "information revolution", so-called because it paved the way for escaping the time- and location-based constraints of print media. At this point in our relatively recent history, the author then argues that a "conventional view of staff development as a transferable package of knowledge to be distributed to teachers in bite-sized pieces needs radical rethinking" (p. 591). In exploring this rethinking, a sizable body of research in the mid-to-late 1990s identifies the role of constructivist learning as an important (but theretofore largely undervalued) component in teacher professional learning, citing related areas such as job-embedded learning and dispersion of staff development throughout the school (Sparks & Hirsh, 1997), learning communities as a vehicle for change-readiness (Hord, 1997), narrative-based and dialogic learning (Rust, 1999) and the role of the principal in facilitating sustained learning communities (Zepeda, 1999).

Empirical studies of teacher professional learning at this time like Hiebert (1999) and Garet, Porter, Desimone, Birman and Yoon (2001) found that collaborative planning and collective participation in professional learning communities were among the most significant variables predicting positive learning outcomes for educators. These findings are reflected in Hargreaves' (2000) call for genuine collaboration between educators: "when this collaboration extends beyond talk into practice and joint work among teachers, when the ties between teachers are strong and professionally meaningful, then the benefits are likely to be especially positive" (p. 165). Broadly speaking, therefore, technology-enabled professional learning in the mid-to-late 1990s involved educators beginning to apply sound pedagogy to their professional learning, seeing themselves as part of a growing online community and realising that the Internet would substantively change their access to information.

Revealing the veracity of Hargreaves' predictions for the fourth age and in contrast to the 1990s, the early 2000s saw dramatic changes to the *scale* of technology use in teacher professional learning. As information access ceased to be a dominant barrier in many developed world economies, the availability of material for teaching and professional learning increased alongside growing preferences for online content delivery. By contrast to the pre-twenty first century reliance on relatively scarce print media, the Internet of the early 2000s offered access to content from any number of sources worldwide. Reaching its tipping point in many economies by the mid-2000s (Cawley & Preston, 2007), the broadband Internet access to which more and more homes and schools signed up enabled educators to begin to explore more widely available rich audio-visual content. Information sources from old media (for example, through the many television channels that began to explore the web as a platform for content delivery) merged with the new media of the day (for example, through the millions, and later billions, of user-generated videos posted online via websites like *YouTube*).

The literature on teacher professional learning in the early-to-mid 2000s reflects the enormous scale of disruption that technology posed, especially in relation to formal learning. New research areas such as Online Teacher Professional Development (OTPD) explored the constructivist learning models that had emerged in the 1990s with a greater focus on the online context, including the importance of situated and distributed cognition and online communities of practice (Vrasidas & Zembylas, 2004). Others advocated a "rediscovery" of Computer-Supported Collaborative Learning (CSCL, a model of digital learning dating back to the 1980s) as a way to promote teacher knowledge building in the rapidly expanding context of online higher education (Stahl, 2002). The growth of the Learning Management System (LMS) represented an infrastructure-led solution in many educational institutions, whereby the technology infrastructure for online courses was given far greater attention than the professional learning needed to fully leverage this technology, compounding Cuban's (2001) concerns of its misuse in most classrooms.

As more educators engaged with online spaces, theories about the nature of online learning emerged, particularly around the many different modes of interaction between teachers, learners and content (T. Anderson & Elloumi, 2004). There appears, at this time, to be a growing understanding of the limitations of online learning constrained solely to educational environments, such as through the online courses of many LMSes or through small-group CSCL. A growing body of research at this time explored the open web and the impact it was having on teachers' professional learning (see, for example, Webb & Cox, 2004). In particular, terms like "life-long learning" and "sustainability" became associated with professional learning in online contexts (Day, 1999), while the term "disruptive innovation" (Christensen & Raynor, 2003) was used to show how organisations learn from, and leverage, rapid and often unforeseen changes in technology. In a study of two thousand Canadian teachers, Smaller et. al. (2005) identified the role played by informal learning experiences outside of their educational institutions. The study found that although 90% of teachers undertook ongoing formal training that averaged eight hours of professional learning per week (including course time, reading and completing activities or assignments), the same teachers spent, on average, fifteen hours per week on *informal* learning (including four hours at work and eleven hours at home).

Further, 88% of respondents utilised the Internet for informal professional learning (by contrast to only 57% when the study was first conducted in 1998), which represented the highest growth area for "favoured modes of informal learning" (p. 33).

For many, the mid-2000s also represents a point at which the emerging concept of the "read/write web" (Richardson, 2005) provided educators with the opportunity to learn by *participating* online. Rather than simply consuming content, the proliferation of Web 2.0 tools (O'Reily, 2005) enabled the creation and sharing of content without the requisite knowledge of website design more commonly associated with the relatively static pages of "Web 1.0". The mid-to-late-2000s thus saw the emergence of a very large body of work on Web 2.0 as an educational research field, including papers that explored its potential in all levels of education (Agee, 2009; Craig, 2007; Drexler, Baralt, & Dawson, 2008; M Grant & Mims, 2009) and a wide range of studies examining areas such as the use of Web 2.0 tools by "digital natives" (Burhanna et al., 2009; Corrin et al., 2011), the benefit of the tools in collaborative co-construction of ideas (Kittle & Hicks, 2009; Stevenson & Hedberg, 2013; Wang, Wang, Fang, & Lin, 2010), their use in preservice teacher education (Cheon, Song, & Jones, 2010) and role in the development of literacy (Handsfield, Dean, & Cielocha, 2009; Lankshear & Knobel, 2007). As Bower, Hedberg and Kuswara (2010) note in their discussion of a framework for Web 2.0-enabled learning designs, with the proliferation of Web 2.0 tools, "it appears that there is finally accord between the design of technology and the student-centred and interactive approaches being advocated by contemporary educational leaders" (p. 1153).

Perhaps most importantly, the rise of Web 2.0 further eroded many of the culturally embedded assumptions about professional learning that had shaped many teachers' beliefs throughout Hargreaves' first three "ages". For example, Huber's (2010) discussion of the use of Web 2.0 tools by many educators sheds light on what the author sees as the pressing need to challenge ongoing traditional beliefs such as "passing information on is enough", "insight must come from outside formal training" and "planning means learning" (p. 42). As Huber elaborates:

> Each of these false assumptions takes hold because of a reliance on traditional models for professional development. The school goes through the motions of professional learning, but its approach is based more on the illusion of collaboration than on substantive, ongoing, sustained conversation (p. 42).

As we have seen, while technology's role in professional learning has changed contextually over the years, its use has often reflected broader (and at-times misplaced) assumptions about how educators and students alike learn. In particular, the assumption that information transmission is sufficient for sustained teacher professional learning has been challenged by the wealth of technology-informed research that highlights the limitations of this approach and offers a myriad of ways to learn through application, experience and interaction. At the same time, Gibson and Brooks (2012) suggest that while research on teacher professional development "highlights the characteristics of effective traditional PD over the last 20 years, we need to update the approach relative to the changing realities and specifically the digital affordances of our time" (p. 1). As Hargreaves (2000) reminds us, "professional development is usually most effective when it is not delivered by extraneous experts in off-site locations, but when it is embedded in the life and work of the school, when it actively secures the principal's or head teacher's support and involvement" (p. 165). Given the divides (in terms of areas like perceived importance, accreditation, consistency and school-wide learning) that still exist between formal and informal learning, further work is needed to explore how school leaders can leverage the kinds of professional learning that teachers practise through emerging and highly personalised models like the PLN.

Disruption – the "New Normal"

Now into the second decade of the twenty-first century, much (if not most) of our information, knowledge and communication are transduced through web-enabled technologies. The late-2000s has been marked by trends such as educational Cloud Computing (Katzan, 2010; Stevenson & Hedberg, 2011), Mobility (Peters, 2009; Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009) and Atomization (Foydel, 2011), each of which reflects our growing use of personalised, portable, connected and "always-on" devices. Content that is created on the web no longer largely relies on linearity or singular authorship. Following the rise of applications in blogging, for example, online authorship is now in the hands of billions, irrespective of geopolitical boundaries, publishing protocols or government censorship. Many educational professionals leverage this technology by freely sharing their ideas, practices, teaching materials and reflections via blogs; the publication of this content promotes further dialogue within worldwide communities of “Edubloggers” (Ray, 2006).

Much of the meaning made evident in many online webpages reflects layers of nuance shaped by points in time, digital modalities, emerging user interfaces and multiple authors. By contrast to the meanings often implied in print media – those associated with singular authorship, publication at a fixed point in time and tendency towards sense-making through linearity – these layers of meaning are often established more subtly through generative, often non-linear iterations emerging from diverse “Participatory Cultures” (Clinton, Purushotma, Robison, & Weigel, 2006). For example, Grosseck and Holotescu (2008) were among the first to note the educational value in *Twitter* as a platform for diverse communities of professionals sharing multimodal content through concise, manageable statements and links in 140 characters or less. Likewise, Atkinson (2009) discusses the subversion of direct instruction, lecturing and presentations through the educational development of the “backchannel”, an ongoing (and often real-time) dialogue or meta-analysis around what has, until recently, been largely conceived as one-way content delivery. The success of the backchannel is evident today in many television and radio programs, conferences, lectures and special events that utilise “hash tags” to organise, and later refer to, the dialogue around the content. Focusing on the example of computer-assisted writing, Hedberg and

Stevenson (2013) have traced developments in user interfaces, web tools and affordances aligned with the development of the Internet in recent years:

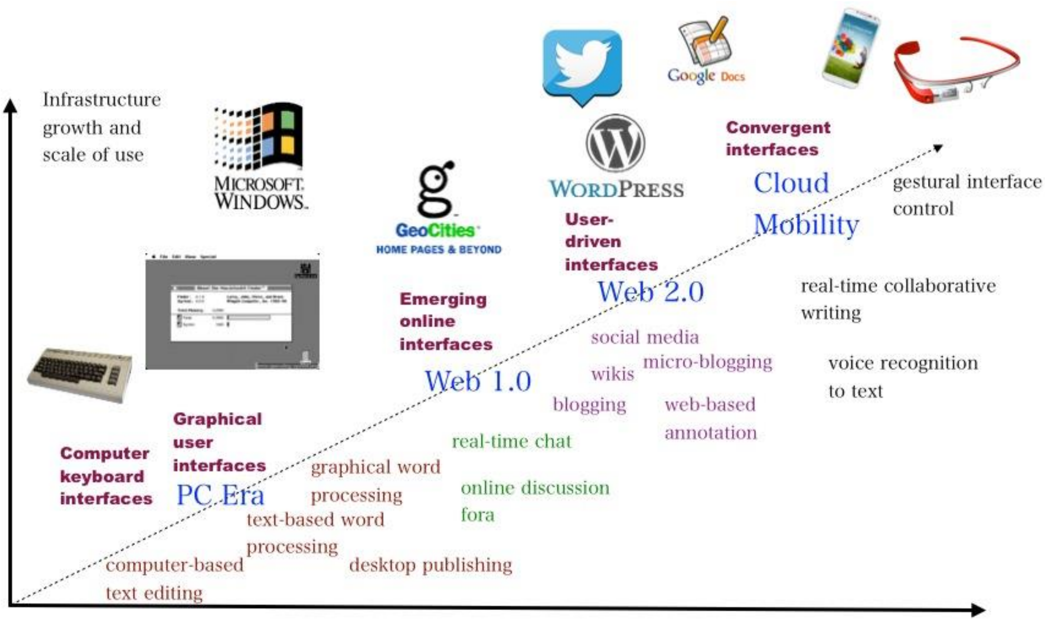

Figure 2.1 - Developments in user interfaces, tools and trends.

(Hedberg & Stevenson, 2013, p. 20)

Changes to the tools, interfaces and modes of authorship have enabled further possibilities for collaboration. As can be seen with a wide range of social networking, mobile-, Web 2.0- and Cloud-based applications and tools, learners can easily collaborate by using multiple technologies and platforms to generate ideas in any number of ways. Examining end-points, examples like Mash-Ups (which represent a repurposing of content using available web tools), Virtual Worlds (which are jointly constructed and shaped by their digital "citizens") and global-scale creative-collaborative efforts like the "Virtual Choir 2000 voices strong" (Whitacre, 2011) and the "YouTube Symphony Orchestra" (Cayari, 2011) provide evidence of the emerging possibilities for pedagogies in online collaboration. Examining the multilayered authoring of a collaborate document illustrated in Figure 2.2, for example, we can more fully understand the connections between collaborative processes and artefacts:

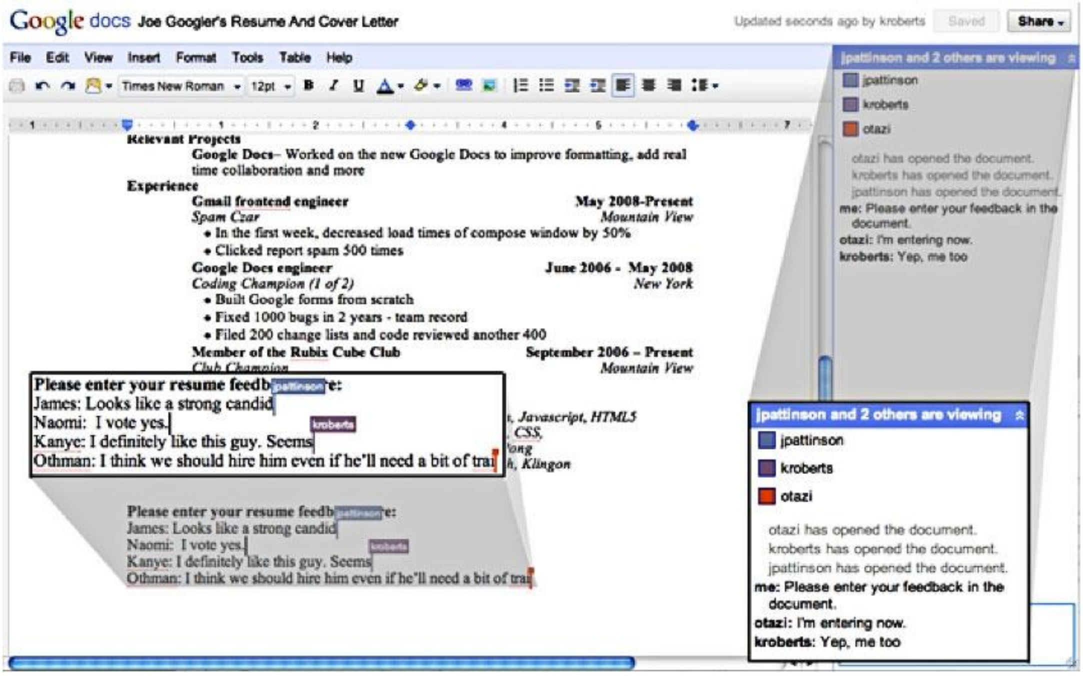

Figure 2.2 - Real-time collaboration between three authors in Google Docs.

(Image: Google)

At a time when the number of technology devices, user interfaces and tools is increasing, there is an emphasis on the personalisation of technology for individual learners. For example, through *Mobility* and *Atomization*, individuals tailor learning experiences to their own needs through ubiquitous access to Internet connectivity and the use of apps on what are, essentially, very personal and highly mobile computers. Now nearly as capable as desktop computers in terms of processing power, mobile devices such as tablets and smartphones are used for purposes widely ranging from social networking or as personal assistants to near full-scale video editing, productivity, language translation, mind mapping, textual analysis, dictation and a host of other uses that are being extended daily. Mobility now represents the vast majority of Internet users - now numbering well in the billions – for whom most of these mobile learning experiences are informal and just-in-time, frequently unplanned and "unsanctioned" by educational discourse. For twenty-first century educators, the kind of informal learning that occurs through the use of mobile devices represents enormous potential for further disruptive innovation, lifelong learning, place-based pedagogy and other areas.

Recent data suggests that the use of mobile devices will continue to further challenge traditional forms of computation such as those associated with desktop and laptop operating systems, as shown in Figure 2.3, illustrating global forecast sales data:

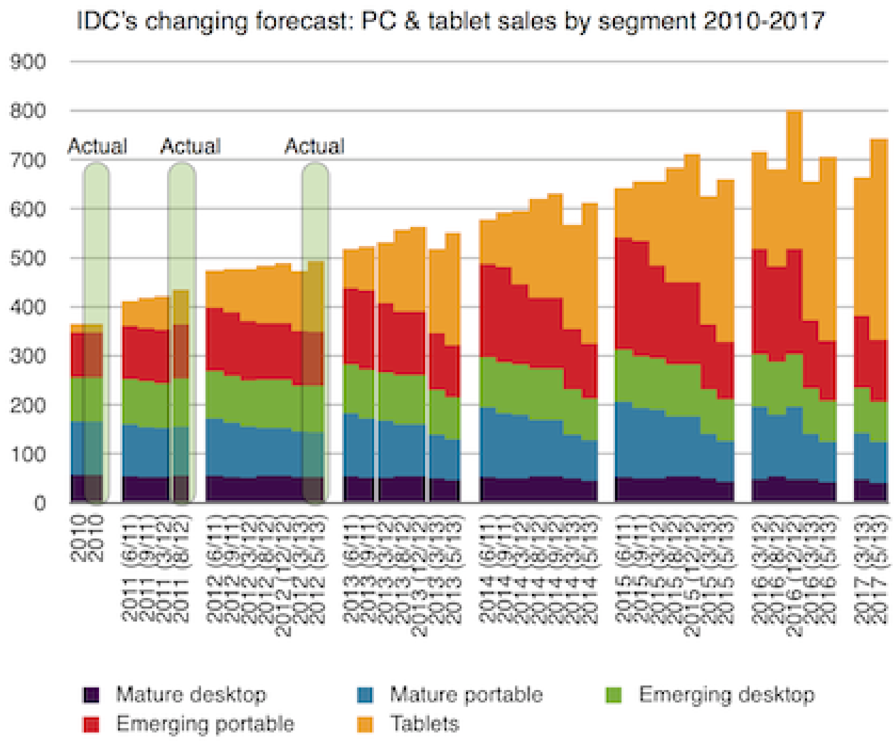

Figure 2.3 - Mobility crossing-points.

(IDC, 2013)

This unprecedented level of access to sophisticated, portable technology represents large-scale disruption and still largely untapped potential for the future of education.

Theorising Professional Learning in a Digital Age

Arguably, the "disruptive innovation" (Christensen & Raynor, 2003; Hedberg, 2010) that marked the mid-2000s has become a well-established part of our current mindset. That is, the technology and education disruption that garnered such attention throughout the first decade of the century has itself become the "new normal" at this point in time. Emerging technologies are continuing to trigger newer forms of pedagogy that supplant older ones; in particular, there are implications for the established pedagogies associated with print media giving way to more experimental, continually changing pedagogies that react to new – and often rapid – technological developments. As Fullan (2013) notes:

> The scenario is this: the status quo is beginning to reach the limits of its yield (the push factor); people still are committed to continuous improvement of the existing system (albeit with marginal results); along comes disruptive innovations (e.g. digital products); these early versions, to use Christensen's critical observation, are "inferior products" (compared at this early stage to existing versions); and what ensues is a "rapid learning cycle" where innovations are tried, discarded, refined, and ever improving (p. 26).

Our approaches to teaching and learning with many of the technologies canvased represent the potential for disruptive innovation that supplants established modes of instruction and until-now unquestioned beliefs and assumptions. The proliferation of technology devices, platforms, tools and applications continues to promote *choice* in the nature, scope and directions of professional learning. Most importantly, for the twenty-first century educator, this choice exists at a very personal level, while at the same time offering seemingly limitless options to share one's own situated learning with the wider digital world.

Exploring the Theoretical Roots of Learning in a Digital Age

Thus far, this chapter has aimed to unpack and critique many of the issues in teacher professional learning that have been shaped by our relationship with a diverse range of technologies – past, present and future. As we have seen, the ways that we now use these technologies reflect our need to understand the realities of the digital world in which we live. In this regard, theory plays a key role in extending our metacognitive understanding of ourselves as learners in the digital age. One prescient issue in the broader field of educational technology is always the extent to which we accept existing theories as explanations for technology-mediated learning – or when we as a research community determine that an emerging or developmental theory would prove more useful. This question is particularly pertinent in the area of technology-enabled teacher professional learning. On the one hand, we have learning that is very personal and dependent on the behavioural and cognitive dimensions of the learner; on the other, we have learning that is distributed across vast networks, information sources and people-to-people connections. Accordingly, the professional learning of teachers in a digital age is, perhaps, equally dependent on the network as on the individual learner. However, the network simultaneously reflects the vast scale of co-constructed and shared ideas and imposes problems with seeing the experience of learning solely through the lens of mutual exclusivity.

Exploring the theoretical roots of contemporary professional learning presents numerous challenges. Arguably, much depends on where focus and emphasis are placed; this placing may define the kinds of learning that are described and studied. For example, while recent concepts like the PLN seem to reflect theoretical roots in pragmatist epistemology through emphasising free inquiry, problem-solving and reflection, older traditions like Computer Supported Collaborative Learning (CSCL) are more commonly associated with the formalised, relatively controlled, scaffolded and "scripted" environments reflected in socio-constructivist theory, while earlier (and even current) iterations of the LMS imply a self-contained, singular learning context that reflects objectivist theories. A review of these and other theories as related to technology-enabled teacher professional learning also provokes discussion on the nature and legitimacy of emerging theories like "connectivism" (Downes, 2006; Siemens, 2008) and "networked learning theory" (Bouchard, 2009). As with any form of education research, establishing a particular theoretical framework shapes the nature of the research that follows.

Driscoll (2005) categorises learning into three broad epistemologies: (1) objectivism, where reality is external and objective and knowledge is acquired mainly through experience; (2) pragmatism, where reality is interpreted and knowledge is acquired through experience, reflection, inquiry; and (3) interpretivism, where reality is internal and knowledge is socially constructed. Considering these three categories, "reality" may be described in reference to the learning environment, including how it is externally conveyed or internally perceived by the learner. Knowledge acquisition may include the technology tools and thought processes that are used to acquire new knowledge. With these dimensions in mind, it is possible to examine educational technology paradigms to more fully explore how learning is theorised in each. Table 2.1 examines how the paradigms of the Learning Management System (LMS), Computer-Supported Collaborative Learning (CSCL) and the Personal Learning Network (PLN) might be compared and broadly aligned to existing theories:

Table 2.1 - Example technology paradigms and key epistemologies.

Objectivism *Learning Management System* (LMS)	**Interpretivism (Socio-Constructivism)** *Computer-Supported Collaborative Learning* (CSCL)	**Pragmatism** *Personal Learning Network* (PLN)
Reality is singular, visible objective, with knowledge acquired through experiences within the singular reality of the online course or learning object.	Reality is constructed in the mind of the learner, with knowledge acquired through interaction with others.	Reality is complex, multifaceted and diverse, with knowledge acquired subjectively through experience, problem solving, reflection and inquiry.
Learning experiences are largely "resource based" (Meso & Smith, 2000) oriented around a central environment such as an online course.	Learning experiences are oriented around agreed, shared tools that are most often employed in small-group settings (Stahl, 2002).	Learning experiences are oriented around a multiplicity of tools employed freely as needed (Richardson & Mancabelli, 2011).
Learning is often structured as activities. It may be stated or implied that learning takes place through specific learning objects like discussion fora. Early iterations of the LMS theorised that online learning largely takes place through the online course (T. Anderson & Elloumi, 2004).	Learning is structured or "scripted" through intrapersonal and interpersonal dialogue and with assistance from a mentor and/or some form of scaffolding (Dillenbourg, 2002).	Learning is structured through intrapersonal and interpersonal dialogue but is largely learner-centred with knowledge as "the sum total of all social capital and connections" (Couros, 2010, p. 125).
Learning is largely infrastructure-and teacher-led. The Learning Management System is centrally controlled and administrated.	Tools are employed explicitly and purposefully as part of knowledge building activities.	Tools are pragmatically employed at different times to serve perceived learning needs (Warlick, 2009).

Objectivism *Learning Management System* (LMS)	**Interpretivism (Socio-Constructivism)** *Computer-Supported Collaborative Learning* (CSCL)	**Pragmatism** *Personal Learning Network* (PLN)
The experiences of each learner are different but occur within the context of a single platform and a specified number of available tools within the platform (e.g. discussion fora, wikis, etc.)(Agee, 2009).	Experiences of each learner are different but small group collaborative settings enable each learner's participation to be compared and evaluated (Strijbos, Strijbos, & Berkhout, 2004).	Experiences of each learner are very unique and not solely contained within the context of any one system (Nussbaum - Beach, 2013)
The focus on learning oriented around one main system enables the objective discussion of affordances and alignment to curricula with a common understanding of the platform and tools.	Standard CSCL tools like Knowledge Forum enable understanding of affordances, alignment to curricula and a shared understanding of platform and tools (Kildare, Williams, & Hartnett, 2006).	It is difficult to make objective comparisons between learners' experiences; however, communities of learners provide an audience for shared reflection.
	Learning experiences are oriented around agreed, shared tools that are most often employed in small-group settings.	Because the tools available are changing rapidly, it is often difficult to align them to understand affordances, align to curricula or have a common understanding of platforms and tools.

Although Table 2.1 represents an abstraction (and there is overlap between these paradigms and the ways that the tools have been used), it aims to show how our use of technologies – as part of particular paradigms that have come into widespread use – reflect various assumptions, theories and practices about how learners learn. These paradigms are now more fully explained alongside their associated learning theories.

Learning Management Systems - the Legacy of Infrastructure and Objectivist Learning

> It is necessary to move e-learning beyond learning management systems and engage students in an active use of the web as a resource for their self-governed, problem-based and collaborative activities…[With the] LMS, e-learning is organised and managed within an integrated system. Different tools are integrated in a single system, which offers all necessary tools to run and manage an e-learning course. All learning activities and materials in a course are organised and managed by and within the system. Recently, the emergence of social software has questioned the use of integrated LMS.

> Today, only few social software tools are employed within existing LMS. The question is: Is the next step to integrate social software tools in LMS? (Dalsgaard, 2006, p. 1)

For many learners who studied online courses via distance education in the late 1990s and early 2000s, the above quotation describes how their learning was primarily organised within the educational institution. Very often, the learning designs were structured objectively through the use of specific tools and spaces and learning was conceptualised within the largely singular framework of the online course.

Indeed, much of the focus on technology in educational institutions has, until recently, dwelt on technology infrastructure necessary to enable online learning within the institution – precisely the problem of "over-selling" that Cuban (2001) articulates. In many cases, the choice of specific hardware often dictates the software used in education. For example, institutions choosing to deploy Macintosh computers provide access to specific tools that many learners have come to associate with creativity (*GarageBand*, *iMovie* or *iWeb*), whereas the decision to deploy Microsoft Windows-based PCs provides access to software often associated with productivity (*Microsoft Word, Excel* or *PowerPoint*). While there is considerable overlap between platforms (for example, *Microsoft Word* runs on both Macs and PCs), in such cases, the decision to favour and deploy certain hardware often rests on an understanding of the particularised affordances of the software platform it underpins.

These infrastructure decisions often reflect the reality of a learning environment that is, to a fair extent, centrally controlled and administrated, for example, by IT personnel who may be removed from teaching and learning. Their decisions have held implications for key infrastructural, pedagogical and broader organisational changes within the institution, such as the many 1:1 technology device programs, the use of specific hardware and software for instructional delivery such as interactive whiteboards (IWBs), or specific negotiated standards for communication such as the favoured formats *Microsoft Word* (*.docx) or Portable Document Format (*.pdf) for academic articles. Most often, the emphasis is on common, or agreed technologies and standards that are deployed throughout the institution; their use may be encouraged, or even mandated, and alternative technologies might be discouraged, or even "blocked". While representing an older paradigm, the legacy of infrastructure-led solutions still persists today and the LMS is arguably a product of this legacy.

Educators and institutions have wrestled with understanding, implementing and "supporting" a growing number of tools, platforms and standards. However, the impact of overarching, multi-platform trends like Cloud-based storage and applications points to the idea of what some have predicted and now regard as "device agnosticism" and "convergence" (Garner, Zoller, Trotter, & Anderson, 2005; Prince, 2011). Unifying Cloud-based software platforms like *Google Drive* and *Microsoft Office 365* now provide, for example, functional spread sheet and word processing capabilities to anyone who has access to a web browser and the Internet; in such cases, the use of one hardware platform over another has become far less important than in previous years. As we have seen, the rapidly growing number of web-based, Web 2.0 and mobile tools also emphasises people-to-people interaction, very often occurring in real-time and without the need to assume the same physical space. As our personalisation of technology devices and tools deepens at the same time as increases to the number and scale of our interactions with others online, many have come to expect that much of our data will be accessible 24/7, from any device, stored "in the cloud". The paradigm of the centrally controlled LMS – as the objective reality initially established to serve the online learning needs within the institution – is, therefore, being challenged by the diversity of tools and platforms in the digital world outside of the institution.

Deploying technology infrastructure in any educational institution requires considerable planning, evaluation and justification on the part of school leaders. The LMS solutions of the late 1990s and early 2000s frequently required hosting, networks, administration and ongoing management by trained personnel, all representing considerable investments of time, money and expertise. Until the impact of Cloud Computing in recent years, institutions have been chiefly responsible for deploying their own hardware and software, resulting in both physical and intellectual ownership of the technologies by those within the institution and a subsequent need to cost-effectively justify the deployment of the technologies in question. The learning-content management system (LCMS) -

which integrates, often at the back-end, with other student (SMS) data - has represented, for at least the last fifteen years, a very widely used hardware-software platform for organised learning experiences with technology tools within the relatively contrived framework of the educational online course. However, given the need to determine these platforms within and for the institution, such use implies an objective separation from the broader context of the Internet. Nonetheless, these LMS platforms have reflected educators' perceived needs of creating online spaces where students can interact, access digitised course materials, view links and participate in object-related learning activities such as quizzes and discussion fora. However, the prevalence of online courses bound up in the large-scale investments by the institution has also meant that much of our intellectual resources as designers of educational experiences have been devoted, rightly or wrongly, to making the platform work.

An interesting case in point has been the wide-scale overuse of discussion fora as an assessment instrument in many higher education courses and as the most commonly used object in most LMS environments. As some have argued, discussion fora remain "shared community spaces in which individual voices may make themselves heard but are afforded no specific space of their own" (Duffy & Bruns, 2006, p. 33). Others have explored this overuse from the learner's point of view, arguing that through learner task-translation, "engaging in [online] discussion as a way of achieving a new understanding of phenomena is rather less likely to occur than engaging in discussion because that is what is seen as being required by the teacher" (Goodyear & Ellis, 2007, p. 342). Further, some have critiqued the methods used by education instructors in assessing through discussion fora, pointing out the shortcomings of "thread length" and "social network analysis" as "statistical approaches that provide at best a rough analysis of the communication... limited to frequency counts and other quantitative measures" (Patriacheas & Xenos, 2010, p. 116). These cases reflect behaviourist assumptions about supposedly being able to objectively measure learning by focusing on observable learner characteristics within the singular framework of the online course.

Increasingly, the literature is reflecting the need for infrastructure-led solutions like the LMS to adapt to the changing technological landscape - and there is some debate about whether or not this is even possible. As Agee (2009) notes:

> [while] the LMS needs to continue serving as an enterprise CMS, it also needs to be a student-centered application that gives students greater control over content and learning. Hence, there is continual pressure for the LMS to utilise and integrate with many of the Web 2.0 tools that students already use freely on the Internet and that they expect to find in this kind of system. Some educators even argue that the next requirement is a Personal Learning Environment (PLE) that interoperates with an LMS (p. 52).

In summary, while we observe tension in terms of the growing need for educators to adapt to increasingly personalised technologies and a much wider range of tools than those that are deployed within the institution, we also observe the same tension in the institutional systems that have occupied much of the headspace of those designers of educational experiences. Given the persistence of infrastructure-led solutions, the objectivist/behaviourist theories underpinning their deployment and use need to be critiqued further in light of more open and diverse paradigms like the PLN.

Computer Supported Collaborative Learning and Social Constructivism

Like the LMS, Computer Supported Collaborative Learning (CSCL) represents a key paradigm for exploring the theoretical roots of professional learning in a digital age. As a research tradition, CSCL represents a very well established field spanning over quarter of a century (Bodemer & Dehler, 2011). In many academic contexts, the term is often used to denote collaboration through online courses (especially in distance learning contexts), with knowledge building activities, assessment and other learning experiences that draw on available tools. Many of the recent empirical studies in CSCL cite tools commonly available in Learning Management Systems, like discussion fora (Goodyear & Ellis, 2007; Patriacheas & Xenos, 2010), wikis (Deters, Cuthrell, & Stapleton, 2010; Meishar-Tal & Gorsky, 2010), task and team management software (Kildare et al., 2006) and other common plug-in tools that blend task and team management with content aggregation, like Knowledge Forum (Chai, Tan, & Hung, 2003; McDougall, Nason,

& McRobbie, 2004). Perhaps due to CSCL being studied through the use of these kinds of software and environments, almost all of the empirical CSCL research has focused on small-group settings. Only recently has the field begun to question the development of methodologies that could address collaboration on a substantially broader level (for example, in studying how hundreds of authors and editors collaborate to produce a *Wikipedia* article) (Kapur et al., 2007).

Early CSCL research focused on disciplinary traditions such as anthropology, sociology, linguistics and communication science, emphasising socially-oriented constructivist viewpoints, or "neo-Piagetian" perspectives (Doise, Mugny, & Saint James-Emler, 1984). Socio-constructivism has since been widely recognised as a basis for exploring knowledge building through online collaboration, often forming an integral part of establishing the parameters for empirical research (Strijbos et al., 2004). Others have suggested that the roots of collaboration as related to traditions like CSCL (and even Web 2.0) can be found in Vygotsky, for whom learning occurs on both inter-psychological and intra-psychological planes (Holton & Clarke, 2006). Vygotsky's influence in traditional and modern classroom contexts is both implicit and explicit when reviewing much of the literature on CSCL. Originally conceived as the Zone of Proximal Development, the difference between the actual developmental level and the level of potential development was explored through "adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Further, in arguing that "what the child is able to do in collaboration today, [she/]he will be able to do independently tomorrow" (1987, p. 211), Vygotsky recognises the value of collaboration as a catalyst for the achievement of sustained, autonomous learning. Others have since explored this relationship between collaboration and autonomy by examining the classroom as a community for distributed cognition, multiple appropriation and shared expertise (Salomon, 1997) and by recognising the "multiple zones of proximal development" in the vast majority of modern teaching and learning environments (Agra Junker, 2013, p. 164).

With socio-constructivism as its conceptual basis, CSCL literature has explored the ways in which technology enables the development of knowledge through the learner's interaction with surrounding culture and society. In particular, researchers and theorists have built on earlier ideas of social constructivism by incorporating a range of learning theories that feed into a notion that is central to technology-enabled collaboration – that "knowledge building" (Chai et al., 2003) can be purposefully and effectively achieved through technology-supported interaction between learners in both real and virtual spaces. Related theories that support this notion include Observational Learning Theory (Bandura, Grusec, & Menlove, 1966), where learners cognitively process behaviour, encode what is observed and store it in memory for later reference. Likewise, drawing on an understanding of knowledge building through social interaction, Activity Theory (Brushlinsky, 1990) examines the significance of situated learning activities and the extent to which the learning subject "not only reveals and manifests himself in his actions… [but] is created and defined in them" (p. 67). More recently, the role of language in collaborative planning and writing experiences has been addressed, emphasising the importance of the learner's observations and interaction with others particularly through the interchange of written language (Halliday, 1993; Haring-Smith, 1994). Finally, Dialogic Theory – which addresses the importance of Socratic dialogue as a basis for learning – has been extended to focus on dialogic *inquiry* (Wells, 1999), emphasising and scaffolding interaction with others as a crucial component in Inquiry-Based Learning and extending dialogue to online interaction.

While encompassing theories on collaborative learning that have emerged from the broader interpretivist roots of socio-constructivism, technology-enabled collaboration has also been aligned in the literature with a number of instructional models. In particular, Cooperative Learning (S. Kagan & Kagan, 1994) and Project-Based Learning (Bell, 2010) are models that have been noted for their applicability to CSCL settings, emphasising the principles of team success, group problem-solving, shared understanding, real-world situated learning and collaborative knowledge building. When conceived as a necessary skill that CSCL can foster, collaboration is often regarded as a key component for learning beyond the classroom, for example, as a measurable workplace competency with associated financial value (Thomson, Perry, & Miller, 2007) or as a form of new media literacy (Lankshear & Knobel, 2007). These views all underscore collaboration as a significant component in situated learning experiences (Lave & Wenger, 1991).

As the literature has shown, CSCL technologies allow for the coordination of synchronous and asynchronous interaction between learners (T. Anderson & Elloumi, 2004), enabling the creation of virtual spaces for communication and knowledge building. Further, the technology often allows a form of archival documentation and storage of records of interaction through the use of the tools. This enables researchers to examine the knowledge building process in both digital and analogue forms through such software features as “revision history snapshots” (Stevenson & Hedberg, 2013). Thus, the role played by technology in CSCL is multi-layered, enabling collaboration through a wide range of forms, media and representations, across distance and time, while recording the development of collaborative processes. However, given the way it has been studied in experimental and other empirical settings, CSCL continues, as a paradigm, to reflect interpretivist-constructivist theories of learning – as both socially mediated and internally/socially-constructed.

Like the LMS, the singularly defined small-group reality of CSCL has faced challenges from the proliferation of web tools. In particular, recent developments in Web 2.0 and Cloud technologies have, in particular, seen substantial gains in terms of the rate at which content is refreshed, now challenging previously held distinctions between synchronous and asynchronous learning. As Hrastinski (2008) points out:

> The debate about the benefits and limitations of asynchronous and synchronous e-learning seems to have left the initial stage, in which researchers tried to determine the medium that works “better”—such studies generally yielded no significant differences. Consequently, instead of trying to determine the best medium, the eLearning community needs an understanding of when, why, and how to use different types of eLearning. Note also that the users decide how to use a medium. For example, in some instances e-mail is used near-synchronously when users remain logged in and monitor their e-mail continuously. Thus, the difference between asynchronous and synchronous eLearning is often a matter of degree (p. 52).

While interaction remains a necessary condition “for the development of new knowledge, skills and attitudes as the learner interacts with the information and the environment” (T. Anderson & Elloumi, 2004, p. 20), arguments like the one above suggest that the interaction in newer forms of technology is much more fluid, taking advantage of continuous Internet connectivity and cross-platform devices and tools. This technological diversity points to the diversity of ways that collaboration now operates in a digital age. While its theoretical roots have focused on interpretivist notions of learning through knowledge building in small-group settings, collaboration through the diversity of tools on the open web – through models like the PLN – represent a vastly untapped field for further research.

Personal Learning Networks and Pragmatist Epistemology

Unlike the purpose-built LMS, the concept of the Personal Learning Network (PLN) is one that has been "retrofitted" to the reality of a vast, diverse network of people, tools and interfaces. In many ways, it attempts to explain this diversity by positioning the learner at the centre of the network and exploring the aspects of the network that can be employed autonomously by the learner to meet their learning needs and interests. As an indicator of the impact of learning on both the individual and those with whom they network, the PLN also draws on the related concepts of the Personal Learning Environment (PLE) and Personalised Learning, with the PLE a reflection of the tools used and Personalised Learning a reflection of the nature of the learning that follows.

In exploring the *theoretical* roots of the PLN as an important component in current and future teacher professional learning, principles of adult learning are important to consider. Research has highlighted the extent to which adult learners are "autonomous and self-directed" (Lieb & Goodlad, 2005) and more often voluntarily engaged in their learning (Brookfield, 1988). Addressing their own learning needs, adult learners are more likely to consult multiple sources of information and conceive their own learning around problem-solving (Javadi & Zandieh, 2011) or engage in learning that specifically requires making sense of past and present experiences (Mezirow, 1991). Research on effective strategies for adult learners has highlighted the importance of dialogue (Vella, 1994), action and reflection (Brookfield, 1988) and the use of models such as Project-, Problem- and Inquiry-Based Learning (Maudsley, 2001; Savin-Baden, 2000; Walton & Matthews, 1989).

While there is limited research that specifically explores the intersection between adult learning principles and technology-enabled learning, earlier studies have identified, for example, that adult learners over the age of fifty more commonly used the Internet to "try something new" than their younger counterparts (Timmermann, 1998, p. 62) and that adult learners learned effectively when technology is integrated with curricula or used as a delivery mechanism, complement to instruction or instructional tool (Ginsburg, 1998). More recent research suggests, however, a re-thinking of technology-enabled adult learning through theoretical perspectives like situated learning and activity theory alongside Marxist-feminist standpoint theory (Sawchuk, 2003) and the need to exercise a degree of scepticism around the so-called "grand claims made about technology-based lifelong learning underpinning countries' competitiveness in a global knowledge economy" (Selwyn, Gorard, & Furlong, 2005).

In Warlick's (2009) theorisation of the PLN, we see a three-fold model focusing on the key areas of: (1) content aggregation; (2) people-to-people connections; and (3) technology tools:

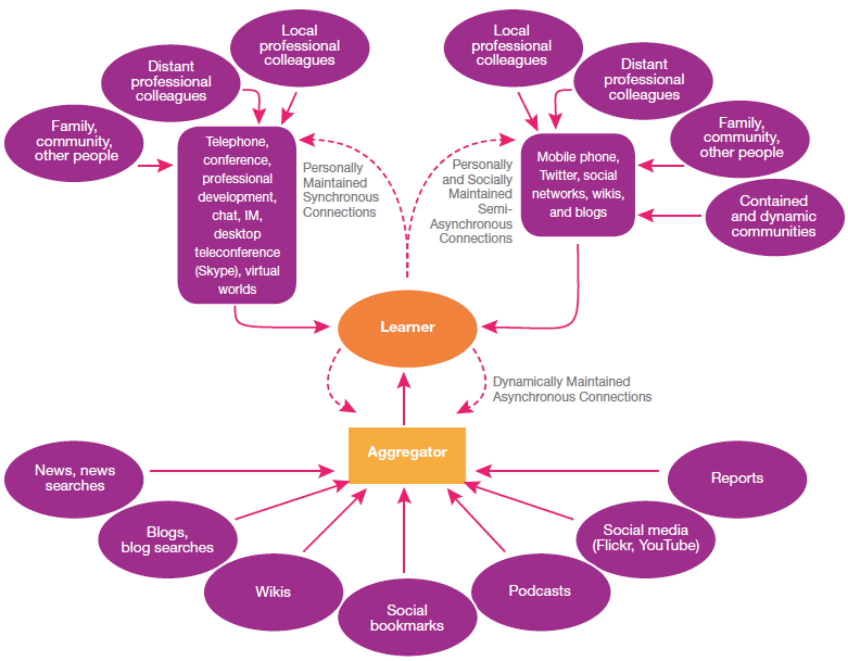

Figure 2.4 - Personal Learning Network (PLN) – emerging model.

(Warlick, 2009, p. 15 - image used with author's permission)

This model places the learner (specifically, in this case, the educator) at the centre of the network, around which exist asynchronous connections to multiple content sources (aggregated through the use of technologies like really simple syndication, or RSS) and synchronous and semi-synchronous connections to people (through the use of technologies like social media, blogs, wikis, voice and instant messaging). Inherent in this model is a plethora of technology tools that are employed in any number of ways to support professional learning and, by implication, a skillset emphasising fluency in the use of some (if not many) of the tools available. In this particular model, we see some alignment between the principles of adult learning articulated in the literature and the diverse use of available tools by teachers to support their learning in a digital age.

Warlick's three-fold model of content, people and tools is reflected elsewhere in the literature. Marin, Negre and Perez (2014) have argued that the significance of the PLN is evident in how it leverages the PLE: "the idea of the PLN is that each person contributes their knowledge so that what is most important is not what each person has in their PLE, but the sharing of those resources" (pp. 2-3). They further note that the PLE can leverage highly constructivist learning that complies with the five features for Meaningful Learning proposed by Jonassen (2008). Similarly, Grant and Hsu (2014) have observed that the PLN both extends on, and enriches, any number of forms of Personalised Learning that take place in the PLE, pointing out that, "due to its network nature, a PLN can help individuals reach out, emulate, and finally integrate the similar practice observed in his/her networked connections' PLE practices to help enrich and improve his/her own PLE" (p. 3). Drawing attention to the growing number of mobile devices used in many educational settings, Castañeda and Adell (2012) argue that these devices and their associated software applications (apps) now form an integral part of teachers' PLEs, especially for preservice teachers.

These principles and perspectives suggest that the PLN holds enormous potential for building upon and improving the learners' PLE and enabling educators to share their understanding of how they learn within local and global communities of like-minded educators. The perspectives explored thus far also suggest several characteristics emerge that describe how teachers may engage with a PLN. Self-directedness and autonomy are evident in the choices made about which information sources are most relevant to learning, which people to follow and which tools are most suitable. Using technologies such as RSS feed aggregators and social media, very large numbers of information sources and people-to-people connections may be cultivated and maintained (for example, using *Twitter*, the learner may "follow" hundreds of education professionals, organisations, bloggers and so on). The multiplicity of connections implies multiple learning pathways and means of finding information most relevant to the learner's needs. The complexity of the network itself suggests learning that is mediated through problem solving; often, finding and sharing information that is most relevant involves understanding how to use a new tool, developing effective ways to combine tools and content, or working out which people-to-people connections provide the best learning opportunities.

Given the constant flux of technology – with new tools, platforms and people emerging all the time – utilising web-enabled technologies for professional learning through the PLN arguably involves continually making sense of the complexities of a changing digital world. While part of this sense-making process is evident in the process of problem solving, reflection plays a critical role in connecting theory with practice. For example, recent research on the "blogosphere" in education identifies the role that like-minded blogging communities play in reflective teacher practice (Sun, 2010) and continuing adult education (L. Lin & Li, 2011). Blogs serve as platforms for sharing digital artefacts such as student work samples, lessons and teacher resources; the "blogosphere" can provide sustained, online communities that focus on reflective teacher practice. Finally, the freedom with which tools and content can be accessed on a wide range of devices and platforms affords considerable learner autonomy. When viewed in this way, PLNs are more clearly aligned to pragmatist epistemology than the objectivist/behaviourist theories that underlie the relatively contained and often singular environment of the LMS and mentor- and scaffold-driven socio-constructivist theories.

Much of literature on pragmatism in education traces the underlying epistemology to the work of John Dewey, for whom learning is firmly grounded in activity and experience. Dewey's notion of experience is, however, "broadly conceived… [and] more than simply a matter of direct participation in events" (Rodgers, 2002, p.

846). Dewey sees the development of human knowledge is an adaptive response to the environment, arguing that learning "cannot take place by direct conveyance of beliefs, emotions and knowledge… it takes place through the intermediary of the environment" (Dewey, 1916, p. 12). Accordingly, he defines the environment as "whatever conditions interact with personal needs, desires, purposes and capacities to create the experience which is had" (Dewey, 1938a, p. 43), suggesting that both change within the self and the environment occur through a dialectical relationship. Further, Dewey points out that "some things which are remote in space and time from a living creature, especially a human creature, may form his environment even more truly than some of the things close to him", for example, through "the activities of the astronomer [that] vary with the stars at which he gazes or about which he calculates" (Dewey, 1916, p. 32). Such statements appear to be as true of the digital age as they were nearly one hundred years ago.

More recently, Dewey's pragmatist theory has given rise to experiential learning as a theory in its own right. Kolb (2014) explains how experiential learning builds on both pragmatism and the schema to substantively incorporate subjective experience:

> [the] learning is called experiential for two reasons. The first is to tie it clearly to its intellectual origins in the work of Dewey, Lewin and Piaget. The second reason is to emphasise the central role that experience plays in the learning process. This differentiates experiential learning theory from rationalist and other cognitive theories of learning that tend to give primary emphasis to acquisition, manipulation and the recall of abstract symbols and from behavioural learning theories that deny any role for consciousness and subjective experience in the learning process (p. 20).

Examining the role of social history, Dewey emphasises the importance of "intellectual tools", including shared social concepts (Eldridge, 1998). In many ways, Dewey's idealised form of learning is problem-solving through free, learner-directed inquiry, which he sees as "the self-controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (1938b, p. 108). Drawing on the concept of warranted assertibility and the work of pragmatist Charles Pierce, Dewey defines truth subjectively as "the opinion, which is fated to be ultimately agreed to by all who investigate… [where] the object represented in this opinion is the real" (p. 343). As Rodgers (2002) points out, reflection plays a crucial role in pragmatist epistemology and "needs to happen in a community, in interaction with others" (p. 845).

Largely due to his work in developing the Long Term Project, Dewey is often credited as the conceptual originator of Project-Based Learning (PBL). In addition to its occasional use in CSCL, this model has been embraced in a number of contexts, including early childhood pedagogies (Glassman & Whaley, 2000; Trepanier-Street, Gregory, & Donegan, 1998), action research (Brydon-Miller, Greenwood, & Maguire, 2003), integrated curricula (Drake & Burns, 2004; Kysilka, 1998), teacher training (Cho & Rathbun, 2013) and in technology-rich high schools (Pearlman, 2006). PBL emphasises problem solving through a form of learner inquiry that is, at times, deliberately unstructured and non-linear (Buck Institute for Education, 2014). While traditional tasks set by teachers tend to indicate a sequence that should be followed and specify end points and products, PBL typically only specifies possible end points, a broad (and often real-world) context in which the task is to take place and rubrics that indicate levels of quality; the specific sequencing of activities and lines of inquiry are often left to individuals and groups to decide autonomously and/or through negotiation with others. To structure thinking in such a way that the learner can move through the task, learner-generated questioning is used iteratively throughout the process. One form this questioning takes is in the three categories of "know", "need to know" and "next steps" (New Tech Network, 2012). While PBL has been used mostly in classroom settings, the principles that underlie the model are essentially those of learner-led inquiry structured only to the extent that is necessary.

Connectivism – Potential, Real or Otherwise?

Pragmatist epistemology sheds light on the nature of learning through the PLN by focusing on the learner at the centre of the model (as in Warlick's conception). However, recent research argues that PLN-enabled learning is not entirely explained by pre-existing theories. In particular, Downes (2006) evaluates Driscoll's three-fold epistemological model (discussed earlier) and adds a fourth epistemology, "connectivism". Addressing the diversity of content sources and people-to-people connections in the PLN and building on the earlier work of

Downes, Siemens (2008) suggests that this new learning theory of connectivism "posits that knowledge is distributed across networks and the act of learning is largely one of forming a diverse network of connections and recognising attendant patterns" (p. 10). Though seminal, the theory is accepted elsewhere in the literature; for example, Mattar (2010) explores connectivism as a manifestation of constructivist learning in online contexts, suggesting that connectivism explains the kind of learning in a digital age that is "active, situated, authentic, experiential and anchored" (p. 1).

As a theory – potential, real or otherwise – connectivism shares some of the qualities of pragmatism, maintaining that learning is socially mediated and transpires through both cognitive and affective domains within a broader (and increasingly online) community. However, it differs in its emphasis on the network as itself the representation of knowledge. While connectivism does not presuppose the existence of a vast network like the Internet, Siemens (2008) nonetheless uses the fact of the Internet to justify the theory: "the ongoing growth of the Internet for teaching and learning will likely continue to raise networks as a prominent means of representing knowledge and the learning process" (p. 17). Connectivism emphasises the skills of seeking out relevant information while filtering extraneous information, suggesting that the learner's "capacity to know is more critical than what is currently known" (Downes, 2006, p. 11). Learning is cyclical, as learners connect and reconnect to a changing network. This connection/reconnection is, in Siemens' (2008) view, an essential part of developing the learner's PLN: "just as our mind is a continuously evolving set of connections between concepts, so our students and their learning can become placed at the centre of a Personal Learning Network which they construct with our help for their maximum benefit" (p. 16). Siemens thus argues, "the growth of networks is beginning to, and will continue to, force a reconsideration of pedagogy" (p. 17).

Kop and Hill (2008) criticise the acceptance of connectivism as a theory, suggesting that while it might satisfy conditions for a *developmental* theory, "it does not seem that connectivism's contributions to the new paradigm warrant it being treated as a separate learning theory in and of its own right" (p. 11). They point out that while connectivism implies that "one's Personal Learning Network is formed on the basis of how one's connection to learning communities are organised by a learner", the reality is somewhat different, "partly because educational staff and institutions have not caught on to the possibilities that digital technology have to offer, and partly because not all people are autonomous learners" (p. 2). Focusing on the role of teachers as learners in a digital age, they assert:

> There is a need for adult educators to closely follow and influence the developments and the debates, and seriously research how their institutions can evolve using the emerging technologies to their and their learners' advantage. In doing so, they would ensure that (adult) education can secure its role of critical engager, and at the same time make the best use of technology – that is in making connections with information and knowledgeable others all over the world to enrich learners' lives and the communities in which they live (p. 11).

While critical of the notion of knowledge as distributed across the network and building on their earlier work, Kop and Bouchard (2011) present a discussion of "networked learning" that draws important distinction between formal (other-directed) and informal (self-directed) learning, pointing out that the networked learning of the PLN is chiefly informal:

> The first and obvious property of networked learning is that it allows learners to freely choose what it is that they want to learn. The control over the object – or content – of one's learning is a central element that distinguishes *informal* learning from the formal and the other-directed from the self-directed. However, it is not the only one. Learners can exercise control not only over what they learn, but also why they learn, and where, how, at what cost and with whom (p. 72, my emphasis).

Similar to earlier arguments discussed above, they examine the theory of connectivism, suggesting that this theory and others like it "equate learning with networking itself, but remain seemingly oblivious to the important corollary that successful learning requires successful networking" (p. 74). The discussion also draws attention to Bouchard's (2009) four-fold model of networked learning, which attempts to illustrate the conditions for successful networked learning as dimensions of learner control and/or autonomy, including the *conative* (motivational and affective domains that influence learners), *algorithmic* (selection of resources and goal-driven learning paths), *semiotic* (changed relationships with language in online contexts through practices such as aggregating, filtering and blogging) and *economic* (in particular, Web 2.0's departure from the notion of organisations and institutions as sources of knowledge):

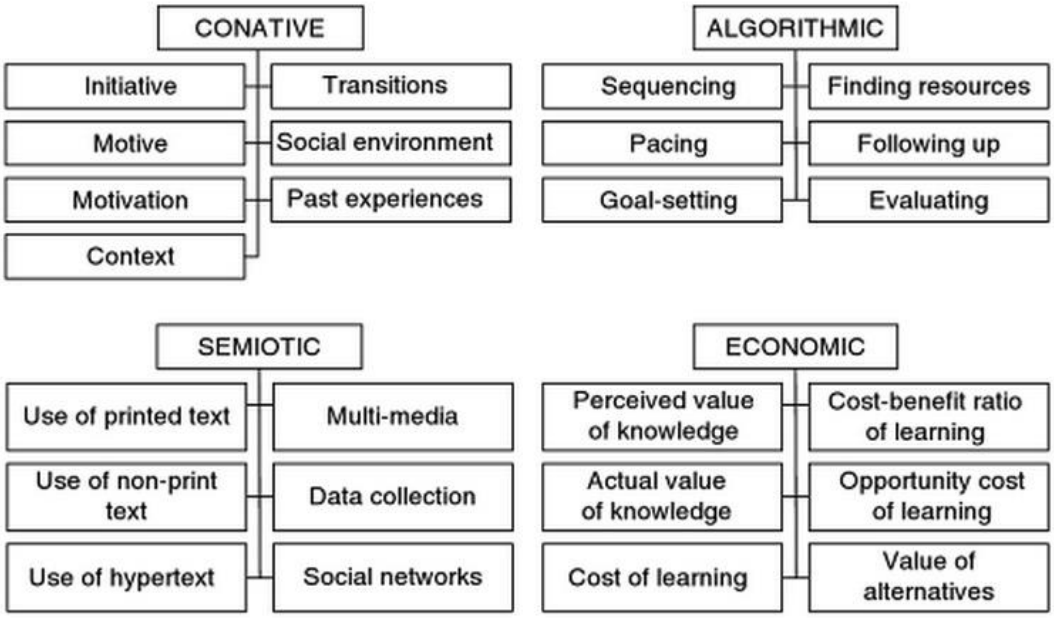

Figure 2.5 - Bouchard's four-dimensional model for informal, networked learning.

(Bouchard, 2009)

As we can see, with the placing of emphasis on either the learner at the centre or on the network around the learner, different theoretical standpoints for the PLN can be reached. In spite of these differences, however, learning through the PLN reflects a reality that is largely subjective and a view of knowledge acquisition that requires considerable autonomy on the part of the learner if it is to be of value. While this autonomy is consistent with the literature on adult learning and theories built on pragmatist epistemology, the arguments addressed here suggest that it cannot be automatically assumed. Further, while learning is dependent on the individual learner's choices and agency, proposed theories like connectivism remind us that there are a multitude of external factors that shape the kind of learning that is possible within the PLN, including economic limitations, semiotic relationships, affective conditions such as the level of emotional engagement and cognitive/behavioural interactions.

As we look to theoretical roots like pragmatist epistemology to explain the complexities of the PLN, Rodgers (2002) reminds us that, "meaning making does not stand isolated from our view of the world but grows out of and leads back into it, possibly demanding that our view change radically. It might also mean that the way in which we participate in the world has to change" (p. 862). Quite apart from the tacit acceptance of the LMS as a singular reality, the broad theoretical roots of the PLN are reflected in the challenges it presents to the underlying assumptions of institutional learning. As Wenger (1998) points out, "our institutions are largely based on the assumption that learning is an individual process, that it has a beginning and an end, that it is best separated from the rest of our activities, and that it is the result of teaching" (p. 3). The PLN presents a very different paradigm for learning that is yet to be fully captured in empirical research. Technology permeates through the process of learning; the tools, context, connections, information, motivation and learning pathway is intricately connected to the digital world around us.

Exploring the Connective Imperative between Past and Future

> Theory isn't abstract; it isn't words on a page; it isn't aesthetically pleasing patterns of ideas and evidence. Theory is concrete. It's distilled practice. Above all, theory is felt, in the veins, in the muscles, in the sweat on your forehead. In that sense, it's moral and binding. It's the essential connective imperative between past and future (Griffiths & Walser, 1974, p. 64).

As educators, we live in a connected, digital world that challenges us to think critically about how we learn and how to leverage what is available now, and plan to leverage what might be available in the future. As this chapter has illustrated, this learning mediated through a diversity of technology tools has a similarly diverse set of theoretical roots. Each individual theoretical standpoint represents learning differently, and it is not always easy or appropriate to combine disparate theories. The perceived need to reconcile diverse theories is nonetheless evidenced in the push to recognise connectivism and other emerging theories as more accurate depictions of how we learn in the twenty-first century. However, the debate surrounding their acceptance within the field is far from conclusive and it remains to be seen whether or not one theory will accurately reflect learning in a digital age.

Aligning theoretical roots with key technology paradigms that have been employed to serve teacher professional learning such as the LMS, PLN and the use of CSCL explains some of the key differences between how learners learn with technology, while also highlighting key implications for future research. Both the LMS and CSCL are very much well established paradigms still being explored in educational research. Their focus on measurable and, to an extent, objectively observable contexts enables empirical research. By contrast, the PLN's emphasis on diverse tools that are freely employed by the individual learner challenges empirical researchers to accurately explore how the many combinations and permutations of different tools (let alone assessing the contribution of each) shape learners' experiences as part of that paradigm.

School leaders endorse approaches to teacher professional learning that reflect the values of society – including the role of the teacher and an understanding of how we can, or should, learn in a digital world. It is in exploring the theories around the "should" that further implications for future research emerge. For example, Glassman (2001) closely examines the historical intersection between pragmatism and interpretivism by exploring the conceptual and historical relationships between Dewey and Vygotsky. Both theorists emphasise the importance of everyday activity in the learning process, reflecting the notion that the human condition is based in social interaction, inquiry and problem solving. As Glassman points out, there is considerable convergence between their broad ideas, and between concepts like Vygotsky's Zone of Proximal Development and Dewey's Long-Term Projects; for both theorists, "there is a problem in immediate activity that is beyond the reach of current thinking" (p. 11). However, exploring the historical bases for their work – Dewey's democratic scepticism of the state compared to Vygotsky's emphasis on the state and the mentor as its representative – Glassman separates the two theorists, stating that, "Dewey is unrepentant in the degree to which he promotes individualism, whereas Vygotsky sees the social organisation as the central agent of change" (p. 12).

Reacting to European state-run, class-based education institutions and Platonic liberationist ideals evident in later nineteenth century philosophy, Dewey (1916) indeed argues vehemently for individualism as the basis of a democratic education:

> The so-called individualism of the eighteenth-century enlightenment was found to involve the notion of a society as broad as humanity, of whose progress the individual was to be the organ. But it lacked any agency for securing the development of its ideal as was evidenced in its falling back upon Nature. The institutional idealistic philosophies of the nineteenth century supplied this lack by making the national state the agency, but in so doing narrowed the conception of the social aim to those who were members of the same political unit, and reintroduced the idea of the subordination of the individual to the institution (p. 86).

As Glassman (2001) notes, the role of shared, social tools in education further separate the two theorists. While history constructs tools (including shared values, procedures, ideals and available resources) that can be used for educational purposes, each theorist sees the use of these tools quite differently:

> For Dewey, culture and history provide a malleable set of means (e.g., tools) that can be used to achieve immediate or easily viewed ends. These tools have worth only to the degree to which they can be used to successfully navigate a given situation. For Vygotsky cultural history provides for a (relatively) more static set of tools and symbols that should eventually enable members of a society to move beyond pure instrumentality, to a higher level of cognitive awareness. Tools are means for specific, culturally approved consequences that act as way stations on the path to a socially defined end. Dewey's cultural instrumentality was criticised for its emphasis on means over ends in social historical development. Dewey posits that education leads to free inquiry, and free inquiry leads to a richer society, but he lacks a description of exactly what a richer society looks like. Vygotsky, on the other hand, is susceptible to the criticism Dewey makes of the entire Soviet educational system—that social goals can easily be turned into propaganda that services the society (p. 5).

While emphasising that "society is one word but many things", (Dewey, 1916, p. 70), Dewey nonetheless alludes to a richer society as one where diverse forms of expression are possible – where people "associate together in all kinds of ways for all kinds of purposes" and the challenge is to "extract the desirable traits of forms of community life which actually exist, and employ them to criticise undesirable features and suggest improvement" (pp. 70, 71).

Conclusion

While established areas like the LMS and use of CSCL reflect attempts to explore technology-mediated learning in singular, empirical contexts, the growing use of the PLN suggests a new methodology is needed to accurately characterise the breadth and depth of teacher professional learning in a very wide range of rapidly shifting and highly personalised online contexts. In particular, the intersection between pragmatist and interpretivist epistemologies highlights the impact of our assumptions on our learning experiences. Technology has undoubtedly played an important role in challenging these assumptions. However, there is still considerable scope for further research that explores the teacher as an autonomous learner, particularly through the learner-centred model of the PLN.

While Dewey in his day deplores "the willingness of our teaching corps to accept without inquiry or criticism any method or device which seems to promise good results… [where] teachers flock to those persons who give them clear-cut and definite instructions as to just how to teach this or that" (Dewey, 1904, p. 152), he also reminds us that "the mistake of making the records and remains of the past the main material of education is that it cuts the vital connection of present and past, and tends to make the past a rival of the present and the present a more or less futile imitation of the past" (Dewey, 1916, p. 66). With its emphasis on individualism, free inquiry, critical use of tools, autonomy and problem solving, pragmatist epistemology arguably lends itself to supporting further research in the use and development of the PLN by educators. However, as the debate around the acceptance of connectivism illustrates, many (if not most) of these qualities cannot be taken for granted.

This chapter has reviewed the role of technology – both past and present – in enabling, supporting and at-times transforming teacher professional learning. The transition from print to digital technologies was examined alongside key changes to professional learning, away from the transmissive "development" of educators towards more learner-centred models that incorporate community, sharing and collaboration. With reference to changes from the mid-1980s (in particular, those evident from Hargreaves' "third age" onwards) to the present day, it was argued that technology has played a pivotal role in eroding many assumptions – for example, Huber's (2010) "passing on information is enough" noted earlier. The chapter also examined a range of key technology paradigms related to professional learning. These included very recent trends such as Web 2.0, Mobility and Atomization. These trends now substantively inform the emerging paradigm of the Personal Learning Network (PLN) that exists alongside more established paradigms such as Computer-Supported Collaborative Learning (CSCL), and the Learning Management System (LMS). These three key paradigms were evaluated in terms of how their theoretical roots have shaped research traditions and underlying epistemologies of learning in online contexts.

While CSCL and the LMS represent paradigms that have been developed, implemented and explored through empirical inquiry over many years – as reflected in their respective bodies of literature – the Personal Learning Network (PLN) has yet to be fully explored. In particular, the PLN aims to reflect a diversity of networks, tools, people-to-people connections and learning contexts (both formal and informal) available in the twenty-first century. As we noted in this chapter, developmental theories such as connectivism are yet to be fully accepted as an accurate depiction of networked learning, though these theories nonetheless reflect the challenges of explaining the evolving nature of digital learning. Similarly, the development of a methodology to accurately investigate the complexity and diversity of professional learning in a digital age remains a challenge. Chapter 3 explores the development of such a methodology.

Chapter 3. Methodology

> Researchers who conduct mixed research studies often adhere to the pragmatist philosophy, in which the researcher mixes research components in any way he or she believes will work for the given research problem, research question, and research circumstance. The pragmatist researcher carefully thinks about the perspectives provided by qualitative and quantitative research, and then he or she constructs a combined or mixed approach to address the research question or questions… We contend that pragmatism offers the philosophy that best supports mixed research (Johnson & Christensen, 2008, p. 442)

Given the complex challenges of researching technology-enabled professional learning and school leadership across a diverse set of tools and contexts, a mixed methodological approach was an essential part of this study. Mixed methodological designs concur with the rejection of the incompatibility thesis (Johnson & Onwuegbuzie, 2004). Similarly, as Johnson and Christensen (2008) note, mixed methodological approaches are often predicated on pragmatism as a way to accommodate competing research interests and requirements. This chapter discusses the main elements of this approach, drawing attention to two key stages that reflect paradigm sequencing and emphasise design decisions. The initial qualitative inquiry in Stage 1 enabled the researcher to explore key concepts within the school context and from the perspectives of current teachers and school leaders. The subsequent quantitative inquiry in Stage 2 measured operational constructs pertaining to Personal Learning Networks (PLNs), Participatory Cultures and Technological, Pedagogical and Content Knowledge (TPaCK) across three mixed purposeful samples comprising educators at all levels – from preservice teachers to principals. The use of mixed methodologies in the study thereby aimed to overcome limitations commonly evident in studies that are solely qualitative or quantitative.

Pragmatist Principles Informing the Research Design

Pragmatist epistemology emphasises experience as educative while acknowledging its subjectivity – in other words, the reality that experiences will differ for each learner. As Chapter 2 showed with recourse to three theoretical standpoints, pragmatism arguably provides the most accurate explanation of the kinds of learning possible through the PLN by emphasising both the learner at the centre of the model and learner autonomy as a necessary condition. While allowing for use in formal contexts, the PLN is more often associated with informal use, where learners self-structure sequences through real-world problem-solving, self-management, free inquiry and reflection (Richardson & Mancabelli, 2011). Further, while educators may be free to employ tools as they see fit, they are also free to repurpose them, and the generativity of many past and present tools supports this repurposing in ways that the originators of the tools may not have anticipated (Zittrain, 2009). The form that PLN-mediated learning takes therefore depends largely on the learner and their decisions, habits, perspectives, values, beliefs and abilities. Through the lens of pragmatist epistemology, these tools are part of our shared social history; however, our individual realities are different, so the ways that each learner employs the tools will differ accordingly

The digital age represents the continual movement between equilibrium and disequilibrium commonly associated with pragmatist inquiry. As technology develops, new sources of information are accessed and delivered rapidly, new tools emerge and new connections are formed. When educators respond to challenges, learning needs are identified and pathways to addressing these needs can be explored. Although these needs have traditionally been explored within and around the learner's immediate physical context (for example, the school or university), the tools now available enable the learner to move into online spaces that exist outside this context, presenting a new disequilibrium to be explored. As Dewey (1938) points out, "the state of disturbed equilibrium [disequilibrium] represents need" (p. 27). Central to his theories of inquiry, this need identified through disequilibrium drives exploration of new ideas and learning goals, each of which may culminate in a kind of temporary equilibrium. Dewey terms this temporary equilibrium the "end-in-view", where "there are no ends beyond the process of successful activity within the context of the immediate action" (Glassman, 2001, p. 5). Hence, while learning is driven by the disequilibrium and need evident in our own learning context, it is also iterative and cyclical; self-identified and self-managed learning goals become the foundation of future learning paths.

When exploring the roots of this kind of inquiry, Dewey's three-stage approach provides further context on the challenges of developing a methodology that is sensitive to the dynamic inquiry process in technology-mediated environments. Dewey's three phases of inquiry include: (a) "the problematic situation", where the disturbed equilibrium (or disequilibrium) is recognised; (b) "the identification of the parameters of the situation", where the scope of the problem is explored; and (c) "the reflection on those parameters and the situation itself with a goal of generating a solution" (Dimitriadis & Kamberelis, 2006, p. 6). Throughout the inquiry process, learners construct knowledge through both primary experience (for example, in interaction with others) and secondary experience (for example, formulating thoughts into written language). As Glassman notes, knowledge in pragmatist inquiry "is the reconstruction of secondary experience through primary experience" and "the knowledge storehouse is dynamic because primary experience continuously forces reconstruction of secondary experience in order to deal with the immediate situation" (2001, p. 8). Further, secondary experience is interwoven with continual reflection; for Dewey, this exists as a scientific method for making meaning and generating new ideas. Rodgers (2002) explores Dewey's theories on reflection as a four-stage process involving presence to experience, description of experience, analysis of experience and intelligent action. In this way, reflection does not, strictly speaking, happen at the end of a learning experience; however, it is an important tool for future activity:

> [Through reflection,] what an individual has learned in the way of knowledge and skill in one situation becomes an instrument of understanding and dealing effectively with the situations which follow. The process goes on as long as life and learning continue (Dewey, 1938a, p. 44).

In twenty-first century technology-rich learning environments, pragmatist inquiry suggests experimentation with available tools while underscoring the importance of primary and secondary experience, problem solving, free inquiry and reflection. As noted in Chapter 2, Warlick's (2009) conception of the PLN shows the learner at the centre, with adjoining nodes for content aggregation and people-to-people connections. Given the seemingly limitless permutations of the tools that now exist in these areas, a mixed research design is needed that accurately captures the learner's use of tools that support and/or enhance their professional learning. This study explores the use of these tools as part of formal structures that exist to support and facilitate professional learning, as well as in informal settings outside of these structures.

Mixed Tools, Mixed Methodologies

Chapter 2 examined pragmatist epistemology as the key theoretical root underpinning the PLN. As a highly adaptive, contextual and difficult-to-research model, the PLN incorporates the physical world of technology devices and tools, the ways these manifest online, and the learners' psychological world of perceptions, interactions and learning experiences. In addition to positioning pragmatism as the philosophical basis of mixed methodological research, Johnson and Christensen (2008) also contend that the pragmatist-informed research "recognises the existence and importance of the natural or physical world as well as the emergent psychological world that includes language, culture, human institutions and subjective thoughts" (p. 443). In keeping with Dewey's notion of the "end-in-view" and life-long learning, they further describe mixed research as an iterative and continual process:

> Organisms are constantly adapting to new situations and environments. Our thinking follows a dynamic homeostatic process of belief, doubt, inquiry, modified belief, new doubt, new inquiry in an infinite loop, where the person or researcher (and research community) constantly tries to improve upon past understandings in a way that fits and works in the world in which he or she operates. The present is always a new starting point (p. 443).

When considering research that is iterative and cyclical, Morgan (1998) argues in favour of mixed research designs that specify time orientation, sequencing and emphasis of each research paradigm:

> A more practical strategy is to designate one of the methods as the principal means of data collection and then to design the complementary method so that it effectively assists the principal one. This division of labour can use either a qualitative or a quantitative technique as the principal method. The choice of a complementary method then depends on what each candidate might add to the principal method. In other words, the first step in the research design process is to select a principal data collection method that has the strengths that are most important to the project's goals. The second step is to select a contrasting complementary method that offers a set of

strengths that can add to the research design's overall ability to meet the project's goals (p. 366).

In addition, Morse (2003) presents notation for showing both sequencing and paradigm emphasis (words abbreviated with uppercase used to indicate prominence and arrows used to indicate sequencing) at key stages throughout a mixed methods study. In developing this study with recourse to sequencing and paradigm emphasis, qualitative inquiry with minor emphasis was employed as a vehicle for developing a more robust quantitative approach with major emphasis. In particular, the challenges of developing a reliable and valid set of instruments for measuring teacher professional learning in a digital age – including a number of constructs not previously explored in empirical settings – meant that qualitative inquiry could serve as a starting point for exploring possible themes. Table 3.1 shows Morse's paradigm and sequencing notation in relation to key design decisions for purpose, instrumentation and sampling.

Table 3.1 - Morse's paradigm emphasis and sequencing for mixed research.

Paradigm, Sequence and Emphasis:	qual →	QUAN
Purpose:	• to explore initial themes about teacher professional learning; • to examine individual and school-based perspectives and leadership decisions; • to understand how professional learning is shaped by the school context; and • to see professional learning through the perspectives of current teachers and school leaders.	• to validate themes about teacher professional learning; • to examine individual attitudes, perceptions, decisions and actions; • to understand professional learning – both formal and informal – outside of the immediate school context; and • to see professional learning through the attitudes, perceptions, decisions and actions of educators from all levels (preservice teachers, classroom teachers and school leaders).
Instrumentation:	• 1-1 interviews; and • focus group interviews.	• Teacher Professional Learning Questionnaire (TPLQ)
Sample:	• teachers and school leaders (n=102) involved in *Connected Communities 21*	• teachers and school leaders (n=102) involved in *Connected Communities 21* • teachers attending one-day training courses at Macquarie ICT Innovations Centre (n=47); and • third-year preservice teachers studying Education (n=56).

In, their framework for mixed research design, Greene, Caracelli and Graham (1989) canvas five possible overarching purposes that may inform the rationale for a mixed methodologies study. In particular, this study drew on their notions of *complementarity* and *development*. On the one hand, they note that the purpose of complementarity is "to measure overlapping but also different facets of a phenomenon, yielding an enriched, elaborated understanding of that phenomenon" (p. 258). The other purposes for mixed research that were less evident in the design but were, nonetheless, important considerations in the implementation of this study included *triangulation*, *initiation* and *expansion*. Triangulation was undertaken by comparing and contrasting the key themes emerging from the qualitative inquiry with those in the quantitative data. Initiation – which seeks new perspectives of frameworks – was an important consideration for interpreting research findings from both stages of the study. Finally, expansion – which "seeks to extend the breadth and range of the inquiry by using different methods for different inquiry components" (Johnson & Christensen, 2008, p. 451) - was important for building on analysis of one sample in the qualitative inquiry with analysis of the same sample alongside others in the quantitative inquiry.

As Table 3.1 denotes, while the primary qualitative emphasis was minor, it provided a necessary starting point for exploring the phenomena, including constructs like the Personal Learning Network (PLN), Participatory Cultures and teacher TPaCK knowledge. In particular, the principle of development "seeks to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions" (Johnson and Christensen, 2008, p. 259). In this context, this study employed the initial qualitative inquiry to explore operational constructs and then develop a robust, valid and reliable quantitative component.

Table 3.2 shows the data matrix with mapping from each of the research questions to the three main instrumentation components that were employed. The table summarises the data that were gathered and reflects how two instruments in the qualitative inquiry – the 1-1 and focus group interviews – were used to inform and develop the Teacher Professional Learning Questionnaire (TPLQ).

Table 3.2 – Data matrix.

Research Question / Data (and sample):	**1-1 LoU Interviews (CC21 School Leaders)**	**School Visits and Focus Group Interviews (CC21 School Leaders)**	**Teacher Professional Learning Questionnaire (CC21 participants, MacICT attendees and preservice teachers).**
1. *How, in what ways, and to what extent do teachers use current technology tools to support their professional learning?*	• Rich descriptions of tools used and their value for professional learning • Preferred tools for specific purposes discussed. • Familiarity with tools examined at the level of the individual educator	• Descriptions by participants of general technology use by educators in their school community. • Familiarity with tools examined at the level of general up-take and use by educators in the school community.	• Instruments measure the use of technology tools for professional learning that have been identified in the research and literature. • Participants report on their perceptions of the tools and value for their professional learning.
2. *How, in what ways and to what extent are professional learning outcomes for teachers shaped by the context in which the tools are used?*	• Personal accounts from school leaders of professional learning decisions, support structures and outcomes in their school community. • Differences between use in, and outside of, school settings are discussed.	• Rich descriptions of the context, including teaching/learning challenges, the technical abilities of educators, access to technology infrastructure and structures that are put in place to support professional learning.	• Participants report on their use of tools both in, and outside of, formal learning settings. • Participants report on required tools vs optional uses of the tools measured.
3. *What principles and heuristics of twenty-first century learning are evident in the ways teachers use tools to support their professional learning?*	• Participants discuss how their professional learning has adapted in response to current C.21st curriculum demands and what they see as necessary for all educators moving forward.	• Discussion of key changes in the school community and the role of technology in relation to these changes. • Reflection on curriculum demands. • Discussion of people who the technology "drivers" are and their role in supporting/facilitating change.	• Key attributes of twenty-first century learning are measured aligned with three current models: Personal Learning Networks (PLNs), Participatory Cultures and Technological, Pedagogical and Content Knowledge (TPaCK).
4. *How and in what ways might professional learning in traditional face-to-face contexts be better informed by the diversity of situated learning experiences in emerging and established online contexts?*	• Participants are asked as school leaders to reflect on learning priorities for other educators in their community and ways of meeting these priorities. • Participants discuss and justify future professional learning initiatives.	• Participants are asked to discuss their professional learning in relation to their school community – what they need to learn and why. • Participants are asked to reflect on what kind of learning they value and most want to encourage – for themselves and their students.	• Participants report on effective uses of the tools for professional learning. • Important factors that support or hinder effective uses are identified. • Important factors that support or hinder learner autonomy are identified.

Professional Learning Contexts

This thesis argues that closely examining the professional learning context can reveal important findings about the nature of the learning and its impact on the school community, with significant implications for all school leaders. While the technology-enabled learning reflected in models like the PLN and Participatory Cultures is often informal, highly personal and subjective, such learning is nonetheless grounded in the beliefs, attitudes and actions of the educator acting in their professional context. Likewise, there are important contextual factors that exist in each context to shape the nature, outcomes and impact of professional learning within and beyond the context. Thus far, the chapter has explained the rationale for the mixed methodological design of the study. Both the epistemological and philosophical frameworks support this design; further, decisions regarding sampling and instrumentation were shaped by three main research contexts in which the study took place.

Context 1: Connected Communities 21 (CC21) educators (n=102).

The *Connected Communities 21 Project* (CC21) was a study of technology-enabled self-managed professional learning (Stevenson, Howe, & Hedberg, 2014). In particular, the study examined how school leaders support and facilitate professional learning in their school communities, especially when confronted with new curriculum challenges. CC21 explored how participants respond to these challenges through sustained professional learning as individuals, in school teams and as part of a broader community of schools involved in the project. The study was specifically timed to coincide with the implementation of the new Australian Curriculum, a curriculum that calls for significant change in terms of pedagogical approaches, the use of new technologies and major revisions to subject content (ACARA, 2012). Professional learning in these three areas was facilitated by school leaders in ways that were responsive to the identified, specific needs of their school community. Further, these three areas align with the Technological, Pedagogical and Content Knowledge (TPaCK) model, a model that emphasises the importance of the intersections between these knowledge dimensions. Table 3.3 describes the dominant challenges in relation to each TPaCK first-order dimension.

Table 3.3 – CC21 TPaCK knowledge dimensions and contemporary challenges.

TPaCK First-Order Dimension	Contemporary Challenges
Technology (TK)	The new curriculum calls for the embedded use of technologies throughout teaching, learning and assessment. All participating schools were faced with the challenges of deploying new technology tools. Deployment often involved the purchase and use of new devices, installation of wireless infrastructure, familiarisation with new platforms and applications. Each school's infrastructure and use of technology tools was different, requiring both school-based and self-managed and identified professional learning to address the needs of teachers and students in the community. To some degree, this also required subversion of official system policies that did not support certain infrastructure (for example, connection of tablet devices to the Wi-Fi network).
Content (CK)	All participating schools were faced with the challenge of implementing New South Wales syllabi for the Australian Curriculum. The curriculum presents new content demands in a wide range of cross-curricular areas, requiring teachers to explore and address weaknesses in their content knowledge. In particular, the curriculum calls for cross-curricular priority areas - including *Sustainability*, *Aboriginal and Torres Strait Islander Stories* and *Australia's Relationship to Asia* - to be embedded and taught in every subject area.
Pedagogy (PK)	The curriculum calls for inquiry-based learning approaches to be adopted as assessment strategies in all core subject areas (Mathematics, English, History, Geography, and Science). In addition to exploring the inquiry-based learning approaches evident in new curriculum demands, most participating schools used their involvement in the project to re-think the pedagogies needed to enhance learning in their community. Some educators engaged in relevant professional learning to understand and implement pedagogical models such as Authentic Learning, Project-Based Learning (PBL) and Inquiry-Based Learning (IBL). Other educators addressed their knowledge of more general pedagogical strategies for implementing the new curriculum.

As part of their participation in the study, schools received A$10,500 of funding that leaders were relatively free to use for professional learning in response to the new curriculum demands. Prior to selection of the sample, all government schools in a large metropolitan area were invited to prepare expressions of interest outlining the professional learning deemed necessary for implementing the new curriculum and how the school leadership team would seek to use the funding to facilitate this learning. Seventeen schools were selected on the basis of expressions of interest that showed evidence of capacity for school-based professional learning that addressed the curriculum-related needs identified by the school leaders. In this way, the Australian Curriculum acted as a contextual catalyst for exploring the different forms of professional development evident in each community.

Participation in the study further required school leadership teams to provide reports on professional learning outcomes, as well as posting weekly updates in a shared public blog. The shared blog posts prompted school leaders to reflect on their progress, and were often used to identify common problems and solutions, promote inter-school dialogue and share links to useful digital resources. Apart from the program's reporting and blogging requirements and the need for each project to include a clear focus on professional development related to the new curriculum, school leadership teams were free to determine the scope and parameters of their perceived learning needs.

The overall sample of 102 participants included principals (n=17, 16.67%) and non-teaching executives (n=13, 12.74%), teachers with leadership roles (for example, ICT mentor and subject coordinators; n=31, 30.4%) as well as regular classroom teachers who had adopted informal leadership roles in their school, such as being the "go to" person for technology support (n=41, 40.2%). The sample included a majority of primary school teachers (n=86, 84.31%) and a small cohort of secondary teachers (n=16, 15.69%). A majority of the sample (n=84, 82.35%) was female. Participants in the sample ranged in age from 24 years old to 65 years old, with a mean age of 40.2 years.

Because of their different needs and interests, the reports shared by each school varied considerably. For example, whereas some schools focused on professional learning with technologies that were currently in place, others used their participation as an opportunity to acquire and explore new technologies. Some schools attempted a school-wide change with every teacher involved, whereas others included only a small number of teachers. Some schools cited specific pedagogical models (for example, "Project-Based Learning"), whereas others cited general pedagogical principles (for example, "student-centred learning"). While each school employed their funding for different forms of professional learning, the majority of schools spent more funds in the areas of teacher release (the provision of time away from classroom duties to plan, work with colleagues or attend training) and the purchase of new hardware devices (most notably, tablets) for teachers to develop their technology skills. Other areas like formal training and the purchase of needed infrastructure for professional learning were less consistent, being applied in a relatively small portion of schools.

CC21 provided a purposive and self-selected sample of school leaders across a large metropolitan area predisposed to using technology for self-managed professional learning. However, while the sample enabled the researcher to explore the involvement of school leaders in facilitating newer forms of professional learning, there were some limitations in qualitatively exploring the CC21 data that required closer analysis through an intensity sample and the follow-up development of the TPLQ. The most notable limitation in the CC21 sample was the scope of professional learning being constrained by the specific parameters of the leadership team's project. While school teams *collectively* determined their projects and associated learning needs, teachers within the school community did not necessarily engage in professional learning that was unrelated to their school's project. To this degree, individual professional learning goals were shaped, and to some degree constrained, by school-determined projects.

In spite of its limitations, the CC21 sample was integral to both stages of the study. In Stage 1, the qualitative study of this sample led to important early findings that enabled the researcher to design the Teacher Professional Learning Questionnaire that formed Stage 2 was delivered to the three samples of educators from different contexts. To clearly identify the key themes in Stage 1 that would inform the design of Stage 2, all data points from the CC21 project were used, including one-on-one interviews with all seventeen principals, focus group interviews with principals and their team of school leaders, blog posts from all participants and collaboratively-written school reports. These data were analysed in *QSR NVivo,* Version 10, with a coding system that combined both *a priori* and inductive codes. This coding system is explained further later in the chapter.

During data analysis, it emerged among the 102 educators that a small number of educators demonstrated beliefs, actions and values that showed some consistency with literature in areas of Personal Learning Networks (PLNs), Participatory Cultures and Technology, Pedagogy and Content Knowledge (TPaCK). To accurately identify which participants showed evidence of having well-established PLNs, the researcher closely examined the data to explore the relationship between those technology tools and networks that were required for participation in the CC21 project and those that were recognised by participants as "additional" or "optional". Among the 102 educators, 19 participants referenced additional tools that had been employed to learn professionally in different online networks, with both the tools and networks being unrelated to their involvement in the project. These educators emerged as potential "best cases" (Johnson & Christensen, 2008) demonstrating connected, autonomous and largely self-managed professional learning. In addition to being identified in the data these educators were often nominated by other leaders in their school community, with words such as "driver", "guru" and "expert" used to describe them. In their interviews, they were readily able to provide clear examples that demonstrated their skills and knowledge with technology. Some of these educators were formally appointed leaders while others were recognised as classroom teachers with informal leadership roles in their school. These educators provided context-specific and were "information-rich" (Patton, 1990, p. 169) in terms of the insights they shared on professional learning in a digital age. Most importantly, these participants were clearly engaged in autonomous professional learning beyond the scope of their school's project.

To more closely understand these participants, eight cases were selected as an intensity sample for closer analysis. Onwuegbuzie and Collins (2007) note that choosing an effective intensity sample involves "choosing settings, groups, and/or individuals because their experiences relative to the phenomena of interest are viewed as intense but not extreme" (p. 286). These eight cases comprised four technology mentors – school leaders that demonstrated effective technology-enabled professional learning – and the principal of their school. Data from these cases provided detailed first-hand accounts of how each participant viewed professional learning – both theirs and their colleagues. In the cases of the school leaders, specific actions, beliefs and values were discussed from the leader's point of view, showing how they engaged in their professional learning while in all cases playing a supporting role in their colleague's professional learning. In the case of the principals, data revealed their beliefs, actions and values in relation to the professional learning needed for their school to move in the direction they believed was best.

In qualitative research, some advocate the use of intensity samples as a way of undertaking deep, case-oriented analysis of key participants within a larger sample (Johnson & Christensen, 2008; Patton, 1990; Sandelowski, 1995). While these eight cases represented a small subset of the complete sample of 102 educators, it was possible to triangulate their statements with the further contextual data of the broader school community of educators, including related input from their colleagues in the focus group interviews and statements from the leadership team in each school's project reports. The eight cases were therefore well situated in their school and demonstrated professional learning that was clearly of value to the community. In the case of technology mentors, it was their independent professional learning – often outside of work hours – that influenced the professional learning that subsequently took place within the school. Their professional learning also played a role in influencing the strategic direction of the school as documented in the school project reports. In the case of principals, it was important to note their awareness of the shift from professional *development* to professional *learning* and explore how they perceived their role in this shift.

To develop the TPLQ, both one-on-one and focus group interview data for the educators in the intensity sample were analysed as part of the initial qualitative inquiry in order to explore operational constructs through emic terms, rich descriptions and context-related discussions. The operational constructs emerging from the analysis to varying degrees confirmed and supported the focus in the TPLQ on measurement of Personal Learning Networks (PLNs), Participatory

Cultures and TPaCK knowledge dimensions. The TPLQ was therefore developed to explore and measure a wide range of forms of technology-enabled professional learning in relation to other samples of educators, including those outside of the CC21 sample. The design and validity of this questionnaire is further discussed later in this chapter.

At the conclusion of the project, all 102 school leaders were invited to complete the TPLQ. Of these, 63 responded (61%). This sample of respondents included a majority of primary teachers (n=53, 84.1%) and female participants (88.9%). In addition to the early qualitative findings, CC21 provided an important sample for exploring teacher professional learning beyond the school context. The instrument asked participants to specifically to report on professional learning "outside of work or study", including various uses of unstructured time, different areas of their Personal Learning Network (PLN), features of their Participatory Cultures and gaps in Technological, Pedagogical and Content Knowledge (TPaCK). The instrument thus explored professional learning beyond the initial scope of the CC21 project.

Context 2: Macquarie ICT Innovations Centre (MacICT) educators (n=47).

The Macquarie ICT Innovations Centre (MacICT) is an organisation located on the grounds of Macquarie University and represents a partnership between the university and the New South Wales Department of Education and Communities (DEC). The organisation exists, first, to provide statewide professional learning opportunities to both government and non-government schools. Second, MacICT provides opportunities for researchers in the university to develop and undertake research projects that relate to the programs offered, and this research may directly involve the participants in these programs. Generally speaking, participants may include teachers and students from primary and secondary schools across NSW, although the centre also occasionally offers programs for both academics and preservice teachers (PSTs). Where studies with DEC teachers and/or students are involved, two separate ethics applications are usually prepared: (a) the university ethics application with Faculty of Human Sciences (FHS) at Macquarie University; and (b) the State Education Research Approval Process (SERAP) with DEC.

Data gathering took place during the first half of 2014. When attending a one-day course and while waiting for their coursework to begin, attendees were invited to complete the Teacher Professional Learning Questionnaire (TPLQ). Of the approximately 180 teachers invited to complete the questionnaire, 47 responded (26.1%). In contrast to the CC21 Project, no interviews were conducted and no qualitative data about the school context were gathered. It is further important to note that the one-day training course delivery represents a still-common approach to technology-based professional learning. This approach also sits in contrast to the CC21 project, where participants worked in teams within their school community and managed professional learning goals and outcomes over a longer period of time, sharing their progress and seeking feedback from others in their school, and in the broader community of schools. The professional learning that occurred specifically in relation to the MacICT training courses was limited to instruction and workshop activities during the training day, with no further monitoring of any professional learning that took place thereafter. The primary purpose of this sample was, therefore, to provide a typical-case cohort of educators interested in using technology in their teaching and professional learning and willing to undertake some formal training to explore this interest further.

As with the TPLQ respondents from the CC21 project, respondents in the MacICT sample were asked to report on professional learning "outside of work or study" in relation to a range of constructs. The sample of 47 educators that chose to respond to the questionnaire included both primary (n=26, 55.3%) and secondary (n=21, 44.7%) teachers. The majority of the sample indicated they were regular classroom teachers without any leadership role (n=40, 85.1%), while a smaller sample indicated they were classroom teachers with a leadership role (n=6, 12.8%) and one respondent indicated the role of current principal (2.1%). The majority of respondents (n=43, 91.5%) were teachers in schools located across the same large metropolitan area as the CC21 sample, while a small minority (n=4, 8.5%) were from rural schools outside this metropolitan area. The sample included a majority of female educators (n=33, 70.2%). Participants ranged in age from 25 to 58, with a mean age of 32.3.

Early career teachers (n=31, 66%) were an important subset of this sample in that they are required to regularly complete formal in-service training for accreditation purposes. MacICT one-day courses are registered for accreditation in New South Wales. The registration of courses now occurs at different levels, based on the career stages outlined by the Australian Institute of Teachers and School Leaders (AITSL). Levels include *Graduate, Proficient, Highly Accomplished* and *Lead.* To some degree, therefore, this sample speaks to the tension between required or mandated professional learning that can be accounted for in the form of a one-day course and optional professional learning that occurs outside of these formal contexts. Interestingly, professional learning for early career teachers is shaped by similar discourses to those shaping the professional learning of preservice teachers (PSTs). By comparing and contrasting these three samples, the researcher sought to better understand the differences between required, formal learning and optional, informal learning.

Context 3: Preservice Teachers (PSTs).

Consistent with most public universities in Australia, Macquarie University offers a teacher education program for preservice teachers (PSTs). Situated within the Faculty of Human Sciences, this program consists of a four-year undergraduate degree that includes units from non-Education areas such as English literature, creative writing, mathematics, science and information technology as well as Education-specific units in areas such as curriculum, pedagogy, classroom management and professional experience. Students typically undertake a four-year full-time program that blends Education and non-Education units, with the bulk of their Education studies – including their professional experience in schools – in the third and fourth years. The Education-specific units offered in the faculty include General Education (EDUC) units that are studied by all PSTs regardless of their specialisation and Teacher Education Program (TEP) units that involve specialisation in certain areas (for example, primary teaching, secondary teaching and individual secondary subject areas such as English, Mathematics and Science). There is also an increasing emphasis on educational technology, with a range of compulsory and optional units that explore current technology trends and tools for teaching and learning. Both face-to-face and online units are supported through the university's Learning Management System *iLearn* (based on the open-source software *Moodle*), and all students are able to connect any web-enabled device to campus-wide Wi-Fi. Macquarie University's teacher education program was founded on notion of the "scholar teacher", a philosophy that emphasises the importance of scholarly inquiry as part of each teacher graduate's ongoing professional practice.

In Semester 1, 2014, Convenors of one primary TEP unit and one secondary TEP unit invited third-year students to complete the Teacher Professional Learning Questionnaire (TPLQ) via online announcements with links to the questionnaire. Of the approximately 180 students invited to complete the questionnaire, 56 students responded (31.1%). These students included both primary (n=19, 34%) and secondary (n=37, 66%) trainees, of whom a majority were female (69.6%). The sample ranged in age from 20 years to 41 years, with a mean age of 22.7. As with the MacICT sample, no further data gathering took place with respect to this sample.

The respondents in this sample were an important representation of typical-case preservice teachers in a large metropolitan area. That they were also asked to report on professional learning "outside of work or study" challenged these participants to distinguish the learning typically required for their program from the further learning that would benefit their future career as teachers. The TPLQ also challenged them to explore the ways they were using technology to support their professional learning, including tools in addition to those that were explicitly used in coursework instruction and/or assessment. To some degree, it could be argued that their familiarity with, and uses of, these tools in some ways reflected the participant's readiness to employ technology to learn professionally beyond the immediate requirements of their Education degree.

Sampling and Instrumentation Summary

As Onwuegbuzie and Collins (2007) note, "sampling decisions typically are more complicated in mixed methods research because sampling schemes must be designed for both the qualitative and quantitative research components of these studies" (p. 281). In relation to all three contexts explored in this study, the strategy of "mixed purposeful sampling" (Johnson & Christensen, 2008; M.Q. Patton, 2002) was employed to accurately compare and contrast professional learning within and between the three contexts discussed. As Johnson and

Christensen (2008) argue, mixed purposeful sampling is a highly effective strategy for mixed methods researchers to develop ideas from one research context and apply them in other contexts:

> A researcher might, for example, conduct a quantitative survey research study based on a random sample, but also use typical case selection to obtain an illuminating case to describe in the final report. Or a researcher might conduct a purely qualitative research study and start with maximum variation sampling, discover a general pattern of finding the data, and then use negative-case selection to determine the generality of the pattern (Johnson and Christensen, 2008, p. 245).

In Stage 2 of the study, mixed purposeful sampling formed the basis of a causal comparative research design. As Askar, Usluel and Mumcu (2006) elaborate, "in causal-comparative research, investigators attempt to determine the cause or consequences of differences that already exist between or among groups of individuals" (p. 144). The three contexts included in this study were distinct in terms of the nature of professional learning that is typically undertaken. To some extent, the beliefs, actions and values that were evident for each participant were shaped by their context. Marked differences existed, for example, between the professional learning undertaken by many preservice teachers compared with that of current teachers. Similarly, there were noticeable differences between the learning of many of the teachers required to complete one-day courses at Macquarie ICT Innovation Centre (MacICT) and that of the school leaders involved in *Connected Communities 21* (CC21).

Onwuegbuzie and Collins (2007) state that "if the mixed methods purpose is development, then sequential designs are appropriate because development involves using the methods sequentially, such that the findings from the first method inform the use of the second method" (p. 291). As noted earlier, this study's design was based on a sequential model with the paradigm emphasis of a smaller qualitative component followed by a larger quantitative component. The initial qualitative component – principally involving close analysis of the intensity sample with further contextual analysis of the larger CC21 sample – enabled the researcher to explore and operationalise the main constructs. This analysis informed the design of the Teacher Professional Learning Questionnaire (TPLQ), supporting its internal validity, helping to frame the wording of specific items and confirming the relevance of the constructs. The TPLQ was applied to the combined sample of educators across the three contexts, enabling the researcher to make key comparisons and contrasts and generalise some of the pertinent findings. Mixed purposeful sampling was thus employed to serve the research objectives throughout key stages of the study.

Table 3.4 outlines how sampling and instrumentation were used to support the study at key stages across the three contexts examined:

Table 3.4 - Assumptions, instrumentation, sampling and outcomes.

Research Paradigm / Research component	qual →	QUAN →
Assumptions:	• Context sensitivity • Personal meaning	• Strength of larger sample sizes • Findings sensitive to sampling method
Instrumentation:	• One-on-one interviews with principals • Focus group interviews with school leaders in school settings	• TPLQ development • Delivery of TPLQ to all three samples
Sample:	• Intensity sample analysis of 8 educators (4 principals and 4 school leaders) • Further contextual analysis of 102 educators involved in CC21 project	• 102 educator recruited during CC21 project (response=61%) • 180 current educators recruited through MacICT one-day courses (response=26.1%) • 180 preservice teachers recruited through online course announcements (response=31.1%)
Sampling Method:	• Self-selection (CC21) • Intensity sampling (researcher-identified)	• Typical and critical case sampling (TPLQ)
Guiding method	• Phenomenology	• Causal Comparative
Outcomes:	• Themes necessary to contextualise quantitative component • Issues to address in the Teacher Professional Learning Questionnaire (TPLQ) • Understanding of learners' frames of reference and appreciation of the learner's context.	• Sample size sufficient for principal components analysis (PCA), discriminant analysis and hierarchical clustering • Sample to population generalisations • Group comparisons through analysis of variance (ANOVA) and t-tests of binary variables to identify areas of statistical significance. • Critical cases for further exploration in follow-up qualitative inquiry

This study was able to use a mixed methods design alongside mixed purposeful sampling to generate findings across a range of areas and samples. These findings included the personal and context-sensitive meanings and frames of reference explored in qualitative inquiry through interviews with unique cases, as well as comprehensive quantitative data from the larger overall sample of preservice teachers, current teachers and school leaders from across a large metropolitan region. As noted earlier, with reference to Morse's (2003) paradigm sequencing and emphasis, the sampling and paradigms were used to develop themes and instrumentation and obtain complementary findings on emerging phenomena that accurately and cohesively describe teacher professional learning in a digital age. The paradigms and their accompanying methodology are now discussed separately in further detail.

Stage 1: Qualitative Inquiry (qual)

As this chapter has outlined thus far, the initial qualitative inquiry was instrumental for drawing out themes and frames of reference to explore throughout this study. Further, it was a necessary component for developing the Teacher Professional Learning Questionnaire (TPLQ). Johnson and Christensen (2008) emphasise the importance of personal meaning and participants' frames of reference in qualitative inquiry. In particular, they describe the approach of phenomenology, where researchers "obtain a view into participants' life-worlds to understand their personal meanings" (p. 395).

As the review of technology tools in Chapter 2 demonstrated, many teachers are now exploring a diversity of tools to support their own professional learning. However, the ways these tools are used differ considerably from one teacher to the next, so inquiry that is sensitive to an individual teacher's use of the tools in their own context was needed to help establish common themes to explore throughout this study. Further, the use of phenomenology as a guiding approach specifically for this stage enabled the researcher to more effectively build on pragmatist epistemology by attempting to understand individual teachers' use of the tools as part of an engagement with their "life-world", including the physical contexts of their home and school environments as well as the diverse online contexts in which they participate.

This section of the thesis explains the methodology that was used for Stage 1, and refers to preliminary results that were key in informing Stage 2. The researcher drew on the four main data points from the *Connected Communities 21* (CC21) project – namely, the one-on-one interviews with all seventeen CC21 principals, focus groups with principals and their team of school leaders, weekly blog posts and the required reports submitted by each school team. Examining the data from these sources, the researcher then developed a coding framework consisting of both *a priori* and inductive codes. The *a priori* codes consisted of the three first-order TPaCK constructs, as described earlier in Table 3.3. These three areas were considered essential components in the conceptualisation of the CC21 project, since all participants would be actively-involved in professional learning related to new technologies that were being implemented, re-thought pedagogical approaches and the content demands of a new curriculum. These three *a priori* codes formed the initial view of the accumulated data. Further inductive analysis generated second-level codes to reflect emerging themes, including the evident popularity, and use, of specific technology devices such as iPads and related concerns about wireless infrastructure, the use of particular pedagogical approaches such as Project- and Inquiry-Based Learning, and recognised challenges in key learning areas of the Australian Curriculum. This coding framework enabled the identification of the intensity sample (n=8) of principals and school leaders who demonstrated the use of technology tools to learn professionally beyond the scope, requirements and networking that took place in the project. These "best cases" provided a richer understanding of the phenomenon of PLN-based learning from the perspectives of the educators themselves. The methodology underpinning Stage 1 and preliminary results are now described in further detail

Phase 1: One-on-one Interviews with Levels of Use (LoU) framework.

Connected Communities 21 (CC21) explored how principals and school leaders were employing technology tools to support professional learning in the TPaCK areas of technology (TK), pedagogy (PK) and content (CK). During an initial project planning day in March, 2013, the researcher and two colleagues conducted one-on-one interviews with all seventeen principals. These interviews sought to identify professional learning as a form of innovation that could transform the school community through the efforts of the school team that was involved in the project. The term *innovation* was conceptually linked to the *Levels of Use of an Innovation* framework (LoU) by Hall, Loucks, Rutherford and Newlove (1975). This framework views innovation as a transformative mechanism within institutional settings, closely allied to the development and dissemination of ideas, support, integration and refinement. When conducting the one-on-one interviews, the researcher and his colleagues placed each principal on one of the eight levels based on the descriptions of professional learning currently taking place in his or her school community. Principals were asked to: (a) describe their school's project for CC21; and (b) discuss theirs and their colleagues' use of technology tools to support their learning within the school context.

The Levels of Use (LoU) framework is an important tool for exploring innovation with technology in that it focuses on the key actions (that is, what the user actually does) when using an innovation. The LoU evaluates the actions that constitute use in the context of the unique environment and positions this use on one of seven levels (Level 0, or "non use" to Level 6, "renewal") that reflect both the individual's use, and the scale of the innovation within this context (that is, the extent to which others in the same environment are using it). Although not explicitly based on pragmatist philosophies, this framework was especially useful because it establishes use of the innovation by exploring the individual's actions within their environment. Further, interviews in which the LoU framework is applied can explore the extent to which problem solving, inquiry, networking and reflection are employed when adopting new ideas. Collectively, the levels span across lack of knowledge about the innovation to sophisticated use within the environment, where the innovation is then sought out by others (for example, colleagues) and spreads to other users. The framework thus assumes that growth in the levels of use is developmental and that the process of development is iterative and cyclical. The levels are theorised as follows:

- *At level 0 (Non-use)*: A teacher takes no action in relation to the program or practice.
- *At level 1(Orientation)*: A teacher seeks information about the program or practice.
- *At level 2 (Preparation)*: A teacher decides to adopt the new practice and prepares to implement it.
- *At level 3 (Mechanical)*: In early attempts to use new classroom strategies, techniques and materials, teachers often feel inadequate and awkward.

Teachers at this level of use often focus on teacher-centred pedagogies. Teachers may speak of problems with using the representations – have used them, but have not really addressed the issues.

- *At level 4 (Routine)*: Teachers establish a satisfactory pattern of behaviours and use the innovation with a view to improving learning outcomes rather than to reducing classroom management concerns. Teachers here will note that their students were more engaged when using the representations, that the representations helped students to better understand or visualise the concepts/ideas in the unit. They talk of students using learning objects independently and supplementing, facilitating, scaffolding learning from them.
- *At level 5 (Refinement)*: Teachers move beyond routine patterns to assess the impact of their efforts and make changes to increase that impact. Teachers use supplemental representations to expand the benefits for their students. They don't only use what was given to them on the professional development days.
- *At level 6 (Integration)*: In using the innovation teachers actively coordinate their efforts with those of their colleagues. Teachers at this level share information with other teachers regarding their effective retrieval and use of the representations. Teachers not only share ideas around the representations but also find additional representations and share with their colleagues.
- *At level 7 (Renewal*): Teachers seek more effective alternatives to the established use of the innovation. Here teachers seem quite comfortable with using the representations given to them, believe in the benefits to their students, choose and utilise additional representations that they may have shared with colleagues and perhaps even speak of other representations they might use next time they do the unit. Teachers here are clear that multiple and different representations support learning and building learning activities around representations makes learning ideas more accessible (Hall, Louks, Rutherford and Newlove, 1975, p. 54).

While not forming a major focus in this study, the specific LoU results of the one-on-one interviews revealed some pertinent preliminary findings. None of the seventeen principals described innovations at Levels 6 or 7. One principal described innovation at Level 5 (Integration) that involved whole-school implementation of technology-rich inquiry-based units of work, which had been led by a small team of "highly-connected" Stage 2 (Grades 3 and 4) teachers. Similarly, one principal described an innovation at Level 4 (Routine) that involved frequent classroom visits and team teaching sessions with a pair of highly "tech-savvy" junior teachers who were adept in using iPads for multimodal creative tasks. The remaining principals were clustered between Levels 0 (Non-use) and Level 3 (Mechanical). These cases involved, to varying degrees of success, principals identifying key problems or challenges they wished to address along with key technology tools that they were in the process of exploring or sought to explore in future. Eleven out of the seventeen principals were clustered in the first three levels, which reflected the fact that their identified innovation was, in the words of one principal, “more of a future intention than a present reality”. Most notable about this larger group of eleven principals was the consistent identification and discussion of barriers that stood in the way of being able to effectively carry out their innovation. The barriers discussed fell into four broad groups: (1) limited time to develop a clear plan and follow it through; (2) the presence of one or more resistant teaching staff in the school; (3) teaching staff with poor, or limited, technology skills; and (4) general uncertainty about the future.

Employing the LoU framework during one-on-one interviews helped to provide a general picture about how new ideas were explored, developed and shared in each school community. By focusing on the principal at this early stage of the study, the researcher was able to examine the role of school leadership in supporting and managing the professional learning of teachers within their community. The data also conveyed each principal’s awareness of the different forms of professional learning being undertaken by teachers with whom they worked, as well as their beliefs and values around professional learning generally. Further, some cases – especially those at Levels 4 and 5 - were illuminating in the extent to which they did reveal the principal and other school leaders as autonomous learners employing tools actively support their professional learning in both formal and informal contexts. Identifying these cases via the principal in the LoU data was important for the later selection of the intensity sample. While these educators may not reflect many, if not most, in the profession, their stories divulged insights that could be explored in greater depth and scope throughout the latter stages of this study.

Phase 2: Focus group interviews.

To understand the professional learning context further and as second steps in the initial qualitative component, the study drew on rich data from focus group interviews that were conducted mid-way in the CC21 project. The researcher invited all seventeen schools to discuss “professional learning being undertaken to achieve project goals” and “share examples of best practice”. Of the seventeen schools involved in the study, seven school principals (n=7, 41.2%) accepted this invitation. Each school focus group consisted of the principal and any school leaders involved in CC21. The interviews were semi-structured, and explored the professional learning being undertaken to achieve the school’s project-related goals. This professional learning was principally school-based, being facilitated by the leaders and principals and reflective of the school context.

The focus group interview data were especially useful for exploring the contexts in which each of the principals in the one-on-one interviews worked. For example, many of the uses of tools that were discussed by principals were observed in practice and discussed further in the school context; this provided a picture of how tools used in professional learning contexts can impact on student learning outcomes. The confirmation of practice that this second stage of interview allowed was further important for enabling the final selection of the intensity sample. Several principals claimed that school leaders were undertaking technology-enabled professional learning independently. Where this was observed, the researcher was able to see evidence not only of the professional learning having been undertaken, but of its impact on the broader school community. Where the one-on-one interviews presented limitations in comprehensively depicting each teacher’s “life-world”, these school visits and focus group interviews enabled the present study to address the limitations by encouraging teachers to talk more about their own professional learning experiences and how these were shaped by the school context. Table 3.5 shows the focus group topics, beginning questions and follow-up questions.

Table 3.5 - Focus group topics, beginning questions and follow-up questions.

Research Question:	Topics:	Beginning Questions	Follow-up Questions
How, in what ways, and to what extent do teachers use current technology tools to support their professional learning?	• Familiarity with current tools • Formal and informal uses of the tools	• What are the main tools you use to support your own professional learning – both as part of CC21 and more generally in your own time? • How do you use these tools? • What impact have they had on your pedagogy?	• What (if anything) are other teachers in the school doing with these tools? • Have you worked with others using these tools? How and in what ways? • Which tools have helped your professional learning the most? Why do you think this is the case? • What impact have these tools had on the pedagogy of teachers in the school?
How, in what ways and to what extent are professional learning outcomes for teachers shaped by the context in which the tools are used?	• Locations where tools are used (e.g. at home or at work) and school context • Formal and informal uses of the tools	• How do you find using tools for your professional learning in your school? • Are there any problems (e.g. blocked websites) using the tools in the school? What impact has this had? • How do you find using these tools at home?	• Have you noticed problems in the ways that other teachers have used these tools? How might these be overcome? • How has the system (i.e. DEC), including system policies, impacted on the use of these tools in the school?
What principles and heuristics of twenty-first century learning are evident in the ways teachers use tools to support their professional learning?	• Personal Learning Network (information sources and people-to-people connections) • Participatory Cultures • TPaCK	• What does twenty-first century learning look like to you? How is it different to the kinds of learning you have known in the past? • Can you tell me about your understanding of pedagogy? • What does your use of technology suggest about the way you learn and/or teach?	• As an educator, what do you do differently now compared with what you might have done in the past? • What kinds of pedagogy suit your style as an educator? • Does your use of technology change your understanding of pedagogy? How and in what ways?
How and in what ways might professional learning in traditional face-to-face contexts be better informed by the diversity of situated learning experiences in established and emerging online contexts?	• Formal and informal uses of the tools • Personal Learning Networks • Participatory Cultures • TPaCK	• How might the technologies you use now change your practice in the future? • What does effective school leadership look like and how can we achieve it? • What barriers exist in your own professional learning and how might these be overcome? • How might current methods for professional learning in face-to-face ways (e.g. course, staff development day, staff meeting) be reconfigured in light of your understanding of twenty-first century learning?	• Teachers: what styles of leadership are evident in your school and how do they impact on your learning and teaching? • Leaders and principals: how would you describe your style as a leader and what impact does it have on the professional learning of teachers in your school?

As Table 3.5 suggests, these questions and data gathered were pertinent for exploring context-specific teacher professional learning in this study. In particular, focusing on teacher knowledge as a topic in relation to school leadership suggested a possible link to be explored in the quantitative component. Similarly, while the relationship between a teacher's use of technology tools and their pedagogy was not originally proposed in this study, this emerged as an important theme that needed to be measured more accurately in the TPLQ. Finally, while interviewees were not asked specifically about their Participatory Cultures or Personal Learning Network, open questions like "What does twenty-first century learning look like to you?" divulged important insights that were then addressed in the construction and delivery of the TPLQ as the basis of the quantitative component, which formed the major emphasis of the study overall.

Phase 3: Ongoing blog posts and school reports.

Connected Communities 21 connected school leaders from all seventeen schools through a series of three face-to-face workshops followed by a final project showcase that was delivered on September 10th, 2013 at Macquarie University. To further support participants as they engaged in project-related professional learning, blog posts were employed using a purpose-built blog. School leaders were encouraged to share key moments of their professional learning classroom practice with the wider community of schools. The blog posts prompted schools to report on their progress, and was often used to identify common problems and solutions, promote inter-school dialogue, continue previous face-to-face discussions online, share personal and school highlights, facilitate teacher reflection and include links to related digital resources. Participants also discussed how they were using current technology tools to support professional learning – both theirs and their colleagues' - in the school.

For many participants (n=83, 81.4%), CC21 represented their first experience in educational blogging. Some saw the challenges of sharing their ideas with an online community of seventeen schools daunting; however, participants were assisted with blogging protocols and procedures during each of the face-to-face sessions. Importantly, as one school leader describes, blogging throughout CC21 provided teachers with an opportunity to acknowledge their strengths and successes in the classroom:

> A lot of people [teachers in my school] have spoken to me about the [CC21] blog, saying, "Is this the kind of thing that I should be worrying about?" They don't realise that with blogging, you're actually going a step further. [I say to them] "You could have actually written about this, this, and this". They say, "Oh, okay. Right", because people don't realise what they're doing is actually very, very good.

The blog posting period started in April 2013, concluding in August of the same year. During this time, school teams posted, on average, 11.41 posts, with a range from 1 post to 39 posts. The number and nature of blog posts were also an important factor when considering educators for the intensity sample. To assist with data analysis, blog posts for each school were compiled and analysed as single sources (with seventeen in total, one source for each school).

Seventeen school reports were the final data point for the CC21 project, and involved the completion of a report template that included brief paragraph responses for each of the following questions:

1. What will be different in your school when you have implemented your innovation and what evidence will you expect to see?

2. Outline the rationale behind why you have chosen this innovation.

3. Considering *planning, programming, teaching, learning* and *assessment* as areas of application, which area(s) does your innovation address? How?

Table 3.6 summarises the key information conveyed in the seventeen school reports that were submitted. This information included the nature of the innovation mapped to each of the three TPaCK components, the number of participants involved in carrying out the innovation and relevant technology infrastructure that was used to support the professional learning necessary:

Table 3.6 - Summary of school report findings

School	Participants	Relevant School Resources	Innovation	Technology	Pedagogy	Curriculum
1	7	Not specified	“Connected Learning” – use of Web 2.0 tools	Competency with *IRIS Connect*	Not clearly articulated	English
2	11	iPads, VC, Xbox, IWBs	Whole-school implementation of inquiry-based learning	Competency with iPads, blogs and IWBs	Use of Inquiry-Based Learning for peer and self-assessment	Not specified
3	3	Lego and robotics kits	Trialling and evaluating sample curriculum units to see what areas of technology can be integrated.	Competency with iPads and robotics kits	Enhancing learning through Inquiry-based learning, Cooperative Learning, "risk taking"	Kindergarten to Grade 4 English
4	9	120 iPads with 40% Wi-Fi coverage, IWBs, Splashtop	1:1 iPad deployment for Year 6	Competency with iPads and mastery of a "core" set of apps	General improvement to teacher pedagogies	English, especially 2A, 5B, 7C and 8D for stage 3.
5	5	Not specified	Not clearly articulated	Not clearly articulated	Inquiry-Based Learning	Science
6	4	IWBs in every classroom, dedicated computer lab with 30 PCs, 20 PCs in library - currently installing Wi-Fi and purchasing 10 iPads	Self-assessment and authentic use of ICT	Ability to Google Docs to facilitate staff meetings	Not clearly articulated	Reading and comprehension, Australian Curriculum English, creative and imaginative thinking
7	6	IWBs in every classroom, 30 iPads and computer lab. School is trialling 1:1 program with two classes and more to come later in the year. School is currently building a "technology centre”.	ICT mentoring program and partnership with neighbouring technical college	Ability to use blogging and email for communication between staff and students	Inquiry-Based Learning to be implemented whole-school.	Not clearly articulated
8	3	7 iPads per stage, computer lab and 4 desktops per classroom	Collaborative planning - learning analytics?	Ability to employ Web 2.0 tools for assessment	Better student-centred learning	English, literacy and numeracy
9	3	Not specified	"problem-based learning to solve real-world Maths problems" - involvement in a schools partnership program which includes them and six primary schools.	Competency with iPads	Problem-Based Learning	Maths

School	Participants	Relevant School Resources	Innovation	Technology	Pedagogy	Curriculum
10	8	100 laptops, IWBs in every classroom	Critical and creative thinking within a technology-enabled learning environment	Ability to use iPads for digital storytelling	Project-Based Learning	English
11	12	PC lab, Mac lab and tablets. Each classroom has 6 iPads,	Training of technology coaches for each stage	Competency with iPads	Project-Based Learning	Literacy
12		IWBs in every classroom, computer lab and class laptops for each year in Stage 3.	"Programming and adapting teaching approaches to the C.21st"	Competency with IWBs	Not clearly articulated	English
13		135 iPads, 15 iPods, 30 active expressions, 6 apple TVs, 35 IWBs and 278 PCs - possibly the most technology-rich school?	Agile learning spaces with technology	Ability to teach in a BYOD environment	Student-centred learning	English
14		Small number of iPads	Small learning community alliance	Ability to use blogging to network with other schools	Not clearly articulated	English/literacy
15		Small number of iPads	A new unit to be written in AC English to address curriculum priority of sustainability.	Ability to teach in a BYOD environment.	Not clearly articulated	AC English - Asian texts (see blog post from Natalie)
16		Small number of iPads	Use of TPACK model to "integrate rather than add on" technology - particularly when designing units of work	Competency with iPads	Inquiry-Based Learning	Year 7 History (AC)
17		Each classroom has an IWB and access to an average of 5 desktops and 3 Laptops per room. We are in the process of purchasing 2-3 iPads per room.	Development of a five-week integrated unit of work - English / Science & Technology	iPads purchase/training	Inquiry-Based Learning	AC English

Qualitative coding framework employed

Johnson and Christensen (2008) point out that while most qualitative researchers tend to generate codes inductively from their examination of the data, *a priori* codes are especially useful when extending upon certain lines of previous research. They elaborate:

> When researchers bring *a priori* codes to a research study, they come in with a start list of codes— an already developed master list that they can use for coding. During coding, however, the researcher should apply these codes only when they clearly fit segments of data. The codes should not be forced onto the data, and new codes should be generated when data segments are found that do not fit any of the codes on the list. In practice, many researchers employ both pre-existing and inductive codes (author's emphasis).

Given the importance of the TPaCK framework in the conceptualisation of the *Connected Communities 21*, the researcher chose to employ *a priori* codes based on each of the three first-order TPaCK elements: Technology Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK). During data analysis, second- and third-level codes were generated inductively to identify the emerging themes that reflected participants' professional learning in these three areas. Given the diversity of school-based initiatives for CC21, it was unsurprising that a wide range of technology uses and pedagogies were explored.

Themes emerging in relation to participants' Technology Knowledge (TK) included the prevalence of iPads, a professional learning focus area for nine of the participating schools (52.9%). Importantly, six of these schools did not have these devices prior to their involvement in CC21, with principals having used some of their CC21 funding to purchase iPads for professional learning and initial use in the classroom. Other technology-related themes that received less emphasis in the data included robotics, social media, Web 2.0 and general technology infrastructure. Most school teams indicated that, through their professional learning focus, they wanted teaching staff to be "competent" and "comfortable" with the technologies explored. Only a small portion of schools (n=4, 23.5%) described more challenging uses of technology. Two schools were preparing for a cross-platform, technology-rich environment that required teachers to be adept in their use of a range of devices and platforms for learning (thereby presenting considerable challenges for their professional learning). Of the remaining two schools, one report indicated that teachers would be using iPads to create multimodal texts so they could develop a richer understanding of multimodality in the new English curriculum. Participants in the remaining school described the use of Google Docs within staff meetings as a starting point for teachers to develop understanding about how the tool could enable real-time collaboration in the classroom.

Themes that emerged in relation to participants' Pedagogical Knowledge (PK) included a strong emphasis on Inquiry-Based Learning, a professional learning focus for a six schools (35.3%). This emphasis was established in the initial school reports and later confirmed during one-on-one and focus group sessions. Two other schools identified a professional learning focus on Project-Based Learning (PBL) while one identified Problem-Based Learning (also PBL) as their area of focus. Several schools (n=3, 20.8%) did not indicate a specific instructional model but instead chose to identify general improvement to teacher pedagogies, most notably through more student-centred learning. Significantly, the remaining portion of schools (n=5, 29.4%) did not provide any indication that teachers were engaging in pedagogy-related professional learning. However, several schools (n=5, 29.4%) acknowledged that their interest in certain pedagogical approaches such as Inquiry- and Project-Based learning was motivated by at least one popular thinker in education.

In contrast to the range of themes that emerged for TK and PK, Content Knowledge (CK) was an area that was fairly limited in its focus on the four initial subject areas for the Australian Curriculum: English, Mathematics, Science and History. As shown in Table 3.6, a majority of schools (n=11, 64.7%) chose English as the content area of focus for professional learning. The other subject areas – Mathematics, Science and History – each had only one school nomination, while remaining schools (n=4, 23.5%) chose not to indicate any curriculum focus for their professional learning.

While the three first-order TPaCK constructs were established as first-level codes in the coding framework, an additional first-level code emerged inductively from the rich discussions about contextual factors that shaped participants' professional learning in the project. These factors first became apparent in the LoU interview data where principals cited the barriers that stood in the way of professional learning in their communities. The factors were further discussed during the focus group interviews. Three themes emerged around technology infrastructure, teacher release time and the role of leadership.

Table 3.7 shows the breakdown of the qualitative coding framework that was employed, with indentations to indicate the level (first, second or third) of the coding applied. The table also shows the number of sources where the code was identified from the total 58 sources used in the study and total number of individual references for each code. Notation ("ap" and "induc") shows the status of the code as either *a priori* or inductive:

Table 3.7 – Qualitative Coding Framework

Node (ap – *a priori*; induc – inductive)	**Sources**	**%**	**Refs**
Technological Knowledge (TK) (ap)	52	89.7%	227
iPads (induc)	37	63.8%	93
Robotics (induc)	2	3.4%	2
Social Media (induc)	19	32.8%	30
Twitter (induc)	4	6.9%	7
Facebook (induc)	15	25.9%	9
Infrastructure (induc)	34	58.6%	104
Wireless routers (induc)	10	17.2%	13
Devices for PL (induc)	24	41.4%	67
Web 2.0 tools (induc)	23	39.7%	40
Pedagogical Knowledge (PK) (ap)	39	67.2%	148
Inquiry-Based Learning (induc)	19	32.8%	51
Project-Based Learning (induc)	4	6.9%	11
Student-centred learning (induc)	5	8.6%	17
Pedagogical fluency (induc)	2	3.4%	2
Popular thinkers in education (induc)	9	15.5%	13
Content Knowledge (CK) (ap)	32	55.2%	35
Australian Curriculum (ap)	32	55.2%	35
English (ap)	17	29.3%	23
Science (ap)	2	3.4%	5
History (ap)	2	3.4%	3
Maths (ap)	1	1.7%	1
Contextual factors (induc)	50	86.2%	187
Time (induc)	23	39.7%	81
Technology access issues (induc)	21	36.2%	60
Device limitations (induc)	9	15.5%	12
Lack of wireless access (induc)	11	19.0%	13
Leadership and change (induc)	13	22.4%	19
"Top down" (induc)	3	5.2%	8
"Bottom up" (induc)	1	1.7%	4
Whole school initiatives (induc)	3	5.2%	7
Team-based initiatives (induc)	4	6.9%	10

This table reflects the dominance of certain themes throughout the CC21 project that have been discussed further by Stevenson, Howe and Hedberg (2014). Perhaps most importantly, the findings suggest that school leaders are aware of the importance that technology plays in professional learning, particularly in response to the challenge of a new curriculum. Further, school leaders are keen to acquire new technology tools to support and enable their teachers' professional learning, newer pedagogical approaches and improved teaching and learning generally. At the time of writing, iPads represented the newest disruption to more traditional approaches in most of the school communities studied. Many principals and school leaders perceived that this technology could play a transformative role in how their teachers learned professionally, and how they subsequently approached teaching and learning in their classrooms. The intensity sample that is discussed further in the next chapter yields some deep insights into how these and other perceptions shaped the culture of professional learning in these schools.

Stage 2: Quantitative Inquiry (QUAN)

The quantitative inquiry formed the largest component of the study. While the initial qualitative component was necessary to explore themes and frames of reference, the quantitative component enabled these phenomena to be measured with a larger sample of educators from a range of backgrounds and contexts. Based on the Teacher Professional Learning Questionnaire (TPLQ) respondents from each of the three contexts, the questionnaire sample included 110 teachers and school leaders from government and non-government schools (that is, the CC21 and MacICT samples) and 56 preservice teachers from Macquarie University (that is, the sample of preservice teachers). Across these three contexts, participants varied in their levels of classroom experience, familiarity with technology tools, degree of training and predisposition towards using technology both in their professional learning and with their students. The TPLQ was developed and first delivered to the participants from CC21 in September 2013, followed by educators in the other two contexts in early 2014. Table 3.8 shows the breakdown of final responses based on the three contexts examined.

Table 3.8 -TPLQ combined sample breakdown.

Contexts:	**Connected Communities 21 (CC21)**	**Macquarie ICT Innovations Centre (MacICT)**	**Preservice Teachers (PSTs)**	**TOTAL:**
Complete responses	n=63	n=47	n=56	n=166
Male:	n=6	n=14	n=17	n=37
Female:	n=57	n=33	n=39	n=129
Primary:	n=53	n=26	n=19	n=98
Secondary:	n=10	n=21	n=37	n=68

Assumptions underpinning the development of the Teacher Professional Learning Questionnaire (TPLQ).

Following the intensity sampling employed in the Stage 1 qualitative inquiry, concepts to be addressed in the questionnaire were tabled and closely examined. The design of the TPLQ was based on several assumptions. First, the elements being explored were correlative, resulting in overlapping meaning between components in the TPLQ. For example, while they exist as separate branches of Warlick's (2009) PLN model, both people-to-people connections and information sources are closely related, such as when a teacher uses their professional connections in *Twitter* as an information source, or news feed of current ideas. Similarly, many of the Participatory Cultures described by Clinton, Purushot, Robison and Weigel (2006) are correlative in the ways they describe learners participating online; working with a simulation may involve various forms of transmedia navigation, while multitasking and distributed cognition overlap in describing learning that is focused on more than one element. Second, more items (rather than less) were employed to measure constructs on the assumption that data analysis following the initial delivery to CC21 participants would establish the most accurate items. Third, the TPLQ employed self-report as the primary means of measuring the constructs, but incorporated checks to establish each component's internal validity.

The data in the intensity sample were closely analysed with a view to exploring the elements of Personal Learning Networks (PLNs), Participatory Cultures and

Technological, Pedagogical and Content Knowledge (TPaCK). The PLN existed as an emerging construct suitable for explaining phenomena like the number of online information sources accessed for professional learning, key people-to-people connections that had been cultivated, the tools used to facilitate and grow the PLN, the context in which the PLN was used and its impact on professional learning outcomes. The quantitative inquiry built on these elements with items intended to measure the size, scope and impact of each learner's PLN. Second, Participatory Cultures operated as an emerging construct for explaining some the ways that learners participate online. Elements focused on online actions, beliefs and values that reflected each participatory culture. To explore these elements further, the quantitative inquiry aimed to establish which behaviours were true of each learner. Third, the TPaCK existed as a relatively established construct that served in this study to explain possible outcomes of technology-enabled professional learning. Elements included self-assessed knowledge in the areas of technology, pedagogy and content and these were broadly consistent with the TPACK framework (Koehler & Mishra, 2009).

Table 3.9 summarises the three main constructs, their related elements stemming from both the qualitative inquiry and the literature, mapped against the main questions of the TPLQ.[1] Some examples of items have been included to indicate the areas respondents were asked to consider:

[1] For a complete version of the Teacher Professional Learning Questionnaire, please refer to Appendix 1

Table 3.9 - Constructs, related elements and TPLQ questions.

Construct	Elements:	TPLQ Questions (with examples)
Personal Learning Network (PLN): **(Couros, 2010; Richardson & Mancabelli, 2011; Warlick, 2009)**	• **Hours per week** spent using the Internet for professional learning *outside of work or study.* • How reported hours per week are roughly **allocated to categories of use.** • Perceived importance of technology tools and associated **online activities**. • **People and organisations** with whom the individual forms a connection for the purposes of professional learning – information that is drawn from them and the individual's willingness to share with them.	• **Question 1:** In a typical week, how many hours of your own time (i.e. outside of hours required for work or study) would you spend using technology to support your professional learning? • **Question 2:** In relation to the number of hours specified, please indicate the percentages of time spent in the following six types of activities for the purposes of professional learning. • **Question 3:** How important do you feel each of the following online activities are to your professional learning? • **Question 6:** Considering the people and organisations in the previous question, with whom do you share information online related to your professional learning?
Participatory Cultures: **(Clinton et al., 2006)**	• **Online behaviours** that reflect participatory professional learning in a range of areas: 1. Play — the capacity to experiment with one's surroundings as a form of problem-solving 2. Performance — the ability to adopt alternative identities for the purpose of improvisation and discovery 3. Simulation — the ability to interpret and construct dynamic models of real-world processes 4. Appropriation — the ability to meaningfully sample and remix media content 5. Multitasking — the ability to scan one's environment and shift focus as needed to salient details. 6. Distributed Cognition — the ability to interact meaningfully with tools that expand mental capacities 7. Collective Intelligence — the ability to pool knowledge and compare notes with others toward a common goal 8. Judgment — the ability to evaluate the reliability and credibility of different information sources 9. Transmedia Navigation — the ability to follow the flow of stories and information across multiple modalities 10. Networking — the ability to search for, synthesise, and disseminate information 11. Negotiation — the ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms.	• **Question 7**: The following statements describe how some people think of their own online behaviours. Use the following scale from 1-7 to indicate whether each statement is true of your own online behaviours (examples of items below): 1. I like to play around with a new technology tool (play) 2. Who I am online is quite different to who I am in person (performance)[2] 3. I search the Internet to find representations of how things work (simulation) 4. I use technology tools to take someone's ideas and make them better (appropriation) 5. I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing (multitasking). 6. I often try new web tools when I hear about them (distributed cognition) 7. My ideas about teaching are influenced by my colleagues (collective intelligence). 8. I'm often unsure about the reliability of information I find online (judgment). 9. I click on links to other material before I finish examining the main content of a web page (transmedia navigation). 10. I share interesting links with others on social network services (networking) 11. I get overwhelmed by the vastness of the Internet (negotiation).

[2] While the construct elements have been indicated in brackets in this table, these were not indicated in the actual questionnaire items.

Construct	Elements:	TPLQ Questions (with examples)
Teacher Knowledge – technology, pedagogy and content **(Chai et al., 2011)**	• **Teacher knowledge** in relation to first-, second- and third-order constructs: 1. TK (Technological Knowledge) - knowledge about features, capacities, and applications of technologies 2. PK (Pedagogical Knowledge) – knowledge about students' learning, instructional methods and processes, different educational theories and learning assessment 3. CK (Content Knowledge) – knowledge of subject matter 4. TPK (Technological Pedagogical Knowledge) – knowledge of the existence and specifications of various technologies to enable learning 5. TCK (Technological Content Knowledge) – knowledge about how to use technology to represent the content in different ways 6. PCK (Pedagogical Content Knowledge) – knowledge of adopting pedagogical strategies to make the subject matter more understandable for the learners 7. TPACK (Technological Pedagogical Content Knowledge) – knowledge of using various technologies to teach and represent the designated subject content	• **Question 8:** Please select the bubble that accurately reflects your level of teacher knowledge in each area. Where items refer to "teaching subject", secondary teachers should consider their main teaching subjects (e.g. Maths), while primary teachers should consider all subjects they teach for the new Australian Curriculum (examples below). 1. I have the technical skills to use computers effectively (TK) 2. I am able to stretch my students' thinking by creating challenging tasks for them (PK) 3. I am confident to teach the subject matter (CK) 4. I am able to facilitate my students to collaborate with each other using technology (TPK) 5. I am able to use technology to introduce my students to real world scenarios (TCK) 6. Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways (PCK) 7. I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests) (TPCK)
Professional Learning and Leadership Context	• **Leadership Decisions and Support structures** that exist to support or facilitate technology-enabled professional learning within the context. • **Contextual Constraints** that impede technology-enabled professional learning within the context. • Professional learning as a shaped by the **purposeful context** studied (CC21, MacICT and PSTs)	• **Question 4:** The following items describe some of the leadership decisions, structures and procedures that commonly exist in schools to support teacher professional learning. How important are each of the items for your professional learning (examples below) 1. The freedom to try new technology tools with my own students (autonomy) 2. Leaders that set a clear direction in the school for teachers to follow 3. Access to the Internet in the staff room (infrastructure) 4. Lesson preparation time (time) 5. Structured professional development days outside of my own school (structured professional development) 6. Unstructured meeting time to share ideas face-to-face with colleagues in my school (unstructured professional learning) • **Demographic Questions:** Please enter your: age, school location, years teaching, teaching areas, current role, number of years in current school and course currently being studied.

Construct 1: Personal Learning Networks.

An initial review of instrumentation specifically relating to the PLN revealed a paucity of research. While this construct may reflect, in part, relatively established phenomena such as networked learning and collaboration, its *empirical* use in educational research appeared far less established. More specifically, the review showed very limited evidence of instrumentation to reliably measure the ways that educators engage in professional learning outside of mentor-driven socio-constructivist training environments. In the case of the PLN, the lack of a formal learning context (for example, an online course) and identifiable mentor (for example, a teacher trainer) presented a challenges in finding reliable ways to measure the participant's PLN.

Nonetheless, interview data from the intensity sample revealed a number of insights that were used to identify the related elements for this construct. Perhaps most notably, all principals and school leaders in this sample – and a number of participants in the broader CC21 sample – acknowledged spending significant amounts of time outside of work and study hours to engage in technology-enabled professional learning. For the school leaders in the intensity sample, this often involved learning how to use a technology tool so that they could better support their colleagues. It also involved use of social media and other networking tools such as online system portals where educators could communicate with colleagues from other schools. In some cases, the use of technology for professional learning needed to take place outside of work and study hours because certain tools and devices were "blocked" within the school network. To explore time more closely in the TPLQ, Question 1 asked all respondents to indicate the number of hours spent using technology for professional learning, while Question 2 asked them to allocate these hours (as percentages) across the range of use categories that were reflected in the qualitative data.

Close examination of participants' uses of technology in the qualitative inquiry revealed some important findings about the perceived value of different use categories of online time and typically associated online activities undertaken when spending time in each category. For example, it was clear that significant portions of time were spent consuming content from a wide range of information sources (both text and multimedia), with smaller (but still important) portions of time spend creating, co-creating and sharing content with colleagues. Certain tools for professional learning were favoured, including open social media tools such as *Twitter*, blogging tools such as *Wordpress* and other collaborative content creation platforms such as *Wikispaces*. Participants were clearly able to describe the value of the tool and articulate how they used it to support their professional learning. While there were some consistencies (for example, all four school leaders in the intensity sample used *Twitter*), there were notable differences (for example, only two of the school leaders blogged). To explore the perceived value of these different uses of the tools, a number of items were included in Question 3 of the TPLQ to reflect typical online activities with the tools mentioned in the qualitative data. The activity was included as the focus with the associated tool as an *example*, to ensure that other equivalent tools could be considered.

Finally, a pertinent theme emerging from analysis of the intensity sample – and one that distinguished this group from others in the broader CC21 sample – was the willingness of both school leaders and principals to share information online through a range of channels. These channels included colleagues within their school and system as well as colleagues in other educational contexts. Some participants – particularly more junior technology mentors – were willing to share information publicly on the web, especially through open social media, public wikis and blogs. Other participants did not demonstrate the same willingness to share through the same channels. For example, three principals in the broader CC21 sample had recently begun using *Facebook* to connect with friends, family and colleagues. They indicated that they were happy to share information with those they had "friended" (formed a connection with appropriate permission) but not with others. Given the notable contrast between those willing to share publicly with anyone on the Internet and those willing to share through fewer, more controllable online channels, it was important to incorporate these differences into the TPLQ.

The participant's willingness to share was explored from two angles: first, in Question 5, the perceived value of different types of people and organisations; and, second, in Question 6, the people and organisations with whom the participant shares information online. Question 5 employed a seven-point scale with the anchored points "Extremely unimportant" and "Extremely important", while

Question 6 employed check boxes. Excerpts from Question 5 and the complete version of Question 6 are shown in the following figures:

Question 5: How important do you feel each of the following types of people and organisations are to your professional learning?

	Extremely unimportant	2	3	4	5	6	Extremely important
Teachers and students in my school	○	○	○	○	○	○	○
The system in which I work (e.g. DEC)	○	○	○	○	○	○	○
State-based organisations (e.g. Board of Studies, NSW Teachers Institute, NSW English Teachers Association, etc.)	○	○	○	○	○	○	○
National organisations (e.g. ACARA, AITSL, Education Services Australia)	○	○	○	○	○	○	○
Software/hardware businesses with educational content (e.g. Microsoft, Adobe, etc.)	○	○	○	○	○	○	○
Bloggers that I follow	○	○	○	○	○	○	○
Social media community pages (e.g. *Facebook* pages)	○	○	○	○	○	○	○
Educators I follow using social media	○	○	○	○	○	○	○

Figure 3.1 - PLN contribution of people and organisations.

Question 6: Considering the people and organisations in the previous question, with whom do you share information online related to your professional learning?

I share information online with:

☐ teachers in my school (e.g. school email, school bulletin)

☐ students in my school (e.g. school email, online course)

☐ educators in my system (e.g. email to teacher in another school)

☐ state-based organisations (e.g. online discussion)

☐ bloggers who I follow (e.g. comments on a blog post)

☐ educators and/or students on closed social networks (e.g. link to *Facebook* friends)

☐ educators and/or students who follow me on open social networks (e.g. link to *Twitter* followers)

☐ anyone publicly on the web (e.g. published blog posts)

Figure 3.2 - PLN willingness to share.

Construct 2: Participatory Cultures.

While seminal in nature, recent attempts to develop instrumentation for profiling the online behaviours of digital learners are encouraging. For example, the *What type of Digital Learner are you?* survey from the University of Exeter has been used to embed digital and information literacy into undergraduate teaching (Karnad, 2013). Similar instruments have been developed to profile twenty-first century learners (21st Century Fluency Project, 2012) and the habits of so-called "digital natives" (Corrin et al., 2011). Although peer-reviewed findings are limited, these attempts underscore the need to address the digital skills of teachers as they are applied in situated professional learning experiences. Understanding how actions, beliefs and values about professional learning manifest through a range of online behaviours was the focus of incorporating Participatory Cultures into the TPLQ.

When examining the qualitative data for possible starting points, it was to some degree difficult to identify participatory cultures with all of the participants in the intensity sample. The researcher drew some inferences from the actions and attitudes observed inasmuch as they suggested that participants had employed certain online behaviours to enhance their professional learning. Some patterns emerged – particularly around the cultures of *play*, *appropriation*, *networking* and *collective intelligence*. For example, the four school leaders in the intensity sample were all able to describe instances of learning something by "playing around" with tools, especially during the evening or on the weekend (that is, outside of formal work hours). Some described resources that they had found and adapted to their school context and all were able to explain the support they offered their colleagues to learn what was needed to address project-related goals. Perhaps most importantly, it was evident that these intensity sample school leaders viewed themselves as part of a broader online community where they could share ideas and resources with colleagues from other schools and systems, and where they could go for answers or further support. To some degree, they saw their contributions as *collective* in the sense that they were adding to the knowledge and skills base of their school communities. Other cultures such as transmedia navigation, distributed cognition and multitasking and were harder to identify in terms of specific actions, beliefs or values described by the participants. Nonetheless, these were important cultures to explore further.

To structure the items for the Participatory Cultures component of the TPLQ, a seven-point scale was employed. This scale enabled consistency with other 7-point questions in the TPLQ and meant that all questions employing a rating scale utilised a 7-point scale. When examining antecedents that addressed learning behaviours and their impact on knowledge-based outcomes, Pintrich's (1991) Motivational Strategies for Learning Questionnaire (MSLQ) emerged as a possible model for the development of items for Participatory Cultures. This self-report instrument with eighty-one items explores learning behaviours through six motivation subscales and nine learning strategies scales. Items are rated through a seven-point, scale with the anchor points of "Not at all true of me" and "Very true of me". As Duncan and McKeachie (2005) note, the MSLQ "has proven to be a reliable and useful tool that can be adapted for a number of purposes for researchers, instructors and students" (p. 117). Others have, accordingly, adapted this instrument to areas such as course-based online learning (Yukselturk & Bulut, 2007) and self-regulated learning (Jacobson & Harris, 2008). Figure 3.3 illustrates the basic structure of the instrument and some example items:

Use the following scale from 1-7, ranging from "Not at all true of me" to "Very true of me".

Questionnaire Item	Not at all true of me						Very true of me
In a class like this, I prefer course material that really challenges me so I can learn new things.	○	○	○	○	○	○	○
If I study in appropriate ways, then I will be able to learn the material in this course.	○	○	○	○	○	○	○
When I take a test, I think about how poorly I am doing compared with other students.	○	○	○	○	○	○	○
I think I will be able to use what I learn in this course in other courses.	○	○	○	○	○	○	○

(Pintrich, 1991)

Figure 3.3 - Pintrich's (1991) Motivated Strategies for Learning Questionnaire.

Online behaviours that participants discussed in the qualitative inquiry were similarly framed as general statements with the same scale as the MSLQ. Figure 3.4 shows the basic structure of the Participatory Cultures items in Question 7 of the TPLQ mapped each individual element or "culture":

Question 7: The following statements describe how some people think of their own online behaviours. Use the scale from 1-7, ranging from “Not at all true of me" to "Very true of me” to indicate whether each statement is true of your own online behaviours.

Participatory Culture Element	Questionnaire Item	Not at all true of me						Very true of me
Play 1	I like to play around with a new technology tool.	○	○	○	○	○	○	○
Play 2	I prefer to be shown how a technology tool works before I use it.	○	○	○	○	○	○	○
Play 3	If I’m stuck using a technology tool, I’ll ask for help from someone who knows.	○	○	○	○	○	○	○
Multitasking 1	I usually maintain focus on the task at hand (multitasking).	○	○	○	○	○	○	○
Multitasking 2	I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing (multitasking).	○	○	○	○	○	○	○
Multitasking 3	When using a technology tool, I prefer doing one thing at a time.	○	○	○	○	○	○	○

Figure 3.4 - Participatory Cultures example items for TPLQ.

It is important to note that like the PLN elements, the items for each of the Participatory Cultures were exploratory in nature. While the eleven cultures are often cited as examples of how individuals can learn effectively through their participation in any number of online communities, accurately measuring this participation – including the motivating factors and outcomes – remains a challenge. To keep its length manageable and ensure consistent response rates, the TPLQ included three items for each culture.

Construct 3: Technological, Pedagogical and Content Knowledge (TPaCK).

A number of researchers have sought to operationalise and measure the TPaCK constructs. This has led to several TPaCK instruments being created, trialled and evaluated in the literature. However, accurately measuring each of the seven TPaCK knowledge dimensions remains a challenge. In their review of recent efforts, Chai, Koh and Tsai (2011) note that while researchers have "attempted to formulate TPACK surveys with construct validity for the seven constructs… this has so far remained a challenge" (p. 596). Nonetheless, factor analysis of their TPACK Survey – an instrument used with a sample of 336 preservice teachers – has revealed loadings in eight factors. These findings suggest that with larger sample sizes, TPACK knowledge can be measured reliably and that, even at the level of preservice teacher education, respondents can distinguish between the first-, second- and third-order dimensions.

In this study, the researcher sought to build on these research findings by exploring the TPaCK dimensions in relation to professional learning. Many educators are aware of the TPaCK model and the intersection of the different types of knowledge. Similarly, educators are often able to articulate weaknesses in their knowledge and relate these to the TPaCK dimensions. Given the TPLQ's focus on technology-enabled professional learning, asking respondents to rate their knowledge in terms of each TPaCK dimension helped to compare different uses of the tools with reported knowledge to show, for example, how reportedly more "knowledgeable" educators used technology as compared with others in the TPLQ sample.

Participants in the broader CC21 sample were able to articulate knowledge areas of strength and weakness when asked. In particular, some principals were quite candid in discussing their limited technology skills expressing their gratitude for the support they received from colleagues, system leaders and the online community. Questions about pedagogical knowledge revealed some interesting insights about the need to be "inspired" by other educators, particularly current popular thinkers in education. Some principals and school leaders drew attention to specific instructional models like Project-Based Learning and Inquiry-Based Learning, though there was concern that although the model was being implemented, some teachers in the school community had only a superficial understanding of its underlying attributes. Generally speaking, all participants were aware that the Australian Curriculum was challenging them with new content that they had not taught before. Most participants believed that they had to combine this new content with appropriate pedagogical delivery and technology use in order to engage their learners and improve on past practice. During both stages of interview, the Australian Curriculum provided an effective prompt for participants to reflect on what knowledge they already had and what needed further attention. Incorporating TPaCK items in the TPLQ was therefore a useful strategy for exploring knowledge dimensions further with participants from all three contexts.

Given its validation with a large preservice teacher sample, the instrument from Chai, Koh and Tsai (2011) was reused in this study by including items with co-efficient loadings of 0.50 and above. This comprised thirty-one items that collectively covered all seven TPaCK constructs (TK, PK, CK, TCK, PCK, TPK and TPaCK). Their confirmatory factor analysis and Cronbach's alpha data were used to verify the reliability of each item. Example items are shown in Figure 3.5. While incorporating this instrument in the TPLQ meant that it was not possible to maintain the same seven-point endpoint anchored scales as used for items elsewhere in the questionnaire, the seven-point fully anchored scale (as shown in Figure 3.5) maintained consistency in the number of degrees possible with the response. Further, the original instrument asked preservice teachers to rate their first and second teaching subjects. While the terms "first" and "second" apply to Secondary Teaching in New South Wales schools, primary teachers are considered generalists and required to teach several disciplines effectively. To avoid confusion, secondary teachers were instructed to consider their main teaching subject, while primary teachers were asked to collectively rate their knowledge of all subjects they teach for the new Australian Curriculum (at the time of writing, these included English, Mathematics, Science and History).

Question 8: Please select the bubble that accurately reflects your level of teacher knowledge in each area. Where items refer to "teaching subject", secondary teachers should consider their main teaching subjects (e.g. Maths), while primary teachers should consider any subjects they currently teach for the new Australian Curriculum.

TPaCK dimension	Item	Strongly disagree	Disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Agree	Strongly agree
CK 1	I have sufficient knowledge about my teaching subject.	○	○	○	○	○	○	○
CK 2	I can think about the content of my teaching subject like a subject matter expert.	○	○	○	○	○	○	○
CK 4	I am confident to teach the subject matter.	○	○	○	○	○	○	○
PCK 3	Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.	○	○	○	○	○	○	○
PCK 4	Without using technology, I can address the common learning difficulties my students have for my teaching subject.	○	○	○	○	○	○	○

Figure 3.5 - Example TPaCK construct items included in TPLQ.

Contextual factors and demographic variables.

Equally important as exploring the three main constructs in the quantitative inquiry was the need to further understand how contextual factors shape technology-enabled professional learning. Given that the qualitative inquiry employed two stages of interview – the second of which was conducted in the school concerned – a rich account of the school context emerged that captured many of these factors. These accounts were especially pertinent in the four intensity sample schools, where educators were engaged in effective professional learning while being appropriately facilitated and supported by school leaders in a number of ways. While it was not possible to capture thick descriptions about the school context in the TPLQ, the researcher was able to itemise many of the support structures that CC21 participants cited and explore participants' perceptions of these across the three educational contexts examined.

The qualitative data in the initial inquiry revealed a number of insights around the nature of time and how it is spent on professional learning during, and outside of, school hours. Participants mentioned examples of professional learning activities that were formalised in some way. Professional learning activities were often timetabled in some form – for example, through team-teaching periods, designated staff meetings, professional development days and release time given for formal training. Other activities such as the completion of online courses and expected consumption of online content prior to staff meetings were formalised to some degree but not given specific time allocations. Similarly, there were a range of cited activities that were not formalised but nonetheless of perceived value to the participants. All of the school leaders in the intensity sample described informal professional learning sessions that took place in available pockets of time during the school day, such technology instruction given on demand. These participants also described their informal professional learning through the use of social media (especially *Twitter*) and experiential learning through playing with new technology tools. Two of the four school leaders also pointed out that since their role involved teaching their colleagues, the act of teaching further consolidated their knowledge (that is, they learned through teaching).

In addition to the emphasis on time as an important factor in professional learning, participants in the qualitative inquiry identified several further factors. Including the provision of network-related support (most notably, Wi-Fi access points) and devices allocated to teaching staff for professional learning, technology infrastructure was considered by many to be a key factor. Similarly, the availability of, and permission to use, tools for shared online spaces, collaboration and enhanced learning were concerns noted by several participants. School leaders and principals further acknowledged the supporting role played by those outside of the immediate school context. In particular, principals cited the support of several popular thinkers in education whose ideas were needed to substantiate leadership initiatives, inform strategic direction and inspire both themselves and their teaching staff. Some principals also acknowledged the role of educational research in substantiating evidence-based practice within the school community.

To explore the range of support structures noted in the qualitative data, Question 4 employed seven-point scale with the anchors "Extremely Unimportant" and "Extremely Important". Figure 3.6 shows the time-related support structures included in the TPLQ:

Questionnaire Item	Extremely Unimportant						Extremely Important
Unstructured professional development days in my own school (e.g. a planning day with colleagues)	○	○	○	○	○	○	○
Release time from class	○	○	○	○	○	○	○
Structured professional development days in my own school (e.g. staff training day)	○	○	○	○	○	○	○
Unstructured meeting time with leaders to discuss concerns face-to-face in my school	○	○	○	○	○	○	○
Unstructured meeting time to share ideas face-to-face with colleagues in my school	○	○	○	○	○	○	○
Lesson preparation time (e.g. designated free period in timetable)	○	○	○	○	○	○	○
Unstructured meeting time to share ideas with colleagues face-to-face outside of my school	○	○	○	○	○	○	○
Listening to a guest visitor during a professional development day or staff meeting	○	○	○	○	○	○	○
Unstructured professional development days outside of my own school (e.g. a planning day with colleagues from other schools)	○	○	○	○	○	○	○
Structured professional development days outside of my own school (e.g. one-day course)	○	○	○	○	○	○	○

Figure 3.6 - Time-related support structures.

Finally, the TPLQ gathered demographic data on participants in all three contexts. Questions asked current educators (in the CC21 and MacICT samples) to indicate age, gender, teaching context (primary or secondary), subjects accredited to teach teaching experience, current role and years working in their current school. Questions asked preservice teachers to indicate age, gender, teaching context (primary or secondary) and which subjects they were undergoing training to teach.

Conclusion

This chapter has attempted to unpack some of the complexities of empirically studying professional learning in a digital age. With so many different forms of technology-enabled learning now possible, there is a clear need for research that, first, captures what may come in future to be defined as best practice and, second, seeks to measure underlying attributes of effective professional learning with other samples from different educational contexts.

Predicated on the principles of pragmatist learning, this study employed a mixed methodologies design in order to explore the nuances of the participants' professional learning through the combination of qualitative and quantitative methods. Sequential design with paradigm emphasis (qual→QUAN) enabled the researcher to explore the diversity of the professional learning in a more open way in the initial qualitative inquiry. Representing a new "disequilibrium", professional learning was first examined through the perspectives of current educators involved in the *Connected Communities 21* (CC21) project. This self-selected purposive sample provided an important starting point for considering how educators engage in more self-managed and school-based forms of professional learning, especially when confronted with key changes in the areas of curriculum, pedagogy and technology. A small number of educators in the sample were able to discuss *autonomous* forms of technology-enabled professional learning, with reference to attributes that included additional time spent outside of work and study hours, smart use of current technology tools to consume and create content, and a diverse network of information sources and people-to-people connections. These participants were included in the intensity sample, the close analysis of which principally informed the design of the Teacher Professional Learning Questionnaire (TPLQ).

To establish a causal-comparative focus in the design, the quantitative inquiry drew on data from educators in three distinct educational contexts. While CC21 school leaders were unique in terms of their involvement in a project that promoted self-managed professional learning, educators from the Macquarie ICT Innovations Centre (MacICT) and Macquarie University preservice teachers (PSTs) were more typical of current educators at their respective stage of career. The use of mixed purposeful sampling in the quantitative inquiry enabled the professional learning evident in each of the three contexts to be compared and contrasted. This comparison and contrast divulged further insights about the nature of each context and how context plays an important role in shaping professional learning activities and outcomes.

The TPLQ was constructed to empirically measure key aspects of three main constructs: (1) Personal Learning Networks (PLNs); (2) Participatory Cultures; and (3) Technological, Pedagogical and Content Knowledge (TPaCK). It was argued that these three constructs are essential for understanding the breadth and depth of technology-enabled professional learning in the contexts studied. Of the three constructs, PLNs and Participatory Cultures are perhaps best regarded as *emerging* in that there is limited research on development of instrumentation to accurately measure the construct and its related elements. By contrast, the TPaCK model has benefited from instrumentation that has been developed, critically examined and validated in recent research. However, it could still be argued that instrumentation for all three constructs requires further development and validation. This study thus provides an initial, exploratory focus on key areas of professional learning hitherto unexamined – areas that will arguably become more important in the years to come.

Chapter 4. Professional Learning and School Leadership in Context

In exploring professional learning in a digital age, empirical research is needed that considers the important relationship between the contexts of the local school and the digital world. Both contexts are equally important and closely interrelated. As educators increasingly engage through diverse online communities with digital tools, information sources and people-to-people connections, many continue to work in schools where face-to-face learning, structured professional "development", timetables, limited resources and traditional assumptions persist. While there is now a sizable body of literature that explores how learning might be further reconceived in the twenty-first century (including areas such as the architecture/layout of schools and classrooms, the structure and delivery of curricula, the role of the teacher, the use of technology and so on) understanding how educators currently engage in professional learning across both local and online contexts remains important.

As noted in Chapter 3, this study employed a sequential, mixed methods design that incorporated an initial qualitative component for exploring teacher professional learning situated within the local school context. The following section reports on the analysis of the qualitative data and how this analysis further informed the research design.

Stage 1: Qualitative Inquiry

The underlying aim of the qualitative inquiry was to iteratively explore the relationship between the use of technology and professional learning in the school context. the *Connected Communities 21* (CC21) sample included a large number of school leaders and principals, thus representing educators responsible for facilitating and supporting professional learning within their communities. With the current implementation of a national curriculum and the nationalisation of teaching standards alongside rapid changes to technology and efforts to re-think pedagogical approaches, educators in this sample were aware of many challenges in contemporary schools. Participants were able to identify – and to some extent personalise – key areas of their professional learning and explain the strategies, tools, support structures and key people that underlie effective professional learning from their perspectives. Participants were also predisposed to using technology and aware of the need to employ current tools in their professional learning.

The school initiatives in which they were engaged prompted participants to discuss both their professional learning and that of their colleagues. In addition to examining technology use, the inquiry considered how participants were making use of other available school resources, including allocated project funding. This study was, therefore, able to explore how teachers typically choose to manage professional learning when working with available resources. In particular, the researcher considered both the formal and informal professional learning activities that were cited.

Table 4.1 illustrates the relationship between the most commonly cited formal and informal activities in the interview data. The table indicates both the tendency of certain experiences towards either formal or informal settings based on the level of structure implied and the context in which experiences were described:

Table 4.1 - Informal and formal professional learning activities cited in interview data.

Formal (usually more structured)	**Informal (usually less structured)**
Training programs	Reading *Twitter* feeds of popular educators
Timetabled staff meetings	Discovering teaching resources through social media
Timetabled team teaching	Impromptu team teaching
Staff Development days	Programming days
Online courses with deliverables	Just-in-time professional learning
Attendance at conference lectures	Lunchroom discussions
	"Playing" with technology tools

It is important to note that professional learning activities are not always solely "formal" or "informal". Some experiences could take place in, or be adapted across, both formal and informal settings. For example, whereas reading a *Twitter* feed is much more likely to represent an informal learning experience, schools can formalise this experience, for instance, by training all staff in the use of *Twitter* during a staff meeting (though this was not the case in any of the schools studied). Likewise, whereas attending a lecture represents a formal learning experience, the conference setting in which the lecture takes place can also provide opportunities to learn informally through networking with colleagues. Nonetheless, positioning participants' descriptions of their professional learning experiences and opportunities as tending towards either formal or informal professional learning enabled the study to distinguish between experiences that are often school- and system-led from those that are learner-led.

The study inquiry explored teacher TPaCK knowledge as an *outcome* of professional learning. School leaders were an important component in the broader CC21 sample, in that they were able to discuss their own professional learning in addition to their leadership actions that often influence their colleagues' learning. With a shared responsibility for teacher professional learning in their school communities, the school leaders in this study worked strategically to manage learning a range of ways, including school initiatives within the formal and/or informal structures outlined above. Participants were often able to explain their rationale for professional learning that incorporates a broad range of strategies and structures, and describe ways in which they were held accountable for costly provisions such as training days, release time, purchases and support personnel. Further, the school leaders in this study often engaged in professional learning outside of their immediate school community – whether through face-to-face events such as conferences and network meetings or in online communities.

As established in Chapter 3, a small subset (n=8) of the broader CC21 sample (n=102) was selected as an intensity sample, including four school leaders that were largely autonomous learners. All four of these school leaders were adept in their use of technology for professional learning and colleagues' input during focus group sessions and changes to technology infrastructure provided evidence that the leader's learning was shaping strategic direction in the school. Further, as this chapter will show, the principals in these schools recognised the value of the technology-enabled professional learning and sought to establish a range of structures to support and facilitate this learning with teaching staff across the school.

Throughout the summary and discussion of interview data, principals and mentors are denoted with the same letters (for example, Principal A and Mentor A) to indicate they were part of the same school (for example, School A).

About the Participants

Mentors.

The sample of mentors included two Classroom Teachers, one Assistant Principal and one Deputy Principal. All of these participants were regarded as "mentors" by other staff and the use of this term led to labelling these leaders as mentors when summarising the findings. All four mentors showed evidence of cultivating well-established Personal Learning Networks that included wide range of face-to-face and online connections beyond their school and system. They described regular use of social media, as well as proficiency with Web 2.0 tools, mobile devices and media creation. In all four cases, their respective positions involved working across their schools to manage, support and improve teacher professional learning with technology. The interview data reveal their key decisions, opinions and underlying values. These data thus shed light on the knowledge and skills developed and shared within the school community and the broader impact of the digital age - including Personal Learning Networks and Participatory Cultures – on teacher professional learning.

Depending on how schools allocate resources, leaders may occupy formal positions such as Deputy or Assistant Principal, or informal positions as classroom teachers who are given additional responsibilities and, commonly, some time allowance in the form of release from face-to-face teaching (RFF). These variations were reflected amongst the four mentors. Two were classroom teachers who were released from teaching (one released on Thursdays, the other released full-time) to work with teachers from other classes on a regular basis. One was an Assistant Principal, a formal position involving a small allocation of non-teaching time and responsibility for a year level or stage. Finally, one mentor was a Deputy Principal, a formal position considered second in charge of the school usually with no timetabled classroom teaching duties. In the case of the classroom teachers, regular RFF was as a result of local staffing allocation decisions made by their principal on the basis of perceived needs in the school community and recognition of the teachers' expertise. Notably, these decisions reflected the perceived importance of team teaching and collaboration as key components in professional learning.

Table 4.2 shows the distribution of gender, position, age, years teaching and the nature of the role for each of the mentors. Both classroom teachers had relatively less experience than the other two mentors; however, this is a finding that is not uncommon in schools where junior teachers are frequently recognised for their expertise with technology.

Table 4.2 - Demographic distribution of participating school leader mentors.

Mentor	Gender	Age	Years Teaching	Position	Role
Mentor A (School A)	M	32	5	Classroom teacher	Full-time release from class for technology learning support
Mentor B (School B)	F	24	2	Classroom teacher	One-day release to team-teach with lesser able colleagues
Mentor C (School C)	F	44	20	Deputy Principal	Non-teaching executive in charge of professional learning for all teaching staff in school
Mentor D (School D)	F	31	10	Assistant Principal	Co-developer of technology-based resources and units of work with lesser able and "resistant" colleagues

Principals.

The principals included in this component of the study were all pre-disposed to using technology and recognised its importance in the school community. All reported high levels of expenditure on technology infrastructure and devices, with substantial recent hardware acquisitions, further development of wireless networks and money for release time and training. Further, all four schools were working towards a target of "1:1", a ratio indicating that one technology device is available for every student in the school. Each principal described himself or herself as a regular user of technology; however, none considered themselves technology experts. Nonetheless, all four principals were personally involved in their school's initiative for CC21, attending network meetings and training, preparing reports and blogging on a shared community blog. Consistent with their role in the school, all of the principals included in the sample had some autonomy in the use of school funds. This autonomy has been extended in recent years through *Local Schools, Local Decisions*, an education reform initiative in NSW public schools "that gives NSW public schools more authority to make local decisions… [and] greater freedom to make decisions about how to use the money we spend on public education" (Department of Education and Communities, 2013).

Table 4.3 shows the distribution of gender, age and years teaching for the principals in the intensity sample:

Table 4.3 - Demographic distribution of participating principals.

Principal	Gender	Age	Years Teaching
Principal A (School A)	F	42	20
Principal B (School B)	F	36	15
Principal C (School C)	M	44	22
Principal D (School D)	F	48	25

Participants' Perceptions of Teacher Professional Learning

Following both stages of data collection and analysis, several themes emerged. Theme 1 – *professional learning and teacher choice through multiple ways and tools* – reflected the diversity of options open to teachers in all four of the schools studied. The second theme emerged around the use of two key terms: *technology "drivers" and technology "buyers"*, broadly reflecting how participants viewed the dynamic relationship between teachers who adopt and innovate with technology tools contrasted with those who wait to be convinced of the value of a tool before using it in their teaching and professional learning. Theme 3 was *the need for* *diverse support bases,* a theme that reflected all leaders' perceptions that professional learning support needed to come from many different sources, including school- and system-based support, but also support from educators and other experts outside of typical school and system networks – especially online. *Technology as an enabler of professional learning* describes Theme 4, reflecting the participants' perceptions that acquiring and using technology tools such as tablet devices could enable newer forms of professional learning that were not possible without the tool. Theme 5 – *inspired leadership* - was drawn from the frequent discussions of several popular thinkers in education, where both principals and mentors described how these thinkers were influencing their leadership decisions. Finally, Theme 6 focused on *the role of the networked teacher,* reflecting participants' perceptions of networked professional learning in the digital age.

Theme: professional learning and teacher choice – multiple ways and tools.

Amongst the four schools, there was support for teacher professional learning in a wide range of forms that aimed to suit both the needs of individual teachers and those of the school community. In particular, the professional learning opportunities described by participants included both structured and unstructured learning opportunities, with a consensus that both forms were important. Most often, unstructured learning was described in reference to finding and sharing resources on the Internet, using social media, informal planning sessions, team-teaching and "playing" with technology devices. Discussions that reflected more structured learning frequently referenced staff development days, after-school meetings, training sessions and workshops. In these more formal settings, leaders played a primary role in determining what their teaching staff needed to learn and often ensured that all teachers were engaged in the same activity, or set of activities.

By contrast, learning in informal settings was frequently left up to the individual teacher working with the mentor. When asked whether there was a clear preference for structured or unstructured professional learning, participants generally reinforced the need for both forms. For example, Principal A referred to professional learning that incorporated both face-to-face sessions (which she described as “one-size-fits-all PL”) and more personalised learning through social media:

> There is the “one-size-fit-all” PL on the Wednesday afternoon where we keep people on pace with the new curriculum and things that are happening. There's also our admin meeting on Tuesdays where we discuss things that have come up again. But people are still turning to the Internet and doing their own professional learning, using tools like Yammer [social media platform for teachers]. I’m often sitting in the staffroom, where people are saying, "Oh, did you see this on Yammer?" People will send links through to me that they find, articles that they’ve read and I’ll send them out to the whole school, so there’s also that happening as well… especially with some of our key leaders. They'll find information that they think is important to what's happening and they will send that out and people will read it and then take it off from there as well.

Principal A noted that in addition to the links that were frequently shared with her via email, she believed that many teachers in the school were actively developing Personal Learning Networks (“…we don’t collate that information but we know it’s happening…”).

Interestingly, all four schools employed a diverse range of technology devices and platforms throughout the school. Both principals and mentors were strongly supportive of these multi-device, multi-platform learning environments; these findings stood in contrast to the single-device environments preferred in many schools. Exploring a possible relationship between these environments and professional learning, participants were asked about the challenges teachers often face when having to accommodate a range of technology devices in their teaching and professional learning. At his school, Principal C described technology-mediated professional learning oriented around play and the school’s decision to employ multiple devices and platforms: “what I did was to say ‘let’s flood the school with the technology and the e-learning, let the teachers play, let them have fun and *then* look at the professional learning…’” However, both the principal and mentor at School C emphasised the importance of multiple platforms and devices for extending their teachers’ thinking.

Mentor C was chiefly behind the school’s recent technology initiative, which involved the development of a multi-platform classroom (“The Hub”) that included Android tablets, iPods, games consoles, a video editing suite, netbooks and a Microsoft Surface Table. The room was deliberately designed to afford teachers and students opportunities to "play" with the technology and inspire teaching and learning. Principal C pointed out that by incorporating multiple devices and platforms in "The Hub", teachers would, he believed, be challenged to be more open-minded in their preparation:

> I think here [at this school] it is the open mindedness that is challenging teachers the most... you won't go in there and use that classroom, The Hub, and be not prepared. You won't be able to run a lesson in there. It is just not set up for that. It is set up for it to be interactive, a lot of movement, and a lot of different styles of learning and working environments. If you are not prepared... you just can't go in there and use it.

Principal C acknowledged that while all teachers were responding to the challenges of the initiative and the learning environment of the hub, "the young teachers are driving the programs in the school [while] the more experienced teachers are saying 'yeah you know what? I like this!'" Accepting that "it is difficult to learn different platforms", he pointed out that with many mobile devices were, regardless of the platform, relatively "easy to learn" for most children and teachers alike.

These coexisting forms of professional learning, technology devices and platforms comprised a significant theme early in the qualitative inquiry. Both principals and mentors were aware of the rapid changes to technology in recent years and regarded some devices as "game changing". For example, Principals B and D both cited the impact of iPads, pointing out that they supplanted earlier digital camera technology and provided students with a mobile alternative to traditional computer labs. Nonetheless, these principals were wary of solely using iPads as the "one tool" in the classroom, noting that these devices still had limitations when compared to desktop and laptop computers. As Principal B observed, "I think that there needs to be a mix of both [iPads and laptops] because I think that both of them have different applications and uses and I certainly see that [mix] progressing into the future".

Interestingly, both Principals C and D de-emphasised specific technology devices in their discussions, focusing on the role of the teacher in responding to change.

For instance, when describing how she wanted her teachers to learn in future, Principal D stated "what I really want staff to understand it that it isn't [just about] the technology that's here and now, it's the ability to develop skills in those students to adapt to future [changes in] technology". Similarly, Principal C described the need to have a learning environment "where the devices are not the integral part of what's happening in the classroom, but the teacher is". Principal D acknowledged that while she often struggled with technology, she had shifted away from reliance on others to "show" her solutions, suggesting that online professional learning "is the same as researching, or if you're wanting theories, or whatever… the world is a classroom now".

All mentors demonstrated an understanding of working in multi-platform, multi-device environments with a range of both structured and unstructured professional learning opportunities. Mentor A argued that his school was progressing well in the use of technology tools for learning while at the same time offering considerable choice for teachers to learn in different ways, analogously stating, "…the train's moving, but the way you get on the train [at our school] is up to you".

Similar to the culture of many mixed-ability classrooms, mentors recognised that teachers had differing levels of proficiency with technology, and that adjustments needed to be made when mentoring colleagues. In this light, mentors tended to classify their colleagues in terms of "early adopters" – those most willing and able to try new ideas – and "resistant" teachers – those who were reluctant and often struggled to do so. While recognising teachers in both categories needed support, most mentors had a tendency to prioritise the learning of the lesser-able teachers. In particular, they described their work with these teachers as often taking place informally through team teaching and extra one-on-one or small group assistance provided during free periods. All mentors mentioned the need for these teachers to be more "comfortable" with the technology in the school, with Mentors A and B also pointing out that some teachers in their schools needed to "shift to digital" ways of working and learning be "up-skilled". Mentor A expressed concern that without the necessary skillset, "some teachers will be left behind", further stating that lack of confidence was often an issue with older teachers in his school.

Finally, a recurring aspect of these multiple forms of professional learning was the importance of teacher *collaboration* with and through the mentors. This is particularly reflected with the two junior teachers – Mentors A and B - who had been informally (that is, without direct system backing) appointed as leaders by their principals. In both interviews, they often referred to themselves as "collaborators" with colleagues, acknowledging that while there was a degree of structure informing their work (for example, being released from face-to-face teaching at certain times), many of the learning experiences they engaged in with colleagues were relatively unstructured. For example, these mentors described professional learning that often took place by request, in available pockets of free time such as recess and lunchtime or during team-teaching sessions. These sessions often involved mentors seeking to understand what their colleagues needed to learn in order to teach specific lessons with a technology component or different pedagogical approach.

In particular, Mentor A appeared very pragmatic about his work with teachers:

> I'm trying to know what people [my colleagues] are doing. People then will book me for periods of time specifically that they need me. In general, many teachers feel as though they need me. So there is that 'need basis' [to my work] … What I've done is at first, those people who want me and are feeling very uncomfortable – I work with them a lot but then step away and move on to other people. What happens is someone is getting a lot of support and then someone else is [saying], "Oh, I need a little bit more", and they come up [to see me] and it's a constant see-saw of everybody just working.

In addition to being very proficient with technology, Mentor B discussed her interest in creativity and Project-Based Learning. She believed that many teachers often struggled to be creative in their use of technology and that there was a need to explore a wider range of pedagogical approaches to address this deficit. In summarising, she observed, "we want to build capacity across a whole staff rather than just those few people who are feeling quite competent". When asked whether teachers across the school should be formally trained, she believed combination of "scaffolding" and "collaboration" was needed to effect change: "we'll certainly be scaffolding that [professional learning] process for them, but it is more about learning through collaboration with a small school like ours… so we're quite collaborative, I'd say".

In summary, although the kinds of professional learning in each school broadly tended towards either more or less structured forms, there was a prevailing belief that learning opportunities needed to be diverse in order to meet the needs of teachers in each school. Mentors generally employed themselves pragmatically in collaboration with colleagues and the kinds of learning experiences discussed were frequently situated and "just-in-time". Most importantly, there appeared to exist considerable degrees of teacher *choice* about when to learn and how to learn. While the school structures did not consistently allow for flexibility (for example, at times where teachers' learning was mandated by the principal or constrained by timetables), there was, nonetheless, a large degree of pragmatism reflected in the way these participants and their colleagues learned.

Theme: resistance to technology and professional learning – the "drivers" and "buyers".

In spite of their interest and experiences as networked educators, both mentors and principals were well aware of cultures of resistance to teacher professional learning, particularly professional learning involving the use of new technology devices. While some teachers were often referred to as the "drivers" of technology in the school, for others this was considered something that needed to be "bought into". When exploring these emic terms further, it emerged that the term "driver" generally referred to a teacher who was self-directed in their learning with, and implementation of, new technologies. By contrast, the term "buying into" referred to resistant teachers signalling their willingness to use new technologies and, in doing so, committing to some professional learning. This arrangement of "buying into" was often understood as a form of bargain – or "carrot and stick" approach – where resistant teachers were offered an incentive (such as a new technology device) but had to commit to professional learning on how to use it. Interestingly, when teachers committed, this professional learning was usually structured in some way to ensure it was completed in a way that was deemed satisfactory by the school's leaders.

In particular, Schools B and D offered iPads to teachers in exchange for formalised commitment to professional learning. In the case of School D, this commitment involved teachers agreeing to invest more of their time (often in free periods or after hours) in order to learn to use it in their teaching. In the case of School B, however, the commitment was formalised through additional staff meetings, as Principal B describes:

> As part of having an iPad, they needed to commit to extra professional learning that went with that iPad... so you weren't just going to get an iPad [for nothing] ... they had to commit to coming to an extra session every fortnight [focusing on] how they could use the iPad in the classroom. I've got one of our APs leading that so I think it's been [about] making sure it [the technology] is incorporated into teaching and learning programs but then allowing teachers to see the possibilities and working on that in a collaborative way.

Amongst the four schools, there appeared some division about the necessity of teachers to engage in technology-mediated professional learning and incorporate technology tools in their teaching. While mentors and principals in Schools A, B and C seemed intent on teachers needing to learn about new technologies in their professional learning, School D expressed this more as an ideal rather than a necessity. In particular, both Principal D and Mentor D stressed the need for teachers to be able to "move at their pace", and not be forced to try new ideas against their will. Principal D expanded on this, describing an "offering" approach, where "driver" teachers who are more able create a "ripple effect" of ideas would "hopefully" spread amongst teachers throughout the school:

> One of my biggest philosophies is that you go with who's ready to go first... and hopefully that ripple effect will take place... once they [driver teachers] have the opportunity to share it [their ideas] with the rest of their stage, it [the reaction by other teachers] will be, "We want some of what you've having... we want some of that too". It's not "you will do this" [to the staff]... it's "if you would like to... here it is for the offering".

Similarly, Mentor D insisted on the importance of resistant teachers "buying into" new ideas and initiatives before they engaged in relevant professional learning. When asked why the "buying in" process was particularly necessary, she replied:

> It's like kids, is it not? In relation to learning, we [teachers] all have different learning styles. We're all at different levels of development, so I think that if you put the supports there, then that's a really positive thing. Teachers are professionals and if they feel that something is right for the kids and that it is something that's going to move their children forward they will buy into it...

While other schools did not openly endorse this degree of freedom about whether to adopt or reject an initiative, principals and mentors clearly saw the need to persuade resistant staff about the benefits of using technology. For example, Mentor A observed that while many teachers in his school were now comfortable accessing online information sources for their professional learning, most were still not ready to share their professional learning with others online, citing blogging as an example:

> A lot of people had spoken to me about blogs… They say, "Is this the kind of thing that I should be worrying [about]?" They don't realise that with blogging, you're actually going a step further in your professional. [I tell them] "You could have actually written about this, this, and this". They say, "Oh, okay! Right!" Many teachers don't realise what they're doing is actually very, very good.

In summary, the data showed an interesting association between teacher professional learning and the use of, and resistance to, technology. Amongst the cultures of resistance in each school, there appeared an understanding that exploring new technologies required a commitment to professional learning, often in addition to regular duties. There was often a belief that resistant teachers needed to "buy into" new initiatives, requiring persuasion and/or the incentive of new technology devices such as iPads. While the broader culture of professional learning was often categorised into the "early adopters" and "resistors", principals and mentors did not generally see this as divisive – but rather appreciated that some staff required further support, persuasion and time to adopt initiatives when compared to others. Nonetheless, all four principals were explicit in their appreciation of the "drivers" in their school community.

Theme: diverse support bases – Ideas, evidence and expertise.

Given that all participants were leaders responsible for the delivery and management of professional learning in their schools, it was important to examine data for evidence of each participant's support base. In other words, it was pertinent to explore where, how and why each participant drew support to better understand their impact on the learning culture of the school as a whole. Mentors A, B and D all showed evidence of very well established PLNs that informed their practice. Mentors A and B were very active on social media, being avid teacher bloggers and considering themselves well connected to online information sources and people. Both of these mentors stated that they were willing to share information related to their professional practice publicly with anyone online, using such tools as social media, discussion fora and blog posts. Similarly, Mentor D used social media as a tool to stay in touch with people that she met during educational events such as conferences and training days. In this light, there was clear evidence to suggest that most of the mentors used their PLNs as a support base for drawing and sharing ideas, and this support base existed largely outside of the traditional school walls.

When further exploring outside connections as part of the individual leader's support base, a number of related elements emerged. Both Principals B and D referred to changing curriculum contexts as an evidential support base for their leadership. Principal B stated, "the Australian Curriculum has done me as a leader a huge favour because... it's not just me as a leader saying that this is what I would like... Now it's becoming mandatory teaching and learning". Similarly, Principal D believed that "the new curriculum really brings what a lot of schools have tried to do for years because they knew that it worked but there wasn't necessarily an evidence base behind it" suggesting that, "now bringing it together… teachers really have no choice but to look beyond the classroom [for learning] with the students". Closely tied to the changing curriculum in terms of its use as *evidence,* most principals believed that research played an important role in supporting their decision-making. For example, Principal C stated, "the teachers [in my school] know that I'll have an educational discussion with anybody in the school but when you come to me to have that educational discussion, what's the theory behind it? If there's no theory behind it or there's no research behind it then there's no discussion". Likewise, Principal B noted, "I want be able to justify the choices I make and ground what I do in research and practice... and I think as leaders we need to be able to demonstrate quite clearly why we make the decisions that we do... to make a difference..".

Within each school, there was evidence of support structures being deliberately put in place to diversify the support base for professional learning. Both Schools A and C employed "Stage[3] Mentors", an unofficial leadership role for teachers who were recognised as having expertise in technology and given responsibility for assisting colleagues in their Stage. While many schools tend to appoint similar leaders formally through the position of Assistant Principal, School A appointed relatively junior Stage mentors who, as Mentor A noted, "were chosen… outside that sort of hierarchy… [as] people who would be trained up, people who everyone knows have been trained up… so they can be mentors [to others]". Likewise, in an attempt to implement a very wide range of devices and platforms in his school, Principal C allocated specific technologies to each Stage: "I have a person now who is in charge of the Android devices; I have people in charge of the PCs, the laptops and the [Microsoft] Surface devices. We had experts right around the school who manage that [technology] for us". He described each stage as a "centre of excellence", arguing that "as teachers move amongst stages they always have that centre of excellence there because they're retraining and training the other staff". When asked about the challenges of equipping each Stage Mentor with skills and assisting teachers to move from one stage to another, Principal C referred to technical training offered by technology vendors, which served as an important component in the school's professional learning.

All principals were explicit in recognising the support of their technology mentors when implementing professional learning in their school. Principal A recognised that her commitment to releasing Mentor A made the school unique: "we have a unique situation in terms that we made a decision to have an ICT mentor [as a classroom teacher released by the principal]. So it was really important that people utilise that resource and access the professional learning that was running, and will continue to run…" Principal B emphasised the importance of Mentor B in ensuring consistent professional learning throughout the school, noting that her collaboration with colleagues was superior to a more structured, formal program:

> You can develop a formal program… but everyone's going to have a different way of doing that and I think we have [with Mentor B] someone who is an expert in creative thinking and seeing that in classrooms... and also very adept

[3] In New South Wales Schools, *Stage* generally refers to the learning across two grades (for example, Stage 2 represents Grades 3 and 4).

> with technology and I think having someone who can work in the classroom with teachers to show them what it looks like in practice would be very different if teachers just went off and taught from the program. I think we've ensured that there's been consistency in what is happening in the programs from Kindergarten to Year 6 because we've had that [expert] teacher doing it. I don't think [without Mentor B] that I would have had so many teachers volunteer to be a part [of the initiative]…

Principal C noted that Mentor C (also his Deputy Principal) was instrumental in effecting professional learning in the school: "[she] has been the driving force with team teaching, demonstration lessons, observation lessons, providing units of work, helping to plan, [and work with] Stages during planning days…" While only an Assistant Principal, Mentor D had received RFF through the use of "transitional funds" from a range of funding sources. With recourse to these funds, Principal D stated, "we've been able to buy two days a week to release teachers, to support with professional learning… our project team leader [Mentor D] now has one day a week where she is available to go into classrooms to either team teach or do a demonstration lesson or be of support to the teachers in the classrooms".

Theme: Technology as an enabler of professional learning.

In addition to participants' recognition of "game-changing" technologies such as iPads, there was evidence further suggesting that, in all four schools, technology played a role in enabling and/or supporting learning experiences and opportunities for teachers and students alike. For each school, these experiences and opportunities took different forms, and often reflected the interests of the individual teacher and/or school initiatives. For example, in School D, participants recognised the relevance of iPads in enabling Inquiry-Based Learning (IBL), a pedagogical approach that they believed was superior to regular instruction. Students used iPads as part of a Science-based assessment task to conduct field research, capturing and classifying images of living things and interviewing members of the school community. Mentor D elaborated on the assessment task, noting the affordances of the iPad further with respect to multimodality and metacognition:

> It's great for my kids if they want to record something, it's such an easy way... like they don't have the ability [at their age] to write a lot of information down but they'll certainly be able to talk about it on the iPad... and it means that

> they're not having to remember the sounds of what they want to write. They can record it; they can go back to write it later. So it's sort of facilitating their thinking and learning.

In School B, iPads were employed for a digital storytelling assessment that was described by the principal and mentor as an example of Project-Based Learning (PBL). Both participants believed that the devices were important for fostering creativity and enabling multimodal forms of representation and expression, especially through the many storytelling mobile apps available. Regarded by her principal as "an expert in creativity", Mentor B believed that the technology employed in a PBL setting would enable improved skills in "problem solving, negotiating [and] communicating", while indicating that her role was primarily to develop "teacher capacity to foster creative thinking, to foster critical thinking and then using the digital tools so ICTs to really support that process".

When further investigating the role of technology as an enabler, an interesting theme emerged in relation to the Australian Curriculum and the way that curriculum objectives are now encouraging many educators to rethink pedagogical approaches and, where possible, use technology to support this rethinking. For example, Mathematics in the Australian Curriculum now emphasises the importance of students becoming "self-motivated learners through inquiry and active participation in challenging and engaging experiences" (Board of Studies, Teaching and Educational Standards, 2012a, p. 10). In the Science curriculum, the relationship between pedagogy and technology is further explained:

> As disciplines, Science and Technology are linked through problem solving, by the skills and processes of scientific inquiry and technological design. Science often draws on tools and processes developed by technology. Technology in turn uses concepts, principles and processes developed by science. The study of Science and Technology provides opportunities for students to think and act critically and creatively, to develop informed attitudes based on evidence and reason, and to participate responsibly in developing innovative working solutions and ideas in response to opportunities and questions relevant to personal, social and environmental issues in their lives (Board of Studies, Teaching and Educational Standards, 2012b, p. 12).

Elsewhere, the English curriculum emphasises the need for students to "create well-structured and well-presented written and multimodal imaginative, informative and persuasive texts for a wide range of purposes and audiences", with a clear implication that multimodality necessitates digital forms of representation (Board of Studies, Teaching and Educational Standards, 2012, p. 20). Given the emphases across Schools B and D on Inquiry-Based Learning, Project-Based Learning, metacognition and multimodality, it was evident that curriculum played an important role in supporting the use of technology as an enabler for the kinds of pedagogical approaches that leaders believed would best meet curriculum objectives. In summary, as Principal D noted, "technology is an important part but is not the only part, but is an umbrella for lots of other stuff and skills that will be required and, whether we like it or not, it's there".

Amongst the four schools, there was evidence that participants believed many technology devices were disrupting traditional approaches. Given this belief, it was unsurprising that these participants often talked about technology as an enabler for encouraging resistant teachers to "come on board", an expression similar to "buying into" that described when resistant teachers decide to adopt an initiative. Principal B cited her teachers' interest in iPads as evidence that they could "learn together" and "willingly" integrate the technology into their practice:

> I think [we had] a really interesting process with the introduction of iPads this year... half way through Term 1 I put out an email saying if anyone would like an iPad - we're just starting with iPads - then let me know and I will buy you one just as way of getting teachers used to that technology. We certainly have teachers who find technology very confronting… So with the iPads, we didn't want to overwhelm staff with what it was going to look like [i.e. the plan for using them in the long term] ... and [we didn't say] "you must use this technology [in your classroom] now..". I wanted that idea that no one is an expert in using this technology... we're all just learning it together. I actually had every member of staff put their hand up and say that they wanted an iPad. For an opt-in program - I thought there would be a group that said they were just too busy this year... and I think that opt-in process is really important because they have all willingly walked into [using] that [technology] in the classroom.

Although none of the participants regarded technology as the most important component for learning in their school community, interview data reflect a common belief amongst participants that changes to technology tools used in professional learning can promote positive changes in other areas of practice. While prompted, in several cases, by new curriculum objectives that emphasise different pedagogical approaches, participants were equally motivated by their beliefs about how students learn best and a need to employ technology in a meaningfully supportive way. In terms of the mentors – where there was "driver" evidence of self-directed professional learning with a range of technology tools – there was an apparent emphasis on more learner-led approaches (such as the IBL and PBL models cited), as well as a pragmatic approach to ensuring that other teachers could learn in ways that best suited them.

On the other hand, principals tended more towards discussing initiatives and safeguards to ensuring that as many staff as possible were "on board". The need to juggle accountability and self-directed inquiry is reflected in the approach taken in School A, as the principal notes:

> We've made sure that people have access to the same professional learning. For example, we had a Saturday professional learning day where they rotated through a variety of experiences looking at the devices that we had available. That was an excellent catalyst so that everybody has the same information. From that point, we said to people, choose something that you think interests you that you want to take on that journey and utilise it. That helps to start it [more autonomous professional learning]. Then people formed groups to support each other in that. So people who are doing the film studio work together so they could support each other.

The approaches taken in each school community were often coupled with the provision of technology devices to many teachers (including resistant teachers) in the school. Evidence suggests that the decision to incentivise professional learning represented a possible way to motivate change and, to some degree, ensure that new initiatives would be adopted.

Theme: inspired leadership.

In the second stage of interviews, all participants were invited to comment on commonly labelled leadership styles such as "top down", "bottom up" and "middle through". In relation to these terms, participants were asked about what kinds of leadership styles worked best to implement initiatives in their school community.

In general, most participants argued for a mix of styles, as is evident in Principal C's comments:

> Look, I think as leaders, that's what we do, yeah [we work out which leadership model is best]. Those models – top-down and bottom-up, middle through – there are times when each is appropriate. There are times when you have to have top-down, there are times when the bottom will draw out the top, there are times when it's a flat line, which is my distributed leadership model. Now, I call the system I have here distributed leadership. There are times when it becomes a pyramid. Fantastic.

Nonetheless, it became evident during interviews that many leaders regarded themselves as part of a broader community of educators that included, outside of the school, a number of popular thinkers. Irrespective of their position, these thinkers were generally regarded as influential, usually to the point where participants would cite their ideas in practice within their school community.

In recent years, popular thinkers in education have emerged in both face-to-face and online contexts. In some cases, these thinkers are employed as consultants who work with schools and systems, engaging in guest lectures, online courses, training programs and mentorships. Very often, however, they achieve enormous reach through established online presences (in some cases, for example, with tens of thousands of *Twitter* followers, active blogs, interactive websites and other forms of web presence). In terms of their reach and impact, they are usually considered popular, with their ideas are often widely shared amongst educators. Given the capacity current web tools for wide-scale sharing of content, the popularity of these educators is amplified through their use of technology. Moreover, it is educators who are predisposed to technology and Personal Learning Networks who more often become familiar with their ideas in online contexts.

Interestingly, while not a set topic of conversation in either stage of interviews, seven out of the eight participants mentioned at least one popular thinker when discussing professional learning in their school community. For example, both Principal C and Mentor C cited an influential thinker in the area of school redesign. While Principal C had heard about the thinker during network meetings and once met him at a guest lecture, Mentor C was only directly connected to the thinker's ideas through various online channels including *Twitter* and online articles. The same thinker was mentioned independently by Mentor D, who observed that while teachers in her school "loved his theories", most had not yet "transferred them into practice". Similarly, in her second interview, Mentor D discussed her connection to another popular thinker in education whom she considered an expert in Inquiry-Based Learning (IBL). Having met this educator in person, Mentor D continued to send and receive messages and tweets online, and at one point used Skype – for which she made special arrangements with system administrators to have unblocked - for videoconference link between the educator (in Canada) and her Year 1 classroom. She believed that the Skype connection was beneficial to her professional learning as well as providing her students with a "meaningful context" and "authentic audience" with whom to communicate. She stated:

> … [this thinker] speaks to me... like, when I listen to her, there's something about what she says and what she does that resonates with me... and I think that that is something that's poignant in relation to teachers and moving them... It [the pedagogy] has to speak to them... it has to hit them in terms of their moral purpose and if the person speaking to them resonates with what they're doing and why they do what they do, and perhaps forces them to challenge some of those things that they themselves weren't quite comfortable with about their practice... that's what pushes people forward.

The above statement illustrates the influence of the popular thinker on this leader's practices in School D. The language reflects what researchers have described as the "affective domain" (Krathwohl & Masia, 1984), where the individual responds to, organises and internalises phenomena in relation to their personal value system. The leader in School D had used the combination of face-to-face and online connections with this popular thinker in order to develop her ideas in relation to what she perceived to be the "moral purpose" of her teaching. Referring to her Mentor's decision to connect with this educator during the focus group interview, Principal D stated, "I've had limited exposure to [the educator] … because I started at the school last year… but I'm a big believer of... you know, you make use of whatever's out there..".

The relationship between technology use and popular thinkers in education is a relatively new phenomenon. As such, the emergence of this relationship in the qualitative component pointed towards the need for further research explore how these and other social media connections are changing the nature of school leadership. In particular, the findings at this stage suggested a need to consider how key ideas that are shared in online contexts permeate school communities and explore the important relationship between personalised online professional learning and learning in more traditional face-to-face contexts.

Theme: role of the networked teacher.

Finally, there was some evidence to suggest that school communities were aware of the role of the networked teacher as a key agent in contemporary teacher professional learning. In particular, the discussion of popular thinkers underscores the importance some participants placed on networking with other educators and "being connected" to current ideas. However, while there was some qualitative evidence to suggest this was happening amongst the participants and, elsewhere, with some teachers in their school communities, the extent to which this kind of professional learning was happening in all schools remained unclear. Nonetheless, in terms of their frames of reference, many participants discussed self-directed online networking as a kind of "next level" for professional learning in their school. As Principal D noted elaborated in her first interview:

> At the back of my mind somewhere else is also teachers' professional learning, the *online* learning that has to occur – and that's something that we haven't bridged yet. As we can see with a lot of professional learning courses with the Department [of Education and Communities], a lot of it is online and that's something else that's going to cause, create a new challenge for schools I think.

Examples of highly connected teachers were easy to identify amongst the four mentors. With her use of Skype, *Twitter* and email, Mentor D had shown initiative in connecting with the popular thinker in Inquiry-Based Learning (IBL), and the connection had an explicit and implicit impact on her practice and "moral purpose". An avid blogger, Mentor A believed in frequently sharing his work (often with up to ten blog posts per week) with the wider online community. Mentor B emphasised the use of technology tools for creativity, sharing examples of her work through social media with like-minded educators. Perhaps the least digitally connected mentor, Mentor C nonetheless described her interest in maintaining strong interschool connections with several neighbouring primary schools. In all four cases, the decision to network outside of the immediate school community was self-directed. As a result, each mentor achieved quite different professional learning outcomes that impacted on their school community in different ways.

Aside from Mentor A's encouragement towards his colleagues to regularly blog, there appeared limited evidence to suggest that either mentors or principals were actively encouraging their staff to develop PLNs beyond the school community. While the "drivers" generally considered self-directed and self-motivated, it was not clear whether or not the kind of skills of independent inquiry and critical thinking they practised in their professional learning were readily transferred to other professional learning settings in the school. For example, when mentors discussed working with other teachers, they frequently described technology in terms of "showing how" the technology was to be used rather than in terms of equipping teachers with the skills needed to find out, and apply, information for themselves. As such, while there was an apparent distinction between the "drivers" and "buyers", it remained unclear how more resistant teachers could be equipped with skills to become self-directed learners.

These findings loosely point to other phenomena in the literature such as "learned helplessness" (Abramson, Seligman, & Teasdale, 1978) and the persistent tendency to use technology to fit – rather than transform – existing practice (Cuban, 2001; Williams, 2008). Nonetheless, all principals acknowledged the need to promote learning beyond the school community. As Principal A noted, "we want to forge connections outside of the school. We have become very isolated... That's just the nature of schools". Referring to his mentor's decision to establish connections with surrounding schools, Principal C stated, "we have it lucky, in that there is a lot of networking that goes on across the schools [in our area]. There is a really strong sharing of ideas, and a lot [happens] through social media".

Conclusion

By focusing on an intensity sample, one of the key aims of the qualitative inquiry was to explore significant insights from a range of schools where leaders are working pragmatically to promote and facilitate professional learning. While this subset of the larger *Connected Communities 21* sample demonstrated considerable autonomy in the use of technology to support their learning and that of their colleagues, these eight participants in the smaller sample described learning contexts that bore some notable similarities with the larger sample. At the time of writing, all CC21 participants were working in schools that were required to implement new curricula and had recently deployed new technology tools that their teachers were required to learn and implement in their lessons. All school communities typically showed similar distinctions between "drivers" and "buyers", and most school principals saw technology as an enabler of professional learning. While some teachers opted to learn independently through what appears to be their own self-directed inquiry, many teachers seemed to require incentives and were co-opted into formal training sessions through the provision of devices like iPads. Nonetheless, there was a prevailing belief amongst all participants that professional learning can, and should, take many forms. These forms were very consistent with those discussed by the eight participants in the intensity sample, and typically included the more structured forms of staff meetings and professional development days alongside the less structured forms of team-teaching, recess/lunch mentoring, online information sharing and experimentation, or "play".

With mentors and principals who were predisposed to using technology for professional learning, the intensity sample revealed a number of key insights. Contemporary schools are undoubtedly complex social environments where learning is mediated through face-to-face and online contexts. While face-to-face forms of professional learning are still apparent in most school communities, they are increasingly competing with the newer online forms. Across both face-to-face and digital contexts, school leaders must now manage professional learning for themselves and the teachers in their school communities; doing so can be both challenging and overwhelming. Leaders recognise the need for ongoing support that is drawn from a widening range of areas, both within and outside of the immediate school context. This support comes in many different forms. For example, leaders make use of evidential support by citing research, expert opinions or curriculum requirements to justify their decisions. They also draw on support of those around them, through people-to-people connections that exist in both face-to-face and online contexts.

Within the school, the people perhaps seen as most supportive are the "drivers", who develop and apply new ideas, often (though not always) as part of their leadership role. Many of these teachers are "tech-savvy", self-directed and able to learn independently. Almost without question, these kinds of teachers are considered very valuable. Outside of the school, popular thinkers in education are playing a role in shaping how leaders respond to the challenges. With an established online presence, their popularity and ideas are often amplified through social media. For an increasing number of educators, the connections forged with these thinkers can be as substantive and meaningful as those with colleagues in and around the school community. Nonetheless, it was surprising to see the considerable influence of popular thinkers in education featuring so heavily in these interview data. It is possible that their relatively recent emergence in online contexts suggests that teachers may be seeking ideas beyond those immediately available in their school and system communities. For school leaders, these thinkers seem to play an important role in inspiring and supporting their decision-making. While one of these thinkers mentioned in the interview is an academic, the others mentioned could better be described as influential "big names" in education, speaking at conferences and operating as high-level education consultants. Whether or not these thinkers are important in encouraging teachers to be more self-directed or reliant on others for their learning is yet to be explored. Further research might consider how key ideas that are shared in online contexts permeate school communities and explore the important relationship between personalised online professional learning and learning in more traditional face-to-face contexts.

To some extent, the schools in the intensity sample exemplified the pragmatism that underpins Dewey's learner-led inquiry. The multiple forms of professional learning reflect the scope of choice open to teachers, and teachers are therefore positioned to evaluate which forms support their learning most effectively. At the same time, there are perennial issues emerging from the data that need further consideration. For example, School B's particular "carrot-and-stick" approach of providing an iPad in exchange for professional learning aimed to ensure teacher participation and the implementation of new technology tools in the classroom. However, it may also reflect a lack of trust, particularly given that participating teachers had to commit additional time for further staff meetings. Whether or not this kind of formalised commitment perpetuates a "buyer" mentality on the part of the teacher who agrees to the arrangement is open to question. Nonetheless, it appears that leaders are prepared to openly or tacitly acknowledge that not all teachers are self-directed, autonomous learners. The implications of this for teacher professionalism in the contemporary school context are yet to be fully explored.

Professional learning has, until recently, taken place in largely face-to-face settings. The learning in these settings is often singular in the sense that most teachers are subjected to the similar school- or system-led training, such as a visiting guest speaker during a staff meeting. In this older paradigm, the term *professional development* emphasises the capacity of the school or system to "develop" the teacher. However, the kinds of professional learning evident in the intensity sample data reflect a notable departure from this paradigm. All four schools embraced multiple technology platforms and tools, with an understanding that this was necessary to prepare learners for the future. Schools A and D frequently used the word "comfortable" when describing how they wanted their teachers to feel when working with new tools, while School C wanted teachers who were "open-minded" and School B wanted teachers who were able "to see the possibilities with technology" while not being "overwhelmed". These findings broadly reflect what is arguably a very important relationship between the tools of learning and the learning itself.

For many participants, the impact of mobile devices on their professional learning was clearly evident. With superior battery life, light weight, voice and gestural interfaces, wireless connectivity and built-in cameras, tablet devices may well prove instrumental in helping more and more teachers conceive new possibilities for technology-enabled learning. No longer needing to rely on traditional technology resources such as computer labs physically tethered to time and place, the *anywhere/anytime* learning possible with mobile devices may be much more suited to the kinds of pragmatist learning explored thus far. However, it is important to report here that at the time of writing, the system of which these four schools were a part did not explicitly authorise the use of iPads on their network. Most schools had to seek special permission and use their own wireless access points so that the devices could access the Internet. Further, as Principal B noted, even older technology tools like netbooks have important affordances that need to be explored. The presence of multiple devices and platforms in all four of the intensity sample schools seems to reflect this reality.

In contemporary schools, the range of devices, apps and affordances widens the range of possible ways to learn, drawing on more of the eleven Participatory Cultures. This was especially exemplified in Principal C's decision to let teachers play with the technology before negotiating the kinds of professional learning would best serve the school's needs. By encouraging experimentation and play, newer forms of professional learning emerge that then inform other aspects of teacher practice, such as instruction, pedagogy and response to curriculum. Play and experimentation have long been associated with Dewey's learner-led inquiry, where "the whole cycle of self-activity demands an opportunity for investigation and experimentation, for trying out one's ideas upon things, discovering what can be done with materials and appliances" (1916, p. 257). However, inherent in this form of inquiry is the kind of self-direction evident in the "driver" analogy. For example, in relation to the mentors in the intensity sample, their actions often stemmed from personal learning, experimentation and inquiry. With established PLNs, these teachers were often self-directed in forging relevant and meaningful connections within and beyond the school community, thereby establishing a much broader base of ideas on which to draw. By contrast, the "buyer" analogy suggests a teacher who needs to be guided in their learning, often with an understanding that the ideas being presented need to be justified and critiqued before they can be implemented. Whether or not the "buyer" teacher's attitude limits the range of ideas explored remains a key question for further research.

It is possible that these analogies may only go so far to explaining the differences between a self-directed, autonomous learner and a learner who waits to be "developed". However, shifting from "buyer" to "driver" is possible, as Mentor A suggests:

> As everybody gets on board, I'm finding it's getting quite interesting. Some of the most reluctant teachers were the ones who I targeted [for remedial training] originally. They were the people who I began to work with and insisted that I work with. They're now the people who are leading the charge.

Chapter 5. Professional Learning Among Contexts

The initial qualitative study in Stage 1 illustrated how school leaders in four school communities responded to the challenges of a changing curriculum. In all four schools, leaders responded in ways that they believed would best serve the unique needs of teachers and students in their school community. The decisions made often reflected the leaders' styles and philosophies, with communities of like-minded leaders often helping to create a school culture where these styles, philosophies and decisions were seen as normal and appropriate. All leaders appeared to approach challenges pragmatically, working with available resources and a diverse range of teaching staff. Stage 1 thus helped to illustrate the kinds of school settings wherein leaders undertake, facilitate and support multiple forms of professional learning. In building on these findings, the underlying aim of Stage 2 was to examine professional learning in relation to a broader range of educational contexts.

With a larger sample of educators across all career stages, Stage 2 explored professional learning through the perceptions of each individual respondent in the Teacher Professional Learning Questionnaire (TPLQ). The following section reports on the quantitative data drawn from the three samples of educators that responded to the questionnaire: *Connected Communities 21* (CC21), *Macquarie ICT Innovations Centre* (MacICT) and *Preservice Teachers* (PSTs).

Stage 2: Quantitative Inquiry

TPLQ items were employed to measure several dimensions of the respondent's Personal Learning Network (PLN) and their participation in online Participatory Cultures. Participants were also asked to rate the efficacy of a range of support structures and to report on their current knowledge in each of the seven TPaCK dimensions. The TPLQ sought to measure important elements in these constructs to further explain how educators in each context undertake technology-enabled professional learning. Key themes from the qualitative component in Stage 1 were explored further, including the differences between the importance of time, formal and informal professional learning, the impact of research on practice and the role of specific technology tools.[4]

The TPLQ also sought to explore the ways professional learning in traditional face-to-face contexts could be extended and enriched through the use of technology. To some degree, therefore, the TPLQ sought to measure the validity of these emerging technology constructs (for example, the extent to which each of the eleven cultures were "true" of each participant) with educators from the three contexts. Likewise, the TPLQ provided the respondent with an opportunity to evaluate some of the most common face-to-face structures that exist in schools to support professional learning. In this respect, the TPLQ explored the nexus between traditional face-to-face and online forms of professional learning. Findings speak to the nature of both community-driven forms of learning in the school and more personalised forms learning online.

There is arguably an increasing – though not fully established - emphasis on *situated* technology-enabled learning. When more educators are given substantial leeway to develop and facilitate their professional learning, such learning can be distinguished from a more prescribed view of what educators should be learning. Among the four intensity sample schools, there was considerable choice for all teachers in what to learn, how to learn, and when to learn. All principals were vocally supportive of these multiple ways to learn with several seeking to incentivise professional learning – for example, through the provision of tablet devices. However, these multiple ways to learn do not equate to complete freedom, and schools and systems are still insisting on for *imposing* professional learning agendas on staff. It was, therefore, important to examine the relationship between the often choice-driven and choice-defined autonomous professional

[4] TPaCK dimensions include the first-order constructs (Pedagogical Knowledge, Content Knowledge and Technology Knowledge), second-order constructs (Technological Pedagogical Knowledge, Pedagogical Content Knowledge and Technological Content Knowledge) and third-order construct (Technological, Pedagogical Content Knowledge).

learning that is implied in educators' uses of online tools and professional learning that is imposed on the educator in what are often more structured ways. The TPLQ findings speak to the complexities of navigating both older and newer forms of professional learning.

Throughout data analysis, several strategies were employed. Frequency distributions for each question were generated and compiled into a set of tables that included mean and median scores, standard deviation and skewness for each of the three contexts. To explore whether ostensible differences among these frequencies were significant, t-tests and ANOVA were employed separately for each question. The t-tests focused on a range of binary variables including primary and secondary teaching contexts, male and female participants, current educators (that is, those in the CC21 and MacICT samples combined) and preservice teachers, as well as a computed variable that enabled the research to distinguish between "low" and "high" online sharers (discussed further throughout the chapter). The ANOVA compared means for each of the three contexts and significant differences were further highlighted through post-hoc Tukey tests of differences between the means. For questions and items where there were marked differences between the contexts, these were explored further through discriminant analysis to identify possible functions that distinguished each group and to use these to explain the nature of the differences observed. Finally, principal component analysis (PCA) was employed for the responses of the combined sample to validate the individual elements of each construct, to examine how the combined sample distinguished these elements and to suggest further possible ways to explore the constructs in future.

Time Spent Using Technology and How it is Spent

About the questions included in this analysis.

Question 1 of the TPLQ explored how much time, and in what ways, educators use the Internet for professional learning in a typical working week. Participants were initially asked to indicate an approximate number of hours they spend using the Internet each week to support their professional learning (*total hours per week*), and then asked to indicate fractions (as percentages) of this time spent in relation to six categorical time variables: (1) reading information; (2) watching and/or listening to multimedia; (3) searching for information; (4) sharing information with others; (5) creating content; (6) co-creating content. These categories were created to encompass a range of typical online activities that had been described by participants in the qualitative inquiry. For each category, several examples were included to assist the respondents in their understanding of the category. For example, the item *watching and/or listening to multimedia* included the examples *iTunes U*, audio/video "course lectures", "podcasts" and "*TeacherTube*", while *co-creating content* included the examples "editing an online course or wiki" and "working on a collaborative document". By asking respondents to indicate the total number of hours and percentages in relation to each categorical time variable, the instrument aimed to reveal how much time educators perceive they are spending online for the purposes of professional learning, and how they typically divide this time into common uses.

Question 6 was also included in the analysis for this section. Question 6 items asked respondents to indicate whether or not they share information with a range of people and/or organisations online that were reflected across eight categories. These categories were constructed to explore the degree of openness associated with the action of sharing the information online. Categories 1-3 referred to sharing information within and between school communities, for example, through an email sent to colleagues or a post to students on a Learning Management System. Category 4 referred to sharing information with state-based educational organisations, such as a comment on a department website or a submission to a curriculum organisation. Categories 5-7 referred to sharing information with others on both open and closed online platforms, such as comments to other educators on *Facebook* or *Twitter*, or posted comments on a blog. Category 8 was simply labelled "with anyone publicly on the web", and referred to the participant's willingness to share information with the understanding that it would be publicly available to anyone – for example, when an educator composes and publishes a blog post published on a public blog or posts an educational video publicly to *YouTube* or *TeacherTube*. In relation to each category, respondents clicked either "yes" or "no" to indicate whether or not they shared with others in the specific context concerned.

Both Question 1 and Question 6 hold relevance in exploring, at a broad level, how educators learn online. While Question 1 aimed to explore Internet use for professional learning as represented among the six categorical time variables, Question 6 explored the nature of online people-to-people connections that are forged with relevant educators and educational organisations and the extent of the participant's willingness to share with these people and organisations.

The three main samples in the study (CC21 participants, MacICT teachers and preservice teachers) included participants at different career stages, with a range of expertise and experience. For some participants – especially the preservice teachers and current teachers engaging in further tertiary study – using the Internet for professional learning involved accessing relevant online coursework material. For others, however, using the Internet was not necessarily a formal or "required" component of their professional learning. Regardless, by examining how much time educators spend, how they divide their time and with whom they connect – all in the context of their professional learning – both Questions 1 and 6 aimed to explore key aspects of learner autonomy. For some educators, for example, choosing to spend proportionately more of their time on *searching for information* and less time *creating content* may reflect particular needs, interests, ways of working and/or priorities. Similar concerns are implicit in educators' decisions about whether or not to share information with others online, such as a teacher who blogs publicly in order to be a part of a community of teacher bloggers and/or seek feedback on their teaching strategies. Responses to both Questions 1 and 6 therefore provided important initial findings about the kinds of online activities, information sources and connections participants perceived to be important and how they manage these in the context of their professional learning.

Initial findings: Time Use and Levels of Online Sharing

In relation to Question 1, data from the combined sample revealed that participants spend, on average, 10.59 hours per week (M=10.59, $SD = 8.57$). Using the percentage values indicated by participants for each of the categorical items, variables were computed to show the actual hours per category. Both values provide a general picture of how much time participants spend using the Internet for professional learning each week, how this time is divided amongst the categories and the actual hours spent in each category.

As Table 5.1 shows, *searching for information* represents the largest component of time spent, followed by *reading information* and *watching and/or listening to multimedia*. By contrast, the other items represent relatively small components of time. Nonetheless, the standard deviation for these items reflected a wide range of responses across the whole sample.

Table 5.1 - Hours per week frequencies (question 1 items)

N=166	*Reading information*	*Watching and/or listening to multimedia*	*Searching for information*	*Sharing information with people*	*Creating content*	*Co-creating content*
Mean (%)	25.95	17.24	31.21	16.10	5.26	3.65
SD (%)	17.05	11.79	16.30	13.24	8.22	7.06
Mean (hrs)	2.44	1.74	3.46	1.77	0.68	0.51
SD (hrs)	2.16	1.59	4.06	2.08	1.19	1.08

An additional variable, *sharing level*, was computed using Question 6 items. Table 5.2 shows the sharing items and frequencies (%) of the total sample for each yes/no response. As indicated, contexts more closely aligned with the immediate school community and the system tended to record higher “yes” responses, while broader contexts such as state-based organisations and social media tended to have higher number of “no” responses. Category 1 recorded the highest number of “yes” responses, while Category 8 recorded the highest number of “no responses”.

Table 5.2 - Sharing contexts frequencies (question 6 items)

Q. 6. With whom do you share information online related to your professional learning?				
I share information online with (tick "yes" to all that apply):	**YES:**		**NO:**	
	N	**%**	**N**	**%**
1. *teachers in my school (e.g. school email, school bulletin)*	116	69.9%	50	0.301
2. *students in my school (e.g. school email, online course)*	66	39.8%	100	0.602
3. *educators in my system (e.g. email to teacher in another school)*	77	46.4%	89	0.536
4. *state-based organisations (e.g. online discussion)*	30	18.1%	136	0.819
5. *bloggers who I follow (e.g. comments on a blog post)*	54	32.5%	112	0.675
6. *educators and/or students on closed social networks (e.g. link to Facebook friends)*	61	36.7%	105	0.633
7. *educators and/or students who follow me on open social networks (e.g. link to Twitter followers)*	41	24.7%	125	0.753
8. *anyone publicly on the web (e.g. published blog posts)*	15	9.0%	151	0.91

Exploring variations in use of time between demographic variables.

Following this initial analysis of the complete sample, factorial repeated measures ANOVAs were conducted for a range of demographic binary variables, including *gender*, *teaching context* (primary/secondary) and *career stage* (current educator or preservice teacher). These analyses explored each categorical time variable in relation to the demographic binary variables, and closely examined significance levels for each of the relationships. T-tests were then conducted for all categorical time variables and each of the binary demographic variables to identify specific items on which the binary groups significantly differed.

To examine possible connections between the extent of sharing and the allocation of time, the frequencies for each participant's "yes" or "no" responses for Question

6 was used to calculate their *sharing index*. For example, a participant who shared information in six of the eight contexts was scored at .75 (6/8), while a participant who shared in all eight contexts was scored at 1.0 (8/8). A *sharing level* variable was then computed using k-means clustering to establish three sharing groups (low/medium/high) based on the *sharing index* for each participant. Both the index and cluster reflected the number of different contexts in which each participant shares information with people and organisations online. One-way repeated measures ANOVA was then applied to the six categorical time variables from Question 1 and the k-means clustered variables for low, medium and high sharers to identify variables on which low, medium and high sharers differed.

The number of hours participants spend online was explored in relation to four binary variables: (1) gender; (2) teaching context (primary/secondary); (3) career stage (current teacher or PST); and sharing level (low/high). These variables enabled a range of comparisons between groups and enabled the identification of functions that were the strongest predictors of group membership through a subsequent discriminant analysis for each instrument. Based on Levene's test for equality of variance and 2-tailed significance values, analysis revealed no significant differences for *gender* among any of the items for Question 1. These findings suggested that gender was not a significant factor in determining the amount of time spent online or the ways that this time is divided among the categorical time variables in Question 1. Similar analysis for Question 6 items showed that both male and female participants are equally as likely to share information with people and organisations among the eight online contexts. However, both repeated measures analysis and t-tests for other demographic binary variables showed varying levels of significance that led to further analysis of teaching context, career stage and sharing level.

Key findings: teaching context –significant differences between primary and secondary teachers.

In relation to the binary variable *teaching context* (primary or secondary) results showed that the amount of time each week spent was significantly affected by the teaching context (primary or secondary), $F(2.49, 357.88) = 46.66$, $p \leq .000$. Further, there was an interaction effect between *reading information* and *searching for information*, suggesting that in addition to spending significantly less time searching for information, secondary teachers spent proportionately more of their time searching for information (however, this was still less time spent overall than primary teachers):

Table 5.3 - Tests of between subject effects for teaching context (Question 1 Items).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	384.849	1	384.85	213.71	.000	.60
Level	25.073	1	25.073	13.92	.000	.09
Error	259.318	144	1.80			

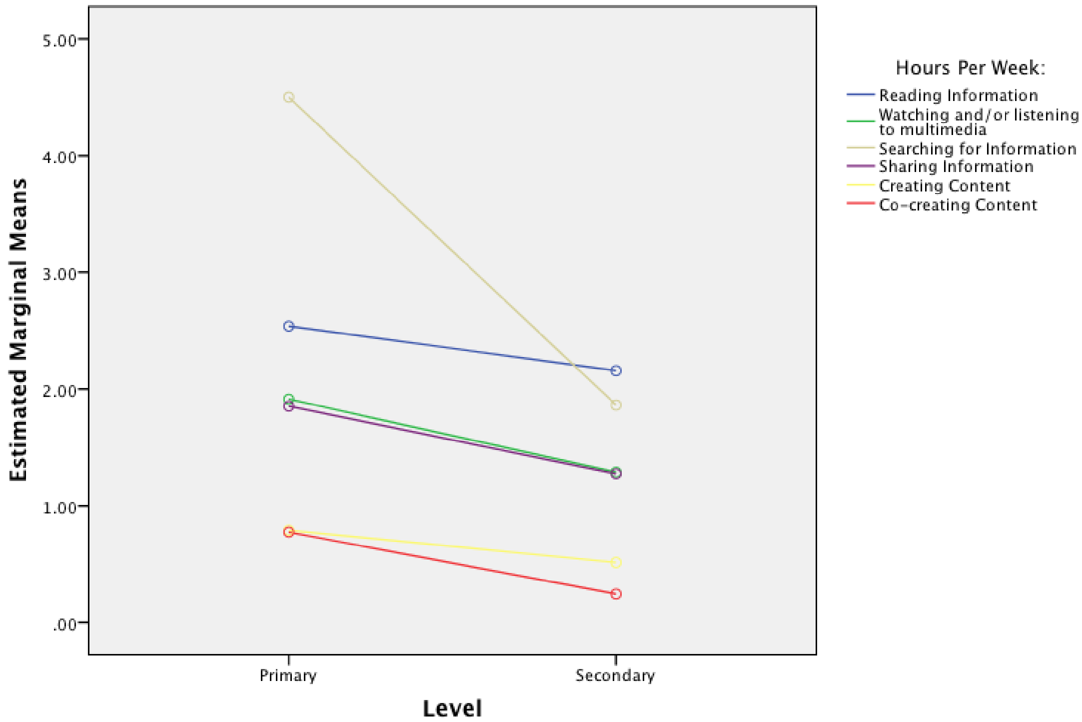

Figure 5.1 - Profile plot for teaching context (Question 1 Items).

Follow-up t-tests confirmed the differences for *teaching context,* revealing that on average, primary educators spent more time online per week overall (M = 12.37, SE = 1.04) than secondary educators (M = 7.34, SE = .68). This difference, -5.03 BCa

95% CI [2.366, 7.695] was significant $t(135.19) = 4.014$, $p \leq .000$, representing a medium-sized effect, d=0.33.

Table 5.4 shows the significance levels of the categorical time variables in Question 1 in relation to *teaching context*. Of note, significant differences exist between each group's total hours spent online per week and how these hours are proportionately divided among the Question 1 items. In particular, the larger effect sizes for *total hours per week* and *searching for information* suggest that the primary educators in the sample spent significantly more time each week using the Internet for professional learning, with proportionately more of their time being spent on *searching for information* than was the case for secondary teachers. By contrast, the data suggest that secondary teachers allocated proportionately more of their time to *reading information*, supporting the interaction effect shown in Figure 5.1 above.

Table 5.4 - Significance Levels by teaching context (Question 1 items).[5]

Variable	**Means**		***t***	**df**	**Sig (2-tailed)**	**Effect Size**
	Primary (n=94)	Secondary (n=72)				
Total hours per week:	12.37	7.34	4.04	135	.000	.33
Reading information (hrs):	2.54	2.16	1.12	140	.265	.09
Watching and/or listening to multimedia (hrs):	1.91	1.29	2.63	141	.009	.22
Searching for information (hrs):	4.50	1.86	4.77	113	.000	.41
Sharing information with others (hrs):	1.85	1.27	1.957	138	.052	.16
Creating content (hrs):	0.79	0.51	1.489	144	.139	.12
Co-creating context (hrs):	0.77	0.24	3.204	118	.002	.28

[5] For expanded results, please refer to Tables A2-5.4a and A2-5.4b in Appendix 2.

Key findings: career stage – significant differences between current educators and preservice teachers.

In relation to the binary variable *career stage* (current educator or PST), there were also initial significant differences. The repeated measures analysis shown in Table 5.5 indicates the amount of time each week spent was significantly affected by the teaching context (primary or secondary), $F(2, 405) = 46.66$, $p \leq .000$ (Greenhouse-Geisser). The profile plot shown in Figure 5.2 reveals no interaction effects for any of the items, showing that preservice teachers report spending less time across every categorical time variable.

Table 5.5 - Tests of between subject effects for career stage (Question 1 Items).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	399.99	1	399.99	208.21	.000	.56
Level	21.40	1	21.40	11.14	.001	.06
Error	315.05	164	1.92			

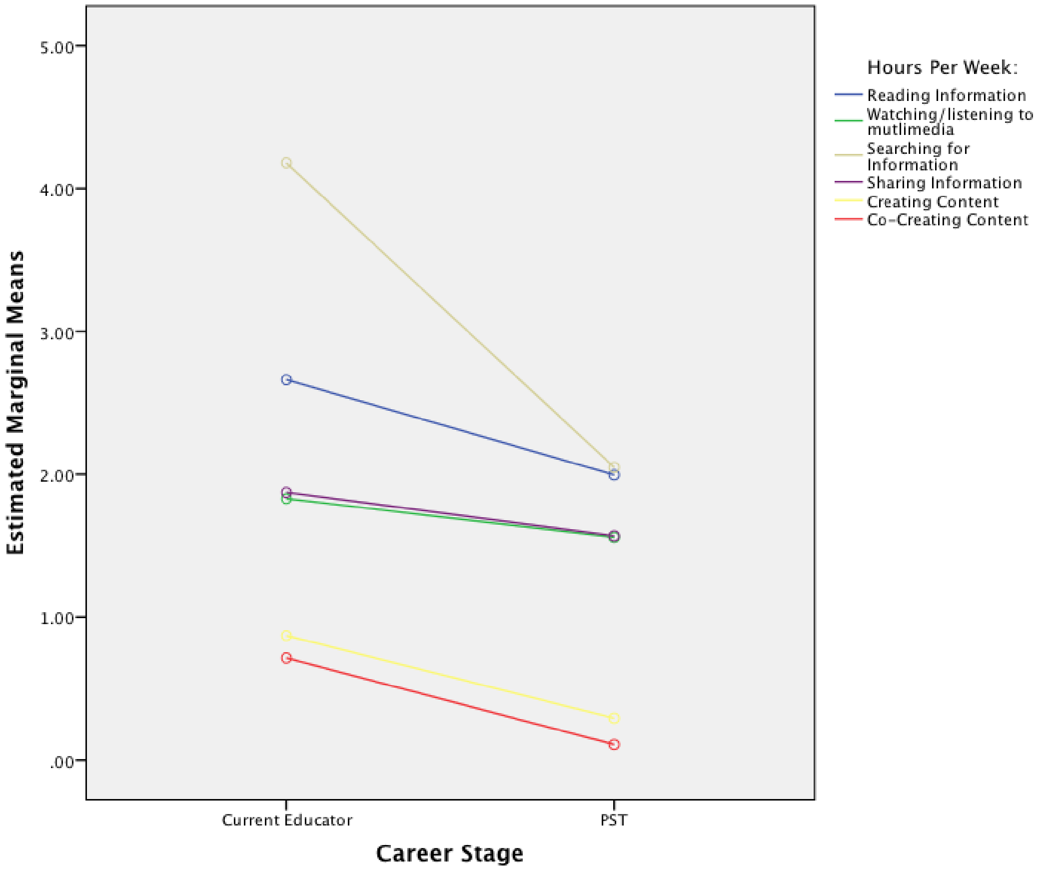

Figure 5.2 - Profile plot for career stage (Question 1 Items).

An initial t-test revealed that on average, current educators spent more time online (*M* = 12.13, *SE=.86*) than preservice teachers (*M* = 7.57, *SE* =.91). This difference, -4.56 BCa 95% CI [1.86, 7.251] was also significant $t(140.8) = 3.65$, $p = 0.000$, representing a medium effect size, d=0.29. Given the evident differences in *career stage* between current educators and preservice teachers in the combined sample, the further t-tests applied were expected to show a greater number of significant differences across the categorical time variables. In many cases, professional learning for preservice teachers is driven by their tertiary coursework, practicum experiences and interaction with peers and colleagues, all of which are largely external drivers. While technology use is a strong component in many teacher-training programs, preservice teachers do not consistently extend their learning beyond current course requirements (Goodyear & Ellis, 2007; Swansea, Furlong, Smith, & Durham, 2013). Preservice teachers have, therefore, a range of different, and competing, priorities, many of which stem from the need to finish their training before entry into the workforce.

Table 5.6 shows the number of significant differences existing between the samples of current educators and preservice teachers in the study. As expected, these data reflect the different approaches to professional learning between the two groups. Of note, significant differences exist for the items *searching for information*, *creating content* and *co-creating content,* with larger effect sizes for these items. From these data, it appears that preservice teachers spend less time overall (*total hours per week*), and proportionately less time searching for information, creating content and co-creating content. Conversely – and as reflected in the mean differences shown in Table 5.1 and below in Table 5.6 – they spend proportionately more of their time reading information and watching and/or listening to multimedia than current teachers. The high 2-tailed significance value for the item *sharing information with others* suggests that both current educators and preservice teachers spend close to the same amount of time (proportionally and in the actual number of hours) in this area.

Table 5.6 - Significance levels by career stage (Question 1 items).[6]

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Current (n=110)	PST (n=56)				
Total hours per week:	12.13	7.57	3.365	140	.000	.29
Reading information (hrs):	2.66	2.00	1.94	118	.055	.18
Watching and/or listening to multimedia (hrs):	1.83	1.56	1.04	111	.302	.10
Searching for information (hrs):	4.18	2.05	4.05	163	.000	.30
Sharing information with others (hrs):	1.87	1.57	0.89	110	.376	.08
Creating content (hrs):	0.87	0.29	3.33	141	.001	.27
Co-creating content (hrs):	0.71	0.11	4.71	140	.000	.37

Key findings: sharing level as a predictor of time spent.

Next, the computed variable for sharing level (based on Question 6 sharing items and three clusters of low, medium and high) was of particular interest. As noted in H4, the number of contexts in which an educator chooses to share online information implied that more or less time might be spent per week on this basis, and that the division of time by high sharers might be different to that of low sharers. From the initial descriptive statistics that were generated for Question 6, it emerged that high sharers typically shared information with colleagues and students in the immediate school context but were also willing to share in other broader contexts, such as with state and national organisations, with educators on

[6] For expanded results, please refer to Tables A2-5.6a and A2-5.6b in Appendix 2.

closed social media (such as *Facebook*, where users typically form connections through "friending") and open social media (such as *Twitter*, where users typically form connections through "following") and publicly on the web (for example, through a published blog post). By contrast, low sharers typically only shared information online within their school community and avoided sharing within these more open online contexts. Most medium sharers tended to lie towards the lower end of their cluster, suggesting they were more closely aligned to the low sharer group.

Repeated measures analysis showed the amount of time each week spent was significantly affected by the sharing level (low, medium and high), $F(2, 380) = 56.39$, $p \leq .000$ (Greenhouse-Geisser). The profile plot shown in Figure 5.3 reveals similar patterns across all the three groups, with a slight interaction effect between *watching and/or listening to multimedia* and *sharing information* for low and medium sharers. When low and high sharers are compared, high sharers report spending more time – both proportionately and in actual hours – than the other two groups across all categorical time variables.

Table 5.7 - Tests of between subject effects for career stage (Question 1 Items).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	538.18	1	538.18	303.77	.000	.65
Sharing Lvl.	44.41	2	22.21	12.54	.000	.13
Error	287.01	162	1.77			

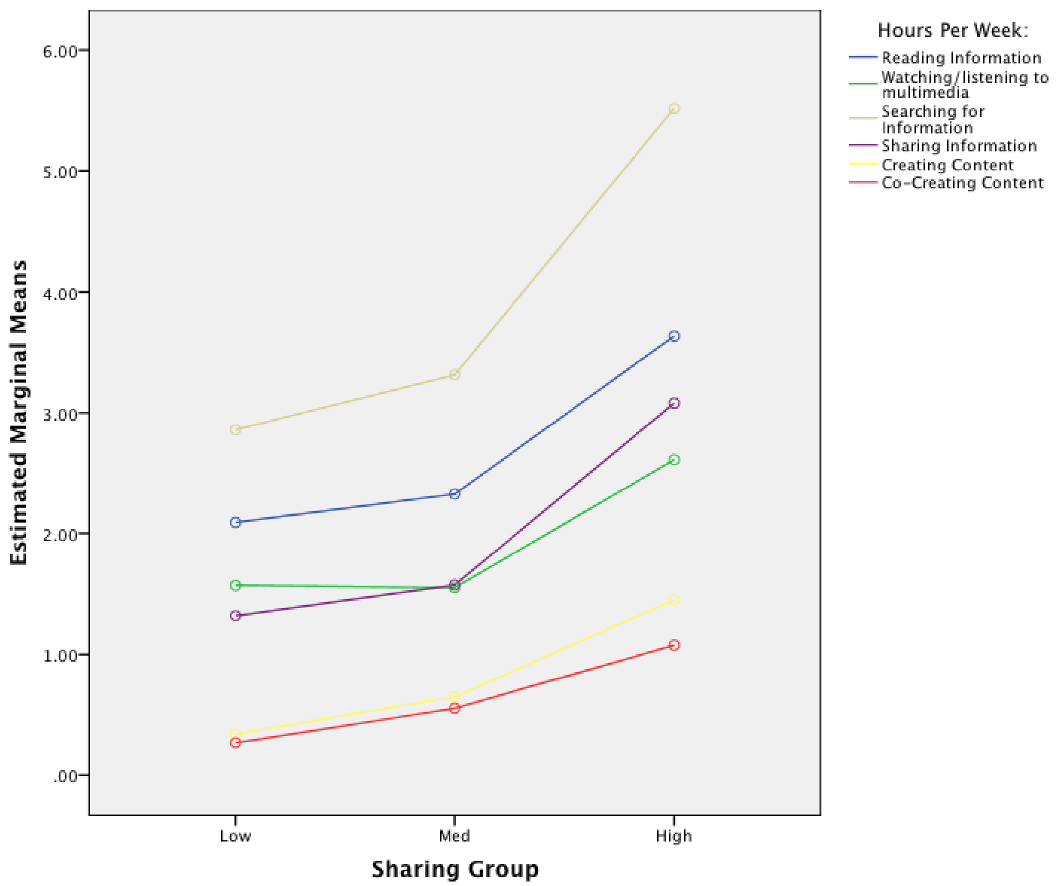

Figure 5.3 - Profile plot for sharing level (Questions 1 and 6 items).

To more closely explore differences between the low and high sharers identified earlier through k-means clustering, follow-up t-tests showed that high online sharers spent substantially more time online (*M* = 17.37, *SE* =.80) when compared to low sharers (*M* = 8.45, *SE* = 2.23). This difference, -8.92 BCa 95% CI [-12.652, -

5.185] was significant $t(32.89) = -3.76$, $p = 0.001$, representing a medium effect size, d=0.55.

Table 5.8 shows the number of hours for *low* and *high* sharing clusters spent in a typical working week as well as the division of this time among categorical time variables. Of note, significant differences exist all items except *searching for information*. While there were noticeably different means for this variable, the mean variance was too great to conclude the validity of group differences. Nonetheless, there exist significant differences for all remaining variables, suggesting that high sharers spend significantly more time each week using the Internet for professional learning. Stronger effect sizes emphasise these differences most notably in the areas of sharing information with others, creating content and co-creating content. By contrast, low sharers spend less time in actual hours in every category.

Table 5.8 - Significance levels by sharing level (Question 1 items).[7]

Variable	**Means**		***t***	**df**	**Sig (2-tailed)**	**Effect Size**
	Low (n=73)	High (n=27)				
Total hours per week:	8.45	17.37	-3.76	33	.001	.55
Reading information (hrs):	2.09	3.64	-2.58	37	.014	.39
Watching and/or listening to multimedia (hrs):	1.57	2.61	-2.67	42	.011	.38
Searching for information (hrs):	2.86	5.52	-2.01	31	.053	.33
Sharing information with others (hrs):	1.32	3.08	-3.42	33	.002	.51
Creating content (hrs):	0.34	1.45	-3.29	29	.003	.52
Co-creating context (hrs):	0.27	1.08	-2.76	28.82	.010	.46

[7] For expanded results, please refer to Tables A2-5.8a and A2-5.8b in Appendix 2.

Summary: significant differences for gender, teaching context, career stage and sharing level.

These data provided an important early picture in relation to the key significant differences between the main samples in the quantitative component of the study. In particular, the extent of significant difference between current educators and preservice teachers showed that both groups are distinct from one another in how they employ their time online for the purposes of professional learning. While current educators spend more time searching for information – a form of active inquiry – preservice teachers typically spend more time reading information and watching and/or listening to multimedia, representing more passive forms of inquiry. Given the increasingly digital nature of their coursework material (for example, weekly readings available in an eReserve library page), preservice teachers may perceive less reason to search for additional learning content amongst other online sources. The significant differences between these groups in terms of creating and co-creating content further suggest that preservice teachers are less actively engaged in online activities for professional learning than the sample of current educators.

While similar differences in terms of reading and searching for information existed between primary and secondary educators, there was no significant difference in terms of proportional time spent creating content. Lastly, the significant differences recorded between low and high sharers and their strong effect sizes suggest that educators who actively share content with a wider range of people and organisations are much more likely to substantially use the Internet to support their professional learning, and that they allocate significantly more time in relation to each of the six categorical time variables. Similarly, these data pointed to early indications of key differences between digital creativity and consumption. Where more time was being spent overall, more time was also allocated to creating and co-creating content. Where less time was being spent, proportionately more of this time was allocated to consumptive activities like reading information and accessing multimedia.

Confirmatory principal components analysis and hierarchical clustering.

Principal Components Analysis was conducted to explore the component structure of the items in Question 1 – how time spent among the various categories of use. The results suggested a four-component solution with Component 1 as creating/co-creating (*creating* and *co-creating* content), Component 2 as information retrieval and processing (*reading* and *searching for information*), Component 3 as learning with multimedia (*watching and/or listening to multimedia*) and Component 4 as sharing information (*sharing information with others*). However, while the pattern matrix and parallel analysis supported the retention of these four components, the Kaiser-Meyer-Olkin measure did not verify the sampling adequacy for the analysis (KMO = .089). Nonetheless, Component 1 (creating/co-creating) accounted for 26.1% of total variance, providing some level of indication that only a small minority of participants overall are spending substantial proportions of time creating and co-creating content, while a much larger majority are spending little or no time in relation to these categorical items.

To address the limitations of the component structure, hierarchical clustering by variables was applied to all Question 1 items using Ward's method of clustering with squared Euclidian distance. Figure 5.4 shows the dendrogram produced. While similar to the PCA solution in terms of groupings between creating/co-creating and reading/searching, this dendrogram reveals a two-cluster solution that separates online information as a broad driver for learning (the bottom two leaves) from the other forms that learning can take when the educator uses the Internet (the top four leaves).

This separation is significant in that it reflects the higher proportions of time spent *reading information* and *searching for information* across the whole sample. It further suggests that information as a driver represents a necessary starting point for further professional learning in other forms.

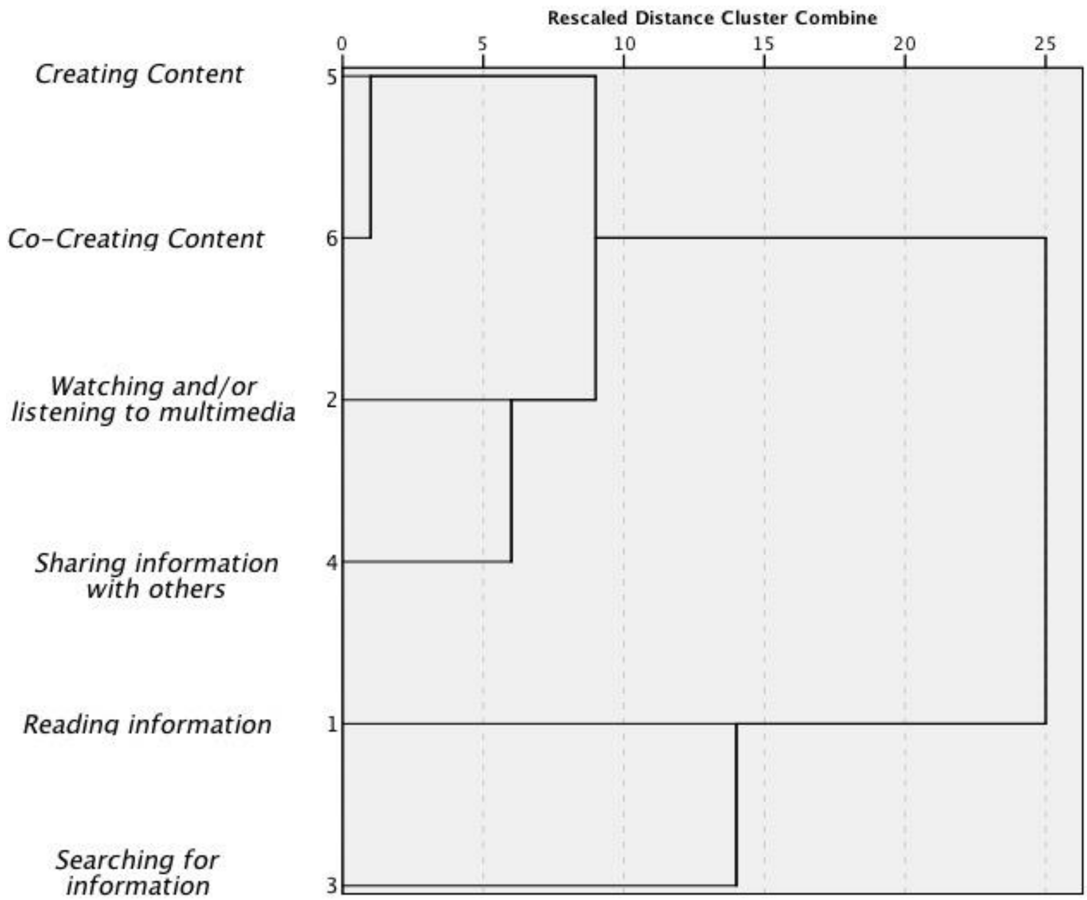

Figure 5.4 - Dendrogram using ward linkage (Question 1 items)

Finally, given the important relationships that had emerged between the levels of sharing computed from the Question 6 items with the data in all Question 1 items, it was important to confirm connections between sharing contexts the validity of the three sharing clusters. Confirmatory PCA was conducted on Question 6 items, employing oblique rotation (direct oblimin). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = 0.536) and all KMO values for individual items were greater than 0.50. An initial analysis was run to obtain eigenvalues for each factor in the data. Three components had eigenvalues greater than one and in combination explained 65.7% of the variance. The scree plot was slightly ambiguous, showing an inflexion justifying the retention of two or three components. Three components were retained because the third factor included three items that contributed to 14.9% of total variance.

Table 5.9 shows the component loadings (>.5) after rotation. The items that cluster suggest that Component 1 is social media and blogging, and Component 3 represents educators within the school and system. Interestingly, Component 2 included two items initially thought to represent very different contexts: *state-based organisations* and *publicly on the web*. It appears that participants perceived these items to be somewhat more similar than different – that by sharing information with state-based organisations such as NSW Department of Education and Communities (DEC) or NSW The Board of Studies, Teaching and Educational Standards (BOSTES) they were, in fact, sharing information publicly on the Internet.

Table 5.9 - Principal Components Analysis (Question 6 Items)

Pattern Matrix[a]			
	Component		
	1	2	3
Bloggers I follow?	.87		
People who follow me on open social networks?	.73		
Educators on closed social networks?	.69		
State-based organisations?		.84	
Anyone publicly on the web?		.65	
Teachers in my school?			.74
Students in my school?			.73
Educators within my system?			.55
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization.[a]			
a. Rotation converged in 15 iterations.			

The three components above supported the k-means clusters that showed three levels of sharers. Level 1 sharers (represented by Component 3) typically shared information within schools and occasionally between schools. Level 2 sharers (Component 1) typically extended sharing to connections within social media – and for many educators, this included educational blog posts, either as a writer, sharer or commenting user. Level 3 sharers (Component 2) were prepared to share information with educational organisations and other people outside of social media circles – that is, publicly on the web.

Relevance of Online Activities

About the questions included in this analysis.

As noted earlier, the Question 1 items for the TPLQ very broadly examined the division of time in relation to the six categorical time variables. Each item encompassed a large range of possible online activities. To further explore the dimensions of these broad constructs, Question 2 included sixteen items (identified from the qualitative data) that described more specific online activities associated with professional learning. Each item was worded in the present continuous tense to describe the specific action involved, and participants were asked to rate the importance of the action for their professional learning by using a 7-point scale with the anchor points of "Extremely Unimportant" and "Extremely Important". For six of the eighteen items, examples were included to clarify how the action might be done. For example, *Wikispaces* was used as an example of *accessing a website that I can edit*, while *Skype* was used as an example of a tool enabling online Voice over IP (VoIP) communication with teachers and/or students. By representing these anchor points as extremes, the instrument intended to explore both the importance and relevance of these activities for the individual learner while drawing attention to the role of prior learning experiences in shaping perceptions of relevance and importance.

The instrument in Question 2 was particularly of interest for the CC21 sample. During the CC21 project, participants had been trained in the use of Web 2.0 tools for blogging (*Wordpress*) and collaboration (*Google Docs*). By contrast, the sample of MacICT teachers was more diverse, including quite "tech-savvy" educators who were already familiar with these tools as well as others who had not used them before. Similarly, the preservice teacher sample included some of Education students who blogged regularly and were experienced with Web 2.0 tools as well as others of less experience.

Further, it is important to note the relationship between experience and perceived importance and/or relevance. Initial descriptive statistics for all instruments drew attention to the fact that low ratings for Question 2 items often reflected a lack of experience using the associated tools. For example, users who did not maintain a blog were far more likely to see writing blog posts as less important for their professional learning. Nonetheless, the range of items provided a broad scope of common online activities that were more or less important to each participant, and the action-oriented language prompted participants to consider the importance of each activity at a personal level.

Initial findings: perceived importance of online activities for professional learning.

Table 5.10 shows the distribution of means for each item in Question 2 across the combined sample. Of note, the top three rated activities included the use of school and system portals (Items 11 and 13), and other education portals (Item 15).

Table 5.10 - Question 2 frequencies (whole sample, n=166).

Item	Mean	SD
1. *Reading online news*	4.96	1.57
2. *Reading blog posts*	4.13	1.59
3. *Commenting on blog posts*	3.22	1.45
4. *Writing blog posts*	3.29	1.53
5. *Accessing websites I can edit (e.g. Wikispaces)*	3.52	1.61
6. *Creating and/or editing websites*	3.51	1.70
7. *Checking articles on Wikipedia*	3.69	1.48
8. *Accessing podcasts (e.g. audio or video content)*	4.62	1.62
9. *Creating audio and/or video content to share*	3.97	1.70
10. *Using Skype (or similar tool) to talk to other educators or students*	3.84	1.62
11. *Accessing content on school portals (e.g. Moodle courses)*	5.42	1.54
12. *Creating and/or editing content on school portals*	4.85	1.70
13. *Accessing content on other education portals (e.g. MOOCs or Edmodo)*	5.17	1.73
14. *Creating and/or editing content on other education portals*	4.41	1.74
15. *Accessing content on social media pages or newsfeeds*	4.38	1.65
16. *Creating or sharing content through social media*	4.29	1.67

Further analysis: one-way ANOVA of main samples.

Initial descriptive statistics for each of the main samples (CC21, MacICT and preservice teachers) suggested notable differences in relation to blogging and website-editing activities. To explore the significance of these differences, One-Way ANOVA was applied to the three samples for all Question 2 items. Eleven of the eighteen items showed between-group *p* values that suggested significant differences between the three groups for a range of specific online activities. The ANOVA for these ten items is shown in Table 5.11. Of note, significant differences exist in the importance placed on *reading online news*, *reading/commenting/writing blog posts*, *accessing* and *creating/editing websites* and *checking articles on Wikipedia*. CC21 teachers significantly differed from the other two groups in the three blog-related items and the Skype item, while preservice teachers differed from the current teacher groups in the items for creating/editing content on editable websites (e.g. *Wikispaces*) and system portals.

Table 5.11 - One-Way ANOVA (online activities) by sample (Question 2 items).

Item	**Means**			**df**	**F-ratio**	**Sig.**
	CC21	MacICT	PSTs			
Reading online news	5.67	4.06	4.93	2	16.65	.000
Reading blog posts	4.89	3.74	3.58	2	13.74	.000
Commenting on blog posts	3.95	2.89	2.65	2	15.64	.000
Writing blog posts	4.14	2.85	2.69	2	19.55	.000
Accessing websites I can edit (e.g. Wikispaces)	4.40	3.15	2.8	2	20.14	.000
Creating and/or editing websites	4.55	3.06	2.69	2	25.55	.000
Checking articles on Wikipedia	4.32	3.15	3.43	2	10.90	.000
Accessing podcasts (e.g. audio or video content)	4.87	4.21	4.69	2	2.33	.101
Creating audio and/or video content to share	4.58	3.8	3.4	2	7.94	.001
Using Skype (or similar tool) to talk to other educators or students	4.34	3.33	3.67	2	5.97	.003
Accessing content on school portals (e.g. Moodle courses)	5.30	5.36		2	0.68	.507
Creating and/or editing content on school portals	5.13	5.02	4.35	2	3.53	.032
Accessing content on other education portals (e.g. MOOCs or Edmodo)	5.26	5.04	4.91	2	0.64	.530
Creating and/or editing content on other education portals	4.68	4.47	4.04	2	2.05	.132

Accessing content on social media pages or newsfeeds	4.20	4.51	4.47	2	0.62	.542
Creating or sharing content through social media	4.04	4.49	4.40	2	1.15	.321

Post-hoc Tukey tests on all items showed that CC21 teachers differed significantly on eight variables ($p < 0.05$) when compared to both MacICT teachers and preservice teachers. By contrast, MacICT and preservice teachers significantly differed on one item only (*Reading online news)*. These results suggest that CC21 teachers were significantly more likely to rate several activities more highly than the other groups.

Table 5.12 shows the pairwise comparisons. Of note, most significant differences lie among the items related to blogging, editable websites and Wikipedia.

Table 5.12 - Post-hoc Tukey tests (Question 2 items)

Item	**CC21- PSTs**		**MacICT - CC21**		**MacICT - PSTs**	
	Mean Dif.	Sig.	Mean Dif.	Sig.	Mean Dif.	Sig.
Reading online news	0.74	.017	-1.60	.000	-0.86	.008
Reading blog posts	1.31	.000	-1.15	.000	0.16	.845
Commenting on blog posts	1.29	.000	-1.06	.000	0.24	.641
Writing blog posts	1.45	.000	-1.30	.000	0.16	.837
Accessing websites I can edit (e.g. Wikispaces)	1.61	.000	-1.25	.000	0.35	.443
Creating and/or editing websites	1.86	.000	-1.48	.000	0.38	.414
Checking articles on Wikipedia	0.90	.002	-1.17	.000	-0.28	.583
Accessing podcasts (e.g. audio or video content)	0.18	.810	-0.66	.088	-0.47	.304
Creating audio and/or video content to share	1.18	.000	-0.78	.042	0.40	.443
Using Skype (or similar tool) to talk to other educators or students	0.67	.063	-1.02	.003	-0.35	.521
Accessing content on school portals (e.g. Moodle courses)	-0.32	.501	0.06	.975	-0.26	.682
Creating and/or editing content on school portals	0.78	.034	-0.11	.934	0.67	.115
Accessing content on other education portals (e.g. MOOCs or Edmodo)	0.89	.015	-0.85	.032	0.05	.989

Creating and/or editing content on other education portals	0.64	.115	-0.21	.802	0.43	.425
Accessing content on social media pages or newsfeeds	-0.27	.641	0.31	.590	0.04	.993
Creating or sharing content through social media	-0.36	.479	0.45	.349	0.09	.961
Number of variables significantly different:		**8**		**8**		**1**

As expected, the significant differences for the blogging items suggested that CC21 participants drew on their experiences of blogging during the project, and that these experiences resulted in more favourable ratings of related items for professional learning (most notably, the "creating" items for websites, audio/video content, and content for school portals). This suggests an important relationship between experience, relevance and perceived importance. It also underscores the need to consider the extent to which guidance with new technology tools is necessary to establish effective learner autonomy. Finally, these significant differences draw attention to the role of the learners' attitude towards the tools of learning. By contrast to the CC21 sample, preservice teachers had relatively limited experiences in areas of blogging, school portals and editable websites. This lack of experience – correlated with less favourable ratings of the related items – points to findings consistent with research that suggests that students may not effectively employ new technology tools for their learning (Tuncay & Tuncay, 2009).

Further analysis: t-tests of demographic binary variables to explore possible significant differences in perceived importance of online activities.

To re-test the other binary variables that were explored in the Question 1 items on the amount of time spent each week, t-tests were conducted. These tests again revealed no significant difference for *gender* or *teaching context*, while revealing some significant *sharing level*. The latter variable recorded significance for one item; high sharers perceived *creating content on school portals* to be significantly more important than was perceived by low sharers (*p = .022*). Given the importance of school portals in the frequencies for the whole sample, these differences further illustrate some of the differences between these groups explored in the Question 1 items. However, similar to Question 1, the t-test for Question 2 items by the *career stage* variable revealed a much wider range of significant differences that reflected the one-way ANOVA between the three main samples. When the three main samples (CC21, MacICT and preservice teachers) were collapsed into the binary *career stage* variable (current educators and preservice teachers), eight items revealed significant differences. These are shown in Table 5.13.

Of note, for all eight items, preservice teachers placed significantly *less* importance on the activity than current teachers. The activities on which they differed included those related to blog posts (*reading, commenting* and *writing*), multimedia, as well as content creation for websites and school portals. The larger effect sizes for the first four items again draw attention to the significant differences explored in Question 1 – specifically, the lack of proportional time spent creating and co-creating content. While the Question 1 findings emphasise the lack of time spent in these areas, these data for Question 2 reveal the lack of importance perceived in relation to associated online activities.

Table 5.13 - Significance levels by career stage (Question 2 items).

Item	**Means**		***t***	**df**	**Sig. (2-tailed)**	**Effect size**
	Current (n=110)	PSTs (n=55)				
Reading online news	4.98	4.93	0.21	112	.833	.01
Reading blog posts	4.40	3.58	3.22	109	.002	.29
Commenting on blog posts	3.50	2.65	3.75	117	.000	.33
Writing blog posts	3.60	2.69	3.84	119	.000	.33
Accessing websites I can edit (e.g. Wikispaces)	3.88	2.8	4.82	148	.000	.37
Creating and/or editing websites	3.91	2.69	5.29	149	.000	.40
Checking articles on Wikipedia	3.82	3.43	1.59	102	.115	.15
Accessing podcasts (e.g. audio or video content)	4.59	4.69	-0.37	117	.709	.03
Creating audio and/or video content to share	4.25	3.40	3.13	111	.002	.28
Using Skype (or similar tool) to talk to other educators or students	3.91	3.67	0.90	108	.368	.09

Accessing content on school portals (e.g. Moodle courses)	5.33	5.62	-1.16	111	.247	.11
Creating and/or editing content on school portals	5.09	4.35	2.70	112	.008	.25
Accessing content on other education portals (e.g. MOOCs or Edmodo)	5.17	4.91	0.94	112	.349	.09
Creating and/or editing content on other education portals	4.59	4.04	2.05	124	.043	.18
Accessing content on social media pages or newsfeeds	4.33	4.47	-0.55	127	.584	.04
Creating or sharing content through social media	4.23	4.4	-0.63	122	.531	.06

Further analysis: discriminant analysis of three main samples.

To explore how Question 2 items predicted group membership, discriminant analysis was run on these items using the grouping variable for the three main samples (CC21, MacICT and preservice teachers). The classification results for the three main samples produced a two-function solution, wherein group membership could be predicted in 70.7% of cases. The first discriminant function explained 79.6% of the variance, canonical = .50, whereas the second explained 20.3%, canonical = .20. In combination, these discriminant functions significantly differentiated the three groups, = .40, (32) = 128.76, $p \leq .000$, and removing the first function indicated that the second function also significantly differentiated the groups, = .80, (15) = 31.96, $p = .007$. The correlations between outcomes and the discriminant functions revealed seven of the items loaded more highly on one of the two functions. Highly positive loading items on Function 1 included *accessing websites I can edit, creating and/or editing websites* and *creating and/or editing content on system portals.* Highly positive loading items on Function 2 included *reading online news, accessing podcasts, accessing content on school portals* and *creating and/or sharing content through social media*.

The canonical discriminant functions plot is shown in Figure 5.5. Of note, this plot shows that the first function discriminated the CC21 teachers from the other two groups, while the second function discriminated preservice teachers from both groups of current educators (CC21 and MacICT). Given that the Function 1 items largely involved “creating” and “editing” in different contexts while the Function

2 items largely involved "accessing", it appears that the importance placed on creating and editing digital content provided a strong predictor of CC21 group membership, while the importance placed on accessing content provided a reasonable predictor of preservice teacher membership. The MacICT group loaded slightly negatively on both functions, suggesting that both functions provided a reasonable predictor of MacICT group membership.

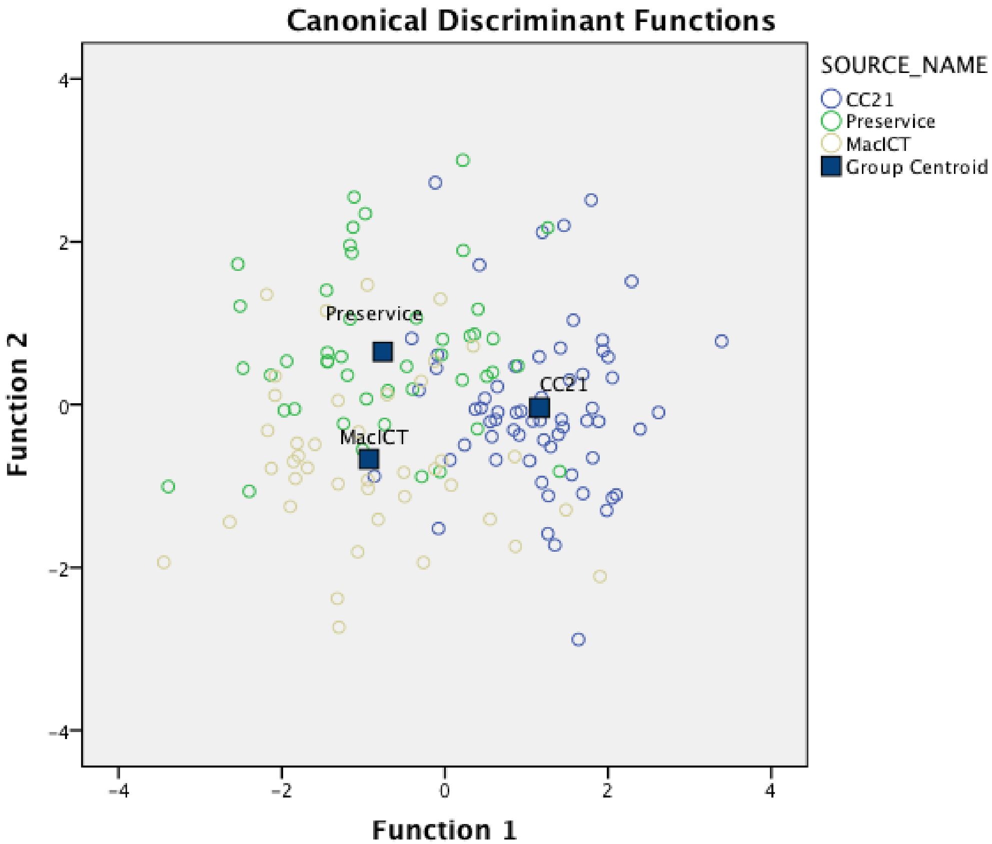

Figure 5.5 - Canonical discriminant functions plot (main samples and Question 2 items)

Final analysis: confirmatory principal components analysis.

Finally, confirmatory PCA was conducted to explore the component structure for Question 2 items. The Kaiser-Meyer-Olkin measure strongly verified the sampling adequacy for the analysis (KMO = 0.82) and all KMO values for individual items were greater than 0.50. An initial analysis was run to obtain eigenvalues for each component in the data. Three components had eigenvalues greater than one and in combination explained 57.28% of the variance. The scree plot was unambiguous, showing an inflexion justifying the retention of three components, and parallel analysis further confirmed this retention. Table 5.14 shows the component loadings (>0.5) after rotation. The items that cluster suggest that Component 1 is editable websites and multimedia, Component 2 is education portals (for example, the LMS) and Component 3 is social media.

Table 5.14 - Principal components analysis (Question 2 items).

Pattern Matrix[a]			
	Component		
	1	2	3
Commenting on blog posts	.90		
Writing blog posts	.87		
Reading blog posts	.84		
Accessing websites I can edit (e.g. Wikispaces)	.79		
Creating and/or editing websites	.73		
Creating audio and/or video content to share	.66		
Checking articles on Wikipedia	.53		
Reading online news	.47		
Accessing content on school portals (e.g. Moodle courses)		.73	
Accessing content on system portals (e.g. DEC My PL)		.71	
Creating and/or editing content on school portals		.67	
Accessing podcasts (e.g. audio or video content)		.48	
Accessing content on social media pages or newsfeeds			-.92
Creating or sharing content through social media			-.88
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization.			
a. Rotation converged in 7 iterations.			

It is important to note that Component 1 – most closely linked to the Function 1 predictors from discriminant analysis – explained 36.01% of total variance. As shown in the pattern matrix above, the highest loading items pertain to blogs and other editable websites. This further suggests that engaging with relevant tools for creating and editing digital content was a key point of difference between participants in the sample.

Given the unique nature of the CC21 participants – having blogged as a requirement for their involvement in the project – the findings here draw further attention to the relationship between learning experiences and their perceived relevance and importance to the learner. As a sample fairly typical of many teacher training programs, the preservice teacher sample were most defined by the lack of importance they placed on creating, co-creating and editing using current technology tools such as blogs and wikis. They placed only slightly more importance on tools that were part of a LMS (such as school and system portals). While they placed more importance on social media (with Item 18 specifying *creating and sharing* with social media), the limited amounts of time they allocated to creating and co-creating in Question 1 suggest that they largely used social media for sharing, rather than creating, digital content.

Online Participatory Cultures

About the questions included in this analysis.

Question 7 included thirty-four items that explored possible constructs for each of the eleven Participatory Cultures described by Clinton, Purushot, Robison and Weigel (2006). Citing research from the *Pew Internet and American Life* project that indicates (close to the time the paper was written) more than one-half of all American teenagers have created media content, and roughly one-third of teens who use the Internet have shared content they have produced (Lenhart & Madden, 2005), the authors define the term participatory culture as "a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one's creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices" (p. 3). To explore the dimensions of online participation, the authors discuss the eleven Participatory Cultures as important ways of engaging with tools, content and people in a diverse range of online communities. Each of the cultures reflect many of the skills needed to participate effectively online:

1. **Play** — the capacity to experiment with one's surroundings as a form of problem-solving;
2. **Performance —** the ability to adopt alternative identities for the purpose of improvisation and discovery;
3. **Simulation** — the ability to interpret and construct dynamic models of real-world processes;
4. **Appropriation** — the ability to meaningfully sample and remix media content
5. **Multitasking —** the ability to scan one's environment and shift focus as needed to salient details;
6. **Distributed Cognition** — the ability to interact meaningfully with tools that expand mental capacities;
7. **Collective Intelligence** — the ability to pool knowledge and compare notes with others toward a common goal;
8. **Judgment —** the ability to evaluate the reliability and credibility of different information sources;
9. **Transmedia Navigation** — the ability to follow the flow of stories and information across multiple modalities;
10. **Networking** — the ability to search for, synthesise, and disseminate information; and
11. **Negotiation —** the ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms (p.4).

While a review of related literature suggests there has no empirical studies measuring Participatory Cultures across these eleven dimensions, they offer an important means of exploring how learners engage in the kinds of autonomous learning implied in the *Pew Internet and American Life*, particularly in relation to digital creativity and sharing. To explore how educators in the three main samples engage in professional learning through online participation, the thirty-four Question 7 items were created to reflect a wide range of online behaviours that could be argued to demonstrate (or, in the case of negative distractors, not demonstrate) participation within each specific culture.

The items were focused mainly on specific examples of online behaviours that were discussed in the qualitative inquiry and demonstrate the culture concerned, rather than attempting to include an exhaustive set of all possible behaviours. For instance, items focusing on *Play* explored some forms of experimentation with current tools and problem-solving strategies, while *Multitasking* items explored some common web browser behaviours and the learner's tendency to either get distracted or maintain focus. Among the eleven Participatory Cultures, there are some overlapping meanings, such as between *Multitasking* and *Distributed Cognition* (both of which involve managing and thinking across more than one task or tool), and *Judgment* and *Negotiation* (both of which involve critical thinking in relation to digital content, whether from information sources or within online communities). A 7-point anchored scale with the anchor points "Not at all true of me" and "Very true of me" allowed participants to accept or reject each statement based on their personal online behaviours.

Initial findings: Participatory Cultures both "very true" and "not at all true".

Table 5.15 shows the Question 7 items with a mean score of 5 or more for the whole sample. Seven of the eleven Participatory Cultures are represented among the most highly rated ("Very true of me") items, while the items of *performance, judgment, negotiation* and *collective intelligence* did not generate mean scores of higher than 5. Broadly speaking, these data provide some initial insights on the whole sample, suggesting that participants are reasonably comfortable with multitasking, information retrieval and solving problems through play (including both asking for help and using trial and error).

Table 5.15 - Top "very true of me" Participatory Cultures (Question 7 items).[8]

Participatory Culture	Item	Mean	SD
Multitasking	*I frequently have multiple tabs open in my web browser and switch between them.*	6.30	1.22
Appropriation	*I use search engines (e.g. Google) to find most things online.*	6.26	1.16
Appropriation	*I use Internet to look things up and check facts.*	6.07	1.18
Simulation	*I search the Internet to find representations of how things work.*	5.68	1.31
Play	*If I'm stuck using a technology tool, I'll ask for help from someone who knows.*	5.48	1.48
Play	*I like to play around with a new technology tool.*	5.34	1.53
Appropriation	*I regard taking someone's work and posting it online as plagiarism.*	5.29	1.81
Transmedia Navigation	*I like a webpage that includes different types of media (audio, video, images, links, etc.).*	5.23	1.38
Play	*I usually solve problems by trial and error.*	5.21	1.34
Distributed Cognition	*I use tools on the Internet to try new ways of doing things.*	5.08	1.44

Exploring the lowest-rated ("Not at all true of me") items (many of which included the negative distractors) further illustrated the profile of all educators in the combined sample. Table 5.16 shows items with mean scores of 3.55 and lower, representing the bottom half of the 7-point scale. As expected, low ratings for the *Multitasking* negative distractor (*...I prefer doing one thing at a time*) indicates that most educators were comfortable managing multiple tasks. The *Negotiation* item (*I get overwhelmed by the vastness of the Internet*) suggests that, broadly speaking, educators in the sample feel comfortable using the Internet and unlikely to feel overwhelmed by online technologies. Finally, the lowest-scoring item (*Who I am online is quite different to who I am in person*) suggests that educators in the combined sample see their online identities as closely aligned with their "in-person" identities. This item represents an important attribute for teacher professional learning that points to a closer connection between how educators

[8] For expanded results, please refer to Tables A2-5.15 in Appendix 2.

express themselves and their ideas in both face-to-face and online contexts. In a study of teacher professional identities, O'Sullivan (2007) found that "most teachers viewed these professional elements [including distinctive ways of being and acting as educators] as being closely aligned with, or even inseparable from, their sense of self, and as occupying a large, significant part of the territory of self" (p. 13). The ways of being and acting in online contexts – as reflected among these participatory culture items – therefore represent tangible indicators of teacher identity in a digital age.

Table 5.16 - Top "Not at all true of me" Participatory Cultures (Question 7 Items)

Participatory Culture	**Item**	**Mean**	**SD**
Transmedia Navigation	*I get distracted if there are too many forms of media on a web page.*	3.55	1.53
Multitasking	*When using a technology tool, I prefer doing one thing at a time.*	3.25	1.61
Negotiation	*I get overwhelmed by the vastness of the Internet.*	2.68	1.69
Performance	*Who I am online is quite different to who I am in person.*	2.35	1.66

Further analysis: exploratory principal components analysis to explore construct validity.

Given the tentative nature of the constructs, exploratory PCA was initially conducted on all Question 7 items to see whether there were consistencies between observable components and the eleven Participatory Cultures. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = 0.71) and all KMO values for individual items were greater than 0.50. An initial analysis was run to obtain eigenvalues for each factor in the data. Eleven components had eigenvalues greater than one and in combination explained 66.7% of the variance. The scree plot was ambiguous, showing an inflexion justifying the retention ten or eleven components, but parallel analysis supported the retention of eleven components. Table 5.17 shows the component loadings (>0.5) after rotation.

Table 5.17 - Exploratory PCA (Question 7 items).

Pattern Matrix[a]											
	Component										
	1	2	3	4	5	6	7	8	9	10	11
I often try new web tools when I hear about them (distributed cognition).	.88										
I like to play around with a new technology tool (play).	.78										
I often sign up for new services on the Internet (judgment).	.69										
I use tools on the Internet to try new ways of doing things (distributed cognition).	.65										
I use technology tools to take someone's ideas and make them better (appropriation).	.64										
I usually solve problems by considering solutions carefully (play).	.57										
I prefer to be shown how a technology tool works before I use it (play).		.70									
If I'm stuck using a technology tool, I'll ask for help from someone who knows (play).		.70									
I usually maintain focus on the task at hand (multitasking).			-.78								
I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing (multitasking).			.76								
I click on links to other material before I finish examining the main content of a web page (transmedia navigation).				.81							
I'm often unsure about the reliability of information I find online (judgment).				.62							
I focus on the main area of a web page before I click on links to other material (transmedia navigation).				-.60							

	1	2	3	4	5	6	7	8	9	10	11
If I discover something interesting on the Internet, I email it to friends (networking).					-.83						
I share interesting links with others on social network services (like Facebook) (networking).					-.69						
I use the Internet to discover new things about myself and others (negotiation).						-.64					
I regard taking someone's work and posting it online as plagiarism (appropriation).							.73				
I use search engines (e.g. Google) to find most things online (networking).							.53				
I frequently have multiple tabs open in my web browser and switch between them (transmedia navigation).							.50				
I get distracted if there are too many forms of media on a web page (multitasking).								.86			
I consider websites like Wikipedia to be unreliable (judgment).									.83		
My ideas about teaching are influenced by my colleagues (collective intelligence).									.56		
I believe that we need to rethink what plagiarism is when interacting with others on the Internet (appropriation).										.71	
Who I am online is quite different to who I am in person (performance).											-.57
I consider my online identity as an extension of who I am face-to-face (performance).											.57

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.a

a. Rotation converged in 25 iterations.

Though eleven components were retained, the overall component structure represented both discrete and overlapping constructs. Component 1 included a range of items from *Play, Collective Intelligence* and *Judgment* that collectively described experimentation and development of ideas with new tools. Components 2 and 3 were both discrete, showing only items from *Play* and *Multitasking* respectively. Component 4 included items from *Transmedia navigation* and *Judgment* that together describe how learners navigate and interpret web pages. Component 5 was discrete, with two items that represented the culture of *Networking*. Component 6 included only one item (explaining 4.3% of total variance) from *Negotiation (I use Internet to discover new things about myself and others*), while Component 7 was a mix of items from *Appropriation, Networking* and *Transmedia Navigation*. Component 8 consisted of one item from *Multitasking* (*I get distracted if there are too many forms of media on a web page)*. Component 9 formed an interesting confluence of *Collective Intelligence* and *Judgment*, describing how participants make sense of the combination of ideas in online spaces. Component 10 included only one item from *Appropriation* (*I believe that we need to rethink what plagiarism is when interacting with others on the Internet*), while Component 11 discretely included two items from *Performance* that referred to online identity. Table 5.18 summarises the key themes that were drawn from the component loadings.

Table 5.18 - Component loadings summary of key themes.

Component	Constructs	Key Themes
1. Experimentation with new tools	• *Distributed Cognition* • *Collective Intelligence* • *Judgment* • *Appropriation* • *Play*	• Experimentation with new online tools to generate new solutions and ideas. • Willingness to try new tools and build on how they have been used by others.
2. Technical support	• Play	• *Need to be shown how to use a technology tool.* • *Willingness to ask for help.*
3. Distraction	• Multitasking	• *Maintaining focus on the task at hand – or being distracted*
4. Surfing habits	• Transmedia Navigation • Judgment	• *Focusing on some or all elements of a webpage with a view to ascertaining reliability/usefulness.* • *Willingness to "surf" the web.*
5. Sharing – old and new	• Networking	• *Old and new ways of sharing online content (email and social).* • *Need to find appropriate ways of professionally networking that avoid issues like "inbox overload".*
6. Identity formation	• Negotiation	• *Using the Internet to discover "new things about myself and others"*
7. Information overload	• Appropriation • Networking • Transmedia Navigation	• *The ease of finding information online and need to ensure a degree of authenticity in one's own work.* • *Being able to easily switch between information sources and people-to-people connections (via tabs on the web browser).*
8. Distraction admission	• Multitasking	• *Admission that it is easy to be distracted when there are too many forms of media on a webpage.*
9. Trust	• Judgment • Collective Intelligence	• *Online vs. face-to-face information sources.* • *Tacit assumption that face-to-face sources may be more trusted than online sources.*
10. Rethinking	• Appropriation	• *Realisation that the Internet has changed the nature of authorship and authenticity.*
11. Evaluating identity	• Performance	• *Online and face-to-face identities are seen as more closely aligned rather than distinctly different.*

It is important to note that the Question 7 instrument was intended to be exploratory in nature, and was informed by multi-dimensional and overlapping constructs. Each construct has a wide range of further elements, and it was not within the scope of the study to explore these beyond the examples that were included in the thirty-four items. While the component loadings reveal that some of the constructs could be discretely identified, others clustered together in various configurations that reflect how the respondents perceived the items. Given the complex, correlative and broad nature of the constructs, further empirical research is warranted in this area. Such research might provide further examples of the eleven cultures and explore the component structure to provide confirmation of the validity of constructs. Nonetheless, the findings presented here draw attention to some important corollaries about the extent to which online behaviours might inform learning. This is especially true of learning that is self-driven, less formally structured and autonomous. In order to leverage the opportunities to learn effectively online, further research needs to understand these behaviours, measure them accurately and explore the implications for encouraging further autonomy and sustained professional learning.

The themes summarised in Table 5.18 reflect some possible assumptions about the combined sample. Generally speaking, Components 1, 4 and 7 describe the need to explore online content by experimenting with new tools, interpret multiple modes, be comfortable with an at-times overwhelming array of information and able to judge what we find online. The abundance of online information also leads to issues of trust in Component 9, which draws on two key cultures – *Collective Intelligence* and *Judgment.* This component suggests that educators draw on information from both online and face-to-face sources, and that in spite of information richness on the Internet, colleagues play an important role in providing ideas. Nonetheless, the need to rethink authorship and authenticity is explored in Component 10. Components 2 and 3 reinforce the need for support and focus when solving problems, and being prepared to ask for help when it is needed. The need for focus is further supported by Component 8, which suggests that most learners are willing to admit that the multiple forms of information and people-to-people connections available on the Internet can easily lead to distraction when there is no clear focus. Component 5 groups both email and social media, with negative loadings that suggest neither is an ideal form of sharing.

Finally, Components 6 and 11 explore the changing nature of identity on the web. The items in Component 6 suggest that while the Internet offers different ways to form one's identity and understand others, face-to-face interaction continues to be important. Further, Component 11 supports the view that educators see online identity as largely similar to "in person" identity.

Further analysis: repeated measures ANOVA and t-tests to test other demographic variables of gender, career stage and sharing level.

To explore the variance between Question 7 items for the whole sample, one-way repeated measures ANOVA was applied. Mauchly's test indicated that the assumption of sphericity had been violated, 1563.26, $p \leq .000$. Therefore, Greenhouse-Geisser corrected tests were reported (). The tests of within-subject effects showed that participants' responses were significantly affected by each of the items, $F(16, 2205) = 49.3$, $p \leq .000$, = .26. Follow up t-tests based on the four demographic binary variables revealed no significant difference for any of the items in relation to *gender* or *teaching context* (primary or secondary). These findings confirmed that *gender* did not represent a strong predictor of the kinds of online behaviours explored in Question 7. The findings also suggest that while primary and secondary educators differed on the time spent online (Question 1) and importance placed on certain activities (Question 2), they did not significantly differ on their online behaviours. However, t-tests that were conducted for *career stage* and *sharing level* revealed a number of significant differences.

Key findings: career stage as possible predictor of *play*, *experimentation*, *appropriation* and *networking*.

When *career stage* was used as the between-subject factor, repeated measures analysis showed the responses to the thirty-four items were significantly affected by the career stage (current educator or preservice teacher). Given the use of several negative distractors, there were a considerable number of interaction effects. However, tests of between subject effects showed significance levels for the between subject factor.

Table 5.19 - Tests of between subject effects for career stage.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	79576.913	1	79576.913	7797.62	.000	.98
Career St.	4.223	1	4.223	.414	.521	.003
Error	1367.509	134	10.205			

Follow-up t-tests revealed significant differences for twelve of the thirty-four items, shown in Table 5.20. Of note, current educators were significantly more likely to take others' ideas and make them better, email links to colleagues, sign up for new services, experiment and play with new web tools and maintain focus on the task at hand. Conversely, preservice teachers were more likely to prefer to be shown how a technology tool works before using it, use the Internet to look up things and check facts, get distracted by something on the Internet, have multiple tabs open on their browsers, focus on the main area of a web page before clicking links and acknowledge that their ideas about teaching are influenced by their colleagues (other students). Broadly speaking, these differences are consistent with the patterns emerging in earlier questions while shedding some further light on preservice teachers' online behaviours. In particular, the lower scores for experimentation and play with new technology tools coupled with the higher scores for wanting to be shown how to use a tool suggest that the preservice teachers in the sample are less likely to engage in generative uses of technology tools for creating and/or co-creating content.

Table 5.20 - Significance levels by career stage (Question 7 significant items only).[9]

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Current Educator (n=110)	PST (n=55)				
I use technology tools to take someone's ideas and make them better (appropriation).	4.68	3.78	3.32	99	.001	.32
I prefer to be shown how a technology tool works before I use it (play).	4.05	4.96	-3.21	101	.002	.31
I use Internet to look things up and check facts (appropriation).	5.91	6.41	-2.98	147	.003	.24
I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing (multitasking).	3.67	4.61	-3.03	89	.003	.31
If I discover something interesting on the Internet, I email it to friends (networking).	4.44	3.48	3.03	96	.003	.31
I often sign up for new services on the Internet (distributed cognition).	4.33	3.50	2.85	101	.005	.30
I frequently have multiple tabs open in my web browser and switch between them (multitasking).	6.16	6.58	-2.50	152	.013	.20
I focus on the main area of a web page before I click on links to other material (transmedia navigation).	4.63	5.20	-2.51	82	.014	.27
I experiment with new web tools when I hear about them (distributed cognition).	5.00	4.36	2.42	104	.017	.23
My ideas about teaching are influenced by my colleagues (collective intelligence).	4.38	4.80	-2.21	98	.029	.22
I like to play around with a new technology tool (play).	5.51	5.00	2.11	118	.037	.19
I usually maintain focus on the task at hand (multitasking).	4.79	4.31	2.04	96	.044	.20

[9] For expanded results, please refer to Tables A2-5.20a and A2-5.20b in Appendix 2.

The remaining items did not include further significant differences beyond those noted above. Items with very similar means included *I usually solve problems by considering solutions carefully, I use Internet to discover new things about myself and others, I believe that we need to rethink what plagiarism is when interacting with others on the Internet* and *I share interesting links with others on social network services (like Facebook)*. The similar means for these items suggest that both current educators and preservice teachers have similar behaviours in relation to problem solving, attitudes towards plagiarism and use of social media, including sharing and discovery.

Findings: sharing level as possible predictor of *play, appropriation, distributed cognition* and *networking*.

When *sharing level* was used as the between-subject factor, repeated measures analysis showed the responses to the thirty-four items were significantly affected by the three sharing clusters (low, medium and high), $F(2,133) = 4.97$, $p = .008$ (Greenhouse-Geisser). Tests of between subject effects further showed significance levels for the between subject factors.

Table 5.21 - Tests of between subject effects for sharing level (Question 7 items).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	84659.04	1	84659.04	8821.70	.000	.99
Sharing level	95.373	2	47.69	4.97	.008	.07
Error	1276.359	133	9.60			

Follow-up t-tests were conducted between the low and high sharers, revealing significant differences for eight of the thirty-four items, shown in Table 5.22. Of note, high sharers were significantly more likely to experiment with new tools to try new ways of doing things, share information with colleagues using both email and social media, use technology to improve on others' ideas, sign up for new services. Conversely, low sharers were significantly more likely to prefer to be shown how a new technology tool works before using it.

Table 5.22 - Significance levels sharing clusters (significant items only).

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Low (n=73)	High (n=27)				
I use tools on the Internet to try new ways of doing things (distributed cognition).	4.71	5.67	-3.10	54	.003	.39
If I discover something interesting on the Internet, I email it to friends (networking).	3.55	4.78	-2.84	47	.007	.38
I use technology tools to take someone's ideas and make them better (appropriation).	4.08	5.15	-2.77	43	.008	.39
I find things online through links shared with me on social networks like Facebook (networking).	3.81	4.93	-2.76	50	.008	.36
I often sign up for new services on the Internet (distributed cognition).	3.52	4.54	-2.39	43	.021	.34
I experiment with new web tools when I hear about them (distributed cognition).	4.34	5.26	-2.36	45	.023	.33
I share interesting links with others on social network services (like Facebook) (networking).	3.84	4.93	-2.33	50	.024	.31
I prefer to be shown how a technology tool works before I use it (play).	4.90	3.93	2.30	42	.026	.33

Final analysis: discriminant analysis of three main samples.

Discriminant analysis was run on all Question 7 items using the grouping variable for the three main samples (CC21, MacICT and preservice teachers). The classification results for the three main samples produced a two-function solution, wherein group membership could be predicted in 82.4% of cases. The first discriminant function explained 65.9% of the variance, canonical = .73, whereas the second explained 34.1%, canonical = .61. In combination, these discriminant functions significantly differentiated the three groups, = .40, (68) = 140.9, $p \leq .000$, and removing the first function indicated that the second function also significantly differentiated the groups, = .63, (33) = 53.26, $p = .014$. The correlations between outcomes and the discriminant functions revealed fifteen of the items loaded more highly on one of the two functions.

Table 5.23 shows the items loading on each function. Broadly speaking, Function 1 included online behaviours that emphasise uncertainty, distraction, the need for support and verification, while Function 2 included online behaviours that emphasise experimentation, sharing, collaboration and focus.

Table 5.23 - Canonical discriminant functions (Question 7 items).

Standardised Canonical Discriminant Function Coefficients		
Red - Function 1 Positive Loadings **Blue - Function 2 Positive Loadings**	**Function**	
	1	**2**
I like to play around with a new technology tool.	-.171	.011
I prefer to be shown how a technology tool works before I use it.	.359	-.079
If I'm stuck using a technology tool, I'll ask for help from someone who knows.	-.134	.293
I usually solve problems by considering solutions carefully.	.188	.020
I usually solve problems by trial and error.	.267	.108
Who I am online is quite different to who I am in person.	.182	.149
I use Internet to discover new things about myself and others.	-.087	-.148
I use Internet to look things up and check facts.	-.158	-.314
I search the Internet to find representations of how things work.	.610	-.011
I consider my online identity as an extension of who I am face-to-face.	.050	.080
I use technology tools to take someone's ideas and make them better.	-.408	.414
I like to come up with all my own ideas.	.015	.270
I regard taking someone's work and posting it online as plagiarism.	-.131	-.091
I believe that we need to rethink what plagiarism is when interacting with others on the Internet.	-.165	-.189
I frequently have multiple tabs open in my web browser and switch between them.	.435	-.014
When using a technology tool, I prefer doing one thing at a time.	-.192	.130
I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing.	.149	-.130
I usually maintain focus on the task at hand.	-.032	.234
I use tools on the Internet to try new ways of doing things.	.152	.268
I often try new web tools when I hear about them.	-.291	-.173
I often sign up for new services on the Internet.	-.214	.022
I consider websites like Wikipedia to be unreliable.	-.308	.260

Standardised Canonical Discriminant Function Coefficients		
Red - Function 1 Positive Loadings **Blue - Function 2 Positive Loadings**	**Function**	
	1	**2**
My ideas about teaching are influenced by my colleagues.	.378	.285
I'm often unsure about the reliability of information I find online.	.083	-.145
I like to verify information online with information in other forms.	.268	-.044
I like a webpage that includes different types of media (audio, video, images, links, etc.).	.219	.089
I get distracted if there are too many forms of media on a web page.	.027	-.196
I focus on the main area of a web page before I click on links to other material.	.222	-.048
I click on links to other material before I finish examining the main content of a web page.	-.080	.121
I use search engines (e.g. Google) to find most things online.	-.075	.089
I find things online through links shared with me on social networks like Facebook.	.007	.380
If I discover something interesting on the Internet, I email it to friends.	-.325	.246
I share interesting links with others on social network services (like Facebook).	.173	-.018
I get overwhelmed by the vastness of the Internet.	.028	.292

Of note, the conservative behaviours in Function 1 include items that refer to uncertainty, the need to verify information and be shown how something works and concerns about being distracted. Function 2 included items that referred to more confident assumptions (for example, *I usually maintain focus on the task at hand*) and more adventurous behaviours (for example, *I use technology tools to take someone's ideas and make them better*).

The canonical discriminant functions plot is shown in Figure 5.6. Of note, this plot shows that the first function discriminated the CC21 teachers from the other two groups, while the second function discriminated preservice teachers from both groups of current educators (CC21 and MacICT). Given that Function 1 describes more conservative behaviours while Function 2 describes more adventurous behaviours, it appears that the more conservative behaviours provided a strong predictor of preservice teacher group membership, while more adventurous online behaviours provided a strong predictor of MacICT teacher membership. The CC21 group loaded slightly negatively on both functions, suggesting that both functions provided a reasonable predictor of CC21 group membership.

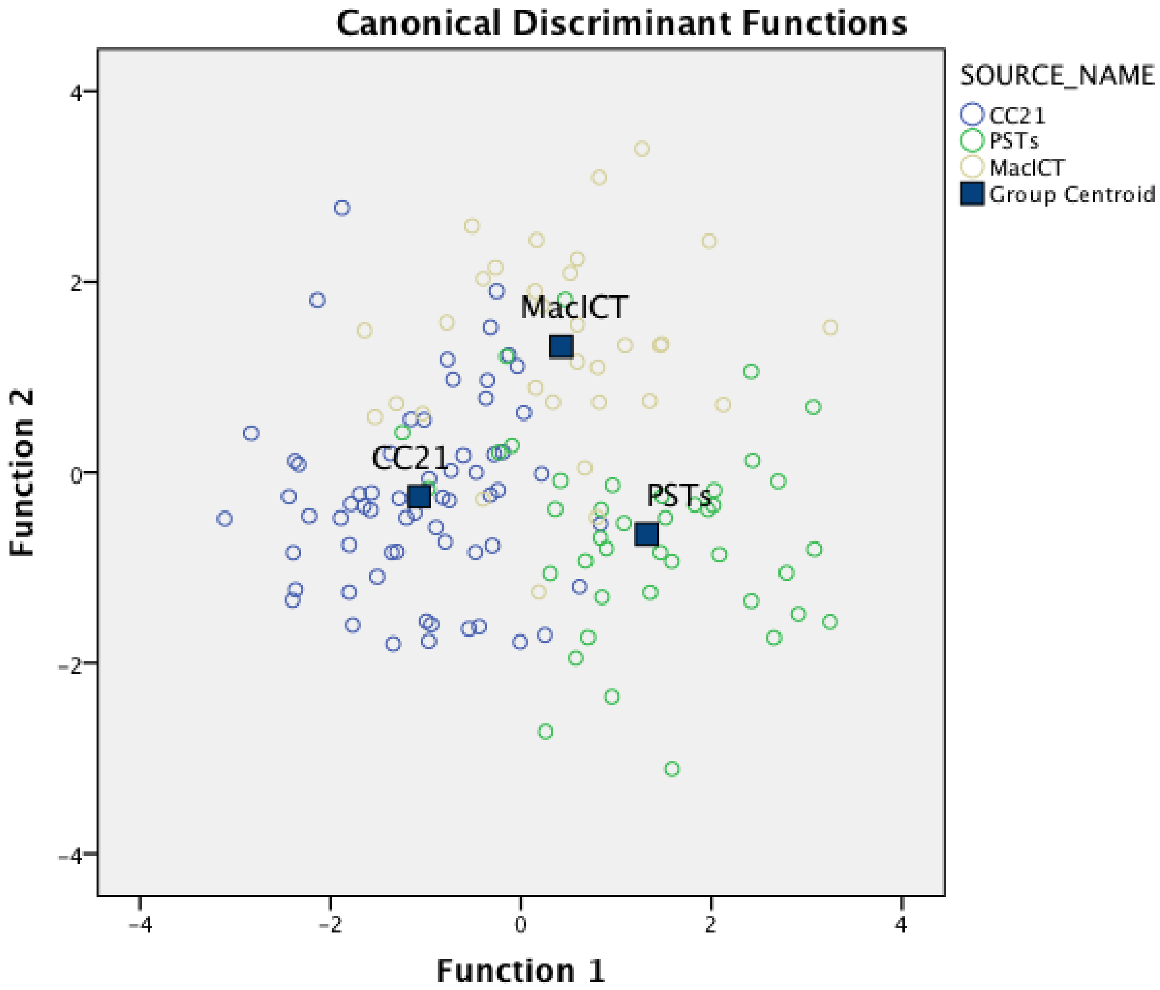

Figure 5.6 - Canonical discriminant functions plot (Question 7 items).

Support Structures for Professional Learning

About the questions included in this analysis.

Question 4 of the TPLQ explored the importance of a range of support structures that underpin teacher professional learning in schools. Support structures have always played a role in supporting teacher professional learning. However, as we continue to explore the shifting nature of professional learning in a digital age, there is further need to examine the dimensions of school-based structures that exist to support both newer and older forms of professional learning. Further, the perceived importance of specific support structures often reflects the educator's perspectives on what motivates their professional learning, since support is an underlying factor in the effective motivation of teachers in many educational contexts (Roy & Sengupta, 2013).

The TPLQ sought to measure the perceived importance of a range of common support structures by asking participants to rate twenty items with a 7-point scale with the anchor points "Extremely unimportant" and "Extremely important". The items were drawn from specific examples noted during the qualitative inquiry, where principals, mentors and classroom teachers discussed the support structures that existed in their school and their importance and relevance for professional learning. It is important to note that while support structures differ from one school to the next, there are some common elements. The twenty items reflect four main areas commonly mentioned in relation to support: (1) the provision of time; (2) the role of leadership and mentoring; (3) the importance of face-to-face support; and (4) the importance of digital tools for support.

As findings in relation to the other instruments have shown thus far, self-direction, inquiry and learner autonomy remain key elements that need to be explored. The TPLQ sought to identify the structures supporting more autonomous, self-directed forms of teacher professional learning that reflect specific aspects of the four main areas outlined above. Of these areas, time emerged during the qualitative inquiry as the dominant support structure. To examine the dimensions of time, both structured and unstructured provisions of time were explored within the school and between schools, reflected in nine of the twenty items.

Further, several items explored the role of leadership and mentoring in terms of leadership style, the leader's ideas and their impact on the school. Differences between face-to-face and online support were explored with key examples, such as the importance of *listening to a guest speaker during a professional development day or staff meeting* as opposed to *online spaces (e.g. shared blog) for sharing ideas between schools*. Finally, other items such as *research papers that I have searched for and accessed* were included as examples of traditional support structures that have evolved somewhat (for example, with classroom teachers now easily able to access relevant research rather than research disseminated by the principal). As such, deliberate negative distractors were not employed in the instrument; however, some items were anticipated to be of more importance to the different kinds of educators included in the combined sample.

Given the difficulties for preservice teachers commenting on support structures that require a more in-depth understanding of the school context, twelve items were omitted in the preservice teacher version of the TPLQ. The first eight items are referred to as *common items* (with data from the combined sample, n=165), while the remaining twelve items are applicable only to the sample of current teachers (n=110).

Initial findings: perceived importance of support structures for professional learning.

Table 5.24 shows the means for the items common to all three samples. Of note, the most important support structure was *access to the Internet in my classroom(s),* while the least important support structure was *research papers I have searched for and accessed*. However, it is important to note that all the mean values for these support structures were relatively high. Although the instrument employed a 7-point scale, the means all common items were greater than 5.5. This suggests that all of these items were perceived as at least very important, with several being considered close to “extremely” important across the sample. Further, the high scores for these items confirm that they represent valid constructs for describing common support structures for educators in the schools included in the study.

Table 5.24 - Support structures frequencies (Question 4 common items, n=165)

Item	**Mean**	**SD**
Access to the Internet in the staff room	6.39	1.27
Access to the Internet in my classroom(s)	6.70	0.80
Structured professional development days in my school (e.g. staff training day)	6.36	1.11
Lesson preparation time (e.g. designated free period in timetable)	6.44	1.03
Software that lets me collaborate with colleagues both face-to-face and online (e.g. Google Docs)	5.86	1.19
A clear policy about how staff and students in the school should communicate online	5.99	1.32
The freedom to try new technology tools with my own students	6.43	0.96
Research papers that I have searched for and accessed	5.64	1.28

Table 5.25 shows the remaining twelve items that were only applicable to current educators (that is, CC21 and MacICT samples). Across this smaller combined sample, the most important support structure was *release from face-to-face teaching (RFF)*, referring to additional time (usually non-scheduled or timetabled) that is allocated to NSW Government teachers for professional learning, often through further funding or at the principal's discretion. Similarly, *unstructured professional development days* scored highly across this sample, referring to allocated PD days that are not formally structured. The least important support structures were *unstructured meeting time to share ideas with colleagues face-to-face outside of my school* and *online spaces for sharing ideas between schools*, both suggesting that support structures for professional learning within the immediate school context were perceived as somewhat more important than those enabling inter-school communication and collaboration. Nonetheless, the means for these twelve items were, similar to the first eight, very high overall.

Table 5.25 - Support structures frequencies (Question 4 additional items, n=110).

Item	**Mean**	**SD**
Structured professional development days outside of my own school (e.g. one-day course)	6.33	1.12
Unstructured professional development days in my own school (e.g. a planning day with colleagues)	6.44	1.01
Unstructured professional development days outside of my own school (e.g. a planning day with colleagues from other schools)	5.84	1.45
Listening to a guest speaker during a professional development day or staff meeting	5.73	1.34
Unstructured meeting time with leaders to discuss concerns face-to-face in my school	6.20	1.11
Unstructured meeting time to share ideas face-to-face with colleagues in my school	6.47	1.02
Unstructured meeting time to share ideas with colleagues face-to-face outside of my school	5.59	1.42
Release from face-to-face teaching (RFF)	6.55	1.09
Online spaces for sharing ideas between schools (e.g. shared blog)	5.62	1.36
Leaders who set a clear direction in the school for teachers to follow	6.53	0.95
Leaders whose ideas are drawn the innovations of other teachers in the school	6.34	1.14
Leaders whose ideas are drawn from current minds in education	6.35	1.15

Further analysis: ANOVA and t-tests to determine between-group differences in the perceived importance of support structures.

When compared with other instruments in the TPLQ, the initial findings presented in Tables 5.24 and 5.25 showed a much more nuanced variation between the responses. Nonetheless, one-way ANOVA applied to the common items for all three samples revealed some significant differences. Four of the eight items showed between-group *p* values that suggested significant differences between the three groups a limited range of support structures (most notably, those relating to technology access and training). The ANOVA for all eight common items is shown in Table 5.26. While there were only limited significant differences between all three groups, the main differences appear to lie between CC21 teachers and the preservice teacher sample, particularly with respect to *structured professional development days in my school* and *the freedom to try new technology tools with my students.*

Table 5.26 - One-Way ANOVA (support structures) by sample (Question 4 common items).

Item	Means			df	F-ratio	Sig.
	CC21	MacICT	PSTs			
Access to the Internet in the staff room	6.61	6.24	6.23	2	1.65	.196
Access to the Internet in my classroom(s)	6.94	6.71	6.40	2	7.00	.001
Structured professional development days in my own school (e.g. staff training day)	6.75	6.2	6.02	2	7.38	.001
Lesson preparation time (e.g. designated free period in timetable)	6.58	6.49	6.23	2	1.76	.175
Software that lets me collaborate with colleagues both face-to-face and online (e.g. Google Docs)	6.15	5.79	5.56	2	3.82	.024
A clear policy about how staff and students in the school should communicate online	6.19	6.02	5.71	2	1.94	.147
The freedom to try new technology tools with my own students	6.72	6.44	6.08	2	7.00	.001
Research papers that I have searched for and accessed	5.79	5.37	5.67	2	1.41	.247

As shown in Table 5.27, post-hoc Tukey tests on all items confirmed that CC21 teachers differed significantly on three variables when compared to preservice teachers and on one variable when compared to MacICT teachers. By contrast, MacICT and preservice teachers significantly differed on no items. These results reflect earlier findings, suggesting that CC21 teachers were significantly more likely to rate several support structures more highly than the other groups. Most notably, these items refer to technology access, structured professional learning through formal training, and the freedom to try new tools with students.

Table 5.27 - Post-hoc Tukey tests (Question 4 common items).

Item	**CC21- PSTs**		**MacICT - CC21**		**MacICT - PSTs**	
	Mean Dif.	Sig.	Mean Dif.	Sig.	Mean Dif.	Sig.
Access to the Internet in the staff room	0.38	.247	-0.37	.320	0.01	.999
Access to the Internet in my classroom(s)	0.54	.001	-0.24	.279	0.30	.147
Structured professional development days in my own school (e.g. staff training day)	0.73	.001	-0.56	.028	0.18	.709
Lesson preparation time (e.g. designated free period in timetable)	0.35	.159	-0.10	.887	0.26	.451
Software that lets me collaborate with colleagues both face-to-face and online (e.g. Google Docs)	0.60	.019	-0.36	.287	0.24	.603
A clear policy about how staff and students in the school should communicate online	0.48	.126	-0.17	.796	0.31	.492
The freedom to try new technology tools with my own students	0.65	.001	-0.28	.278	0.36	.147
Research papers that I have searched for and accessed	0.12	.870	-0.43	.222	-0.31	.485
Number of variables significantly different:		**4**		**1**		**0**

To explore the additional items applicable only to current teachers, t-tests were conducted (shown in Table 5.28) on the remaining twelve items for both CC21 and MacICT teachers. As indicated, six of the twelve items were significantly different, and in all six cases, CC21 teachers rated the support structure more highly than did MacICT teachers. The significance values and effect sizes emphasise that the main differences lie in relation to structured training outside of the school, the role of guest speakers (that is, outsiders visiting the school) and unstructured time to work with colleagues both within *and* outside of the school. These findings suggest that CC21 teachers were more readily interested in professional learning opportunities outside of their schools than were teachers in the MacICT sample.

Table 5.28 - Significance levels by sample (Question 4 additional items).

Variable	**Means**		***t***	**df**	**Sig (2-tailed)**	**Effect Size**
	CC21	MacICT				
Structured professional development days outside of my own school (e.g. one-day course)	6.64	5.85	3.24	53	.002	.41
Unstructured professional development days in my own school (e.g. a planning day with colleagues)	6.61	6.17	2.04	62	.046	.25
Unstructured professional development days outside of my own school (e.g. a planning day with colleagues from other schools)	5.94	5.68	0.90	95	.371	.09
Listening to a guest speaker during a professional development day or staff meeting	6.17	5.05	4.15	62	.000	.47
Unstructured meeting time with leaders to discuss concerns face-to-face in my school	6.42	5.88	2.38	74	.020	.27
Unstructured meeting time to share ideas face-to-face with colleagues in my school	6.75	6.05	3.41	67	.001	.39
Unstructured meeting time to share ideas with colleagues face-to-face outside of my school	5.85	5.2	2.29	80	.024	.25
Release time from face-to-face teaching (RFF)	6.63	6.44	0.89	90	.378	.09
Online spaces for sharing ideas between schools (e.g. shared blog)	5.75	5.41	1.18	73	.240	.14
Leaders who set a clear direction in the school for teachers to follow	6.67	6.32	1.76	69	.082	.21
Leaders whose ideas are drawn the innovations of other teachers in the school	6.35	6.32	0.15	98	.884	.01
Leaders whose ideas are drawn from current minds in education	6.54	6.05	2.14	81	.035	.23

Further analysis: t-tests of demographic binary variables.

T-tests on remaining demographic binary variables and all twenty items showed some significant differences. In relation to *teaching context* (primary/secondary), results indicated that primary teachers were significantly more likely than secondary teachers to favour access to the Internet in their classrooms, structured staff training days, guest speakers and release time from face-to-face teaching.

These findings were loosely consistent with expectations, given that primary teachers in New South Wales Government schools generally receive less release time from class than secondary teachers, and given the high proportion of primary teachers in the CC21 sample (n=10, 15.9%).

However, t-tests on Question 4 items for low and high online sharing clusters again revealed a number of more pronounced differences, with five of the twenty items showing *p* values of less than .05, as indicted in Table 5.29. Of note, low sharers are significantly more likely than high sharers to favour guest speakers during professional development days, meeting time for face-to-face discussions with colleagues and release time from face-to-face teaching. By contrast, high sharers were significantly more likely to favour software for collaboration and freedom to try new technology tools with students.

Table 5.29 - Significance levels by sharing level (Question 4 items).

Variable	**Means**		***t***	**df**	**Sig (2-tailed)**	**Effect Size**
	Low	High				
Listening to a guest speaker during a professional development day or staff meeting	5.92	4.85	2.62	43	.012	.37
Software that lets me collaborate with colleagues both face-to-face and online (e.g. Google Docs)	5.55	6.26	-2.44	44	.019	.35
Unstructured meeting time to share ideas face-to-face with colleagues in my school	6.67	5.89	2.37	42	.023	.35
Release time from face-to-face teaching (RFF)	6.64	5.96	2.05	33	.049	.33
The freedom to try new technology tools with my own students	6.22	6.74	-2.03	42	.049	.30

These findings suggest that the extent to which educators share in a diverse range of online contexts provides a reasonable predictor of several key support structures. Most notably, low sharers favour support structures that emphasise provision of time within the school and the importance of face-to-face communication. In addition to spending more time online (Question 1), favouring tools for digital creation and sharing (Question 2), exhibiting Participatory

Cultures that incorporate collaboration and experimentation (Question 7), high sharers tend to prefer technology tools and freedom as key support structures for their professional learning. The largest mean difference – *listening to a guest speaker* – suggests that low sharers are far more likely to prefer information that is presented in traditional face-to-face contexts within their school community.

Final analysis: confirmatory principal components analysis.

Principal Components Analysis was conducted on two clusters of items for Question 4. Given the high proportion of questions focusing on time – and the heavy emphasis on time as a discussion point during the qualitative inquiry – it was necessary to explore time as a broad construct separate to the other support structures. Confirmatory PCA was therefore conducted on the nine time-related items in Question 4 items, employing oblique rotation (direct oblimin). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = 0.819) and all KMO values for individual items were greater than 0.50. An initial analysis was run to obtain eigenvalues for each factor in the data. Two components had eigenvalues greater than one and in combination explained 63.1% of the variance. The scree plot was unambiguous, showing a clear inflexion justifying the retention of two components. Table 5.30 shows the component loadings (>0.5) after rotation. The items that cluster suggest that Component 1 refers to time-related support structures inside the school, while Component 2 refers time-related structures outside of the school.

Table 5.30 - Principal components analysis (Question 4 time-related items).

Pattern Matrix[a]		
	Component	
	1	2
Release time from face-to-face (RFF)	.89	
Unstructured meeting time to share ideas face-to-face with colleagues in my school	.77	
Lesson preparation time (e.g. designated free period in timetable)	.76	
Structured professional development days in my own school (e.g. staff training day)	.69	
Unstructured professional development days in my own school (e.g. a planning day with colleagues)	.64	
Unstructured meeting time with leaders to discuss concerns face-to-face in my school	.60	
Unstructured professional development days outside of my own school (e.g. a planning day with colleagues from other schools)		.91
Unstructured meeting time to share ideas with colleagues face-to-face outside of my school		.70
Structured professional development days outside of my own school (e.g. one-day course)		.43
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.		
a. Rotation converged in 11 iterations.		

This two-component solution confirms earlier findings in relation to the items on which CC21 teachers most significantly differed, and findings in relation to the significant differences between low and high sharers. For some educators – especially those in the high sharing group – a willingness to extend beyond the immediate school community appears to correlate strongly with a much wider and more favourable view of learning opportunities outside the school than those contained within the school.

Finally, PCA was conducted on remaining items for Question 4. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = 0.800) and all KMO values for individual items were greater than 0.50. Three components had eigenvalues greater than one and in combination explained 61.94% of the variance. The scree plot was slightly ambiguous, showing an inflexion justifying the retention of two or three components. Three components were retained, because the third component explained 10.46% of variance and was verified through parallel analysis. Table 5.31 shows the component loadings (>0.5) after rotation. The items that cluster suggest that Component 1 refers to leadership and autonomy, Component 2 refers to access to information and Component 3 refers to online technologies for professional learning.

Table 5.31 - Principal components analysis (Question 4 other support items).

Pattern Matrix[a]			
	Component		
	1	2	3
A clear policy about how staff and students in the school should communicate online	.83		
Leaders whose ideas are drawn the innovations of other teachers in the school	.76		
Leaders who set a clear direction in the school for teachers to follow	.72		
Leaders whose ideas are drawn from current minds in education (e.g. Lane Clark, John Hattie or Stephen Heppell)	.66		
The freedom to try new technology tools with my own students	.66		
Research papers that I have searched for and accessed	.61		
Access to the Internet in the staff room		.90	
Access to the Internet in my own classroom(s)		.60	
Listening to a guest speaker during a professional development day or staff meeting		.57	
Online spaces for sharing ideas between schools (e.g. shared blog)			.94
Software that lets me collaborate with colleagues both face-to-face and online (e.g. Google Docs)			.81
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

These findings shed further light on how educators perceive common support structures for their professional learning. Leadership represents a complex area that includes the style and decision-making of individual leaders, the policies in place, extent to which they allow various forms of autonomy and role as disseminators of information to their colleagues. While Component 2 initially suggests technology access, the inclusion of *listening to a guest speaker* suggests that respondents perceived these items as more about access to information than access to infrastructure. However, technology tools feature as the sole focus of Component 3, suggesting that respondents perceived the use of these tools as different to other more traditional means of communication.

Validating TPaCK Dimensions

About the questions included in this analysis.

Questions 8 and 9 of the TPLQ formed an instrument that explored professional learning in relation to the Technological Pedagogical Content Knowledge (TPaCK) framework. The instrument was based The TPaCK Survey (Chai et al., 2011), which involved a study of approximately two hundred preservice teachers and measured their knowledge across the seven TPaCK constructs:

1. **TK (Technological Knowledge)** — knowledge about features, capacities, and applications of technologies;
2. **PK (Pedagogical Knowledge)** — knowledge about the students' learning, instructional methods and process, different educational theories, and learning assessment to teach subject matter;
3. **CK (Content Knowledge)** — knowledge of the subject matter;
4. **TPK (Technological Pedagogical Knowledge)** — knowledge of the existence and specifications of various technologies to enable teaching approaches;
5. **TCK (Technological Content Knowledge)** — knowledge about how to use technology to represent the content in different ways;
6. **PCK (Pedagogical Content Knowledge)** — knowledge of adopting pedagogical strategies to make the subject matter more understandable for the learners; and
7. **TPaCK (Technological Pedagogical Content Knowledge)** — knowledge of using the various technologies to teach and represent the designated subject content (p 597).

Thirty-one items from the TPaCK Survey were included in the TPLQ, incorporating the original instrument's 7-point fully anchored scale ("Strongly disagree", "Disagree", "Slightly disagree", "Neither agree nor disagree", "Slightly agree", "Agree" and "Strongly agree"). While each item was coded with the specific TPaCK construct, this coding was not indicated to respondents during the delivery of the instrument (that is, they simply viewed and responded to the statement without knowledge of the specific construct to which it pertained). However, some distinctions were evident in the wording of items. For example, the Pedagogical Content Knowledge (PCK) items all proceeded with the qualifier "Without using technology…" to indicate that the item was not focused on technology. To maintain these distinctions, the TPLQ allocated non-technology items (PK, PCK, CK) to Question 8 and technology items (TK, TCK, TPK, TPaCK) to Question 9. Questions 8 and 9 respectively included the framing statements "The following group of items are about your knowledge of curriculum and pedagogy in general" and "The following group of items are about your knowledge of curriculum and pedagogy in relation to technology".

The measurement of TPaCK knowledge for the participants in this study is significant. By responding to the TPaCK items, participants identified important personal areas of strength and weakness. These areas reflect both teachers' capacity to learn, and the learning that has taken place prior to their response. Given the TPaCK's emphasis on technology – and technology's role in establishing and developing Personal Learning Networks – the TPaCK Survey provides a further measure of teacher knowledge as a *product* of professional learning in a digital age, and as an important element in the *process* for effective future professional learning.

Importantly, the items in the TPaCK Survey emphasise ability as a form of applied knowledge, rather than emphasising static knowledge that has little or no application in the classroom. This emphasis is necessary to more fully explore the impact of professional learning on the school community. Further, it is important to note that the TPaCK Survey items were included as valid and reliable measures of all seven constructs. Through exploratory and confirmatory factor analysis, the authors of this instrument have shown that each of the knowledge constructs load on separate factors when conducted with their sample of preservice teachers. The inclusion of this instrument in the TPLQ was, therefore, especially important for drawing conclusions beyond the immediate sample in this study.

Initial findings: educators' self-reported TPaCK knowledge.

Table 5.32 shows the complete set of items included in the instrument, as well as the mean values for the combined sample ordered from largest to smallest. Of note, the top eight items refer to first-order constructs (TK, PK and CK), with all of these items scoring mean values of 5.8 or higher. Second order constructs (TPK, TCK and PCK) feature more prominently with mean values of between 5.0 and 5.8, while two of the five items for the third order construct of TPaCK were among the lowest rated (with mean values of 5.12 and 5.04). The top eight items include all four of the pedagogical knowledge (PK) items, two technological knowledge (TK) items and two content knowledge (CK) items.

These initial findings suggest that participants felt more confident in their knowledge of separate domains, and less confident when the knowledge domains were merged in second and third order constructs. The three lowest-rated items reflect quite complex combinations of these knowledge dimensions, suggesting that the complexity evident in the item may have prompted lower ratings. Similarly, several pedagogical content knowledge (PCK) items were among the lowest rated items, standing in contrast to the higher rating of pedagogical knowledge (PK) items. This suggests that while many educators in the sample felt confident in their knowledge of pedagogy, they felt less confident in adopting pedagogical strategies to address subject content in their teaching.

Table 5.32 - TpaCK frequencies (Question 8 and 9 items).

Item	**Mean**	**SD**
TK: *I have the technical skills to use computers effectively.*	6.15	0.88
CK: *I am confident to teach the subject matter.*	5.98	1.12
TK: *I can learn technology easily.*	5.96	1.06
CK: *I have sufficient knowledge about my teaching subject.*	5.92	0.93
PK: *I am able to stretch my students' thinking by creating challenging tasks for them.*	5.92	0.85

Item	Mean	SD
PK: *I am able to guide my students to adopt appropriate learning strategies.*	5.85	0.84
PK: *I am able to help my students to reflect on their learning strategies.*	5.82	0.93
PK: *I am able to guide my students to discuss effectively during group work.*	5.80	0.97
TPCK: *I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.*	5.76	1.06
PK: *I am able to help my students to monitor their own learning.*	5.75	0.96
TCK: *I am able to use technology to introduce my students to real world scenarios.*	5.70	1.08
TCK: *I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.*	5.68	1.11
TPK: *I am able to facilitate my students to use technology to construct different forms of knowledge representation.*	5.65	1.05
TPK: *I am able to facilitate my students to collaborate with each other using technology.*	5.65	1.03
CK: *I think about the content of my teaching subject like a subject matter expert.*	5.50	1.14
TCK: *I am able to facilitate my students to use technology to plan and monitor their own learning.*	5.49	1.07
TPCK: *I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).*	5.46	1.18
PCK. *Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.*	5.44	1.42
TK: *I keep up with important new technologies.*	5.40	1.39
TCK: *I know about the technologies that I have to use for the research of content of my teaching subject.*	5.37	1.23
PCK: *Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.*	5.35	1.42
TPCK: *I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).*	5.32	1.31
TK: *I know how to solve my own technical problems when using technology.*	5.27	1.47
PCK: *Without using technology, I can support students to manage their learning of content for my teaching subject.*	5.26	1.41
PCK. *Without using technology, I can engage students in solving real world problem related to my teaching subject.*	5.22	1.50
TCK: *I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).*	5.21	1.33
PCK: *Without using technology, I can address the common learning difficulties my students have for my teaching subject.*	5.20	1.40
CK: *I gain deeper understanding about the content of my teaching subject on my own.*	5.19	1.37

Item	Mean	SD
TPCK*: I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).*	5.12	1.50
TPCK*: I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).*	5.04	1.25
TCK*: I can use specialized software to perform inquiry about my teaching subject.*	5.04	1.43

Further analysis: t-tests of demographic binary variables.

To re-test the binary variables that were explored in other instruments, similar t-tests were conducted. The t-tests for *gender* revealed significant differences for only two of the thirty-one items (TK: *I can learn technology easily* and TK: *I know how to solve my own technical problems when using technology*). For both these items, male educators reported significantly higher levels of knowledge than did female educators:

Table 5.33 - Significance levels by gender (Questions 8-9 significant items).

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Male (n=37)	Female (n=129)				
TK: *I can learn technology easily.*	6.60	5.92	3.11	26	.004	.52
TK: *I know how to solve my own technical problems when using technology.*	6.40	5.29	3.36	20	.003	.60

T-tests for *teaching context* revealed a larger number of significant differences across the whole sample. However, given the high proportion of preservice teachers in the secondary group and the nature of the instrument as measuring knowledge, these differences were less attributable to the educator's context and more attributable to their level of experience. This assumption was confirmed when the preservice teacher sample was removed from analysis and t-tests were conducted for all items and *teaching context*, revealing no significant differences.

In relation to the *career stage* variable, t-tests explored the differences in levels of knowledge for current educators and preservice teachers. Twenty-three of the thirty-one items revealed significant differences, as indicated in Table 5.34. Of note, in all twenty-three instances, preservice teachers reported significantly lower levels of knowledge than did current educators. First-order items included three items for content knowledge (CK) and five items for pedagogical knowledge (PK). Only one technological knowledge item (TK) – *I keep up with important technologies* – was included. Interestingly, second order constructs revealed significant differences for only one item for pedagogical content knowledge (PCK) and technological pedagogical knowledge (TPK), while all technological pedagogical content knowledge (TPaCK) items revealed significant differences. While the initial findings show that mean values for the sample are relatively high (with no mean values below 5.04), these findings suggest that preservice teachers mostly perceived that their limited experience was a key factor in reporting their level of knowledge in relation to the constructs. Larger effect sizes (d > .40) for eight items draw attention to several knowledge areas that preservice teachers find challenging. Of these eight items, six include content knowledge ("C") in the construct, six include technological knowledge ("T") and four include pedagogical knowledge ("P"). Further, the eight d > .40 items include two first order constructs (from CK and TK), four second-order constructs (from TPK, TCK and PCK) and two third-order constructs (TPaCK), suggesting that preservice teachers perceive significant challenges across the three levels of the TPaCK.

Table 5.34 - Significance levels by career stage (Questions 8-9, significant items).

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Current Educator (n=110)	PST (n=55)				
CK: *I have sufficient knowledge about my teaching subject.*	6.15	5.39	4.26	62	.000	.48
CK: *I think about the content of my teaching subject like a subject matter expert.*	5.7	5.05	3.04	71	.003	.34
CK*: I am confident to teach the subject matter.*	6.32	5.21	4.78	52	.000	.12
PCK. *Without using technology, I can engage students in solving real world problem related to my teaching subject.*	5.06	5.59	-2.29	120	.024	.55
PK: *I am able to stretch my students' thinking by creating challenging tasks for them.*	6.11	5.48	4.00	68	.000	.05
PK: *I am able to guide my students to adopt appropriate learning strategies.*	6.06	5.39	4.32	67	.000	.04
PK: *I am able to help my students to monitor their own learning.*	5.95	5.30	3.74	74	.000	.05
PK: *I am able to help my students to reflect on their learning strategies.*	6.00	5.41	3.43	71	.001	.21
PK: *I am able to guide my students to discuss effectively during group work.*	5.99	5.36	3.65	78	.000	.13
TPCK*: I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).*	5.29	4.45	3.89	80	.000	.44
TPCK*: I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).*	5.69	4.90	3.66	70.43	.000	.47
TPCK*: I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).*	5.46	4.31	4.34	73.58	.000	.40
TPCK*: I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).*	5.63	4.54	4.42	61.67	.000	.38
TPCK*: I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.*	5.96	5.28	3.61	72.67	.001	.38

Variable	Means		*t*	df	Sig (2-tailed)	Effect Size
	Current Educator (n=110)	PST (n=55)				
TCK*: I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).*	5.42	4.71	2.77	67.13	.007	.40
TCK*: I know about the technologies that I have to use for the research of content of my teaching subject.*	5.71	4.57	5.16	66.74	.000	.40
TCK*: I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.*	5.84	5.29	2.59	67.04	.012	.45
TCK*: I can use specialised software to perform inquiry about my teaching subject.*	5.41	4.17	5.03	73.59	.000	.49
TCK*: I am able to use technology to introduce my students to real world scenarios.*	5.89	5.24	3.52	82.86	.001	.39
TCK*: I am able to facilitate my students to use technology to plan and monitor their own learning.*	5.73	4.90	4.35	72.47	.000	.32
TPK*: I am able to facilitate my students to use technology to construct different forms of knowledge representation.*	5.88	5.07	4.30	69.61	.000	.53
TPK*: I am able to facilitate my students to collaborate with each other using technology.*	5.83	5.21	3.30	74.28	.002	.30
TK*: I keep up with important new technologies.*	5.68	4.74	3.62	67.95	.001	.51

To explore how the extent of each educator's online sharing correlated with perceived TPaCK knowledge, t-tests were run on all TPaCK items for the low and high sharing clusters. Significant differences were revealed for twenty items, showing that in every instance, high sharers reported higher levels of TPaCK knowledge than did low sharers. Table 5.35 shows these differences. Of note, the larger effect size for TCK*: I am able to use technology to introduce my students to real world scenarios* (*d* = .51) suggests that high sharers may be significantly more likely to draw on relevant technology and content-related material as part of their involvement in a wider range of online communities. By contrast, the much lower effect sizes for TPaCK items suggest that generalising beyond the immediate sample for these items is problematic and that further research exploring knowledge in relation to this third-order construct and levels of online sharing is warranted.

Table 5.35 - Significance levels by sharing level (Questions 8-9, significant items).

Variable	**Means**		**t**	**df**	**Sig (2-tailed)**	**Effect Size**
	Low	High				
CK: I am confident to teach the subject matter.	5.68	6.24	-2.1	64	.040	.18
PK: I am able to stretch my students' thinking by creating challenging tasks for them.	5.72	6.27	-2.86	55	.006	.22
PK: I am able to guide my students to adopt appropriate learning strategies.	5.66	6.23	-2.99	56	.004	.13
PK: I am able to help my students to monitor their own learning.	5.47	6.00	-2.16	45	.036	.25
PK: I am able to help my students to reflect on their learning strategies.	5.6	6.08	-2.3	55	.025	.11
PK: I am able to guide my students to discuss effectively during group work.	5.6	6.23	-2.9	51	.006	.16
TPCK: I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).	4.49	5.65	-4.59	61	.000	.02
TPCK: I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).	5.09	5.96	-3.48	67	.001	.09
TPCK: I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).	4.55	5.50	-2.89	64	.005	.05
TPCK: I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).	4.89	5.62	-2.39	56.92	.020	.36
TCK: I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).	4.89	5.54	-2.1	55.31	.041	.37

Variable	Means		t	df	Sig (2-tailed)	Effect Size
	Low	High				
TCK: I know about the technologies that I have to use for the research of content of my teaching subject.	4.81	5.81	-3.56	66.5	.001	.31
TCK: I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.	5.36	5.96	-2.35	63.37	.022	.30
TCK: I can use specialised software to perform inquiry about my teaching subject.	4.36	5.88	-5.03	63.24	.000	.38
TCK: I am able to use technology to introduce my students to real world scenarios.	5.4	5.92	-2.03	52.41	.047	.51
TCK: I am able to facilitate my students to use technology to plan and monitor their own learning.	5.11	6	-3.69	53.90	.001	.39
TPK: I am able to facilitate my students to use technology to construct different forms of knowledge representation.	5.28	5.96	-2.78	53.51	.007	.34
TPK: I am able to facilitate my students to collaborate with each other using technology.	5.31	5.92	-2.24	46.23	.030	.30
TK: I know how to solve my own technical problems when using technology.	4.95	5.77	-2.59	59.18	.012	.23
TK: I keep up with important new technologies.	5.04	5.73	-2.02	50.64	.049	.27

Further analysis: discriminant analysis of three main samples.

Discriminant analysis was run on all items for Questions 8-9 using the grouping variable for the three main samples (CC21, MacICT and preservice teachers). The classification results for the three main samples produced a two-function solution, wherein group membership could be predicted in 82.8% of cases. The first discriminant function explained 67.3% of the variance, canonical = .73, whereas the second explained 32.7%, canonical = .59. In combination, these discriminant functions significantly differentiated the three groups, = .31, (62) = 123.56, *p* ≤ .000, and removing the first function indicated that the second function also significantly differentiated the groups, = .65, (30) = 45.27, *p* = .036. The correlations between outcomes and the discriminant functions revealed eighteen of the items loaded more highly on one of the two functions.

Table 5.36 shows the items loading on each function. Broadly speaking, Function 1 included items with a stronger emphasis on content knowledge ("C") and technology skills ("T"), while Function 2 included items with a stronger emphasis on pedagogical knowledge ("P"). The items that loaded on Function 1 reflect the skills and knowledge required to teach content effectively with the use of technology, while the items that loaded on Function 2 reflect pedagogical strategies for learner autonomy, inquiry and metacognition (including the use of technology).

Table 5.36 - Canonical discriminant functions (Questions 8-9 items).

Standardized Canonical Discriminant Function Coefficients		
Red - Function 1 Positive Loadings **Blue - Function 2 Positive Loadings**	**Function**	
	1	2
CK: *I have sufficient knowledge about my teaching subject.*	.162	.427
CK: *I think about the content of my teaching subject like a subject matter expert.*	.223	-.334
CK: *I gain deeper understanding about the content of my teaching subject on my own.*	-.148	-.458
CK: *I am confident to teach the subject matter.*	.649	-.284
PCK: *Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.*	.297	-.273
PCK: *Without using technology, I can address the common learning difficulties my students have for my teaching subject.*	.193	.487
PCK: *Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.*	.245	-.782
PCK: *Without using technology, I can engage students in solving real world problem related to my teaching subject.*	-.730	-.008
PCK: *Without using technology, I can support students to manage their learning of content for my teaching subject.*	-.317	.843
PK: *I am able to stretch my students' thinking by creating challenging tasks for them.*	-.255	.570
PK: *I am able to guide my students to adopt appropriate learning strategies.*	.072	.398
PK: *I am able to help my students to monitor their own learning.*	-.392	.123
PK: *I am able to help my students to reflect on their learning strategies.*	.159	-.709
PK: *I am able to guide my students to discuss effectively during group work.*	.202	.149
TPCK: *I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).*	-.253	.437
TPCK: *I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).*	.046	.124

Standardized Canonical Discriminant Function Coefficients		
Red - Function 1 Positive Loadings **Blue - Function 2 Positive Loadings**	**Function** 1	 2
TPCK: *I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).*	.326	-.613
TPCK: *I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).*	.296	.086
TPCK: *I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.*	-.446	-.344
TCK: *I can use the software that is created specifically for my teaching subject.*	-.133	-.245
TCK: *I know about the technologies that I have to use for the research of content of my teaching subject.*	.497	.239
TCK: *I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.*	-.114	-.297
TCK: *I can use specialised software to perform inquiry about my teaching subject.*	.174	.615
TCK: *I am able to use technology to introduce my students to real world scenarios.*	-.188	-.180
TCK: *I am able to facilitate my students to use technology to plan and monitor their own learning.*	.089	1.341
TPK: *I am able to facilitate my students to use technology to construct different forms of knowledge representation.*	-.435	-.580
TPK: *I am able to facilitate my students to collaborate with each other using technology.*	.307	-.435
TK: *I have the technical skills to use computers effectively.*	.354	-.024
TK: *I can learn technology easily.*	-.487	.433
TK: *I know how to solve my own technical problems when using technology.*	-.026	-.130
TK: *I keep up with important new technologies.*	.526	-.205

The canonical discriminant functions plot is shown in Figure 5.7. The first function discriminated both CC21 teachers and preservice teachers from MacICT teachers, while the second function discriminated MacICT teachers from the other two groups. Given that Function 1 describes includes items about confidence and expertise with subject content and technology skills, while Function 2 emphasises pedagogical strategies, it appears confidence and expertise provided strong predictors of CC21 and preservice teacher group membership, while pedagogical strategies provided a strong predictor of MacICT teacher membership.

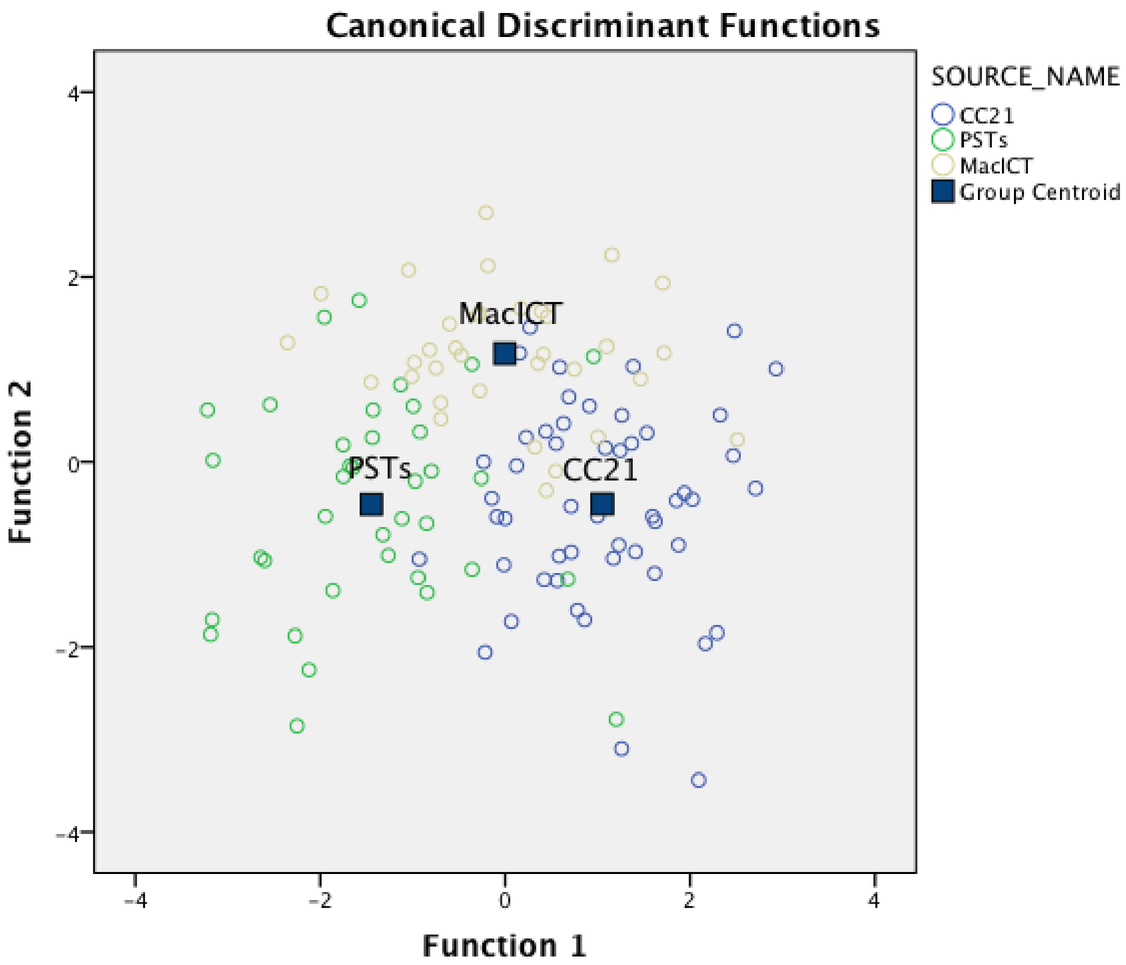

Figure 5.7 - Canonical Discriminant Functions Plot (Questions 8-9 Items).

Final Analysis: Confirmatory Principal Axis Factoring.

Finally, to confirm the different ways respondents perceived the seven constructs and compare and contrast findings to the eight-factor solution reported by Chai, Koh, & Tsai (2011), Principal Axis Factoring – the method used in the original study – was applied to all TPaCK items across the three samples. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = 0.89) and all KMO values for individual items were greater than 0.50. An initial analysis was run to obtain eigenvalues for each factor in the data. Five factors had eigenvalues greater than one and in combination explained 72.3% of the variance. The scree plot was unambiguous, showing an inflexion justifying the retention of five factors.

Table 5.37 shows the factor loadings after rotation. The items that load on Factor 1 include all second- and third-order technology constructs (TCK, TPK and TPCK). Factor 2 includes all PCK items, while Factors 3-5 include first-order constructs for TK, PK and CK respectively.

Table 5.37 - Principal axis factor analysis (Questions 8-9 items).

Pattern Matrix[a]					
	Factor				
	1	2	3	4	5
TPCK*: I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).*	.85				
TPCK*: I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).*	.80				
TCK*: I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.*	.74				
TPK*: I am able to facilitate my students to collaborate with each other using technology.*	.73				
TPCK*: I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).*	.73				
TPCK*: I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.*	.71				
TCK*: I can use specialised software to perform inquiry about my teaching subject.*	.70				
TPK*: I am able to facilitate my students to use technology to construct different forms of knowledge representation.*	.69				
TCK*: I am able to facilitate my students to use technology to plan and monitor their own learning.*	.67				
TCK*: I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).*	.65				
TCK*: I am able to use technology to introduce my students to real world scenarios.*	.61				
TCK*: I know about the technologies that I have to use for the research of content of my teaching subject.*	.60				
TPCK*: I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).*	.60				
PCK. *Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.*		.92			
PCK. *Without using technology, I can support students to manage their learning of content for my teaching subject.*		.90			
PCK. *Without using technology, I can engage students in solving real world problem related to my teaching subject.*		.86			
PCK*: Without using technology, I can address the common learning difficulties my students have for my teaching subject.*		.85			

PCK*: Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.*	.84			
TK*: I can learn technology easily.*		.94		
TK*: I have the technical skills to use computers effectively.*		.71		
TK*: I know how to solve my own technical problems when using technology.*		.68		
PK*: I am able to help my students to reflect on their learning strategies.*			-.94	
PK*: I am able to help my students to monitor their own learning.*			-.91	
PK*: I am able to guide my students to discuss effectively during group work.*			-.79	
PK*: I am able to guide my students to adopt appropriate learning strategies.*			-.69	
PK*: I am able to stretch my students' thinking by creating challenging tasks for them.*			-.51	
CK*: I have sufficient knowledge about my teaching subject.*				.87
CK*: I am confident to teach the subject matter.*				.73
CK*: I think about the content of my teaching subject like a subject matter expert.*				.49
CK*: I gain deeper understanding about the content of my teaching subject on my own.*				.47

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 9 iterations.

While it was not possible to produce the same eight-factor solution as the authors of the instrument, these results show that participants across the three samples were able to distinguish between all first-order constructs and pedagogical content knowledge (PCK). That remaining constructs all loaded in Factor 1 suggests that participants were not able to distinguish between second- and third-order constructs that included technological knowledge ("T"). While a larger and more homogenous sample may be more likely to produce similar results to the original study, these findings suggest that participants across the three samples in this study were able to accurately identify and report on most of the TPaCK constructs.

Conclusion

This chapter has examined some of the key perceptions that underpin a teacher's use of diverse technology tools for the purposes of professional learning. By comparing educators from three distinct contexts, the researcher sought to show that their perceptions are often shaped by the context in which they work and learn professionally. The results further suggest that perceptions measured here act as predictors for the use of different technology tools, thereby shaping the nature and quality of professional learning outcomes. These results generally indicate favourable perceptions of technology tools for the CC21 sample that sit in contrast to those of the MacICT and preservice teacher samples. The results also speak to the importance of operationalising and measuring emerging constructs, especially in the areas of Personal Learning Networks (PLNs) and Participatory Cultures. Chapter 6 discusses the results for both stages of the study.

Chapter 6. Discussion

This chapter discusses the important overarching themes drawn from the analysis of qualitative and quantitative data. These data speak to the complexities of professional learning and school leadership in the digital age. As educators use technology tools to support increasingly personalised professional learning, they build their Personal Learning Network (PLN) and practise skills through their involvement in various online Participatory Cultures. As the researcher has sought to show, this world of online learning is far from separate to the world of face-to-face learning that persists in many school communities. This connection was evident, for example, in the sense that principals clearly valued the autonomous learning that technology mentors in Stage 1 described. These connected school leaders play an important role in drawing on ideas from information sources and colleagues that exist beyond the traditional school and system networks. In particular, the school leaders in the intensity sample used these ideas to transform the learning in their school community, thereby bridging the gap between online and face-to-face contexts. To understand how best to support professional learning in future, we therefore need to see these worlds of face-to-face and online professional learning as intricately connected.

Thus far, this study has investigated a broad range of technology tools, constructs and contexts. The literature review in Chapter 2 argued that although there are well-established findings in the more constrained online contexts of small-group Computer Supported Collaborative Learning (CSCL) and the Learning Management System (LMS), the emerging constructs explored in this study are far more challenging to operationalise and measure. Nonetheless, the study presents key starting points and further steps in empirically examining these constructs and their relationship to school leadership and professional learning. This chapter discusses the findings from both stages of the study, with recourse to the literature, each of the three main participant contexts and the research questions that underpinned the inquiry.

The three themes addressed in this Chapter include: (1) the role of contextual factors; (2) the roles of creativity and sharing; and (3) the role of technology. The term "role" is intended, first, to emphasise the function of each theme in enhancing professional learning and school leadership practices; and, second, to explain the importance of each theme in future research. To ground the discussion in its theoretical framework of pragmatism, quotes have been included that encapsulate the key discourses of each theme.

Research Questions

Research Question 1 – *How, in what ways, and to what extent do teachers use current technology tools to support their professional learning?* – focuses on the use of technology for professional learning. This question served to capture the diversity of technology use for professional learning and reflect the reality that educators in the digital age often employ a wide range of tools in ways they deem appropriate and personally meaningful. For example, each of the four technology mentors in the intensity sample employed the use of *Twitter* to connect with educators within and beyond their system, but each had selected different educators to follow based on needs and interests. By drawing from the Stage 1 participants the most common tools and uses thereof, the researcher was able to itemise current tools and associated uses to explore the perceived importance and relevance of these with participants from all three contexts in the Teacher Professional Learning Questionnaire (TPLQ).

Research Question 2 - *How, in what ways and to what extent are professional learning outcomes for teachers shaped by the context in which the tools are used?* – was very important to the overall design of the study. By examining professional learning within a specific context, the researcher was able to show that the school context plays a key role in determining the nature and effectiveness of technology-based professional learning, a finding that has been echoed throughout the literature (Caldwell & Spinks, 2013; Pearlman, 2006; Williams, 2008). Contexts such as *Connected Communities 21* (CC21) that provide for more open-ended, unstructured and self-managed professional learning arguably enable leaders to better ensure that such learning is responsive to the needs of the school community. These contexts also allow for more diverse forms of professional learning that are more closely aligned with the PLN and the eleven Participatory Cultures. Principals and school leaders in the study seemed aware of the need to promote multiple ways and tools for their colleagues to learn. It is therefore important to closely examine the underlying support structures in terms of the extent to which they allow for, or hinder, these multiple forms of learning. Analysis of the Macquarie ICT Innovations Centre (MacICT) sample reveals some of the many persistent limitations embedded in more traditional modes of professional learning such as the one-day training course. Both this sample and that of the preservice teachers (PSTs) to some degree speak to the lack of autonomy that can be observed in typical case samples.

Research Question 3 - *What principles and heuristics of twenty-first century learning are evident in the ways teachers use tools to support their professional learning?* – speaks to the need to better articulate the nature of effective professional learning in and around contemporary school communities. This question speaks to “false assumptions” that Huber (2010) refers to in describing professional learning that, in spite of being well-intentioned, is “neither sustained, targeted, ongoing, nor job embedded” (p. 42). To some degree, this question was intended to enable the researcher to more fully understand the emphasis on professional *learning* and how this sits in contrast to older forms of professional *development*. Given the emergent nature of twenty–first century constructs such as the PLN and Participatory Cultures, there is a need for further empirical evidence that supports their use in professional learning and informs future planning. Indeed, defining what twenty-first century professional learning currently looks like – or could look like in future – remains a key challenge.

Research Question 4 – *How and in what ways might professional learning in traditional face-to-face contexts be better informed by the diversity of situated learning experiences in emerging and established online contexts?* – explores the possibilities for better aligning the worlds of face-to-face and online professional learning. The findings in relation to this question highlight Smylie’s (2014) problem of “the troublesome relationship between evaluation and professional development – [and] the [related] opportunities for teachers to learn and improve their practice in response to and beyond the process of evaluation itself” (p. 97). Data from the intensity sample in Stage 1 showed that while the world of online learning held value, particularly for the self-directed autonomous technology mentors, achieving similar outcomes for all staff in school remained out of reach. Within the school setting, costly provisions such as release time and further training remain a de facto choice for many school leaders. While it is hard to ensure accountability when professional learning is left to individual discretion and managed in available pockets of time outside of work or study hours, it is nonetheless important to appreciate the value of this kind of learning. Principals such as those in the CC21 sample that incentivise autonomous professional learning through a combination of a new technology device provided in exchange for additional hours and meeting time appear to be navigating the terrain that exists between formal and informal professional learning. They also appear to be using such incentives to encourage positive attitudes and learning behaviours among their staff. It is therefore important to further explore how school leaders leverage available support structures to foster newer forms of professional learning that are responsive to current and future needs.

Theme 1: The role of contextual factors – the how, when and why

> A person may become expert in technical philosophy, or philology, or mathematics or engineering or financiering, and be inept and ill-advised in his action and judgment outside of his specialty. If, however his concern with these technical subject matters has been connected with human activities having social breadth, the range of active responses called into play and flexibly integrated is much wider. Isolation of subject matter from a social context is the chief obstruction in current practice to securing a general training of mind. Literature, art, religion, when thus dissociated, are just as narrowing as the technical things which the professional upholders of general education strenuously oppose (Dewey, 1916, p. 59).

This study first examined teacher professional learning, with a view to understanding the kinds of opportunities, support mechanisms, key personnel and leadership decisions that exist in school communities. The study also investigated professional learning that happens online – frequently beyond the school walls – exploring the possible impact this learning has on the school community as part of the Stage 1 qualitative inquiry. The Stage 2 quantitative component then sought to operationalise and measure the constructs evident in both the literature and the data, examining several key dimensions of teacher professional learning and school leadership through the perspectives of each respondent to better understand how their perceptions reflect the context in which they work and shape the professional learning they undertake. The study also explored common contextual factors that school leaders employ to facilitate professional learning, including the provision of time, technology infrastructure and leadership direction. This study aimed, in part, to reveal how contextual factors shed light on current and future possibilities for professional learning in the twenty-first century.

Connected Communities 21 (CC21) – self-directed leaders of learning.

Given that both qualitative and quantitative stages of the study included CC21 participants, the picture they present is more comprehensive than those of the other two samples. In addition to their responses to the TPLQ, data from one-to-one and focus group interviews provide substantial insights into their school cultures and the impact that participants' professional learning has on their school community. In terms of quantitative findings – and when compared to the other two samples – CC21 teachers demonstrated a wider range of positive attributes in relation to professional learning, representing the strongest cohort of autonomous learners in the study. While not all CC21 participants were considered technology "experts", the TPLQ data show they were more willing to experiment with new tools, especially those used to create, co-create and share digital content. CC21 school teams frequently included many teachers with leadership roles like the mentors described in the qualitative inquiry. Perhaps most importantly, however, each CC21 school team included the school principal. As the qualitative inquiry showed, school principals were often willing to be directly involved in professional learning and often applied a "hands-on" approach when working with their mentors and other staff. The benefits of principal participation to this extent are well recognised in the literature, and include the realisation of school cultures more resilient to change and teachers who are more likely to collaborate and share ideas (Berrett, Murphy, & Sullivan, 2012; Hayes, 2006; Wolosoff & Wolosoff, 2007).

As noted in the summary of the key qualitative findings, the mentors in each of the four intensity sample CC21 schools worked strategically with their principals to effect change. As part of working towards this change, their roles frequently involved managing and facilitating professional learning in a wide range of forms that were often pragmatically suited to the individual learner and the specific school context. Irrespective of the fact that all CC21 participants were required to share online information related to their school's progress and their professional learning during the project, many of these participants (especially the four mentors in the qualitative component) were frequent sharers, and were quite prepared to do so in both face-to-face and online contexts. Further, as the results for Question 7 (the Participatory Cultures component) of the TPLQ suggests, these educators see their face-to-face and online identities as far more similar than different.

Macquarie ICT Innovations Centre– typical-case "like to be shown" educators.

By contrast to the CC21 sample, the MacICT teachers were more diverse, working in a much wider range of schools. Although data for this sample are only drawn from the quantitative inquiry, quantitative findings reveal a range of attributes that may be applicable to other contexts. Of the three groups, MacICT teachers reported spending the largest number of hours outside work each week on professional learning (M=12.98); however, this figure also varied much more widely than the other two samples (SD=10.60). They reportedly spent more of their time in sharing information with people, but were less likely than CC21 teachers to share across most of the eight contexts included in Question 6. Unlike CC21 participants, MacICT educators were not explicitly encouraged, or required, to share information with colleagues online, so their responses to the sharing items perhaps more closely reflect the typical-case uses of tools for sharing in the general population. The patterns in the quantitative data suggest that online sharing activities were largely confined to closed social media (for example, *Facebook*) and email. MacICT teachers were far less likely than CC21 teachers to use more open forms of sharing, such as with *Twitter* or through published blog posts.

Preservice Teachers – required learning over optional learning.

When compared with the other two samples, the preservice teachers were a more homogenous sample, being students within the one institution. As with the MacICT sample, findings for preservice teachers are limited to the results for the TPLQ. Nonetheless, the preservice teachers included in the sample were all completing third-year Education units (as part of a four-year, full-time program) and were required to engage in twenty days of professional experience. A wide range of government and non-government schools provide professional experience for students at Macquarie University. On the one hand, the completion of only twenty days of experience represents a limiting factor in exploring their perceptions of important areas such as leadership decisions, time-related support structures and in-service training programs for current teachers. On the other hand, their tertiary training via Education coursework represents a very large component of their professional learning at this stage in their career. Noting that the TPLQ explored areas such as uses of time "outside of work or study" contrasted with the course-driven necessities of completing their degrees and becoming accredited to teach, the quantitative results of this study can shed further light on the relationship between formal, "required" learning and informal "optional" learning.

Learning that *is* and learning that *could be*.

The data from both forms of inquiry speak as much to the professional learning that *could be* as to the professional learning that *is*. At a time when technology discourses so readily shape how educators think about learning, discourses in areas such as school change, twenty-first century learning skills, digital citizenship and low barriers to digital creativity reflect considerable potential, the realisation of which often depends on how well teachers engage in the learning necessary to implement change, whether as part of a whole school initiative or their classroom practice. Moreover, at a time when information overload threatens to overwhelm many educators, emerging models like the Personal Learning Network (PLN) provide a structured way of thinking and managing a diversity of tools, information sources and people-to-people connections. Given the wide-scale availability of these sources and connections alongside the recent proliferation of low-cost or free technology tools, it is not difficult to see why advocates of the PLN continue to promote its potential within and between many school communities, and elsewhere in educational research. Unlike traditional face-to-face learning – largely dependent on costly allocations of time and human resources such as visiting experts or system leaders – the PLN represents ready access to learning that is more personalised, convenient, accessible and low-cost. It is therefore understandable why most of the principals and mentors in the qualitative inquiry saw online teacher professional learning as an important "next step" for their school.

The potential for this kind of learning still sits at odds with the reality in many schools, where contextual factors such as resistant teachers, poor technology infrastructure, traditional leadership and false assumptions as to what constitutes effective learning often constrain the potential. While the PLN represents a flexible and open model, especially for online professional learning, all of the schools involved in the study still relied on face-to-face learning as their dominant paradigm. At a time when there is renewed focus on concepts such as blended and blurred learning as mid-way points, there still exist considerable differences in approaches to undertaking, managing and supporting professional learning in both face-to-face and online contexts. The online context can be both powerful and personally meaningful, particularly when educators invest time beyond the face-to-face paradigm, growing their PLN and engaging in what is highly autonomous, unstructured and often “DIY” learning. While for some teachers, this kind of learning may appeal for any number of reasons, other teachers may opt for further guidance, more structure and face-to-face instruction. Therefore, both forms of professional learning have key roles to play in the future. Schools and systems will need to manage and support learning across both face-to-face and online contexts, navigating the territory of when, why, how and for whom the different approaches, uses of time and tools are most effective. These challenges ahead arguably call for a highly pragmatic approach to learning that, while centred on the needs and interests of the individual, is grounded in their school context and aligned with relevant change agendas, such as strategic goals, new curricula and/or the required implementation of teacher standards.

As part of working out what is possible and some of the best ways forward, this study has substantially drawn on the perspectives and perceptions of educators at all levels and career stages. In an empirical study such as this, there clearly is a need to properly contextualise – and, where appropriate, control for – these perceptions. For example, Question 1 of the TPLQ focused on “hours of your own time (that is, outside of hours required for work or study)” that are typically spent on professional learning in a working week. Such a question is interesting in terms of the hours that educators perceive are spent on professional learning, the actual number of hours spent and the possible difference between the two values. That high online sharers reported, on average, much more time spent than did low sharers reflects the reality that high sharer educators spend more time online and that they perceive tools such as social media to be important vehicles for their learning outside of the school. Likewise, the lower importance ratings of many online tools by most preservice teachers reflects both the reality that students may receive limited exposure to the tools in tertiary coursework and the related perception that they are not helpful (or, perhaps more importantly, *necessary*) for the kinds of professional learning required at this stage of their careers. In summary, these contextual factors are crucial for understanding the significance of both perceptions and reality.

Educators as critical evaluators of professional learning.

In spite of the differences between perceptions and reality, teachers at all career stages and levels play an important role in evaluating professional learning. The tools and their uses, alongside the cultures for participation and support structures that exist represent important areas of professional learning in relation to which judgment needs to be continually exercised. Moreover, perceptions are a very important element of pragmatism, a theory of learning that reflects the options, choices and actions available to the learner when they are presented with problems, questions and tools for learning. Each tool supports and shapes learning in different ways, depending on *when*, *how* and *why* it is employed. With varying levels of guidance (for example, in a one-on-one session with a mentor during lunchtime, watching an instructional online video or simply experimenting by themselves), educators may select and employ tools that work for them, use them to varying degrees and engage in problem solving and/or inquiry. While these forms of learning may not be largely directed or monitored by others, there is often a purposeful context in which the educator employs the tool. Among the CC21 participants, tools for blogging, collaboration and sharing were used in both instructional (face-to-face training) and self-directed (during time outside of work and/or study) settings. The need to understand and learn from the actions of teachers in a range of schools was an important purpose behind the use of the tools. Likewise, during the qualitative inquiry, professional learning in Schools A, B and C was purposefully linked to experimentation and play with cross-platform devices and tools in order to become more fluent with technology and maximise the affordances available to teachers and students in the school. In particular, Principal C advocated play – an open form of professional learning - *before* determining what the form that other professional learning would take.

Where tangible device use, leadership decisions, and support structures are relatively easy to identify as relevant contextual factors, the nature and depth of professional learning through online communities and tools is a lot harder to measure. Most the schools in the study were yet to make this form of learning a necessary component in the agenda for their school's professional learning. Aside from the preservice teachers, whose study hours beyond formal lectures and tutorials are not always clearly defined, most teachers in the study were not explicitly required by their principals to use online tools for professional learning outside of designated work hours. The exception to this was the CC21 sample, which consisted of teachers who had volunteered to be a part of the project and develop a school plan for responding to curriculum, technology and pedagogical demands. These teachers were required to post weekly blog posts documenting their school's progress and sharing pertinent findings that they thought would benefit other school communities. Although the activities of planning, evaluating and sharing were additional to their typical workload, the vast majority of schools (n=14, 82%) collectively spent AU$60,170 (representing 47.53% of total project funds) on the area of teacher release so that teachers would have sufficient time in the working day to complete some or all of the activities. This finding supports the important corollary that educators often seek to create more available time for both planning and professional learning. The need to develop the skills required to learn professionally in more open online contexts as part of new and yet-to-be-fully-explored paradigms requires substantial amounts of further time away from the still-dominant paradigm of face-to-face classroom instruction. Moreover, as teachers become more skilled and autonomous in their use of tools for professional learning, the need for less structured, more open allocations of time arguably become apparent.

Optionality – the elephant in the room.

While school leaders may ask or encourage teachers to undertake a range of technology-related activities such as play, experimentation, digital creation and sharing, in many situations where these activities occur outside of work and study hours, educators are usually not monitored or held accountable for their learning. As Principals A and D in the intensity sample recognised, the PLN was a recognisable and important element in the learning of some of their teachers; however, monitoring and supporting this kind of learning throughout the school was a difficult challenge to undertake (as Principal A noted, simply identifying which teachers were actively engaged with a PLN was hard because “it’s very personal”). Similarly, the preservice teachers in the study were regularly required to complete online coursework, attend examinations, undertake professional experience, complete assignments and prepare documentation for their accreditation – all external markers of many teacher education programs that are monitored and measured.

However, findings suggest that PLN-based learning was perceived as a largely optional area of their professional learning, with widely varying hours spent online outside of study and key differences in perceiving the importance of many tools for managing their PLN. This issue resonates with OECD findings (Werquin, 2010) on non-formal learning that indicate that in spite of non-formal learning recognition being high on policy agendas, “there is a patent lack of visibility as regards people’s real knowledge, skills and competences, since those acquired during their working lives or other activities remain invisible” (p. 20). The challenge of measuring and rewarding non-formal professional learning bears some similarity with the problem of accountability in online learning articulated by Goodyear and Ellis (2007) in their discussion of the emphasis tertiary students place on required learning for coursework at the cost of learning that is considered optional. Regardless of the context, there remain few assurances that learning seen as optional will occur amongst all learners within the context.

This implicit optionality was also observed for educators in the MacICT sample. Many of these participants were institute-registered teachers, required to regularly undertake further formally accredited training, often in the form of a one-day training course, staff meeting or professional development day. At the time of writing, New South Wales Institute accredited hours do not include informal online learning, so for most of the current educators in the study, activities such as connecting with others via social media or co-creating digital content were likely perceived as optional in comparison to required, accredited hours.

The issue of optionality calls into question whether or not teachers and school leaders are likely to invest time into more autonomous and inquiry-led forms of professional learning in the future. The principals in the study recognised these forms of learning in key areas (for example, the technology mentors that were given further release time to work with other teachers and support their learning); however, they also recognised that adequate time and resources were needed (for example, through allocating further release time during the CC21 project or incentivising optional professional learning sessions through the provision of iPads). Optionality underscores the importance of school culture as a key context for what some refer to as the "tipping point" (Gladwell, 2006). During the qualitative inquiry, it was evident that school leaders were aware of the need to have more teachers behind many school-based initiatives, whether whole-of-school or small-team approaches were undertaken. These leaders recognised that professional learning was a key element of managing the change process and that commitment to this learning was required. Moreover, in describing or alluding to the "buyers and drivers" analogy, many of these leaders recognised the optional nature of professional learning initiatives that are difficult to account for or measure. In particular, the technology-based initiatives in the qualitative inquiry encouraged many of the participants to play, experiment with and "figure out" new tools. There may be identifiable "tipping points" for professional learning in each school community, but reaching them requires a more nuanced understanding of how the "buyers" can effectively become "drivers".

From both stages of inquiry, it is evident that almost all educators have a capacity to learn how to effectively use a wide range of technology tools and platforms through their own autonomy, inquiry and problem solving. Nonetheless, when taking into account key contextual factors such as accreditation and training requirements, leadership actions and the dominance of the face-to-face paradigm, the currency this learning holds may well fall short of the more traditional, observable and measurable forms of professional learning. For example, sending a teacher to a one-day training course or providing an iPad in exchange for attendance at training sessions enables school leaders to them hold accountable for the investment of time and/or money by requiring them to pass on resources, train others or change observable aspects of their practice. Similarly, allocating release time for planning may involve the production of teaching programs. The relative ease with which these measures of accountability can be ensured when more traditional forms of professional learning are undertaken call into question whether or not schools are ready to embrace more open and autonomous forms of professional learning that may be harder to quantify or account for. Such a question invites further inquiry into whether or not school leaders trust teachers to manage their own professional learning alongside the related issue of whether or not to allow wider choice in options to learn professionally. When educators within a school community all receive the same professional learning – such as during many face-to-face sessions – it is possible, on one level to objectively describe the learning that has taken place. On another level, however, all educators have different needs, interests, experience and levels of expertise. Managing professional learning that is sensitive to these individual attributes arguably calls for a greater understanding of the role that more personalised learning can play in improved professional learning outcomes for all educators, now and in the future.

Theme 2: The Roles of Creativity and Sharing

> We are thus compelled to recognise that within even the most social group there are many relations which are not as yet social. A large number of human relationships in any social group are still upon the machine-like plane. Individuals use one another so as to get desired results, without reference to the emotional and intellectual disposition and consent of those used. Such uses express physical superiority, or superiority of position, skill, technical ability, and command of tools, mechanical or fiscal. So far as the relations of parent and child, teacher and pupil, employer and employee, governor and governed, remain upon this level, they form no true social group, no matter how closely their respective activities touch one another. Giving and taking of orders modifies action and results, but does not of itself effect a sharing of purposes, a communication of interests (Dewey, 1916, p. 6).

The findings of this study strongly suggest that sharing and creativity are significant and closely interrelated elements of successful professional learning. In particular, the exchange of ideas in both face-to-face and online contexts forms an important basis for supporting creativity. For example, in a higher education study, Paulus and Yang (2000) found that “under the right conditions, the idea exchange process in groups may be an important means for enhancing creativity and innovation in organizations” (p. 76). Similarly, in a study of workplace interactions, Schepers and Van den Berg (2007) found that “knowledge sharing was related to cooperative-team perceptions and procedural justice; and that knowledge sharing mediated the relationships of cooperative team perceptions and procedural justice with work-environment creativity" (p. 407). Creativity lends itself to sharing, particularly in the online context, where ideas, resources, work samples and links can be disseminated easily to both close and distant colleagues, or publicly on the web. The sharing of ideas through the use of digital tools can therefore provide a rich and diverse learning environment for supporting further creativity.

At the same time, the school environment also plays an important role in supporting creativity and sharing as valid and effective forms of professional learning. In the literature, there is evidence to suggest that the balance between competition and cooperation is key to cultivating a supportive environment for educators in which to create and share. In terms of classroom practice and as a pedagogical approach, for example, Cooperative Learning draws attention to the at-times highly competitive nature of many typical classroom structures. Exploring the most commonly employed classroom structure of *whole-class question-answer*, Kagan (1990) asserts:

> In this arrangement, students vie for the teacher's attention and praise, creating negative interdependence among them. That is, when the teacher calls on one student, the others lose their chance to answer; a failure by one student to give a correct response increases the chances for other students to receive attention and praise. Thus, students are set against each other, creating poor social relations and peer norms against achievement (pp. 12-13).

Further, it has been argued that similar competitive structures are widely evident in broader school and system communities. Noting the neo-liberal emphasis on competition in many education contexts where issues such as standardised testing and leagues tables encourage further competition between educators, students and schools, Hargreaves (2003) has argued that an overemphasis on competition ultimately "prevents schools and teachers from learning from one another. People keep their best ideas to themselves. Districts become the antithesis of learning organisations" (p. 168). Clearly, there are important implications for ensuring that school communities are supportive and cooperative in their encouragement of creativity and sharing amongst educators and their students. Interestingly, while a number of CC21 participants were keen to learn more about Inquiry-Based

Learning as an instructional method in their classrooms, others in the recent literature emphasise the role that these methods can play in supporting teacher professional learning. Among them, Leonard (2015) calls for collaborative inquiry as a conceptual starting point for school-based professional learning in the twenty-first century. Others, including Cho and Shen (2013) and Lin, Huang and Chuang (2015) suggest self-regulation in online learning is a crucial predictor of learning that needs further attention.

Sharing and school leadership.

The study has examined creativity and sharing across a range of variables, stages and contexts. In the qualitative inquiry, both creativity and sharing were important topics of discussion for many participants. Most notably, all of the principals in the intensity sample were keen to encourage the sharing of ideas amongst their staff and prepared to explore a range of tools and support structures to aid this sharing. For example, in School A, the principal recognised the value of social media as a means of supporting professional discussions beyond the immediate school context, while in School D, the principal described her offering approach with technology tools and the "ripple effect", where good ideas would hopefully spread amongst her staff and teachers would be keen to implement them. Principal C's implementation of a multi-platform technology "hub" was intended to challenge his teachers to be more creative in their use of technology and pedagogy, while Principal B advocated "collaborative programming, where teachers "work together on writing very strong, conceptual-based programs".

The principals and mentors in the intensity sample also recognised that the free sharing of ideas was an important basis for creativity in their school communities. Principal A described the nature of her staff weekly meetings, where teachers were encouraged to talk openly about creativity in their classrooms:

> Once a week… [we meet] where the kindergarten team [for example] can say, "hey, this is what I'm doing", or "these are my kids' work samples", or "this is what I found", or "what are you finding?" The professional dialogue is there and it's an expectation. Everybody goes back to their classroom and sticks work on the walls. Everybody then comes to discuss [as a group] what's happening.

Similarly, Principal B chose to release Mentor B from face-to-face teaching because she was considered a competent digital creator. As the principal stressed, "by putting creativity at the centre of what you do [as a teacher], the classroom is a different place… so creativity is something I would like to embed here [in this school]". Principal B also argued that most teachers do not integrate creativity into their teaching programs, and believed that Mentor B could play a positive role in encouraging teachers to be more digitally creative by sharing her practice, particularly during the times she was released from her face-to-face teaching duties and engaged in team-teaching with colleagues.

Connected Communities 21 – authentic creating and sharing for higher order professional learning.

Amongst the CC21 schools, there was evidence the recognised need for inter-school sharing. As part of their involvement in the project, all participants were required to share information about their school's progress in responding to the challenges of curriculum, pedagogy and technology. Frequently based on mutual interests and needs, school communities were encouraged to collaborate and learn from one another, and funding was not tied to explicit professional learning outcomes. As a research design, CC21 sought to cultivate a cooperative interschool environment that existed in both face-to-face contexts (such as the professional learning and sharing days that participants attended) and online contexts (for example, through the weekly blog posts and emails). The results for CC21 participants in both qualitative and quantitative stages of the study suggest that this environment has played an important role in supporting effective professional learning in the digital age, largely by tapping into the nexus between creativity and sharing, and by cultivating a cooperative interschool environment.

At the same time, findings point to some of the many challenges facing schools. The TPLQ explored creativity and sharing at the level of the individual educator, with a view to understanding related issues such as how much time is being spent on these activities, which tools are employed and which online behaviours or Participatory Cultures are in play. The results for both Question 1 (time spent online in relation to categorical time variables) and Question 2 (the perceived importance of key online activities for the educator's professional learning) revealed that allocating sufficient time for creativity is a problem for many educators. Proportionately, participants report spending very small amounts of time digitally creating and/or co-creating content (on average, 5.3% and 3.7% respectively) as a component in their professional learning. In general, most professional learning activities fell into the category of consumption, with items such as *reading information* and *watching and/or listening to multimedia* representing comparatively large time components (26% and 17.2% respectively). This finding draws attention to a possible disconnect between the learning of students and that of teachers in many school communities. While educators commonly accept Anderson and Krathwohl's (2001) revision of Bloom's taxonomy – a revision that places synthesis and creating the highest order of thinking – findings in this study suggest that educators may not see creating as a key component in their professional learning. Though these items in the TPLQ examined creativity and co-creativity as time components outside of work and study, the results nonetheless suggest that insufficient time is being dedicated to creativity as a component of professional learning in a digital age. This insufficiency is especially apparent for the sample of educators that on average spent the least time creating and co-creating and the most time consuming content: the preservice teachers.

Question 6 of the TPLQ in explored the nature of the participant's PLN by asking them to record whether or not they had shared in a particular online context. The results are somewhat limited in their representation of the extent of each participant's PLN, being a measure of the number of different contexts in which the educator is willing share without providing a further measure of the *extent* of sharing within each context. Therefore, in spite what the results for Question 6 may indicate, it is be possible that some high-sharers were not identified, especially if their sharing operated within fewer online contexts (for example, an educator who substantially uses open social media but no other forms of sharing). While identifying the full extent of each individual's PLN was outside the scope of this study, the findings nonetheless reveal significant correlations between the number of sharing contexts and a range of other variables. The Question 6 items were useful inasmuch as they reflect common contexts for sharing. In addition to being asked to share information through means such as email, the school's LMS or a system portal, many educators are now being encouraged to pursue more open platforms for online sharing, such as *Twitter* and public blogs. Question 6 provides a useful marker of the educator's willingness to explore the context in question along with its associated tools and platforms. On the one hand, while a large proportion of teachers in the study share information through email (69.9%), very few were willing to share with *anyone, publicly on the web* (9%). These findings for these sharing contexts are important because they represent not only the means of sharing, but also the forum in which the ideas, resources and other creative artefacts are shared. An educator who uses email to share information in the immediate school community may benefit from their colleagues' input in what are largely private exchanges of ideas, while an educator willing to share information publicly benefits from a much wider audience of educators in the online community.

Perhaps most importantly, the contextual purpose for sharing and creativity may need to be clearly established before more educators are willing to share their ideas publicly online. For some, this will involve a pivotal shift from Hargreaves' (2000) second age of the autonomous professional ("teaching in a box") to the third age of the collegial professional. However, in a similar vein to Dewey's criticism of the "not yet social" cited earlier, Hargreaves cautions:

> Not all teachers are being drawn to their colleagues, of course. Many remain ignorant about or indifferent to the possibilities of collaboration, and some cling tightly to their classroom autonomy when others try to force collaboration upon them. While there is little solid evidence about the extent to which teachers in general are now working more collaboratively, numerous case studies and interview-based inquiries point to growing commitments to collaboration, and testify to its mounting importance in the landscape of teaching not least as a way of making sense of and responding to new external curriculum and assessment demands (pp. 162-163).

The recognition of the growing commitment to collaboration is perhaps most strongly evident amongst the findings for CC21 educators, who as part of the project were engaged in collaboratively responding to the challenges of curriculum, technology and pedagogy. As a self-selected sample with a large number of principals and school leaders, these educators were more predisposed to collaboration than the other two groups. Moreover, the inter-school connections they forged as part of their involvement in the project are somewhat different to the personal connections that many educators form online through their PLNs. However, the provision of both face-to-face and online environments for creativity and sharing appears to have been a key factor in the success of the project.

The benefits of sharing for professional learning.

Based on the results for Question 6, the *sharing level* computed variable applied throughout TPLQ data analysis repeatedly reveals how important an educator's willingness to share in a wider range of online contexts is for their professional learning. Participants in the high sharing cluster performed consistently well in relation to a number of variables. High sharers typically reported investing more time into creating, co-creating and sharing digital content. This investment of time appears to correlate quite closely with more favourable perceptions of the digital tools examined and with higher levels of teacher knowledge in important areas like inquiry-based learning, authentic tasks and pedagogical approaches, as reflected among the significant TPaCK items. While there were high sharers in every sample, they were particularly well represented in the CC21 sample, where participants arguably benefited both from their willingness to share in general, and from their involvement in the project. Likewise, CC21 participants in the low and medium sharing clusters benefited from the guidance that was provided with tools for collaboration and blogging, as well as from their interaction with other, more tech-savvy educators from a range of schools – that is, benefiting from being encouraged to share more than they otherwise would. Further, this guidance provided to CC21 participants during structured professional development days seems to have played a positive role in shaping their perceptions of the tools' importance for professional learning, as evidenced by discriminant analysis for several TPLQ components that showed clear distinctions between CC21 and the other two samples.

From their responses, it appears overall that participants in the high sharing cluster demonstrate greater levels of confidence in their use of technology tools for professional learning. The twenty items among Questions 8 and 9 for which there were significant differences between low and high sharers revealed that, on average, high sharers reported significantly higher levels of TPaCK knowledge than those in the low sharing cluster. Moreover, the eight significantly different items for Question 7 (Participatory Cultures) shows that those high sharers are more likely than participants in the low sharing cluster to learn through experimentation, play, problem solving and networking. Conversely, the results for Question 4 items (support structures) reveal that low sharers have a clear preference for structured, face-to-face professional development while high sharers appreciate support structures like software for online collaboration and freedom to try new technology tools. Importantly, low sharers were significantly more likely than high sharers to require support in the form of release from face-to-face teaching (RFF). This points to the possibility that high sharers are more able to manage time for their learning both within and outside of the school community. The significant amounts of time they do, in fact, spend outside of work – over and above participants in the low sharing cluster – suggests there is some form of underlying motivation for learning that clearly warrants further research. It may be possible that educators engaging in higher levels of sharing receive more validation for their work than those who restrict their sharing to private exchanges and/or face-to-face contexts. Likewise, it may be possible that high sharers are more intrinsically motivated learners, or that online sharing is an important factor in the development of learner autonomy amongst educators.

Macquarie ICT Innovations Centre – one-day courses provide limited opportunities.

In comparison to the CC21 sample, MacICT educators reportedly spent slightly more time creating digital content (7.1% compared to 6.7%), though this difference was not significant (p = .79). On the other hand, CC21 educators spent significantly more time *co*-creating digital content than MacICT educators (6.3% compared to 3.0%, p = .02). Given that MacICT participants were similar to CC21 participants in terms of time spent creating yet significantly different in terms of time spent co-creating, these results suggest that MacICT educators may not have benefited from having a sustained online community in which to share their work and create with colleagues rather than by themselves. In Question 2, both post-hoc Tukey tests and discriminant analysis showed that MacICT educators were, in fact, much closer to preservice teachers in their perceptions of the importance of each online activity, especially those pertaining to editable websites and blogs. Similarly, in relation to the support structures listed in Question 4, MacICT educators were less likely than CC21 educators to place the same value on support structures that incorporated unstructured time. Post-hoc Tukey tests of the eight common support structures revealed no significant differences between MacICT and preservice teachers for those items, again pointing to similarities between these groups. In contrast to the CC21 sample and as attendees for one-day face-to-face training workshops, MacICT educators did not have a commonly articulated context for online sharing and creativity, a fact that may explain why they reported less time spent co-creating than did CC21 educators. While co-creating represents the smallest component of time spent across the three samples, it is nonetheless very important for maximising the learning outcomes associated with creating, being an action that embodies reciprocal creativity and sharing rather than an individual activity.

These findings draw attention to co-creation as both a challenging and rewarding professional learning activity, especially when undertaken in an online setting. Currently, a wide range of tools exists to enable educators to work together across different times and places. However, mastery of such tools is difficult for those who prefer face-to-face learning, given their need to develop skills that may be readily applied beyond the face-to-face settings associated with many school communities. Again, willingness to share online – as evidenced by the results for Question 6 – appears to be a key factor in undertaking both creativity and co-creativity as professional learning activities. In real hourly terms each week, high sharers spent more than fourfold the amount of time creating (1.45 hours compared with .34 hours) and more than threefold the amount of time co-creating (1.08 hours compared with .27 hours) than did those participants in the low sharing cluster. Given the importance of creating and co-creating as key forms of higher order learning, the implications of more or less time spent in these areas could, over time, prove very significant. In a typical school year of forty weeks and based on the figures reported for Question 1, the average time high sharers spend across these areas would amount to 101.2 hours, compared with low sharers spending just 24.4 hours. While these results are limited to the three samples studied and may be prone to margins of error, the findings suggest that further research exploring the impact of creativity and co-creativity as forms of professional learning is warranted.

In spite of the more limited amounts of time spent co-creating, there were some positive attributes emerging in the quantitative findings for MacICT teachers that warrant further attention. In the discriminant analysis of the Participatory Cultures items in Question 7, MacICT teachers were distinguishable in their responses to several items. Perhaps most notably, the items *If I'm stuck using a technology tool, I'll ask for help from someone who knows, I use technology tools to take someone's ideas and make them better* and *I find things online through links shared with me on social networks like Facebook* provided strong predictors of MacICT group membership. These responses suggest that while MacICT educators were predisposed to professional learning with technology in both structured and unstructured forms, there was a clearer preference for more structured forms, perhaps explaining their attendance at the one-day workshops.

At the same time, MacICT teachers also placed significantly less importance than the other two groups on items pertaining to more traditional transmissive forms of professional development, such as *listening to a guest speaker during a professional development day or staff meeting*. These differences suggest that some MacICT teachers may be ready to move away from the dominant face-to-face paradigms that are reflected in many school communities and training programs. Nonetheless, some of these educators may need further guidance before they can learn in highly autonomous ways.

Preservice teachers: competition hinders sharing.

Perhaps most notably, the findings from the sample of preservice teachers in this study draw attention to problems with earlier assumptions in the literature that young people are naturally more digitally creative than their older counterparts (Lenhart & Madden, 2005; Prensky, 2005). While the majority of participants in the preservice teacher sample fell into the age range of 21-24 years old, their responses did not reflect higher levels of digital creativity. The TPLQ specifically explored creativity for the purposes of professional learning, and it is possible that some of the preservice teachers might engage in digital creativity for other purposes.

Nonetheless, the amounts of time indicated in response to Question 1 and levels of importance indicated in response to Question 2 quite strongly suggest that these preservice teachers may not fully recognise the importance of digital creativity for their future careers. Instead, TPLQ findings indicate that preservice teachers spend less time using the Internet for professional learning overall, and proportionately much more of their time on consumption in areas like watching and/or listening to multimedia and reading online content. Given the importance of developing high quality teaching resources and strategies for their future careers – alongside the proliferation of technology devices in schools – this lack of time invested in digital creativity is concerning.

Unlike CC21 participants, preservice teachers are generally not consistently encouraged to share their professional learning with others. Vying for grades and future jobs, they are more likely to be competitive and guarded in what they choose to share – supporting Hargreaves' view that a strong neo-liberal emphasis in education discourages sharing in schools. Furthermore, like most undergraduate students, a large portion of preservice teachers engage in casual and part-time work that frequently approaches full-time hours, a factor that among several Australian higher education studies has been associated with lower GPA scores (McKenzie & Schweitzer, 2001) and significantly higher levels of study-related stress (Burns, 1991; McInnis, James, Hartley, & others, 2000).

Given that these pressures and many competitive processes and outcomes frequently mark their tertiary learning experiences, it is not surprising that preservice teachers in this study shared information, on average, in far fewer online contexts than current educators. This finding echoes earlier evidence in the literature, such as Kennedy, et. al. (2007) who found that "the use of collaborative and self-publishing 'Web 2.0' technologies that have often been associated with this generation is quite low" (p. 517).

The combination of limited professional experience, the need to complete tertiary teacher training and the overemphasis on competition appears to encourage preservice teachers to share less and focus more on the areas most necessary to gaining accreditation and employment. The online behaviours in which preservice teachers in this study are engaged appear to have been shaped by their circumstances, with less time-consuming behaviours such as using the Internet to check facts taking precedence over play and experimentation – and more consumptive activities taking precedence over creative ones. By contrast, current educators do not have the pressures of completing preservice training, and many have greater job security. Though Hargreaves' concerns clearly still persist in modern schools, there may well be more positive attitudes to sharing amongst current educators in schools than there are in the highly competitive and increasingly marketised environment of the modern-day university.

Theme 3: The Role of Technology

> It is pertinent to note that in the history of the race, the sciences grew gradually out from useful social occupations. Physics developed slowly out of the use of tools and machines… The great advance of electrical science in the last generation was closely associated, as effect and as cause, with application of electric agencies to means of communication, transportation, lighting of cities and houses.... These are social ends, moreover, and if they are too closely associated with notions of private profit, it is not because of anything in them, but because they have been deflected to private uses – a fact which puts upon the school the responsibility of restoring their connection, in the mind of the coming generation, with public scientific and social interests (Dewey, 1916, p. 172).

Developed in relation to pragmatist epistemology, this study has attempted to understand what amounts to a wide range of technology tools for enabling professional learning, as reflected in the literature and as identified, discussed and perceived by the participants across the three samples. This research design is admittedly broad, standing in contrast to the more finite empirical studies of particular tools, areas and contexts, such as examining specific uses of *Twitter* as a social media platform in higher education. While these more finite studies can lead to valuable findings that support or negate the use of certain tools in quite specific contexts, they do not necessarily take into account the broader reality in which many educators employ a *range* of tools in different configurations and contexts. As new tools are developed, educators have the agency to *choose* how, in what ways, and to what extent these tools will be used to support their professional learning. However, the degree to which this choice is exercised may be dependent on the context in which the tool is used, such as exploring it freely in time outside of work or study as opposed to being required to use it in specific ways at certain times by an employer, colleague or instructor. As we have seen for many current educators in the study, learning in an online context is often less formal and less structured than many traditional contexts such as the one-day course or staff meeting. Therefore, the choices and actions that exist at the level of the individual educator in both face-to-face and online contexts are especially important.

The Personal Learning Network – a new model for professional learning?

By exploring the Personal Learning Network (PLN) as an emerging model that is arguably closely aligned with pragmatism, the study has investigated the use of technology tools in two key areas: first, to aggregate multiple online information sources; and second, to facilitate, expand and amplify the range of possible people-to-people connections (Warlick, 2009). While these two areas provide a useful starting point for exploring professional learning in a digital age, different educators undoubtedly place varying emphases on each of the tools currently available. Understanding some of the factors that inform these emphases has been an important element in the design of the TPLQ. By exploring the key relationships between decisions, actions and perceptions, the study has attempted to empirically measure some of the many dimensions of autonomous professional learning. In particular, the study has examined technology-enabled learning in both formal and informal settings with a view to understanding how the findings in one area can inform future work in the other.

Drawing attention to technology as an enabler rather than an end in itself, the study's findings speak to Dewey's notion of *tools* as "reference points for the individual as she attempts to navigate life situations… that inform immediate activity, but in an atmosphere of free inquiry… do not limit it" (Glassman, 2001, p. 5). Perhaps most importantly, as Glassman further points out, "the meaning of tools in a Deweyan framework is directly related to their value in a given situation… [and] when the tools no longer have pragmatic value, they are modified or rejected by the individual using them" (p. 5). As noted in Chapter 2, this framework is critically different to social constructivism, where the teacher and tools often intentionally serve the collective interests of others, such as the state, as evident during the 1930s when Vygotsky developed his theories of socio-constructivism in communist Russia. In reference to the PLN as a pragmatic model for professional learning that can encompass a range of technology tools for different purposes, this study supports the notion of the learner at the centre of the network, around which the tools exist to serve their needs and interests. In the online context, the autonomous learner has considerable agency to explore, select, evaluate and employ the tools that they perceive will support their learning. However, in the digital age, the use of these tools is, to some degree, mediated by the interests of those who develop and monetise them. Therefore, while many free and low-cost tools can be powerful enablers of learning, the need to evaluate, repurpose and, if necessary, reject available tools are as prescient in the digital age as in Dewey's time.

The pragmatist nature of technology use for learning in schools.

Amongst the four schools in the intensity sample, there was strong evidence of pragmatist conceptions underlying the deployment, use and evaluation of technology tools for learning. In particular, the prevalence of cross-platform environments in all four schools emphasises the importance of having multiple tools available and the belief that no one tool can, by itself, effectively support the full range of learning needs evident in the school community. Both Principal A and Mentor A were sceptical of a one-device approach, citing iPads as an example of an expensive device that presents limitations. Principal A suggested that support for using a given technology tool was more important than the tool itself, implying that with the right level of support, teachers are more likely to realise the affordances and limitations of whatever tools available:

> I mean, it's great for schools that have taken on the whole "iPad one for a child". But it has its limitations as a device. We have a certain component of them here, but we have an affordable device [the X01 netbook] that has also limitations as the "one device". Still, I can buy a lot more those for $100 [apiece] than I can iPads. So it just depends how you support teachers so that they feel they can embrace the right tool and use it to enhance their teaching. It's about strategically ensuring that teachers have the most support they need, because when they are supported, they'll give it a go.

Similarly, Principal B's strong support for a "mix" of iPads and netbooks reflects the underlying belief that neither tool could solely meet the full range of needs in School B. Principal C's "Hub" was designed to challenge teachers to respond to a diverse range of tools and platforms while developing knowledge of the affordances of each, addressing the problem of educators simply using the tool to fit existing practice. However, given that The Hub was being launched at the time of the visit to School C, it was not clear whether or not teachers would be able to effectively plan lessons that could incorporate each tool. In her school, Mentor D had purposefully employed the use of Skype to connect with the education consultant in Canada. This action enabled her to access further support and educate her students about the value of video conferencing technology for connecting people from around the world.

As noted in Chapter 2, adult learning is a particularly important context for exploring the use of technology within a pragmatist framework. Citing a body of research in this area, Lieb and Goodlad (2005) argue that autonomy and self-direction are key principles of adult learning, stating that such learners "need to be free to direct themselves" (p. 1). They further note that self-directed learning for most adults is usually relevancy-oriented and practical, but that adult learners "must see a reason for learning something… [and] the learning has to be applicable to their work or other responsibilities to be of value to them" (p. 2). The educators in this study were all able to employ technology tools to engage in professional learning, both within and outside of their school community. The positive ratings of support structures such *the freedom to try new technology tools with my students* further attest to the importance educators placed on freedom of choice. However, there was inconsistent evidence to suggest that all educators in the study saw reasons for using the tools that were cited. Failure to see these reasons may have led some to simply use the tool as required by their principals rather than using it purposefully to meet their learning needs, or to simply reject the tool altogether.

In this context, it is important to bear in mind Dewey's conception of *slavery* as tied to the *mechanical use* of tools rather than to *intelligent action*. For Dewey, the use of tools at the mechanical level means that the learner is unlikely to extend their use of the tool beyond socially sanctioned or required uses. In this respect, Dewey argues that the learner becomes a "slave" to the tool, and wasted potential results:

> It is generally believed, for example, that slave labour was ultimately wasteful even from the purely economic point of view—that there was not sufficient stimulus to direct the energies of slaves, and that there was consequent wastage. Moreover, since slaves were confined to certain prescribed callings, much talent must have remained unavailable to the community, and hence

> there was a dead loss. Slavery only illustrates on an obvious scale what happens in some degree whenever an individual does not find himself in his work. And he cannot completely find himself when vocations are looked upon with contempt, and a conventional ideal of a culture which is essentially the same for all is maintained (1916, p. 262).

While promoting free inquiry, pragmatist epistemology also draws attention to the impact of an education that does not properly equip learners to fully understand the tools they employ for learning. While pragmatists maintain that such understanding is best cultivated through primary experience (rather than simply learning *about* the tool), adult learners have an important role to play when guiding their students. In the digital age, children are more susceptible to the hidden agendas of the companies that promote the many free and low-cost tools now available. For example, *LinkedIn's* recent lowering of the minimum age for users – from eighteen to thirteen – provides a valuable opportunity for younger learners to develop their online professional identities at an earlier stage. This move coincides with a similar move to promote sponsored university pages to school-aged children, enabling them to access relevant information to inform their choices for future study. However, As Dignan (2014) points out, "*LinkedIn's* moves are designed to increase reach as well as bolster frequency. After all, if *LinkedIn* can get career minded people young with a university hook, it can be the resume and networking tool for a good 50 to 60 years" (np.) Therefore, the tools of the digital age need to be regarded as powerful, but far from value-neutral. Recognising when such tools have been "deflected to private uses" remains an important element of being an informed and empowered user.

While pragmatism broadly describes how educators in the study used technology tools for professional learning, the study itself only examined specific tools as examples within process-oriented contexts. In both the interview questions and TPLQ, these examples served as possible reference points without attempting to limit the scope of tools that might be used, either now or in the future. Given the prolific growth of the Internet over the last fifteen years, it is highly likely that many of the examples cited in this study will be supplanted with newer tools in the immediate years to come. These continual processes of development and supplantation often reflect the market forces of innovation and competition, being at one level largely beyond the control of the individual learner. However, the user base for any product can play an important role in shaping its development. Among many free and "freemium" web tools – where the costs of development and use are largely met by advertisers and investors – the number of users represents a significant factor in the success of the business model behind the tool. While there is an obvious tension between the developers' loyalties to investors and advertisers on the one hand, and users on the other, factors like positive reviews and user-led endorsements are important to sustaining the popularity and financial viability of the tool alongside its attractiveness for further investment. In other words, many developers value and respond to user feedback – and this is one plausible way to achieve the re-purposing and revision of tools within a broader, democratic Deweyan framework. Critically engaging in dialogue with technology developers therefore represents an important democratic responsibility for adult learners in the digital age.

Technology experience and fluency.

Undoubtedly, pragmatist epistemology hinges on the experience of the learner. As this study has revealed, experiences can be substantially shaped by both online and face-to-face contexts. Where experience with technology tools is limited, there is evidence in the study's findings to suggest that educators do not attach the same levels of importance to the tool that others who are more experienced do. A primary limiting factor to experience is, by extension, the level of learner autonomy. Rather than professional learning being limited by the information scarcity of the print era, an educator's willingness to explore new tools for accessing information and people-to-people connections is now a primary factor in the experiences that will become part of their professional learning. While openness to new experiences is especially important to ensure that professional learning is responsive to the evolving needs of school communities, so too is establishing formal professional learning that supports the development of learner autonomy rather than a dependence on the provider.

The diversity of tools and platforms among the intensity sample schools reflects the recognised need for fluency for all educators. From the qualitative data, it appears that some educators in these school communities had a predisposition towards exploring new tools through play, inquiry and experiential learning. In turn, the principals appeared to highly value the teachers that were able to demonstrate autonomy and move beyond mechanical use of the tools, often through creating new solutions, accessing previously unknown information and cultivating new connections. To develop further autonomy, the four mentors played an important role. Each of these mentors represented highly autonomous educators who were able to train themselves where necessary, while equipping lesser-able teachers – many of whom preferred face-to-face mentoring – with similar skills. As educators in the qualitative inquiry appear to recognise, technology is a powerful enabler, but the experiences and autonomy levels of the teachers using them limit the potential. As noted in Chapter 2, many of the tools now available enable new and still untapped professional learning opportunities, promising to disrupt and transform learning. In the qualitative data, there was evidence of excitement amongst school leaders for possible professional learning with new tools, along with a strong sense of collegiality around the professional learning challenges ahead. In contrast, there was no clear evidence of teachers negatively judging those with more limited ability or experience with the tools in question. Neither was there strong evidence of particularly harsh judgment of those who might actively resist the use of new tools. However, there was strong evidence of leaders' praise for teachers who acted as "drivers", with the perceived need to support them further with time and other resources.

Technology "drivers" and "buyers".

The "driver" and "buyer" analogies are especially apt when discussing the role of technology in professional learning. In many schools, there are teachers that are either resistant to, or lacking skills in, many of the technology tools now available. While the mentors in the qualitative inquiry worked hard to support lesser-able colleagues, principals tried different approaches to incentivise, compel and/or encourage those resistant to change. The findings suggest that there may indeed be a crucial "tipping point" in terms of technology predisposition becoming self-directed and autonomous.

In particular, the CC21 findings reveal that some guidance with flexibility plays an important role in this managing this shift. Further, actual experience in using the tools is very important. For CC21 participants, the purposeful use of tools for creating, co-creating and sharing appear to have played a pivotal role in these participants valuing the associated tools more highly than the other two groups.

Whether or not guidance with the tools in question needs to happen in a face-to-face setting is an important question. The findings suggest that for many "drivers", face-to-face learning may frequently be unnecessary; for the "buyers", however, such learning is essential for ensuring that they receive some exposure to the use of the tools. While navigating the terrain of what kind of professional learning works best for whom remains a challenge, principals can play a role in ensuring that play, inquiry, choice and freedom are key elements of any professional learning initiatives. Most importantly, recognising and managing the shift from less autonomy to more autonomy – from "buyer" to "driver" - arguably calls for a more nuanced and learner-specific implementation of support structures, such as decreasing highly structured professional learning and allowing for more open-ended forms as the educator demonstrates more autonomy.

Experience with technology - a precursor to favourable perceptions.

The results for the TPLQ are somewhat limited by the specification of tools as examples. While teachers were not directly asked to rate specific brands of tools, the use of categories (for example "websites that I can edit") and examples (for example, "Wikispaces") was intended to help the respondent be aware of typical tools that are used in education to achieve specific aims. In particular, the items in Question 2 did not presuppose direct experience in using the tool in question. It was fairly assumed, that teachers who had more or less experience using the tools cited as examples would still be able, to some extent, to evaluate it for achieving the specific aim. Of course, as the results for some participants suggest, limited experience often limits the perspective through which the tool is judged, not least because awareness and appreciation of the tools' importance for learning may hinge substantially on this experience or lack thereof. Nevertheless, perceptions from both experience and non-experience remain important.

TPLQ data indicate that both MacICT and preservice teachers did not as favourably view many of the tools and online activities, especially those related to creating, co-creating and sharing digital content. For both samples, these less favourable ratings correlate with less amounts of time being spent in these areas, as noted in the divisions of time – and time spent overall - in Question 1. For the preservice teachers, the combination of significantly less time spent with significantly less favourable ratings of the activities and tools points to the possible lack of experience with the tools in question and further highlights the importance of appropriate guidance. Noting that preservice teachers have far less experience than most current educators, their uses of technology tools for professional learning may be largely confined to what they learn about in coursework, apply in professional experience and/or try in time outside of work and study. In many cases, these experiences are limited to the handful of years spent completing their Education degrees. By contrast to the CC21 sample, it therefore appears that educators who have limited experiences using technology tools are far more likely to see the tools as relatively unimportant for their professional learning. For preservice teachers, their degree and gaining accreditation are undoubtedly both very important and largely dependent on passing coursework and professional experience. In this context, it appears that at the preservice career stage, less formal and less structured forms of professional learning are subservient to professional learning in the often highly structured teacher education programs.

Participatory Cultures and the murky waters of online behaviours.

The results for Participatory Cultures items in Question 7 shed further light on many of the online behaviours that characterise the preservice teacher sample. These results suggest that when compared with current educators (that is, both CC21 and MacICT samples combined), preservice teachers are significantly less likely to build on others' ideas, experiment with new tools and share information with colleagues. By contrast, they are significantly more likely to prefer to be shown how a technology tool works before using it and to use the Internet to look up and check facts. They also more readily admit to being easily distracted, having trouble focusing on one task at a time and being unsure about the reliability of content they find on the Internet.

While further work needs to be done to validate the constructs that inform the eleven Participatory Cultures, these results appear to lend weight to many of the issues identified elsewhere in the TPLQ, with current educators who reported lower levels of creativity, co-creativity and sharing frequently reporting a preference for more structured, face-to-face forms of professional learning. These findings again point to the need for support structures to be flexible to the needs of the individual learner. They also suggest that any formal professional learning program needs to incorporate learner autonomy as a key aim to ensure that learning continues beyond the life of the course.

Chapter 7. Conclusion

This study has explored the current and future potential for technology-enabled professional learning and school leadership. Given there is a diverse range of tools available to support educators and provide opportunities to network, access information, create and share, the potential for learning in the future naturally flows in many directions. In this digital age, *personalisation* has now come to define the nature of learning for many individuals, whether through the highly personal devices such as tablets and smartphones, or through the Personal Learning Network (PLN) constructed around the unique needs and interests of the individual learner. Given the diversity in teacher skills, their choice of tools, the many opportunities to learn and learning preferences that exist, defining what constitutes *best practice* for professional learning in the future is challenging. Nonetheless, by recognising diversity and choice as important starting points, we can distinguish the digital age from the preceding industrial age with its vestiges of uniform classrooms and staffrooms now challenged by the push towards learning that is personal and highly connected. Doing so means that we must recognise and support learning that happens both within, and beyond, the school walls.

Limitations of the Study

In drawing conclusions, a number of limitations of the present study should be noted. As explained in Chapter 3, the focus of professional learning in *Connected Communities 21* (CC21) was school- and team-based. Specific professional learning activities were, at times, determined by the individual participant, while at other times were determined by other school leaders or through team-based planning. These aspects of the research design for the project made it difficult for the researcher to separate: first, individual and group actions; and, second, professional learning that was required for the project and professional learning that occurred in addition to project requirements. To some degree, these issues were addressed through the selection of the intensity sample as the best cases of individuals who clearly demonstrated high levels of agency and autonomy. Further, the focus on first-order TPaCK dimensions meant that the professional learning that was studied was grounded in these important elements. However, it remains that the school-based projects determined for the purposes of CC21 represent a constraining factor that no doubt shaped the professional learning that took place for some of the participants. Future research could address this limitation by separating the actions of individuals from those of the group, and more explicitly separating "required" professional learning from "additional" professional learning when instrumentation is designed and implemented. The underlying nature of CC21 as a model for a collective case study design of school-based professional learning nonetheless remains relevant, and the cases discussed within this sample have yielded insights that are consistent with the overall aims of the study.

While the study has explored technology use as a key element in professional learning at the present time, such technology use always interacts with other forms of professional learning, including face-to-face interaction. Clark (1994) was among the first to claim that technology-based media "will never influence learning" (p. 21), citing pedagogy as the confounding – and largely unaddressed – variable when examining learning outcomes that stem from technology use. Similar arguments have been expressed about cost-effectiveness of technology when it is misused (see, for example, Cuban, 2001), and superficial or "flashy" use of for learning (see, for example, Jonassen, 2008). In the context of these and similar arguments, it is problematic to make any claims that individual tools – or combinations of tools – actually enhance professional learning without the intermediary of the individual user of the tool in question. Nonetheless, by looking more closely at the teacher's underlying values, actions and beliefs, it is possible to begin to explore, and better understand, pedagogy as the confounding variable. Future research might look critically at tools in terms of their affordances and identify the actions, beliefs and/or values that best enable these affordances to be realised along with other contextual factors that help or hinder.

Similar to the two samples of current educators, preservice teachers evidently had some difficulty separating the learning required for their coursework and additional – or "optional" - learning that the TPLQ specified was "outside of work or study". This muddying of the waters between required and optional learning represents a limitation in the study that must be noted. Goodyear and Ellis (2007) frame the problem by examining students' motivation to learn within coursework, suggesting they are far more motivated by graded tasks than non-graded tasks, even when the learning value between these kinds of tasks is equivalent. However, it also should be noted that in Australia, at the time of writing, entry into the teaching profession is highly competitive and there is a shortage of jobs – a reality conveyed to students in many first- and second-year Education lectures and circulated in the media. The preservice teachers in the study were well aware of the difficulties they face in future employment, and most appear to understand the need for further professional learning for the purposes of positioning themselves competitively. Future research might contextualise the present reality for preservice teachers further, by examining their perceptions about employability and how these intersect with their decisions to learn professionally beyond the requirements of their coursework. In spite of the grey area between required and optional learning, we see here, the same persistent issue evident in the CC21 and MacICT: the need to accurately measure and reward additional, non-formal learning.

The remaining limitation relates to the reliability – and to some degree, validity – of the constructs addressed. As noted at several points in this thesis, the three main constructs explored – Personal Learning Networks (PLNs), Participatory Cultures and Technological, Pedagogical and Content Knowledge (TPaCK) – are multi-dimensional and difficult to operationalise. In developing the Teacher Professional Learning Questionnaire (TPLQ), the researcher recognises that the treatment of these constructs in this study is exploratory and tentative. However, it remains that each of these three models are widely popular amongst practitioners and researchers in education. Therefore, further research might build on both findings and shortcomings to ensure that instrumentation can accurately measure the construct. In the case of the PLN, the challenges are vast, since measuring the size, scope, quality and impact of an individual's professional learning network is challenging. Future research in this area would best employ mixed methodologies to capture both quantitative and qualitative data on an important phenomenon in the digital age.

Professional Learning Horizons

In the space of two decades, we have moved away from the dominant paradigm of print media to a shifting digital world where information is in flux. Most educators throughout the developed world – and, increasingly, the developing world – are able to tap into relevant information sources and people-to-people connections on their personal and increasingly powerful devices. Many no longer accept that the "one-size-fits-all" industrial approaches that have defined education until relatively recently should continue. As we further investigate the options now available, technology tools are being used to effectively enable the kind of personalised learning that Dewey theorised a century ago – learning that has, for the most part, been unattainable in the face the many industrial realities that have persisted for so long. Many educators are, for example, re-exploring learner-centred instructional models for which Dewey's learner-led inquiry laid the foundations; for example, the authors of the 2014 *Horizon Report for K-12* note:

> Project-based learning, problem-based learning, inquiry-based learning, challenge-based learning, and similar methods foster more active learning experiences, both inside and outside the classroom. As technologies such as tablets and smartphones are more readily accepted in schools, educators are leveraging these tools, which students already use, to connect the curriculum with real life applications. These active learning approaches are decidedly more student-centred, allowing learners to take control of how they engage with a subject and to brainstorm and implement solutions to pressing local and global problems (L. Johnson, Adams Becker, Estrada, & Freeman, 2014).

By positioning their students at the centre of the learning and encouraging them to develop pathways that reflect their interests and employ tools accordingly, educators are challenging the long-held belief that knowledge transmission from teacher to learner constitutes acceptable pedagogy. At the same time, educators have the opportunity to place themselves at the centre of *their* professional learning and consider their needs and interests, strengths and weaknesses and future career goals.

Breaking ties with the traditions of the print era.

Though we no longer have the same kinds of information and location constraints that marked the industrial age, some in education persist with assumptions tied to the older realities of the print era. Schools may, for example, invest large amounts of money to procure the physical presence of a guest speaker at a staff development day where similar, perhaps even superior, learning outcomes could be realised by exploring freely available content online and using the money for teacher release. Similarly, school leaders may assume that their teachers need to be formally trained by attending a structured course, where it may be possible for these teachers to train themselves, or one another. In evaluating these and similar decisions made by school leaders, the digital age encourages us to challenge, where appropriate, assumptions such as information scarcity, the need for face-to-face instruction and the acceptability of knowledge transmission and uniform learning.

While many in recent times have argued that each learner is individual, some have nonetheless used industrial constraints such as large class sizes and standardised tests to argue that it is not always possible to meet the needs of the individual learner in a typical classroom setting. The same arguments have held for professional learning, where increasingly antiquated models like the *professional development days* have, for example, existed to justify assumptions that the teacher is “developed” on certain sanctioned days through the agency of school and system leaders, rather than learning throughout the school year and through their agency. By examining how educators autonomously use technology tools to support their learning, this study has argued that it is possible to see some of the ways forward, provided that we understand the realities of the school context and its role in supporting professional learning now and in the future.

The constructs explored in this study provide important landmarks that can guide us. However, these constructs are not without limitations. Though rich with potential, the Personal Learning Network provides scarce guarantee that educators will be autonomous, purposeful and successful in self-directed, technology-enabled professional learning. In this light, the results of this study reflect both sides of the PLN in the literature, with advocates arguing that “PLNs open up doors to sources of information that were not even available a few years ago, and continually evolving technologies are making it easier to capture and tame the resulting information overload” (Warlick, 2009, p. 13) and critics cautioning that “not all people are autonomous learners” (Kop & Hill, 2008b, p. 11). On one level, Warlick’s conceptual model shows that the uses of the tools can be broadly divided into the two areas of content aggregation and people-to-people connections. However, this model remains largely developmental and, perhaps most importantly, does not explicitly incorporate digital creativity. In order to challenge recurrent assumptions from the print era, we need to be actively exploring, discussing and evaluating emerging models such as the PLN and Participatory Cultures.

Prioritising creativity for higher order professional learning.

As the results of this study have shown, understanding digital creativity is especially important, given its role – quite possibly undervalued – in higher order *professional* learning. The eleven Participatory Cultures that comprise another important developmental model in the literature are predicated on the assumption that young people are highly digitally creative. Several years on, we may cast some doubt on that basis; assuming digital creativity as a starting point may be especially problematic when many teachers – young or old – are yet to fully experience success in digital creativity with the tools available. Where educators persist with largely consumptive online behaviours, we cannot assume that they learn at the same level as educators who create and share to a much larger extent. Moreover, where experience with digital tools is limited in general, we need to be cautious in assuming that educators understand the tools sufficiently to be able to employ and evaluate them in both teaching and learning.

It is important to note that while some tools encourage creativity at the fringes, others more substantially require it. For example, posting a comment in an online article and creating high quality digital media may both be creative activities, but they are far from equal in terms of input, amounts of time spent or effects on learning. The findings from this study point to the very real possibility that relatively few teachers are engaging in activities that involve substantial digital creativity as part of their professional learning. As noted in the previous chapter, these findings in turn reflect a possible disconnect between the recognition of creativity as a form of higher order learning for students and its role in higher order professional learning for teachers. Whether or not the limited representation of digital creativity among the three samples reflects the general population of educators is a topic for future research.

However, an important starting point may be to accept, as did Principal B in the intensity sample, that many teachers are yet to fully experience substantial digital creativity, not least as a valid and recognised form of professional learning in its own right. Based on the indications in this study, it may be wise to further accept that a minority of educators are employing appropriate time and uses of the tools to master digital creativity for their professional learning – skills which would arguably be highly transferable to their classroom teaching. While from these assumptions it does not necessarily follow that digital creativity is not nurtured in the classroom, it is possible to argue that teachers have a limited experiential base on which to draw when teaching their students how to be creative with digital tools. Ohler (2013) explores the impact of this kind of limited experiential base on teaching and assessment, highlighting the problems of unfamiliarity with digital media literacy:

> It's easy for the technology under-skilled (that is, many teachers working in a classroom today) to get lost in the new environment of the digital landscape and fall victim to what I call "giving an A for Anything". That is, because teachers aren't new media literate, they give an inflated grade rather than risk being unfair to the students or risk doing a poor assessment job because of their unfamiliarity with the genre of new media (p. 87).

While recent literature on teacher-learner partnerships maintains that educators do not need to be technology "experts" (Fullan, 2013; M. R. Prensky, 2012), an understanding of the learning processes that underpin the use of digital tools for creativity is essential. Educators who are more conversant with these processes through their experiences with digital creativity as part of professional learning are arguably better placed to transfer skills and foster digital creativity in the classroom. Therefore, it may well be that our perceptions of what constitutes valid and effective professional learning need to be rethought to meet the challenges of the digital age.

Need for further research with emerging constructs

It is further important to note that while useful as developmental models describing digital learning in various forms, both the PLN and Participatory Cultures are yet to be fully verified in empirical research. This study has explored the viability of operationalising these constructs, building on successful research in the area of the Technological Pedagogical Content Knowledge (TPaCK) model. Future research could seek to validate and measure key elements of the PLN, such as the size and scope of the learner's network, the impact of key connections on practice, the evolution and influence of key educational ideas throughout the network, the qualitative and quantitative differences between PLNs, the further impact of PLNs on the school community and the factors that promote their effective cultivation.

Research may play a role in promoting further recognition and acceptance of learning theories such as Connectivism, and enabling researchers to develop similar theories in future to reflect the breadth and depth of the network, its relationship to the learner, and the role of the learner's thoughts and actions in shaping the network. Through the lens of pragmatism, this study has closely examined the PLN by focusing on the individual educator and their perceptions and uses of technology tools for professional learning as well as considering the school and online communities as important contexts for shaping the kinds of learning possible. The network itself represents a much broader context that is harder to measure. However, the use of Big Data – already being explored for business interests – may well provide opportunities for researchers to glean a much bigger picture understanding of the role of technology in professional learning through learning analytics.

Similarly, examining the online behaviours that underpin each of the eleven Participatory Cultures (play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking and negotiation) may allow researchers to identify all kinds of factors that promote improved cognitive processes and learning outcomes with technology. Doing so will require us to further pilot instrumentation and establish the validity of constructs to the point where we may accurately and reliably measure a broad range of online behaviours and understand their impact on learning. This study has shown that when linked to behaviours and actions, each of the eleven cultures go some way to describing how we interact and work online; however, the instrumentation employed in this study was necessarily limited to a set of examples that reflect only certain aspects of the constructs. Given the emphasis on creativity in the original theorisation of these constructs, further research could incorporate specific creative processes and products to show how online behaviours relate to digital creativity and how key behaviours can be promoted to realise improved learning outcomes. As such, the

Participatory Cultures represent potentially important predictors in future studies. Once we know what these constructs might enable, relevant support structures might be put in place to ensure that effective online behaviours are encouraged and developed.

For its part, this study has argued that it is possible to closely examine and measure key attributes of professional learning in school and online contexts. The study has also examined the important relationship between these contexts – for example, by considering the value of connected and capable technology mentors to their school community. Further PLN research might involve broadening the scope of what is measured – most notably, the extent of the network – while at the same time looking more closely at the individual educator. The findings of this study suggest that there is much to be learned from identifying and examining best cases, whether by considering the highly connected educators that draw on diverse networks of information sources and people-to-people connections to inform their practice, or by looking at representational models of successful PLNs.

At the same time, it is important to remember the personal, individual nature of the PLN; research needs to be both qualitative and quantitative to capture the richness of the learning while providing some measure on the extent of its effectiveness in relation to professional learning outcomes. There will, no doubt, be a multitude of ways to reach what might at some point constitute best practice, but further research will help to uncover some of the best ways forward. Similarly, there are potential best cases in terms of the Participatory Cultures. Understanding the behaviours of highly autonomous educators could pave the way for important insights about how to promote and cultivate learner autonomy online – such as how we may go about encouraging the technology "buyers" to become "drivers". With an increasing emphasis on national teacher standards in many educational contexts, there needs to be a clear recognition of the value of technology-enabled autonomous professional learning. This study has suggested that this learning is often positioned as *optional* – and as such, may go largely unmeasured and unrewarded. Given its importance in the digital age, the hours spent on professional learning outside of work and study times need to be recognised.

Although the TPaCK remains a robust model for exploring teacher knowledge, what constitutes important knowledge in the future may be very different to the present. Nonetheless, drawing on earlier work by Chai, Koh and Tsai (2011), this study was able to further show that the TPaCK dimensions can be empirically separated, measured and targeted. Examining how each knowledge dimension is demonstrated may be crucial for identifying individual strengths and weaknesses across the important areas of technology, pedagogy and content, specifically in terms of how these areas interrelate and integrate. Importantly, these TPaCK areas were evident in the CC21 project – where participants responded to the present-day challenges of technology, pedagogy and Australian Curriculum, both on a personal level and as part of their school community. These knowledge dimensions represent the ongoing challenges for educators everywhere. As such, where empirical research is able to pave the way for educators to identify their strengths and weaknesses across these dimensions, there is enormous potential to more effectively leverage and personalise future professional learning initiatives. Recourse to TPaCK instrumentation in future studies will enable research findings that promote a high level of professionalism, where educators are more accurately able to target their weaknesses and use technology tools wisely to address these.

School Leadership in a Digital Age

This study has examined the middle ground between face-to-face and online learning, exploring how the learning in a school can effectively support, manage, promote and draw on the learning that happens beyond the school. While the school community does not have to be where professional learning solely takes place, the findings in this study suggest that it will nevertheless continue to play a very important role in shaping the learning that happens elsewhere. In this respect, school leaders – with influence over many of the support structures and knowledge of their teaching staff – have a critical role to play. Undoubtedly, school leaders have always played an important role in teachers' learning, responding to the challenges and needs of their school communities while working within the larger contexts of curricular, technological and pedagogical change. Whereas these contexts were relatively stable throughout the twentieth century – with emphases on print-based information, face-to-face learning and the relatively "private" classroom walls – the findings of this study reflect the twenty-first century reality that leaders are now challenged to perform in very different ways. They continue to identify and model best practice, transforming school cultures and establishing and maintaining appropriate structures to support the sustained learning of both teachers and students.

While working on a very local level to implement state and national agendas in many schools where face-to-face learning often still dominates, many leaders are exploring a growing number of online learning communities and information sources as a form of professional support. Such leaders recognise that the challenges ahead require professional learning solutions that are not "one-size-fits-all". Future research should, therefore, consider the important relationship between autonomous, technology-enabled learning and leadership. The digital age calls for leaders who are willing to participate in broader communities. Therefore, school leaders should continue to network other schools and industries, employing technology tools to share best practice and seeing themselves as part of a broader community.

School leaders - the brokers of buyers, drivers and sharers.

While it remains unclear as to how "buyers" become "drivers", effective school leadership may well represent the most significant factor. Most of the leaders in this study pragmatically employed a wide range of support structures, incentives and imperatives to encourage professional learning amongst their teaching staff. Clearly, incentives such as iPads given in exchange for professional learning can work up to a point, but they function largely as extrinsic forms of motivation. By contrast, the high online sharers identified in the TPLQ data appear to be more intrinsically motivated, spending considerably more time online, often without the same kinds of tangible incentives provided by school leaders in several of the intensity sample schools. The TPLQ data in this study was able to show strong correlations between high sharing and other measurable attributes of online professional learning. However, there needs to be further research examining why some educators choose to share more information online than others, in terms both of the number of contexts and the extent of sharing within each context.

As explored in the previous chapter, sharing represents an important way of challenging the current neo-liberal emphasis in education. The fact that the high sharers in this study seemed to benefit more than their low sharing counterparts perhaps speaks to their willingness to cooperate rather than compete with their colleagues. The apparent guardedness in sharing of the preservice teachers in this study suggests, on the other hand, that competition will only serve to limit the dissemination of best practice. While not addressed in this study per se, it is important to note that online sharing is often reciprocal. High sharers may draw on the feedback they receive online, while also spending more time learning, engaging and creating digital content. Consequently, the positive relationships that are forged may be an important element of the motivation they appear to demonstrate. Further research might more closely explore this reciprocal relationship and its role in professional learning.

Sharing also plays a critical role in helping leaders to address context-specific challenges that exist within and between school communities. Many are now educating students for the world beyond the classroom and bridging the divide between institutional learning and learning in the real world. Doing so involves developing skills that are resilient to the future – if not "future proof" – and promoting pedagogies that facilitate high levels of learner autonomy in order to avoid unnecessary dependence on the teacher, school or system. These educational challenges equate to professional learning challenges for teachers and school leaders and often reflect the ideals of Dewey's pragmatist theory. School leaders play a key role in framing these challenges for their community and guiding educators to respond to them in a way that address the context-specific needs within the community. Of course, there are no one-size-fits all solutions for a school any more than there are for all teachers within the school. Although the challenges may be similar for individuals within the community, personalised learning is essential for ensuring that the educator responds *personally* to the challenges and is *personally* held accountable for their actions.

Leaders of professional learning.

Amongst the intensity-sample schools, it is relatively easy to observe leadership decisions that have been made, as well as their impact on the school community. In particular, many of the decisions noted in the qualitative inquiry can be traced to positive outcomes later in the quantitative results. For example, Principal C chose to "flood the school" with technology and "let the teachers play" before considering what forms professional learning with the technology tools in question might take. Like most other leaders in the study, this principal recognised the importance of cross-platform devices and tools, and the need for teachers to develop fluency in their use of the tools as an enabler of pedagogical fluency. The emphasis on play is further evident in TPLQ data in terms of many areas, such as time spent creating, co-creating and sharing content or the importance of play as a participatory culture "to experiment with one's surroundings as a form of problem solving" (Clinton, Purushotma, Robison, & Weigel, 2006, p. 4). Principal A released Mentor A from all face-to-face teaching duties so that he was free to work with teachers across the school at any given time in the working week. His emphasis on blogging was, by his account and the accounts of several colleagues, an important element in validating teachers' positive experiences using technology. As with play, creativity and sharing are both highly significant areas in the TPLQ that point to possible catalysts for more autonomous professional learning.

Connected Communities 21 – a working model for agile leadership and technology-enabled professional learning.

While CC21 participants – the broader sample that included a sizeable number of school leaders – did not consistently demonstrate best practice with creating and co-creating digital content, their willingness to experiment with relevant tools and see them as important for their professional learning suggests they were more likely than participants in the other groups to utilise them effectively and meaningfully. These findings shed further light on the relationship between guided learning and autonomous learning. CC21 participants' involvement in structured professional development days appears to have provided them with a form of situated learning with tools that enabled communication and collaboration across school communities. For example, while blogging was taught as a digital skill during the professional development days, its use enabled inter-school communication and further collaboration, and it is evident that participants were more aware of these purposes for using the tool. The findings are further supported by the results for Question 2 (online activities for their professional learning), where CC21 participants significantly differed from other groups in their favourable ratings of items such as *creating/editing websites* and *writing blog posts*. They are also supported by the results for Question 4, where CC21 participants significantly differed in the importance they placed on both *structured professional development days* and *the freedom to try new tools with my students*.

On a broader level, the CC21 results suggest that carefully-planned guidance in the use of digital tools – and even some form of mandated use in some situations – can lead to more positive professional learning outcomes. The framing of the CC21 project around the need for schools to connect – both face-to-face and online – with one another and to share important aspects of leadership decisions and classroom practice was of key relevance in establishing a more real-world context for professional learning. These findings suggest that educators' experiences can serve as an important form of validation for their use of digital tools for professional learning. Moreover, where the tools are applied with a genuine need to learn, their use is far more meaningful than where technology tools are taught in an isolated, disconnected fashion (Jonassen, Howland, Marra, & Crismond, 2008). Many CC21 participants needed to connect with one another to find out, and share, important information related to areas such as technology device deployment, resources for pedagogical approaches and aspects of the Australian Curriculum. This need to learn – coupled with the real-world context – appears to correlate with improved professional learning outcomes for many CC21 participants. Where professional learning takes place that is aided by tools for connecting, collaborating and sharing, there is certainly reason to believe that we have moved beyond Hargreaves' "autonomous professional" age of teaching "in a box" towards the "post-professional age" where professionalism is far more defined by the meaningful connections one establishes beyond the four walls of the classroom.

The need to re-think professional learning as *training*.

By contrast, the picture of MacICT educators that emerges is one that speaks to both the importance and limitations of face-to-face, one-day training courses. Like the CC21 educators, MacICT participants recognised the importance of release time from face-to-face teaching alongside the roles of effective leaders and leadership decisions in their schools. However, while MacICT participants were willing to undertake formal training, it is unclear how much value this training provides in terms of changing their perspectives and practices and thereby leading to more sustained professional learning. Although the larger amounts of time they spend online each week is encouraging, the lack of importance they place on certain activities points to similar problems with the preservice sample, especially with respect to the areas of co-creating content and collaborating beyond the immediate school environment. Unlike the CC21 project, one-day courses at MacICT do not necessarily provide a sustained, real-world context for teachers to employ relevant tools in addressing key problems. In particular, such courses do not necessarily encourage sharing of ideas beyond the life of the course, unless this sharing is supported and reinforced in the school community, or unless the educator freely chooses to employ relevant digital tools for sharing.

Accordingly, the findings for the MacICT sample suggest that many teachers in this sample need further support to achieve similar results to the CC21 sample. Their use of available tools is arguably shaped as much by their perspectives and attitudes as by the time they spend in key areas. Typical-case teachers and schools may not place the same value and emphasis on using technology tools for creating, co-creating, sharing and collaborating within and between school communities. Therefore, it would seem that while MacICT participants were predisposed to using the tools, predisposition to technology is an insufficient condition for technology-enabled autonomous learning. At the same time, there appears to be real potential to leverage this sample's interest to explore new tools and encourage them to draw on their teaching experience when evaluating the tools relative to their professional learning needs. Given these educators' willingness to ask for help and their appreciation of technology, school and system leaders might reconceive one-day training courses to better enable professional learning that extends far beyond the life of the training provided.

The need to re-think preservice teacher training.

The problems that are evident in the preservice teachers' responses call into question whether or not teacher education programs are adequately serving their professional learning needs, both in the short and longer terms. It appears that the preservice teachers in this study were working pragmatically with a view to gaining accreditation and employment. At its heart, however, pragmatism needs to foster genuine inquiry, and for inquiry to be genuine, it needs an underlying purpose that is directly relevant to the needs of the individual learner. On the surface, this seems at odds with the kinds of learning in many (if not most) teacher education programs, where unit outlines, predetermined readings, set bibliographies and formal assessment all combine to represent the dominant ideologies of undergraduate institutional learning. Often, in many postgraduate learning contexts, genuine inquiry is fostered and creativity is applied through original research. However, this stands in contrast to the many undergraduate programs where students may more commonly see research and practice as mere requirements for passing assignments rather than prompting the generation of new ideas. Leaders in higher education have, therefore, a responsibility to build further capacity in preservice teachers for the autonomous learning that is necessary to support them throughout their careers.

Challenges and Opportunities Ahead

This study has illustrated some of the important professional learning challenges and opportunities ahead, exploring implications for educators at different career stages and across a range of contexts that include primary and secondary school communities, formal one-day courses, sustained professional learning programs, inter-school networks and teacher education programs. In each of these contexts, there is some evidence to suggest that the professional learning that occurs falls short of what is now required. Nonetheless, with the opportunities for learner-centred professional learning presented by so many tools that now mark the digital landscape, educators can tailor the network around their individual needs and interests and leverage this learning to meet challenges such as changing curricula and the use of specific technologies or pedagogical approaches in their classrooms.

While knowledge gaps still exist, the information scarcity that marked the print era no longer applies; information and expertise are freely available to redress any such gaps. New sources of knowledge are ubiquitous, whether in the form of high quality content such as videos, blogs and research, or through the many opportunities to personally connect with educators around the world. Even ten years ago, much of the open, autonomous and connected professional learning that now takes place would not have been possible without huge expense.

Educators at all career stages and levels have a shared responsibility to leverage the positive changes that have characterised the digital age while being aware of possible problems that may emerge in the future.

Principals need their "drivers".

As many of the principals in the intensity sample recognised, the future will necessitate more educator "drivers". This necessity calls for school leaders to challenge the "buyers", those who often wait for initiatives to be presented to them rather than seizing new opportunities. Complex problems will require creative solutions, with integrative thinking, autonomy, inquiry and experimentation just some of the cognitive skills that will be in high demand. As Fullan (2013) notes, both innovation and improvement will need to go hand-in-hand:

> The question for the field of education is how it can best participate in this rapid learning cycle while working in an otherwise less and less functional system. The general conclusion for me is that this will be a messy period in which the best stance is to become a reflective doer and learner. One way of cutting this is to think of working simultaneously on continuous improvement and on innovation (p. 26).

Undoubtedly, during this messy period, it will be education's "drivers" (Fullan's "doers and learners") who create the solutions that meet their school's needs while carefully exploring the tools, thoughts and actions that promote further autonomy amongst their colleagues and students. This study reveals that among the heuristics of twenty-first century learning is the need for a *reason* to learn. Sinek (2009) has explored the need for leaders to "start with *why*" when describing what their organisation seeks to achieve, noting that "very few people or organisations know *why* they do what they do" (np). As personalised learning becomes more prevalent in education, there will be a greater need for learners to determine and articulate the reasons that underpin their learning. It is the strength and authenticity of these reasons that will shape the learning that follows.

These *reasons to learn* arguably represent a large component in any educator becoming a "driver". While technology tools present opportunities for personalised learning, such learning should connect with the learner's intrinsic motivation. External influencers such as school and system objectives, teacher standards and formal course requirements are undoubtedly important for ensuring quality and equity in any education system. However, how these influencers align with an educator's personal needs and interests is a twenty-first century question that we cannot afford to ignore. For example, where standards indicate rigid benchmarks against which the educator is measured, an educator's learning may well be funnelled into meeting those benchmarks rather than into innovating and reflecting in the way that Fullan and others suggest is necessary. In this light, it is relatively easy for the motivation to shift from being intrinsic to extrinsic, particularly when compliance-driven agendas become the main focus in school and system communities and educators' work is predominantly about addressing requirements. Therefore, the nature of the challenge is integral to the nature of the professional learning; real and open challenges that call for creativity result in professional learning that is vastly different to the more closed challenges that call for compliance. Understanding the balance between these kinds of challenges is imperative in the digital age. As noted in the previous chapter, learning that is disconnected from a deeper social purpose is, as Dewey argues, best regarded as a form of modern-day "slavery".

We have a shared responsibility to critically evaluate professional learning.

The study's findings suggest that educators need to play a greater role in the evaluation of the many forms of professional learning now available. In particular, educators at all levels need to closely compare options for both face-to-face and online learning. The merits and limitations evident in these two areas need to be weighed up in terms of cost and benefit, in light of relevant research findings and the needs of individual educators. For example, if attending a workshop in person, educators should carefully consider whether the content, learning experiences and connections available at the workshop are superior to those that might be available online. If online learning is equal to, or better than, the learning available in such workshops, school leaders should not necessarily be prepared to fund release time or the cost of the course simply because attendance can be monitored and checked off.

On the other hand, leaders must not use cost savings arguments to justify why online learning represents the preferred (or only) option available in circumstances where face-to-face learning is clearly warranted. In making such decisions, school and system leaders must listen to educators at all levels and career stages and be prepared to change their support structures and practices. Further research that examines comparable face-to-face and online learning experiences is needed to identify specific contexts in which one approach leads to significantly better professional learning outcomes. Where trust is established between school leaders and educators that are highly autonomous and effective in their professional learning, further support in the form of unstructured release time may be warranted. It may be that through this release time, other forms of online learning may evolve that take professional learning in even more exciting and rewarding directions.

While the reasons to learn are an integral part of personalised learning in the digital age, there are a number of areas originally linked to twenty-first century learning that have been challenged in the literature, including the recognition of so-called "twenty-first century skills", the digital divide between so-called "immigrants" and "natives", the validity of multi-tasking and the assumption that young people are highly creative. Challenging aspects of twenty-first century learning for which there is limited empirical evidence is important for ensuring that the professional learning initiatives adopted in schools and systems are evidence-based. In the context of pragmatist learning theory, however, experience is very important indicator of successful learning, and research methodologies such as action research – that are sensitive to cycles of emerging practice and reflection – should have a place in all school communities. Researchers and leaders alike need to continue to consider the perspectives of everyone in education – teachers and students, novices and experts – in order to fully understand the collective needs of the school community. Twenty-first century learning should not automatically imply an unattainable ideal or make unnecessarily bold claims; rather, it should reflect the reality of the times.

Creativity and sharing matter.

While representing a comparatively small component of time spent during professional learning, creativity needs to be a very important reason for learning in its own right. For preservice teachers, for example, time spent creating is essential for future career development, enabling the application of pedagogies, interpretation of curricula and the development of quality teaching resources. When educators spend time creating, they engage in the kinds of higher order thinking that are so important in their classrooms, thereby engaging with the practices, processes and products that are essential elements of good learning. When such creativity occurs in a digital context, there is enormous scope for the sharing of ideas and artefacts within much broader communities of practice and scholarship. Educators learning to share is, in turn, important for teaching students how to follow safe and appropriate practices when working online. This study has found that when given the choice, many educators tend more towards online consumption than towards online creativity. As such, looking at the contexts in which digital forms of creativity are encouraged, and even required, is important for any future professional learning initiative. Given that many educators lack the autonomy of those who more freely create and share their work online, further guidance is warranted. Finally, digital creativity needs to be substantive for the learning to be effective; while many educators are comfortable with micro-blogging on closed social networks such as *Facebook*, these educators could be encouraged to explore other areas such as media, game design and blogging.

The role and importance of sharing emerged as an early finding during the qualitative inquiry, later confirmed in the TPLQ data. Mentors A and B were avid and public in their digital sharing through tools such as open social media, blog posts, wikis and online discussion fora. The sharing level variable in the TPLQ data was applied during analysis, revealing a range of significant differences between groups, interaction effects and positive effect sizes. As a variable – or possible set of variables – the sharing level of any educator undoubtedly represents an important consideration in further research examining professional learning in online contexts. Until only recently, many online professional learning programs have been restricted to the frequently behaviourist environments of many password-protected intranets, Learning Management Systems and other courseware. Future programs do not need to be restricted to such environments; educators can be encouraged to utilise open tools and share in much broader communities so that learning can more easily continue after such courses are completed. Employing tools that are highly transferable may well lead to more-sustained professional learning, with long-term goals and superior learning outcomes. As part of this learning, online sharing may be introduced to resistant learners gradually in forms that are suited to their learning behaviours and with which they are comfortable.

The TPLQ findings suggest that the high sharers often outperform low sharers in areas such as of time spent online, favourable perceptions of tools and knowledge of certain TPaCK areas. In terms of the Participatory Cultures, high sharers rated strongly items that reflected more autonomous – and even risk-taking – online behaviours. The Principal Components Analyses for both the sharing items in Question 6 and support structures in Question 4 revealed important distinctions between learning within the school environment and learning outside of it. The two-component solution for the time-related support structures showed that participants distinguished Question 4 items largely on the basis of whether time was spent inside or outside the school.

Similarly, the three-component solution for Question 6 items showed that participants saw online sharing as typically occurring in three main contexts: (1) within and between schools and systems; (2) through groups on social media; and (3) publicly on the web. Importantly, those with high sharing indices were much more likely to share across these three contexts, while those in the low sharing group were much more likely to share information only within their school and on closed social media. These results highlight the nexus between *inside* and *outside* in the digital age; while education is still largely about the face-to-face learning that takes place inside the school walls, it is those educators and students who embrace learning outside of these walls that can play a powerful role in improving the learning of their peers and colleagues.

While the boundary that separates inside from outside is increasingly permeable, outside learning is still largely conceived as *additional,* thus requiring large amounts of precious time. As more educators play, experiment, create and share, they invest more of themselves into the many online spaces that exist. In the time spent exploring new communities and engaging in new behaviours, educators have the opportunity to rethink their professional identities and challenge many assumptions tied to the face-to-face paradigm. To further leverage these experiences for professional learning, the underlying support structures will need to shift from the more rigid structures associated with face-to-face learning towards new structures that promote more freedom, flexibility and unstructured time. School hours, timetables, lessons, bells, duties and meetings are by their nature rigid and seek to manage learning in structured ways that reflect this older paradigm.

As other workplaces become much more flexible – with such benefits as flexible hours, permission to work from home, provisions for rotating through departments and opportunities to travel – there will be increasing pressure on schools to allow for more flexible forms of working and learning. To fully explore these possibilities for education, further time is essential. Funding cuts and similar restructuring measures that only take time away from educators weakens their capacity for autonomous professional learning. By the same token, those who do invest large amounts of time outside of work hours should be trusted and rewarded. It may well be that more monitoring and accountability around the kinds of personalised online learning explored in this study needs to happen to achieve the levels of trust and support required.

Inspired leadership.

As an emerging concept, the *inspired leadership* that was identified in the qualitative inquiry is clearly a twenty-first century phenomenon. All of the popular thinkers in education that were cited during interviews provide further traction for learning theories such as Connectivism, demonstrating the extent to which this form leadership and its attendant knowledge is dispersed across vast networks of connected minds in education, and especially dependent on the sharing and amplification of ideas through social media. With their large reach, popularity and marketability, these "celebrity" educators may well represent a future trend in education that, at its best, reflects aspects of Hargreaves' (2000) "fourth age", where post-professional educators increasingly draw on the outside world to meaningfully transform practice.

For many educators who have lived through the second and/or third ages in the relative privacy and autonomy of the classroom walls, the phenomenon of inspired leadership is both exciting and daunting. Perhaps an important part of the appeal of these and other popular thinkers in education is the broader online communities they cultivate and the chance they offer many educators to become a part of these communities. Given their popularity, their ideas may represent a common language of sorts, often with simple catch phrases that are readily transferable from one context to the next. At its worst, however, inspired leadership may well represent the interests of neo-liberalism, encouraging school leaders to invest in ideas that are popular without necessarily being evidence-based. The cost of bringing many of these thinkers to visit and speak at schools, systems and conferences is often enormous – even unjustifiable in circumstances when similar presentations are freely available on websites such as *YouTube*. Nevertheless, as was evident in Mentor D's discussion of the Inquiry-Based Learning thinker, the influence of popular thinkers on teacher identity could prove very significant in the future. Exploring the impact of inspired leadership in a digital age is, therefore, an important topic for future research.

Guided and self-directed professional learning.

While the diversity and openness of the digital world seems to encourage a form of "DIY" professional learning where educators decide what and how to learn, the findings of this study speak to the continued importance of guidance, whether in the form of face-to-face mentoring such as the recess and lunch time sessions offered by Mentor A, or through the feedback loops for high sharers in various online communities. However, for many in education, guidance is still very often associated with face-to-face instruction. As this study shows, where such instruction is offered, ensuring that the learning is able to continue beyond the life of the session is important. Creating or perpetuating dependence on the instructor discourages autonomy; how such learning is positioned is therefore key to ensuring that it adds value.

In addition to face-to-face guidance, it is essential that future researchers explore other forms, especially the forms that guidance might take in open online communities. Such guidance might augment, enhance or even replace traditional face-to-face learning. As this study has revealed, giving guidance at formative stages in the use of technology tools for professional learning seems to have a powerful effect on attitude and subsequent use of the tools, especially where the learning is positioned as "real world" and aligns to the needs and interests of the individual educator and/or their school community. Future research therefore needs to closely examine these needs in terms both of connectedness and disconnectedness. Where educators' needs are deeply connected to those of their school communities, *personalised* professional learning is arguably leveraged to its fullest.

In spite of schools and systems that may now or in future promote freedom and flexibility, this study's findings suggest that some – if not many – educators are unlikely to perceive certain technology tools as beneficial to professional learning where they have not had positive experiences using them. These experiences cannot be simple technology sessions where the technical aspects of the tool are emphasised at the cost of exploring situated uses. Therefore, guidance needs to provide more resistant educators with opportunities to experience success in their professional learning while drawing on their experience to more fully understand the tool in its broader social context. Guidance also needs to explain and model robust pedagogies and sound learning principles at the same time as demonstrating use.

The findings for the Participatory Cultures items in Question 7 show how key online behaviours may be linked. For example, successfully navigating webpages requires skills in the areas of transmedia navigation and judgment, and in some respects these skills may be inseparable. Understanding how certain online behaviours predict others and inform learning could lead to powerful findings that help instructors, mentors and other leaders pinpoint and target the skills needed for successful experience with a wide range of technology tools. Simply encouraging or mandating tools for use may, on the other hand, lead to self-defeating attitudes based on limited or poor experience with the tools in question. While structured forms of professional learning such as tertiary coursework, one day courses, and inter-school projects can open up new horizons for future research and self-directed inquiry, these forms of learning must exist to ultimately foster learner independence to the very structures themselves.

Building capacity for autonomous learning for future teachers.

In the digital age, the role of the tertiary institution in training the preservice teacher for the classroom may well need a radical re-thinking. While many tertiary educators seek to foster lifelong, independent learning, the structures in many undergraduate courses appear competitive and short sighted, focusing on the immediate – albeit necessary – goals of graduation and accreditation. At the same time, studies of preservice and early-career teachers have found that some are quick to downplay the value of their theoretical training in favour "on-the-job" learning (Harvey, Yssel, Bauserman, & Merbler, 2010; Stoughton, 2007). Regardless of preferences for theory or practice, preservice teachers need to be trained for independence and autonomy. To enable these attributes, tertiary educators might explore the application of pedagogical approaches that foster genuine inquiry, such as with the current emphasis on Problem-Based Learning in many Medicine programs (Barrows, 1996; Ilic & Maloney, 2014; Jin & Bridges, 2014) or with the emphasis on Design Thinking in some Business programs (Brown & Wyatt, 2010; Martin, 2009). Given the focus in many programs on textbooks and reference lists, it is evident that preservice teachers at undergraduate level are not being trained as researchers, per se. However, this lack of research training means that educators are not well placed to identify and apply evidence-based practice later in their careers. This may well explain why educators latch onto the ideas of popular thinkers in education rather than engaging in the scholarship needed to inform an evidence-based approach.

For many preservice teachers, the focus on passing their coursework, gaining accreditation and entering the classroom may be antithetical to learning through more open forms of inquiry. This focus appears at odds with the kinds of autonomous learning that this study has shown principals value highly. It is the requirements of many preservice teacher-training programs that need further scrutiny. For example, Goodyear and Ellis (2007) argue that higher educators need to design tasks "such that a task specification is better seen as a resource for action rather than a prescription of action", further noting that:

> Students in higher education should be exercising some autonomy, discovering what they need to have in place to learn effectively, making some choices about who they want to work with, share discoveries with, and trust. But – we have to acknowledge – the exercise of such prerogatives can bring short-term harm as well as long term-benefits (p. 341).

Tertiary educators in the digital age need to be prepared to face the "short-term harm" to the institution – including its structures, traditions and values – in order to realise the long-term benefits to learning, society and the individual.

Encouragingly, triangulation between TPLQ samples and the stages of this study indicates that there is honesty to what preservice teachers are saying. For example, the significantly lower ratings for all TPaCK items indicate that these preservice teachers are prepared to acknowledge what they are yet to learn, just as the responses for the each of the time-items reflect their priorities at this stage in their career. This honesty is an excellent starting point for more effectively integrating metacognition and inquiry into teacher training programs. Where preservice teachers are able to identify and explore what they need to learn, we may be able to better establish cognitive skills that can be developed and applied well after the training has finished. However, fostering genuine inquiry may not be possible if rigid course requirements encourage set ways of thinking and limit the scope of inquiry possible. The rhetoric in future programs must shift from conveying what teachers need to know to allowing preservice teachers time and leeway to identify and explore personal weaknesses and knowledge gaps while capitalising on their strengths. Perhaps more important than knowledge, they must develop the cognitive and social skills to survive beyond the point of accreditation – and such skills need not be solely relegated to "on the job" training.

Conclusion

Some educators have lived and worked for many years before the advent of this turbulent, complex and evolving digital age, while others in the early stages of their career may not have experienced a time that is much, if any, different from what we now know. Regardless of our experiences and background, it is now an exciting time to be an educator. As we embrace the messiness of the immediate years ahead, we need to be prepared to let go of assumptions tied to realities that no longer apply. At this time – and at all times – educators need to be wary of calling themselves or their colleagues "experts". As Dewey notes, "to the one who is learned, subject matter is extensive, accurately defined, and logically interrelated. To the one who is learning, it is fluid, partial, and connected through his personal occupations" (1916, p. 177). Novice or experienced, we are all learners in the digital age – and we all continue to learn long after the formal lessons of school and university have finished. Thankfully, we have considerable scope to learn – in our own time and at our own pace – with the devices and tools at our fingertips.

With seemingly limitless access to information and people in the global education community, we are never far from the ideas and support we need. Such ideas and support allow us to realise best practice in a career where social connectedness is incredibly important and gives meaning to our work and identities. To improve as educators and as human beings, we need time, freedom and support. We should be especially wary of neo-liberal emphases that threaten to weaken and simplify the profession, limiting the scope of possibilities and discouraging us from the important acts of play, experimentation, creativity and sharing. It is through these acts that we continue to nurture our learning, as well as the learning of those we teach. The goal of education should be to explore and celebrate what makes us more human. The technology tools of the current age are an important, if not essential, means to that end.

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Appendix 1: Teacher Professional Learning Questionnaire (TPLQ)

Introduction

This short questionnaire explores teacher professional learning in a digital age. The data gathered will enable the research team to better understand how teachers use current technology tools to support their professional learning.

The questions focus on the use of online technologies for professional learning, the provision of support structures in school and the level of teacher knowledge in relation to technology, pedagogy and subject content. The whole questionnaire takes approximately TWETNY MINUTES to complete. As teacher, your professional opinions on the topics in this questionnaire are very important.

The responses you provide will be treated confidentially and the instrument has been approved by the Macquarie University Ethics Committee in the Faculty of Human Sciences. The questionnaire is also anonymous; no personally identifying information is required at any stage.

You do not have to be in this study if you do not want to be. You do not have to answer any question that you do not want to answer for any reason, and there will be no consequences for choosing not to complete the questionnaire. We will be happy to answer any questions you have about this study. Should you have any questions about the questionnaire, you can contact Professor John Hedberg (Chief Investigator) – email: john.hedberg@mq.edu.au or PH: 9850 9894.

By clicking the "Next" button below, you consent to participate. We would like to thank you for your time, involvement and professional opinions.

Hours Per Week - Technology for Professional Learning

1. In a typical week, how many hours of your own time (i.e. outside of hours required for work or study) would you spend using technology to support your professional learning?

   Approximate hours per week: ________

2. In relation to the number of hours specified above, please indicate the PERCENTAGES of time spent in the following six types of activities for the purposes of professional learning.

   If you do not spend any time doing the type of activity, please write "0”. Your percentages should total 100%.

   Reading information (e.g. online news, blog posts, articles on *Wikipedia*, etc.): ______

   Watching or listening to audio and/or video content (e.g. iTunes U, YouTube, etc.): ______

   Searching for information (e.g. Google searches): ______

   Communicating with others (e.g. email, instant messaging, status update, etc.): ______

   Creating your own online content (e.g. blog posts, podcasts, etc.): ______

   CO-creating/editing content (e.g. online course or wiki, collaborative document, etc.):______

Online Activities

3. How important do you feel each of the following online activities are to your professional learning?

Questionnaire Item	Not at all true of me						Very true of me
Reading online news	○	○	○	○	○	○	○
Reading blog posts	○	○	○	○	○	○	○
Commenting on blog posts	○	○	○	○	○	○	○
Writing blog posts	○	○	○	○	○	○	○
Accessing websites I can edit (e.g. Wikispaces)	○	○	○	○	○	○	○
Creating and/or editing websites	○	○	○	○	○	○	○
Checking articles on	○	○	○	○	○	○	○
Wikipedia	○	○	○	○	○	○	○
Accessing podcasts (e.g. audio or video content)	○	○	○	○	○	○	○
Creating audio and/or video content to share	○	○	○	○	○	○	○
Using Skype (or similar tool) to talk to other educators or students	○	○	○	○	○	○	○
Accessing content on SCHOOL portals (e.g. Moodle courses)	○	○	○	○	○	○	○
Creating and/or editing content on school portals	○	○	○	○	○	○	○
Accessing content on SYSTEM portals (e.g. DEC My PL)	○	○	○	○	○	○	○
Creating and/or editing content on system portals	○	○	○	○	○	○	○
Accessing content on other education portals (e.g. MOOCs or Edmodo)	○	○	○	○	○	○	○
Creating and/o editing content on other education portals	○	○	○	○	○	○	○
Accessing content on social media pages or newsfeeds	○	○	○	○	○	○	○
Creating or sharing content through social media	○	○	○	○	○	○	○

Support Structures, People and Organisations

4. The following items describe some of the leadership decisions, structures and procedures that commonly exist in schools to support teacher professional learning. How important are each of the items for your professional learning?

Questionnaire Item	Extremely Unimportant						Extremely Important
Access to the Internet in the staff room	○	○	○	○	○	○	○
Access to the Internet in my own classroom(s)	○	○	○	○	○	○	○
Structured professional development days IN my own school (e.g. staff training day)	○	○	○	○	○	○	○
Structured professional development days OUTSIDE of my own school (e.g. one-day course)	○	○	○	○	○	○	○
Unstructured professional development days IN my own school (e.g. a planning day with colleagues)	○	○	○	○	○	○	○
Unstructured professional development days OUTSIDE of my own school (e.g. a planning day with colleagues from other schools)	○	○	○	○	○	○	○
Unstructured meeting time with leaders to discuss concerns face- to-face IN my school	○	○	○	○	○	○	○
Unstructured meeting time to share ideas face- to-face with colleagues IN my school	○	○	○	○	○	○	○
Unstructured meeting time to share ideas with colleagues face-to-	○	○	○	○	○	○	○

Questionnaire Item	Extremely Unimportant						Extremely Important
face OUTSIDE of my school							
Listening to a guest visitor during a Professional development day or staff meeting	○	○	○	○	○	○	○
Lesson preparation time (e.g. designated free period in timetable)	○	○	○	○	○	○	○
Release time from class	○	○	○	○	○	○	○
Software that lets me collaborate with colleagues both face-to- face and online (e.g. Google Docs)	○	○	○	○	○	○	○
Online spaces for sharing ideas between schools (e.g. shared blog)	○	○	○	○	○	○	○
A clear policy about how staff and students in the school should communicate online	○	○	○	○	○	○	○
The freedom to try new technology tools with my own students	○	○	○	○	○	○	○
Leaders who set a clear direction in the school for teachers to follow	○	○	○	○	○	○	○
Leaders whose ideas are drawn the innovations of other teachers in the school	○	○	○	○	○	○	○
Leaders whose ideas are drawn from current minds in education (e.g. Lane Clark, John Hattie or Stephen Heppell)	○	○	○	○	○	○	○
Research papers on current educational issues that I have accessed	○	○	○	○	○	○	○

5. How important do you feel each of the following people and organisations are to your professional learning?

Questionnaire Item	**Extremely Unimportant**						**Extremely Important**
Teachers and students in my school	○	○	○	○	○	○	○
Teachers within my system (but not in my school)	○	○	○	○	○	○	○
State-based organisations (e.g. DEC, Board of Studies, Teaching and Educational Standards)	○	○	○	○	○	○	○
National organisations (e.g. ACARA, AITSL, Education Services Australia)	○	○	○	○	○	○	○
Software/hardware businesses with educational content (e.g. Microsoft, Adobe, etc.)	○	○	○	○	○	○	○
Bloggers I follow	○	○	○	○	○	○	○
Social media community pages (e.g. *Facebook* pages)	○	○	○	○	○	○	○
Educators I follow using social media	○	○	○	○	○	○	○
Educators that share audio/video content (e.g. podcasts or videos on TeacherTube)	○	○	○	○	○	○	○

6. Considering the people and organisations in the previous question, with whom do you share information online related to your professional learning?

   I share information online with:

   ☐ teachers in my school (e.g. school email, school bulletin)

   ☐ students in my school (e.g. school email, online course)

   ☐ educators in my system (e.g. email to teacher in another school)

   ☐ state-based organisations (e.g. online discussion)

   ☐ bloggers who I follow (e.g. comments on a blog post)

   ☐ educators and/or students on closed social networks (e.g. link to *Facebook* friends)

   ☐ educators and/or students who follow me on open social networks (e.g. link to *Twitter* followers)

   ☐ anyone publicly on the web (e.g. published blog posts)

Online Participatory Cultures

7. The following statements describe how some people think of their own online behaviours. Use the following scale from 1-7 to indicate whether each statement is true of your own online behaviours.

Questionnaire Item	Extremely Unimportant						Extremely Important
I like to play around with a new technology tool.	○	○	○	○	○	○	○
I prefer to be shown how a technology tool works before I use it.	○	○	○	○	○	○	○
If I'm stuck using a technology tool, I'll ask for help from someone who knows.	○	○	○	○	○	○	○
I usually solve problems by considering solutions carefully.	○	○	○	○	○	○	○
I usually solve problems by trial and error.	○	○	○	○	○	○	○
Who I am online is quite different to who I am in person.	○	○	○	○	○	○	○
I use Internet to discover new things about myself and others.	○	○	○	○	○	○	○
I use Internet to look things up and check facts.	○	○	○	○	○	○	○
I search the Internet to find representations of how things work.	○	○	○	○	○	○	○
I consider my online identity as an extension of who I am face-to-face.	○	○	○	○	○	○	○
I use technology tools to take someone's ideas and make them better.	○	○	○	○	○	○	○
I like to come up with all my own ideas.	○	○	○	○	○	○	○
I regard taking someone's work and	○	○	○	○	○	○	○

Questionnaire Item	Extremely Unimportant						Extremely Important
posting it online as plagiarism.							
I believe that we need to rethink what plagiarism is when interacting with others on the Internet.	○	○	○	○	○	○	○
I frequently have multiple tabs open in my web browser and switch between them.	○	○	○	○	○	○	○
When using a technology tool, I prefer doing one thing at a time.	○	○	○	○	○	○	○
I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing.	○	○	○	○	○	○	○
I usually maintain focus on the task at hand.	○	○	○	○	○	○	○
I use tools on the Internet to try new ways of doing things.	○	○	○	○	○	○	○
I often try new web tools when I hear about them.	○	○	○	○	○	○	○
I often sign up for new services on the Internet.	○	○	○	○	○	○	○
I consider websites like *Wikipedia* to be unreliable.	○	○	○	○	○	○	○
My ideas about teaching are influenced by my colleagues.	○	○	○	○	○	○	○
I'm often unsure about the reliability of information I find online.	○	○	○	○	○	○	○
I like to verify information online with information in other forms.	○	○	○	○	○	○	○
I like a webpage that includes different types of media	○	○	○	○	○	○	○

Questionnaire Item	Extremely Unimportant						Extremely Important
(audio, video, images, links, etc.).							
I get distracted if there are too many forms of media on a web page.	○	○	○	○	○	○	○
I focus on the main area of a web page before I click on links to other material.	○	○	○	○	○	○	○
I click on links to other material before I finish examining the main content of a web page.	○	○	○	○	○	○	○
I use search engines (e.g. Google) to find most things online.	○	○	○	○	○	○	○
I find things online through links shared with me on social networks like *Facebook*.	○	○	○	○	○	○	○
If I discover something interesting on the Internet, I email it to friends.	○	○	○	○	○	○	○
I share interesting links with others on social network services (like *Facebook*).	○	○	○	○	○	○	○
I get overwhelmed by the vastness of the Internet.	○	○	○	○	○	○	○

Technological, Pedagogical and Content Knowledge

8. The following group of items are about your knowledge of curriculum and pedagogy in general.

   Please select the bubble that accurately reflects your level of knowledge in each area. Where items refer to "teaching subject", secondary teachers should consider their main teaching subjects (e.g. Maths), while primary teachers should consider all subjects they teach.

Item	Strongly disagree	Disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Agree	Strongly agree
I have sufficient knowledge of my teaching subject(s).	○	○	○	○	○	○	○
I think about the content of my teaching subject(s) like a subject matter expert.	○	○	○	○	○	○	○
I gain deeper understanding about the content of my teaching subject(s) on my own.	○	○	○	○	○	○	○
I am confident to teach the subject matter.	○	○	○	○	○	○	○
Without using technology, I can help my students to understand the content knowledge of my teaching subject(s) through various ways.	○	○	○	○	○	○	○
Without using technology, I can address the common learning difficulties my students have for my teaching subject(s).	○	○	○	○	○	○	○
Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject(s).	○	○	○	○	○	○	○
Without using technology, I can engage students in solving real world problems related to my teaching subject(s).	○	○	○	○	○	○	○

Item	Strongly disagree	Disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Agree	Strongly agree
Without using technology, I can support students to manage their learning of content for my teaching subject(s).	○	○	○	○	○	○	○
I am able to stretch my students' thinking by creating challenging tasks for them.	○	○	○	○	○	○	○
I am able to guide my students to adopt appropriate learning strategies.	○	○	○	○	○	○	○
I am able to help my students to monitor their own learning.	○	○	○	○	○	○	○
I am able to help my students to reflect on their learning strategies.	○	○	○	○	○	○	○
I am able to guide my students to discuss effectively during group work.	○	○	○	○	○	○	○

9. The following items are statements that a teacher might make about their knowledge of technology in relation to both pedagogy and curriculum. Please select the bubble that accurately reflects your level of knowledge in each area.

Item	Strongly disagree	Disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Agree	Strongly agree
I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).	○	○	○	○	○	○	○
I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).	○	○	○	○	○	○	○
I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).	○	○	○	○	○	○	○
I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.	○	○	○	○	○	○	○
I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).	○	○	○	○	○	○	○
I know about the technologies that I have to use for the research of content of my teaching subject.	○	○	○	○	○	○	○
I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.	○	○	○	○	○	○	○
I can use specialised software to perform	○	○	○	○	○	○	○

Item	Strongly disagree	Disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Agree	Strongly agree
inquiry about my teaching subject.							
I am able to use technology to introduce my students to real world scenarios.	○	○	○	○	○	○	○
I am able to facilitate my students to use technology to plan and monitor their own learning.	○	○	○	○	○	○	○
I am able to facilitate my students to use technology to construct different forms of knowledge representation.	○	○	○	○	○	○	○
I am able to facilitate my students to collaborate with each other using technology.	○	○	○	○	○	○	○
I have the technical skills to use computers effectively.	○	○	○	○	○	○	○
I can learn technology easily.	○	○	○	○	○	○	○
I know how to solve my own technical problems when using technology.	○	○	○	○	○	○	○
I keep up with important new technologies	○	○	○	○	○	○	○

Demographic Information

10. Finally, we would like to know some details about you that will help us to contextualise the findings from this study. None of your personal details are shared with anyone outside of the research team - and no personal details will be published in any form.

    Please select the description that currently matches your role as an educator:*

    ○ Classroom teacher

    ○ Teacher with a leadership role

    ○ School executive (non-teaching)

    ○ Principal

    Please enter your school context:

    ○ Primary

    ○ Secondary

    Please indicate the number of years (including this year as one) you have worked in your current SCHOOL: __________*

    Please indicate the number of years (including this year as one) you have worked in your current ROLE: __________*

    Please select your gender

    ○ Male

    ○ Female

    Please enter your age (we won't tell!): ______

* Not included in the Preservice Teacher version of the TPLQ.

Appendix 2: Expanded Results

Table A2-5.4a Significance Levels by teaching context (Question 1 items) – Group Statistics.

Time Use Category	Level	N	Mean	Std. Deviation	Std. Error Mean
Reading information (hrs):	Primary	84	2.5390	2.20786	.24090
	Secondary	62	2.1569	1.90363	.24176
Watching and/or listening to multimedia (hrs):	Primary	84	1.9135	1.74607	.19051
	Secondary	62	1.2873	1.11980	.14221
Searching for information (hrs):	Primary	84	4.4994	4.63751	.50599
	Secondary	62	1.8629	1.75290	.22262
Sharing information with others (hrs):	Primary	84	1.8534	2.24308	.24474
	Secondary	62	1.2738	1.31319	.16678
Creating content (hrs):	Primary	84	.7897	1.30687	.14259
	Secondary	62	.5141	.92933	.11803
Co-creating context (hrs):	Primary	84	.7740	1.36560	.14900
	Secondary	62	.2437	.56716	.07203

Table A2-5.4b Significance Levels by teaching context (Question 1 items) – Full T-Test Results.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Reading information (hrs):	Equal variances assumed	.157	.693	1.095	144	.275	.38205	.34900	-.30778	1.07187
	Equal variances not assumed			1.119	140.483	.265	.38205	.34129	-.29269	1.05678
Watching and/or listening to multimedia (hrs):	Equal variances assumed	6.636	.011	2.472	144	.015	.62621	.25329	.12557	1.12685
	Equal variances not assumed			2.634	141.493	.009	.62621	.23774	.15623	1.09619
Searching for information (hrs):	Equal variances assumed	9.279	.003	4.255	144	.000	2.63654	.61968	1.41170	3.86137
	Equal variances not assumed			4.769	112.506	.000	2.63654	.55280	1.54129	3.73179
Sharing information with others (hrs):	Equal variances assumed	6.905	.010	1.817	144	.071	.57963	.31903	-.05095	1.21021
	Equal variances not assumed			1.957	137.607	.052	.57963	.29616	-.00598	1.16525

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Creating content (hrs):	Equal variances assumed	3.082	.081	1.417	144	.159	.27564	.19456	-.10892	.66020
	Equal variances not assumed			1.489	143.829	.139	.27564	.18510	-.09023	.64151
Co-creating context (hrs):	Equal variances assumed	19.590	.000	2.878	144	.005	.53027	.18426	.16605	.89448
	Equal variances not assumed			3.204	117.589	.002	.53027	.16550	.20253	.85801

Table A2-5.6a - Significance levels by career stage (Question 1 items) – Group Statistics

Time Use Category	Career Stage	N	Mean	Std. Deviation	Std. Error Mean
Reading information (hrs):	Current Teacher	110	2.6615	2.19817	.20959
	PST	56	1.9954	2.03332	.27171
Watching and/or listening to multimedia (hrs):	Current Teacher	110	1.8292	1.59389	.15197
	PST	56	1.5587	1.58790	.21219
Searching for information (hrs):	Current Teacher	110	4.1784	4.58721	.43737
	PST	56	2.0477	2.18468	.29194
Sharing information with others (hrs):	Current Teacher	110	1.8733	2.07969	.19829
	PST	56	1.5688	2.09012	.27930
Creating content (hrs):	Current Teacher	110	.8705	1.25810	.11996
	PST	56	.2929	.93888	.12546
Co-creating context (hrs):	Current Teacher	110	.7143	1.24895	.11908
	PST	56	.1080	.36354	.04858

Table A2-5.6b - Significance levels by career stage (Question 1 items) – Full T-Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Reading information (hrs):	Equal variances assumed	2.248	.136	1.892	164	.060	.66616	.35201	-.02889	1.36120
	Equal variances not assumed			1.941	118.714	.055	.66616	.34316	-.01334	1.34565
Watching and/or listening to multimedia (hrs):	Equal variances assumed	.010	.922	1.035	164	.302	.27040	.26132	-.24559	.78639
	Equal variances not assumed			1.036	111.140	.302	.27040	.26100	-.24678	.78758
Searching for information (hrs):	Equal variances assumed	6.291	.013	3.288	164	.001	2.13074	.64809	.85107	3.41042
	Equal variances not assumed			4.052	163.459	.000	2.13074	.52586	1.09240	3.16909

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Sharing information with others (hrs):	Equal variances assumed	.161	.688	.891	164	.374	.30455	.34197	-.37069	.97978
	Equal variances not assumed			.889	110.279	.376	.30455	.34253	-.37426	.98335
Creating content (hrs):	Equal variances assumed	9.748	.002	3.031	164	.003	.57769	.19057	.20141	.95397
	Equal variances not assumed			3.328	141.746	.001	.57769	.17358	.23455	.92083
Co-creating context (hrs):	Equal variances assumed	31.848	.000	3.552	164	.000	.60630	.17068	.26928	.94333
	Equal variances not assumed			4.714	140.583	.000	.60630	.12861	.35204	.86057

Table A2-5.8a - Significance levels by sharing level (Question 1 items) – Group Statistics

Time Use Category	Sharing Group (Low/High)	N	Mean	Std. Deviation	Std. Error Mean
Reading information (hrs):	Low	73	2.0918	2.07337	.24267
	High	27	3.6351	2.83890	.54635
Watching and/or listening to multimedia (hrs):	Low	73	1.5712	1.57214	.18401
	High	27	2.6109	1.78507	.34354
Searching for information (hrs):	Low	73	2.8592	3.44546	.40326
	High	27	5.5188	6.54454	1.25950
Sharing information with others (hrs):	Low	73	1.3204	1.45467	.17026
	High	27	3.0800	2.52485	.48591
Creating content (hrs):	Low	73	.3408	.68726	.08044
	High	27	1.4500	1.69904	.32698
Co-creating context (hrs):	Low	73	.2687	.56267	.06586
	High	27	1.0755	1.48043	.28491

Table A2-5.8a - Significance levels by sharing level (Question 1 items) – Full T-Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Reading information (hrs):	Equal variances assumed	4.584	.035	-2.977	98	.004	-1.54332	.51839	-2.57204	-.51460
	Equal variances not assumed			-2.582	36.754	.014	-1.54332	.59781	-2.75488	-.33176
Watching and/or listening to multimedia (hrs):	Equal variances assumed	.520	.473	-2.829	98	.006	-1.03968	.36745	-1.76888	-.31048
	Equal variances not assumed			-2.668	41.815	.011	-1.03968	.38971	-1.82625	-.25311
Searching for information (hrs):	Equal variances assumed	1.655	.201	-2.635	98	.010	-2.65965	1.00947	-4.66291	-.65639
	Equal variances not assumed			-2.011	31.484	.053	-2.65965	1.32248	-5.35519	.03588
Sharing information with others (hrs):	Equal variances assumed	8.620	.004	-4.336	98	.000	-1.75955	.40581	-2.56488	-.95423
	Equal variances not assumed			-3.417	32.599	.002	-1.75955	.51487	-2.80756	-.71155
Creating content (hrs):	Equal variances assumed	17.970	.000	-4.668	98	.000	-1.10925	.23762	-1.58080	-.63770

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
	Equal variances not assumed			-3.294	29.203	.003	-1.10925	.33673	-1.79773	-.42077
Co-creating context (hrs):	Equal variances assumed	27.659	.000	-3.970	98	.000	-.80686	.20323	-1.21016	-.40356
	Equal variances not assumed			-2.759	28.823	.010	-.80686	.29242	-1.40509	-.20863

Table A2-5.15 - Complete Frequencies for Participatory Cultures Items

Participatory Cultures Item	Mean	SD	Skewness
Play: [I like to play around with a new technology tool.]	5.34	1.53	-.35
Play: [I prefer to be shown how a technology tool works before I use it.]	4.34	1.72	-.21
Play: [If I'm stuck using a technology tool, I'll ask for help from someone who knows.]	5.48	1.48	-.61
Play: [I usually solve problems by considering solutions carefully.]	4.62	1.26	.38
Play: [I usually solve problems by trial and error.]	5.21	1.34	-.07
Performance: [Who I am online is quite different to who I am in person.]	2.35	1.66	1.12
Negotiation: [I use Internet to discover new things about myself and others.]	3.89	1.92	.03
Appropriation: [I use Internet to look things up and check facts.]	6.07	1.18	-.87
Simulation: [I search the Internet to find representations of how things work.]	5.68	1.31	-.43
Performance: [I consider my online identity as an extension of who I am face-to-face.]	4.56	1.95	-.39
Appropriation: [I use technology tools to take someone's ideas and make them better.]	4.39	1.64	-.03
Collective Intelligence: [I like to come up with all my own ideas.]	4.52	1.38	.20
Appropriation: [I regard taking someone's work and posting it online as plagiarism.]	5.29	1.81	-.72
Appropriation: [I believe that we need to rethink what plagiarism is when interacting with others on the Internet.]	4.51	1.77	-.27
Multitasking: [I frequently have multiple tabs open in my web browser and switch between them.]	6.30	1.22	-1.90
Multitasking: [When using a technology tool, I prefer doing one thing at a time.]	3.25	1.61	.11
Multitasking: [I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing.]	3.97	1.80	-.04
Multitasking: [I usually maintain focus on the task at hand.]	4.63	1.39	.19

Distributed Cognition: [I use tools on the Internet to try new ways of doing things.]	5.08	1.44	.08
Distributed Cognition: [I experiment with new web tools when I hear about them.]	4.79	1.60	-.10
Distributed Cognition: [I often sign up for new services on the Internet.]	4.06	1.76	.04
Judgment: [I consider websites like Wikipedia to be unreliable.]	4.33	1.45	-.07
Collective Intelligence: [My ideas about teaching are influenced by my colleagues.]	4.52	1.11	.17
Judgment: [I'm often unsure about the reliability of information I find online.]	3.99	1.11	-.06
Judgment: [I like to verify information online with information in other forms.]	4.70	1.45	-.02
Transmedia Navigation: [I like a webpage that includes different types of media (audio, video, images, links, etc.).]	5.23	1.38	-.04
Transmedia Navigation: [I get distracted if there are too many forms of media on a web page.]	3.55	1.53	-.02
Transmedia Navigation: [I focus on the main area of a web page before I click on links to other material.]	4.82	1.25	.55
Transmedia Navigation: [I click on links to other material before I finish examining the main content of a web page.]	3.91	1.41	.21
Networking: [I use search engines (e.g. Google) to find most things online.]	6.26	1.16	-1.22
Networking: [I find things online through links shared with me on social networks like Facebook.]	4.18	1.88	-.13
Networking: [If I discover something interesting on the Internet, I email it to friends.]	4.13	1.89	.01
Networking: [I share interesting links with others on social network services (like Facebook).]	4.08	2.12	-.04
Negotiation: [I get overwhelmed by the vastness of the Internet.]	2.68	1.69	.41

Table A2-5.20a - Significance levels by career stage (Question 7 items) – Group Statistics

Participatory Cultures Item	Career Stage	N	Mean	Std. Deviation	Std. Error Mean
Play: [I like to play around with a new technology tool.]	Current Teacher	104	5.51	1.607	.158
	PST	50	5.00	1.294	.183
Play: [I prefer to be shown how a technology tool works before I use it.]	Current Teacher	104	4.05	1.697	.166
	PST	50	4.96	1.628	.230
Play: [If I'm stuck using a technology tool, I'll ask for help from someone who knows.]	Current Teacher	103	5.53	1.552	.153
	PST	50	5.38	1.338	.189
Play: [I usually solve problems by considering solutions carefully.]	Current Teacher	104	4.63	1.345	.132
	PST	50	4.60	1.088	.154
Play: [I usually solve problems by trial and error.]	Current Teacher	104	5.14	1.464	.144
	PST	50	5.34	1.022	.145
Performance: [Who I am online is quite different to who I am in person.]	Current Teacher	103	2.35	1.690	.167
	PST	50	2.36	1.601	.226
Negotiation: [I use Internet to discover new things about myself and others.]	Current Teacher	104	3.86	1.938	.190
	PST	50	3.96	1.906	.269
Appropriation: [I use Internet to look things up and check facts.]	Current Teacher	104	5.91	1.315	.129
	PST	49	6.41	.734	.105
Simulation: [I search the Internet to find representations of how things work.]	Current Teacher	104	5.59	1.377	.135
	PST	49	5.88	1.130	.161
Performance: [I consider my online identity as an extension of who I am face-to-face.]	Current Teacher	104	4.64	1.905	.187
	PST	50	4.40	2.040	.289
Appropriation: [I use technology tools to take someone's ideas and make them better.]	Current Teacher	104	4.68	1.603	.157
	PST	50	3.78	1.569	.222
Collective Intelligence: [I like to come up with all my own	Current Teacher	103	4.46	1.426	.141

Participatory Cultures Item	Career Stage	N	Mean	Std. Deviation	Std. Error Mean
ideas.]	PST	50	4.64	1.274	.180
Appropriation: [I regard taking someone's work and posting it online as plagiarism.]	Current Teacher	103	5.25	1.786	.176
	PST	50	5.38	1.861	.263
Appropriation: [I believe that we need to rethink what plagiarism is when interacting with others on the Internet.]	Current Teacher	104	4.52	1.784	.175
	PST	50	4.50	1.753	.248
Multitasking: [I frequently have multiple tabs open in my web browser and switch between them.]	Current Teacher	104	6.16	1.394	.137
	PST	50	6.58	.673	.095
Multitasking: [When using a technology tool, I prefer doing one thing at a time.]	Current Teacher	104	3.35	1.630	.160
	PST	50	3.04	1.577	.223
Multitasking: [I can get distracted by something on the Internet, and have trouble regaining focus on what I was doing.]	Current Teacher	103	3.67	1.706	.168
	PST	49	4.61	1.835	.262
Multitasking: [I usually maintain focus on the task at hand.]	Current Teacher	104	4.79	1.384	.136
	PST	49	4.31	1.357	.194
Distributed Cognition: [I use tools on the Internet to try new ways of doing things.]	Current Teacher	104	5.24	1.411	.138
	PST	50	4.76	1.451	.205
Distributed Cognition: [I often try new web tools when I hear about them.]	Current Teacher	103	5.00	1.615	.159
	PST	50	4.36	1.495	.211
Distributed Cognition: [I often sign up for new services on the Internet.]	Current Teacher	102	4.33	1.742	.173
	PST	50	3.50	1.669	.236
Judgment: [I consider websites like Wikipedia to be unreliable.]	Current Teacher	103	4.41	1.424	.140
	PST	50	4.16	1.490	.211
Collective Intelligence: [My ideas about teaching are influenced by my colleagues.]	Current Teacher	104	4.38	1.100	.108
	PST	50	4.80	1.088	.154
Judgment: [I'm often unsure about the reliability of information I find online.]	Current Teacher	104	4.03	.970	.095
	PST	50	3.90	1.374	.194

Participatory Cultures Item	Career Stage	N	Mean	Std. Deviation	Std. Error Mean
Judgment: [I like to verify information online with information in other forms.]	Current Teacher	103	4.56	1.348	.133
	PST	49	4.98	1.626	.232
Transmedia Navigation: [I like a webpage that includes different types of media (audio, video, images, links, etc.).]	Current Teacher	103	5.19	1.435	.141
	PST	50	5.30	1.266	.179
Transmedia Navigation: [I get distracted if there are too many forms of media on a web page.]	Current Teacher	104	3.49	1.481	.145
	PST	49	3.67	1.638	.234
Transmedia Navigation: [I focus on the main area of a web page before I click on links to other material.]	Current Teacher	104	4.63	1.141	.112
	PST	50	5.20	1.385	.196
Transmedia Navigation: [I click on links to other material before I finish examining the main content of a web page.]	Current Teacher	103	4.05	1.175	.116
	PST	50	3.62	1.783	.252
Networking: [I use search engines (e.g. Google) to find most things online.]	Current Teacher	104	6.25	1.244	.122
	PST	48	6.29	.967	.140
Networking: [I find things online through links shared with me on social networks like Facebook.]	Current Teacher	104	4.33	1.856	.182
	PST	50	3.86	1.906	.270
Networking: [If I discover something interesting on the Internet, I email it to friends.]	Current Teacher	104	4.44	1.837	.180
	PST	50	3.48	1.854	.262
Networking: [I share interesting links with others on social network services (like Facebook).]	Current Teacher	103	4.05	2.148	.212
	PST	50	4.16	2.084	.295
Negotiation: [I get overwhelmed by the vastness of the Internet.]	Current Teacher	104	2.71	1.611	.158
	PST	49	2.61	1.858	.265

Table A2-5.20b - Significance levels by career stage (Question 7 Items) – Full T-Test Results.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Play: [I like to play around with a new technology tool.]	Equal variances assumed	20.303	.000	1.957	152	.052	.510	.260	-.005	1.024
	Equal variances not assumed			2.111	117.825	.037	.510	.241	.031	.988
Play: [I prefer to be shown how a technology tool works before I use it.]	Equal variances assumed	1.005	.318	-3.163	152	.002	-.912	.288	-1.482	-.342
	Equal variances not assumed			-3.209	100.520	.002	-.912	.284	-1.476	-.348
Play: [If I'm stuck using a technology tool, I'll ask for help from someone who knows.]	Equal variances assumed	7.622	.006	.601	151	.549	.154	.256	-.352	.660
	Equal variances not assumed			.633	111.091	.528	.154	.243	-.328	.636
Play: [I usually solve	Equal	2.864	.093	.115	152	.909	.025	.218	-.406	.456

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
problems by considering solutions carefully.]	variances assumed									
	Equal variances not assumed			.123	117.340	.902	.025	.203	-.376	.426
Play: [I usually solve problems by trial and error.]	Equal variances assumed	19.994	.000	-.850	152	.396	-.196	.230	-.651	.259
	Equal variances not assumed			-.961	132.153	.338	-.196	.204	-.599	.207

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Performance: [Who I am online is quite different to who I am in person.]	Equal variances assumed	3.468	.065	-.037	151	.971	-.010	.286	-.576	.555
	Equal variances not assumed			-.037	102.052	.970	-.010	.281	-.568	.547
Negotiation: [I use Internet to discover new things about myself and others.]	Equal variances assumed	.252	.616	-.314	152	.754	-.104	.332	-.760	.551
	Equal variances not assumed			-.316	98.288	.753	-.104	.330	-.759	.550
Appropriation: [I use Internet to look things up and check facts.]	Equal variances assumed	42.439	.000	-2.456	151	.015	-.495	.201	-.893	-.097
	Equal variances not assumed			-2.977	146.692	.003	-.495	.166	-.823	-.166

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Simulation: [I search the Internet to find representations of how things work.]	Equal variances assumed	25.595	.000	-1.289	151	.199	-.291	.226	-.737	.155
	Equal variances not assumed			-1.383	112.906	.169	-.291	.210	-.708	.126
Performance: [I consider my online identity as an extension of who I am face-to-face.]	Equal variances assumed	.843	.360	.728	152	.468	.244	.336	-.419	.907
	Equal variances not assumed			.710	91.071	.479	.244	.344	-.439	.927

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Appropriation: [I use technology tools to take someone's ideas and make them better.]	Equal variances assumed	.057	.812	3.295	152	.001	.903	.274	.362	1.444
	Equal variances not assumed			3.320	98.689	.001	.903	.272	.363	1.442
Collective Intelligence: [I like to come up with all my own ideas.]	Equal variances assumed	.103	.749	-.773	151	.441	-.184	.238	-.653	.286
	Equal variances not assumed			-.804	107.645	.423	-.184	.229	-.637	.269
Appropriation: [I regard taking someone's work and posting it online as plagiarism.]	Equal variances assumed	.056	.813	-.409	151	.683	-.128	.312	-.744	.489
	Equal variances not assumed			-.403	93.611	.688	-.128	.317	-.756	.501

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Appropriation: [I believe that we need to rethink what plagiarism is when interacting with others on the Internet.]	Equal variances assumed	.083	.774	.063	152	.950	.019	.305	-.584	.622
	Equal variances not assumed			.063	98.389	.950	.019	.303	-.583	.621
Multitasking: [I frequently have multiple tabs open in my web browser and switch between them.]	Equal variances assumed	21.299	.000	-2.001	152	.047	-.417	.208	-.828	-.005
	Equal variances not assumed			-2.501	151.989	.013	-.417	.167	-.746	-.087
Multitasking: [When using a technology tool, I prefer doing one thing at a time.]	Equal variances assumed	.181	.671	1.103	152	.272	.306	.278	-.242	.855
	Equal variances not assumed			1.116	99.701	.267	.306	.274	-.238	.851
Multitasking: [I can get distracted by something	Equal variances	1.881	.172	-3.106	150	.002	-.942	.303	-1.542	-.343

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
on the Internet, and have trouble regaining focus on what I was doing.]	assumed									
	Equal variances not assumed			-3.026	88.532	.003	-.942	.311	-1.561	-.324
Multitasking: [I usually maintain focus on the task at hand.]	Equal variances assumed	.313	.577	2.024	151	.045	.482	.238	.011	.953
	Equal variances not assumed			2.038	95.852	.044	.482	.237	.013	.952
Distributed Cognition: [I use tools on the Internet to try new ways of doing things.]	Equal variances assumed	1.278	.260	1.961	152	.052	.480	.245	-.004	.964
	Equal variances not assumed			1.941	94.402	.055	.480	.247	-.011	.972

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Distributed Cognition: [I often try new web tools when I hear about them.]	Equal variances assumed	2.489	.117	2.355	151	.020	.640	.272	.103	1.177
	Equal variances not assumed			2.419	104.172	.017	.640	.265	.115	1.165
Distributed Cognition: [I often sign up for new services on the Internet.]	Equal variances assumed	.288	.592	2.808	150	.006	.833	.297	.247	1.420
	Equal variances not assumed			2.850	101.317	.005	.833	.292	.253	1.413
Judgment: [I consider websites like Wikipedia to be unreliable.]	Equal variances assumed	1.304	.255	.994	151	.322	.248	.249	-.245	.740
	Equal variances not assumed			.979	93.308	.330	.248	.253	-.255	.750
Collective Intelligence: [My ideas about	Equal variances	.056	.813	-2.202	152	.029	-.415	.189	-.788	-.043

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
teaching are influenced by my colleagues.]	assumed									
	Equal variances not assumed			-2.211	97.760	.029	-.415	.188	-.788	-.042
Judgment: [I'm often unsure about the reliability of information I find online.]	Equal variances assumed	20.025	.000	.671	152	.503	.129	.192	-.251	.508
	Equal variances not assumed			.596	73.295	.553	.129	.216	-.302	.560
Judgment: [I like to verify information online with information in other forms.]	Equal variances assumed	3.623	.059	-1.663	150	.098	-.416	.250	-.911	.078
	Equal variances not assumed			-1.556	80.452	.124	-.416	.268	-.949	.116

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Transmedia Navigation: [I like a webpage that includes different types of media (audio, video, images, links, etc.).]	Equal variances assumed	5.553	.020	-.444	151	.658	-.106	.238	-.577	.365
	Equal variances not assumed			-.464	108.883	.644	-.106	.228	-.558	.346
Transmedia Navigation: [I get distracted if there are too many forms of media on a web page.]	Equal variances assumed	1.541	.216	-.689	151	.492	-.183	.266	-.708	.342
	Equal variances not assumed			-.665	86.156	.508	-.183	.275	-.731	.364
Transmedia Navigation: [I focus on the main area of a web page before I click on links to other material.]	Equal variances assumed	4.789	.030	-2.682	152	.008	-.565	.211	-.982	-.149
	Equal variances not assumed			-2.506	82.041	.014	-.565	.226	-1.014	-.117

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Transmedia Navigation: [I click on links to other material before I finish examining the main content of a web page.]	Equal variances assumed	23.784	.000	1.774	151	.078	.429	.242	-.049	.906
	Equal variances not assumed			1.545	70.325	.127	.429	.277	-.125	.982
Networking: [I use search engines (e.g. Google) to find most things online.]	Equal variances assumed	6.615	.011	-.205	150	.838	-.042	.203	-.443	.360
	Equal variances not assumed			-.225	115.549	.823	-.042	.185	-.409	.325
Networking: [I find things online through links shared with me on social networks like Facebook.]	Equal variances assumed	.757	.386	1.449	152	.149	.467	.322	-.170	1.104
	Equal variances not assumed			1.436	94.521	.154	.467	.325	-.179	1.113

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Networking: [If I discover something interesting on the Internet, I email it to friends.]	Equal variances assumed	.355	.552	3.035	152	.003	.962	.317	.336	1.589
	Equal variances not assumed			3.025	95.993	.003	.962	.318	.331	1.594
Networking: [I share interesting links with others on social network services (like Facebook).]	Equal variances assumed	.261	.610	-.304	151	.762	-.111	.367	-.836	.613
	Equal variances not assumed			-.307	99.851	.759	-.111	.363	-.831	.608
Negotiation: [I get overwhelmed by the vastness of the Internet.]	Equal variances assumed	.481	.489	.338	151	.736	.099	.293	-.480	.679
	Equal variances not assumed			.322	83.182	.749	.099	.309	-.515	.714

Table A2-5.34a - Significance levels by career stage (Questions 8-9) – Group Statistics

TPaCK Item	Career Stage	N	Mean	SD	Std. Error Mean
CK: [I have sufficient knowledge about my teaching subject.]	Current Teacher	100	6.15	.744	.074
	PST	44	5.39	1.083	.163
CK: [I think about the content of my teaching subject like a subject matter expert.]	Current Teacher	99	5.70	1.044	.105
	PST	44	5.05	1.238	.187
CK: [I gain deeper understanding about the content of my teaching subject on my own.]	Current Teacher	98	5.28	1.391	.140
	PST	44	5.00	1.329	.200
CK: [I am confident to teach the subject matter.]	Current Teacher	98	6.32	.726	.073
	PST	43	5.21	1.440	.220
PCK: [Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.]	Current Teacher	100	5.31	1.542	.154
	PST	44	5.43	1.087	.164
PCK: [Without using technology, I can address the common learning difficulties my students have for my teaching subject.]	Current Teacher	100	5.23	1.530	.153
	PST	44	5.14	1.069	.161
PCK. [Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.]	Current Teacher	100	5.41	1.531	.153
	PST	44	5.52	1.131	.170
PCK. [Without using technology, I can engage students in solving real world problem related to my teaching subject.]	Current Teacher	99	5.06	1.628	.164
	PST	44	5.59	1.085	.164
PCK. [Without using technology, I can support	Current Teacher	100	5.16	1.549	.155

TPaCK Item	Career Stage	N	Mean	SD	Std. Error Mean
students to manage their learning of content for my teaching subject.]	PST	44	5.48	1.000	.151
PK: [I am able to stretch my students' thinking by creating challenging tasks for them.]	Current Teacher	100	6.11	.737	.074
	PST	44	5.48	.927	.140
PK: [I am able to guide my students to adopt appropriate learning strategies.]	Current Teacher	99	6.06	.712	.072
	PST	44	5.39	.920	.139
PK: [I am able to help my students to monitor their own learning.]	Current Teacher	100	5.95	.880	.088
	PST	44	5.30	1.002	.151
PK: [I am able to help my students to reflect on their learning strategies.]	Current Teacher	98	6.00	.837	.085
	PST	44	5.41	.996	.150
PK: [I am able to guide my students to discuss effectively during group work.]	Current Teacher	100	5.99	.904	.090
	PST	44	5.36	.967	.146
TPCK: [I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools.]	Current Teacher	101	5.29	1.211	.121
	PST	42	4.45	1.152	.178
TPCK: [I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools.]	Current Teacher	101	5.69	1.093	.109
	PST	42	4.90	1.206	.186
TPCK: [I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).]	Current Teacher	101	5.46	1.389	.138
	PST	42	4.31	1.456	.225
TPCK: [I can design inquiry activities to guide	Current Teacher	101	5.63	1.129	.112

TPaCK Item	Career Stage	N	Mean	SD	Std. Error Mean
students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).]	PST	41	4.54	1.416	.221
TPCK: [I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.]	Current Teacher	100	5.96	1.024	.102
	PST	40	5.28	1.012	.160
TCK: [I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).]	Current Teacher	101	5.42	1.227	.122
	PST	42	4.71	1.436	.222
TCK: [I know about the technologies that I have to use for the research of content of my teaching subject.]	Current Teacher	99	5.71	1.052	.106
	PST	42	4.57	1.252	.193
TCK: [I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.]	Current Teacher	100	5.84	1.032	.103
	PST	42	5.29	1.215	.188
TCK: [I can use specialised software to perform inquiry about my teaching subject.]	Current Teacher	101	5.41	1.298	.129
	PST	42	4.17	1.360	.210
TCK: [I am able to use technology to introduce my students to real world scenarios.]	Current Teacher	100	5.89	1.063	.106
	PST	42	5.24	.983	.152
TCK: [I am able to facilitate my students to use technology to plan and monitor their own learning.]	Current Teacher	101	5.73	.989	.098
	PST	42	4.90	1.055	.163
TPK: [I am able to facilitate my students to use	Current Teacher	101	5.88	.962	.096

TPaCK Item	Career Stage	N	Mean	SD	Std. Error Mean
technology to construct different forms of knowledge representation.]	PST	41	5.07	1.034	.162
TPK: [I am able to facilitate my students to collaborate with each other using technology.]	Current Teacher	99	5.83	.980	.098
	PST	42	5.21	1.025	.158
TK: [I have the technical skills to use computers effectively.]	Current Teacher	101	6.24	.873	.087
	PST	42	5.95	.882	.136
TK: [I can learn technology easily.]	Current Teacher	100	5.99	1.040	.104
	PST	42	5.88	1.109	.171
TK: [I know how to solve my own technical problems when using technology.]	Current Teacher	101	5.42	1.444	.144
	PST	42	4.93	1.504	.232
TK: [I keep up with important new technologies.]	Current Teacher	99	5.68	1.260	.127
	PST	42	4.74	1.466	.226

Table A2-5.34b - Significance levels by career stage (Questions 8-9) – Full T-Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CK: [I have sufficient knowledge about my teaching subject.]	Equal variances assumed	6.480	.012	4.905	142	.000	.764	.156	.456	1.071
	Equal variances not assumed			4.257	61.543	.000	.764	.179	.405	1.122
CK: [I think about the content of my teaching subject like a subject matter expert.]	Equal variances assumed	.020	.888	3.248	141	.001	.652	.201	.255	1.048
	Equal variances not assumed			3.043	71.373	.003	.652	.214	.225	1.078
CK: [I gain deeper understanding about the content of my teaching subject on my own.]	Equal variances assumed	.584	.446	1.107	140	.270	.276	.249	-.217	.768
	Equal variances not assumed			1.126	86.379	.263	.276	.245	-.211	.762

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CK: [I am confident to teach the subject matter.]	Equal variances assumed	26.357	.000	6.067	139	.000	1.107	.182	.746	1.468
	Equal variances not assumed			4.781	51.623	.000	1.107	.232	.642	1.572
PCK: [Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.]	Equal variances assumed	3.311	.071	-.474	142	.636	-.122	.257	-.630	.386
	Equal variances not assumed			-.541	114.040	.589	-.122	.225	-.568	.324
PCK: [Without using technology, I can address the common learning difficulties my students have for my teaching subject.]	Equal variances assumed	8.587	.004	.368	142	.713	.094	.254	-.409	.597
	Equal variances not assumed			.421	114.851	.674	.094	.222	-.347	.534

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PCK. [Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.]	Equal variances assumed	3.684	.057	-.438	142	.662	-.113	.257	-.621	.396
	Equal variances not assumed			-.492	109.455	.624	-.113	.229	-.567	.341
PCK. [Without using technology, I can engage students in solving real world problem related to my teaching subject.]	Equal variances assumed	9.514	.002	-1.973	141	.050	-.530	.269	-1.062	.001
	Equal variances not assumed			-2.292	119.542	.024	-.530	.231	-.988	-.072
PCK. [Without using technology, I can support students to manage their learning of content for my teaching subject.]	Equal variances assumed	8.987	.003	-1.248	142	.214	-.317	.254	-.820	.185
	Equal variances not assumed			-1.468	122.449	.145	-.317	.216	-.745	.111

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PK: [I am able to stretch my students' thinking by creating challenging tasks for them.]	Equal variances assumed	8.793	.004	4.375	142	.000	.633	.145	.347	.919
	Equal variances not assumed			4.004	67.951	.000	.633	.158	.317	.948
PK: [I am able to guide my students to adopt appropriate learning strategies.]	Equal variances assumed	9.695	.002	4.763	141	.000	.674	.142	.394	.954
	Equal variances not assumed			4.319	66.815	.000	.674	.156	.363	.986
PK: [I am able to help my students to monitor their own learning.]	Equal variances assumed	5.090	.026	3.937	142	.000	.655	.166	.326	.983
	Equal variances not assumed			3.744	73.506	.000	.655	.175	.306	1.003

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PK: [I am able to help my students to reflect on their learning strategies.]	Equal variances assumed	7.380	.007	3.663	140	.000	.591	.161	.272	.910
	Equal variances not assumed			3.429	71.441	.001	.591	.172	.247	.934
PK: [I am able to guide my students to discuss effectively during group work.]	Equal variances assumed	3.319	.071	3.748	142	.000	.626	.167	.296	.957
	Equal variances not			3.652	77.512	.000	.626	.172	.285	.968

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
	assumed									
TPCK: [I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).]	Equal variances assumed	.010	.919	3.807	141	.000	.835	.219	.401	1.268
	Equal variances not assumed			3.887	80.390	.000	.835	.215	.407	1.262
TPCK: [I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).]	Equal variances assumed	.210	.647	3.810	141	.000	.788	.207	.379	1.197
	Equal variances not assumed			3.658	70.434	.000	.788	.216	.358	1.218
TPCK: [I can create self-	Equal	.655	.420	4.429	141	.000	1.146	.259	.634	1.657

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).]	variances assumed									
	Equal variances not assumed			4.343	73.582	.000	1.146	.264	.620	1.672
TPCK: [I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools.]	Equal variances assumed	4.204	.042	4.865	140	.000	1.097	.226	.651	1.543
	Equal variances not assumed			4.423	61.665	.000	1.097	.248	.601	1.593
TPCK: [I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.]	Equal variances assumed	1.695	.195	3.587	138	.000	.685	.191	.307	1.063
	Equal variances not assumed			3.605	72.665	.001	.685	.190	.306	1.064
TCK: [I can use the software that is created	Equal variances	2.428	.121	2.959	141	.004	.702	.237	.233	1.170

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
specifically for my teaching subject.]	assumed									
	Equal variances not assumed			2.773	67.126	.007	.702	.253	.197	1.207
TCK: [I know about the technologies that I have to use for the research of content of my teaching subject.]	Equal variances assumed	2.453	.120	5.531	139	.000	1.136	.205	.730	1.542
	Equal variances not assumed			5.156	66.739	.000	1.136	.220	.696	1.575

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TCK: [I can use appropriate technologies to represent the content of my teaching subject.]	Equal variances assumed	1.789	.183	2.768	140	.006	.554	.200	.158	.950
	Equal variances not assumed			2.589	67.042	.012	.554	.214	.127	.982
TCK: [I can use specialised software to perform inquiry about my teaching subject.]	Equal variances assumed	.020	.889	5.129	141	.000	1.239	.242	.762	1.717
	Equal variances not assumed			5.030	73.590	.000	1.239	.246	.748	1.730
TCK: [I am able to use technology to introduce my students to real world scenarios.]	Equal variances assumed	.009	.925	3.409	140	.001	.652	.191	.274	1.030
	Equal variances not assumed			3.520	82.855	.001	.652	.185	.284	1.020
TCK: [I am able to	Equal	.008	.927	4.471	141	.000	.828	.185	.462	1.194

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
facilitate my students to use technology to plan and monitor their own learning.]	variances assumed									
	Equal variances not assumed			4.353	72.474	.000	.828	.190	.449	1.207
TPK: [I am able to facilitate my students to use technology to construct different forms of knowledge representation.]	Equal variances assumed	.508	.477	4.438	140	.000	.808	.182	.448	1.168
	Equal variances not assumed			4.304	69.611	.000	.808	.188	.434	1.183
TPK: [I am able to facilitate my students to collaborate with each other using technology.]	Equal variances assumed	.529	.468	3.357	139	.001	.614	.183	.252	.976
	Equal variances not assumed			3.296	74.282	.002	.614	.186	.243	.985

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TK: [I have the technical skills to use computers effectively.]	Equal variances assumed	.003	.957	1.773	141	.078	.285	.161	-.033	.603
	Equal variances not assumed			1.766	76.065	.081	.285	.161	-.036	.607
TK: [I can learn technology easily.]	Equal variances assumed	.191	.662	.559	140	.577	.109	.195	-.276	.494
	Equal variances not assumed			.545	72.756	.588	.109	.200	-.290	.508
TK: [I know how to solve my own technical problems when using technology.]	Equal variances assumed	.022	.884	1.815	141	.072	.487	.268	-.043	1.018
	Equal variances not assumed			1.785	73.987	.078	.487	.273	-.057	1.031

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TK: [I keep up with important new technologies.]	Equal variances assumed	2.391	.124	3.849	139	.000	.939	.244	.457	1.421
	Equal variances not assumed			3.621	67.945	.001	.939	.259	.421	1.456

Table A2-5.35a - Significance levels by sharing level (Questions 8-9) – Group Statistics

TPaCK Item	Sharing Group (Low/High)	N	Mean	Std. Deviation	Std. Error Mean
CK: [I have sufficient knowledge about my teaching subject.]	Low	57	5.75	1.074	.142
	High	26	6.08	1.017	.199
CK: [I think about the content of my teaching subject like a subject matter expert.]	Low	57	5.28	1.206	.160
	High	26	5.73	1.218	.239
CK: [I gain deeper understanding about the content of my teaching subject on my own.]	Low	57	5.18	1.338	.177
	High	26	5.46	1.240	.243
CK: [I am confident to teach the subject matter.]	Low	56	5.68	1.377	.184
	High	25	6.24	.970	.194
PCK: [Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.]	Low	57	5.54	1.166	.154
	High	26	5.31	1.644	.322
PCK: [Without using technology, I can address the common learning difficulties my students have for my teaching subject.]	Low	57	5.16	1.265	.168
	High	26	5.50	1.364	.267
PCK. [Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.]	Low	57	5.63	1.190	.158
	High	26	5.58	1.629	.319
PCK. [Without using technology, I can engage students in solving real world problem related to my teaching subject.]	Low	57	5.32	1.365	.181
	High	25	5.52	1.610	.322
PCK. [Without using technology, I can support students to manage their learning of content for my teaching subject.]	Low	57	5.30	1.239	.164
	High	26	5.42	1.793	.352

TPaCK Item	Sharing Group (Low/High)	N	Mean	Std. Deviation	Std. Error Mean
PK: [I am able to stretch my students' thinking by creating challenging tasks for them.]	Low	57	5.72	.881	.117
	High	26	6.27	.778	.152
PK: [I am able to guide my students to adopt appropriate learning strategies.]	Low	56	5.66	.880	.118
	High	26	6.23	.765	.150
PK: [I am able to help my students to monitor their own learning.]	Low	57	5.47	.966	.128
	High	26	6.00	1.058	.208
PK: [I am able to help my students to reflect on their learning strategies.]	Low	57	5.60	.961	.127
	High	26	6.08	.845	.166
PK: [I am able to guide my students to discuss effectively during group work.]	Low	57	5.60	.961	.127
	High	26	6.23	.908	.178
TPCK: [I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).]	Low	55	4.49	1.230	.166
	High	26	5.65	.977	.192
TPCK: [I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).]	Low	55	5.09	1.295	.175
	High	26	5.96	.916	.180
TPCK: [I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).]	Low	55	4.55	1.653	.223
	High	26	5.50	1.241	.243

TPaCK Item	Sharing Group (Low/High)	N	Mean	Std. Deviation	Std. Error Mean
TPCK: [I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).]	Low	55	4.89	1.410	.190
	High	26	5.62	1.203	.236
TPCK: [I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.]	Low	54	5.48	1.112	.151
	High	26	5.92	1.164	.228
TCK: [I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).]	Low	55	4.89	1.410	.190
	High	26	5.54	1.240	.243
TCK: [I know about the technologies that I have to use for the research of content of my teaching subject.]	Low	54	4.81	1.428	.194
	High	26	5.81	1.021	.200
TCK: [I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.]	Low	55	5.36	1.267	.171
	High	26	5.96	.958	.188
TCK: [I can use specialised software to perform inquiry about my teaching subject.]	Low	55	4.36	1.508	.203
	High	26	5.88	1.143	.224
TCK: [I am able to use technology to introduce my students to real world scenarios.]	Low	55	5.40	1.132	.153
	High	26	5.92	1.055	.207
TCK: [I am able to facilitate my students to use technology to plan and monitor their own learning.]	Low	55	5.11	1.083	.146
	High	26	6.00	.980	.192
TPK: [I am able to facilitate my students to use technology to construct different forms of	Low	54	5.28	1.089	.148
	High	26	5.96	.999	.196

TPaCK Item	Sharing Group (Low/High)	N	Mean	Std. Deviation	Std. Error Mean
knowledge representation.]					
TPK: [I am able to facilitate my students to collaborate with each other using technology.]	Low	54	5.31	1.079	.147
	High	26	5.92	1.164	.228
TK: [I have the technical skills to use computers effectively.]	Low	55	6.11	.809	.109
	High	26	6.42	.809	.159
TK: [I can learn technology easily.]	Low	55	5.93	1.103	.149
	High	26	6.19	.895	.176
TK: [I know how to solve my own technical problems when using technology.]	Low	55	4.95	1.520	.205
	High	26	5.77	1.243	.244
TK: [I keep up with important new technologies.]	Low	55	5.04	1.478	.199
	High	26	5.73	1.430	.280

Table A2-5.35a - Significance levels by sharing level (Questions 8-9) – Group Statistics

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CK: [I have sufficient knowledge about my teaching subject.]	Equal variances assumed	.087	.769	-1.290	81	.201	-.323	.250	-.820	.175
	Equal variances not assumed			-1.317	51.009	.194	-.323	.245	-.814	.169
CK: [I think about the content of my teaching subject like a subject matter expert.]	Equal variances assumed	.024	.877	-1.572	81	.120	-.450	.286	-1.020	.120
	Equal variances not assumed			-1.566	48.068	.124	-.450	.287	-1.028	.128
CK: [I gain deeper understanding about the content of my teaching subject on my own.]	Equal variances assumed	.012	.913	-.924	81	.358	-.286	.310	-.902	.330
	Equal variances not assumed			-.951	52.036	.346	-.286	.301	-.890	.318
CK: [I am confident to teach the subject matter.]	Equal variances assumed	2.824	.097	-1.843	79	.069	-.561	.305	-1.168	.045
	Equal variances not assumed			-2.101	64.011	.040	-.561	.267	-1.095	-.027

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PCK: [Without using technology, I can help my students to understand the content knowledge of my teaching subject through various ways.]	Equal variances assumed	4.468	.038	.749	81	.456	.236	.315	-.391	.863
	Equal variances not assumed			.661	36.927	.513	.236	.357	-.488	.960
PCK: [Without using technology, I can address the common learning difficulties my students have for my teaching subject.]	Equal variances assumed	.245	.622	-1.115	81	.268	-.342	.307	-.952	.268
	Equal variances not assumed			-1.084	45.346	.284	-.342	.316	-.978	.293
PCK. [Without using technology, I can facilitate meaningful discussion about the content students are learning in my teaching subject.]	Equal variances assumed	2.377	.127	.172	81	.864	.055	.317	-.577	.686
	Equal variances not assumed			.153	37.649	.879	.055	.356	-.667	.776

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PCK. [Without using technology, I can engage students in solving real world problem related to my teaching subject.]	Equal variances assumed	.326	.569	-.590	80	.557	-.204	.346	-.893	.485
	Equal variances not assumed			-.553	39.811	.583	-.204	.369	-.951	.542
PCK. [Without using technology, I can support students to manage their learning of content for my teaching subject.]	Equal variances assumed	3.409	.068	-.368	81	.714	-.125	.339	-.799	.550
	Equal variances not assumed			-.322	36.306	.749	-.125	.388	-.911	.662
PK: [I am able to stretch my students' thinking by creating challenging tasks.]	Equal variances assumed	.049	.825	-2.731	81	.008	-.550	.201	-.951	-.149
	Equal variances not assumed			-2.863	54.533	.006	-.550	.192	-.935	-.165
PK: [I am able to guide my students to adopt appropriate learning strategies.]	Equal variances assumed	.604	.440	-2.842	80	.006	-.570	.201	-.969	-.171
	Equal variances not assumed			-2.992	55.617	.004	-.570	.191	-.952	-.188
		Levene's Test for		t-test for Equality of Means						

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
		Equality of Variances								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PK: [I am able to help my students to monitor their own learning.]	Equal variances assumed	.263	.609	-2.235	81	.028	-.526	.235	-.995	-.058
	Equal variances not assumed			-2.159	44.712	.036	-.526	.244	-1.017	-.035
PK: [I am able to help my students to reflect on their learning strategies.]	Equal variances assumed	2.229	.139	-2.191	81	.031	-.480	.219	-.917	-.044
	Equal variances not assumed			-2.299	54.708	.025	-.480	.209	-.899	-.062
PK: [I am able to guide my students to discuss effectively during group work.]	Equal variances assumed	.030	.862	-2.836	81	.006	-.634	.224	-1.079	-.189
	Equal variances not assumed			-2.898	51.113	.006	-.634	.219	-1.074	-.195
TPCK: [I can formulate in-depth discussion topics about the content	Equal variances assumed	2.096	.152	-4.226	79	.000	-1.163	.275	-1.711	-.615
	Equal variances			-	60.709	.000	-1.163	.254	-1.670	-.656

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, Discussion Forums).]	not assumed			4.587						

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TPCK: [I can structure activities to help students to construct different representations of the content knowledge using	Equal variances assumed	5.202	.025	-3.079	79	.003	-.871	.283	-1.433	-.308
	Equal variances not assumed			-3.476	66.922	.001	-.871	.250	-1.371	-.371

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
appropriate ICT tools (e.g. Webspiration, Mindmaps, Wikis).]										
TPCK: [I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g., Blogs, Webquests).]	Equal variances assumed	3.891	.052	-2.613	79	.011	-.955	.365	-1.682	-.227
	Equal variances not assumed			-2.892	63.775	.005	-.955	.330	-1.614	-.295
TPCK: [I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).]	Equal variances assumed	.201	.655	-2.259	79	.027	-.724	.321	-1.363	-.086
	Equal variances not assumed			-2.392	56.920	.020	-.724	.303	-1.331	-.118

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TPCK: [I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.]	Equal variances assumed	1.269	.263	-1.639	78	.105	-.442	.269	-.978	.095
	Equal variances not assumed			-1.613	47.473	.113	-.442	.274	-.992	.109
TCK: [I can use the software that is created specifically for my teaching subject. (e.g., e-dictionary/corpus for language, Geometric sketchpad for Maths; Data loggers for Science).]	Equal variances assumed	.434	.512	-2.003	79	.049	-.648	.323	-1.291	-.004
	Equal variances not assumed			-2.097	55.314	.041	-.648	.309	-1.266	-.029
TCK: [I know about the technologies that I have to use for the research of content of my teaching subject.]	Equal variances assumed	2.414	.124	-3.171	78	.002	-.993	.313	-1.616	-.370
	Equal variances not assumed			-3.559	66.499	.001	-.993	.279	-1.550	-.436

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TCK: [I can use appropriate technologies (e.g. multimedia resources, simulation) to represent the content of my teaching subject.]	Equal variances assumed	4.850	.031	-2.132	79	.036	-.598	.280	-1.156	-.040
	Equal variances not assumed			-2.354	63.368	.022	-.598	.254	-1.105	-.090
TCK: [I can use specialised software to perform inquiry about my teaching subject.]	Equal variances assumed	3.310	.073	-4.557	79	.000	-1.521	.334	-2.185	-.857
	Equal variances not assumed			-5.027	63.235	.000	-1.521	.303	-2.126	-.916
TCK: [I am able to use technology to introduce my students to real world scenarios.]	Equal variances assumed	1.028	.314	-1.983	79	.051	-.523	.264	-1.048	.002
	Equal variances not assumed			-2.034	52.411	.047	-.523	.257	-1.039	-.007
TCK: [I am able to facilitate my students to use technology to plan and monitor their own learning.]	Equal variances assumed	1.031	.313	-3.560	79	.001	-.891	.250	-1.389	-.393
	Equal variances not assumed			-3.691	53.898	.001	-.891	.241	-1.375	-.407

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TPK: [I am able to facilitate my students to use technology to construct different forms of knowledge representation.]	Equal variances assumed	1.937	.168	-2.700	78	.009	-.684	.253	-1.188	-.180
	Equal variances not assumed			-2.783	53.507	.007	-.684	.246	-1.176	-.191
TPK: [I am able to facilitate my students to collaborate with each other using technology.]	Equal variances assumed	.192	.663	-2.303	78	.024	-.608	.264	-1.134	-.082
	Equal variances not assumed			-2.242	46.230	.030	-.608	.271	-1.154	-.062
TK: [I have the technical skills to use computers effectively.]	Equal variances assumed	.026	.873	-1.631	79	.107	-.314	.193	-.697	.069
	Equal variances not assumed			-1.631	49.163	.109	-.314	.192	-.701	.073
TK: [I can learn technology easily.]	Equal variances assumed	.112	.739	-1.069	79	.288	-.265	.248	-.759	.229
	Equal variances not assumed			-1.152	59.558	.254	-.265	.230	-.725	.195
TK: [I know how to solve my own technical problems when using	Equal variances assumed	1.182	.280	-2.406	79	.018	-.824	.342	-1.505	-.142
	Equal variances			-	59.176	.012	-.824	.318	-1.461	-.187

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
technology.]	not assumed			2.586						
TK: [I keep up with important new technologies.]	Equal variances assumed	.165	.685	-1.995	79	.050	-.694	.348	-1.387	-.001
	Equal variances not assumed			-2.019	50.642	.049	-.694	.344	-1.385	-.004

Appendix 3: Ethics Approval

RE: HS Ethics Application - Approved (5201300264)(Con/Met)

Fhs Ethics <fhs.ethics@mq.edu.au> 28 May 2013 at 11:27
To: Prof John Hedberg <john.hedberg@mq.edu.au>
Cc: Dr Matt Bower <matt.bower@mq.edu.au>, Ms Kate Highfield <kate.highfield@mq.edu.au>, Mr Michael Stevenson <michael.stevenson@mq.edu.au>

Dear Prof Hedberg,

Re: "Connected Communities 21 Project"(5201300264)

Thank you for your recent correspondence. Your responses have addressed the issues raised by the Faculty of Human Sciences Human Research Ethics Sub-Committee, effective 28th May 2013. This email constitutes ethical approval only.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72.pdf.

The following personnel are authorised to conduct this research:

Dr Matt Bower
Mr Michael Stevenson
Ms Kate Highfield
Prof John Hedberg

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 28th May 2014
Progress Report 2 Due: 28th May 2015
Progress Report 3 Due: 28th May 2016
Progress Report 4 Due: 28th May 2017
Final Report Due: 28th May 2018

NB. If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Sub-Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the

Sub-Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

5. Please notify the Sub-Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/policy

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of approval to an external organisation as evidence that you have approval, please do not hesitate to contact the Ethics Secretariat at the address below.

Please retain a copy of this email as this is your official notification of ethics approval.

Yours sincerely,

Dr Peter Roger
Chair
Faculty of Human Sciences Ethics Review Sub-Committee
Human Research Ethics Committee

Faculty of Human Sciences - Ethics
Research Office
Level 3, Research HUB, Building C5C
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NSW GOVERNMENT | Education & Communities

Prof John Hedberg
Department of Education Faculty of Human Sciences
Macquarie University
MACQUARIE UNIVERSITY NSW 2109

DOC13/206318
SERAP Number **2013113**

Dear Prof Hedberg

I refer to your application to conduct a research project in NSW government schools entitled *Researching Connected Communities 21*. I am pleased to inform you that your application has been approved. You may contact principals of the nominated schools to seek their participation. **You should include a copy of this letter with the documents you send to schools.**

This approval will remain valid until 28 May 2014.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

Name	Approval expires
John Hedberg	10/05/2014
Michael Eric Stevenson	10/05/2014
Catherine Ridgeway Howe	10/05/2014.

I draw your attention to the following requirements for all researchers in NSW government schools:

- School principals have the right to withdraw the school from the study at any time. The approval of the principal for the specific method of gathering information must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.
- Any proposal to publish the outcomes of the study should be discussed with the research approvals officer before publication proceeds.

When your study is completed please forward your report to: Manager, Quality Assurance Systems/Research, Department of Education and Communities, Locked Bag 53, Darlinghurst, NSW 1300.

You may also be asked to present the findings of your research.

I wish you every success with your research.

Yours sincerely

Dr Susan Harriman
Leader, Quality Assurance Systems
29 May 2013

Policy, Planning and Reporting Directorate
NSW Department of Education and Communities
Level 1, 1 Oxford Street, Darlinghurst NSW 2010 – Locked Bag 53, Darlinghurst NSW 1300
Telephone: 02 9244 5060 – Email: serap@det.nsw.edu.au