Chapter 6: Developing digital smarts in initial teacher education: What motivates new teachers to continue using digital technologies for learning?

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Abstract

The *New Zealand Curriculum,* the overarching curriculum document for both primary and secondary education, enshrines an expectation that teachers engage in Teaching as Inquiry. This is seen as linking to both evidence-informed practice and evolving pedagogical content knowledge. In a rapidly developing, complex mobile digital education, the need for teachers to constantly evolve their technological pedagogical content knowledge is pressing. In initial teacher education (ITE), one challenge is how teacher educators support ITE students' development of evidence-informed reflective practices with digital technologies to match their content knowledge. For ITE students, this is heightened because they are growing their pedagogical knowledge concurrently with learning to incorporate digital technologies in lessons, mostly for the first time. ITE students are in the position of working out how to appropriate unfamiliar digital affordances and devices for learning in unfamiliar classrooms of students, in unfamiliar schools, and sometimes teaching unfamiliar content.

The focus of this chapter is, through a qualitative, thematically analysed study of 74 ITE students, an examination of their efforts in this regard via online postings about their practicum experiences as they experimented with digital technologies in secondary school classrooms. The key question for the study was *What do secondary graduate ITE students come to value regarding using digital technologies in learning contexts?* Findings showed these students creatively applied digital technologies to learning contexts, while adapting to differences among schools and their technological constraints or affordances. Findings also suggest that continuance theory can help understand ITE students' decisions about what prompts them to continue using digital technologies for learning, and how continuance theory links to agency, structures and cultural practices.

Keywords: continuance theory, initial teacher education, digital technologies, ICT, pedagogy, learning, digital smarts

Introduction

The potential for digital technologies to support the kind of learning promoted in the *New Zealand Curriculum* (Ministry of Education, 2007) is of interest to teacher education in this country, and

resonates with efforts in other countries where e-learning opportunities are also developing rapidly. This is particularly relevant in preparing teachers for the secondary school sector, where content rather than process has often taken precedence, often resulting in many instances of teacher-centric and student-passive classroom instruction and practices. Also, while there is considerable hype about digital technologies transforming learning, the reality is sometimes quite different. Yapp (2014), for example, summarises the hyperbole around educational silver bullets when he says:

> Every few years there is a claim made that technology X will 'transform' education such as whiteboards, the WWW, podcasts, tablets, VLEs, mobiles and now MOOCs. Indeed claims on technology and its transformational potential can be found around TV, film, radio and other media for over 100 years. (para. 4)

Essentially, he argues that such determinism has consistently overtaken good sense. Sometimes, the hype around the technology completely ignores the purpose of education, which is to teach young people how to think, get on with others, understand how to behave ethically and morally, continue to learn throughout their lives and contribute to the fabric of the society they live in. A digital technology of itself cannot provide this—a point also raised by Khoo and Merry's chapter in this book. Teachers and other significant others, including parents, continue to have a role to play in fostering these kinds of knowledges. The opportunity digital technologies offers is that they open up access to knowledge and information previously not readily available to all. Harnessing this potential is critical for learners who have grown up with ubiquitous access.

And, as Mayes and de Freitas (2013) urge, "there is no escaping the need to adopt a theory of learning" (p. 18) for good pedagogical design. This need is greater than it has been in the past, since digital technologies are changing the face of what it means to have both access to knowledge and information, and have the potential to alter the dynamic of teacher-centric and student-passive classroom practices. There is a trend in what happens when learners, instead of the teacher, use technologies for learning (see for example Wright, 2010a). In 2010a, I noted the trend away from teacher-centric to co-constructive behaviours in classrooms where students were able to use a digital tool/resource. Such alterations of the pedagogical dynamic appeared to occur whether or not it was deliberately designed for. In some cases, the research pointed to a degree of surprise on behalf of the teacher that learners took such a keen interest in helping each other, sharing expertise and taking the learning beyond the lesson. This suggests that harnessing that dynamic by deliberately structuring learning to take advantage of it is increasingly important.

One small New Zealand study I was involved in evaluated a pilot project in which secondary school students were using their own mobile devices to learn with (Wright, 2010b). Through interviewing close to 30 students across three classes, I discovered that these learners were more likely to share content when it was stored on their mobile devices; review it and learn from it; and show their parents. This parental sharing (see also Khoo and Merry's chapter as well as Archard and Archard's—both in early childhood settings) happened much more frequently than if students used traditional exercise books for their work. These learners were also keen to extend using their devices in other subjects. They wanted to be able to review classwork and instruction outside of class time, seamlessly blurring their learning spaces and places. This study's findings suggest shifts in learning practices

provided much more agency for learners than had been previously available and positively influenced students' relationships with their teachers.

This shift links to Pachler, Cook, and Bachmair's (2010) argument that young people exercise considerable levels of agency in their private lives when they use digital tools, so it would seem sensible to bridge this gap with their school practices. This extends Prensky's (2001) descriptive distinctions between the behaviours of digital natives and digital immigrants. In other words, for those born into the digital environment, it is natural to have at one's disposal a digital tool linked to the Internet. It is also natural and usual to to be unafraid of it. However much the metaphor has been misunderstood since it was first described (Prensky, 2011), it still marks a certain distinction between what is natural and comfortable for some, and possibly unnatural and irksome for others. Powering down at the school gate is no longer tenable, and so teachers need to understand what learning can be like for students who are already powered up and, functionally at least, digitally smart. As Thomas asserts,

> The information age has made sophisticated information seeking skills *more* needed by students not less. Prudent information seeking will be mandatory in the twenty-first century, not an optional extra or something relegated to a 'smart' tool or an 'expert' system. (Thomas, 2011, p. 121 of 216)

It would appear, then, that now is the time to address the issue of 'power down' (Prensky, 2001, p. 3). Pachler et al. (2010), for example, describe people leading digital lives in terms of cultural appropriation and structures. Agency relates to the degree to which the user takes charge of the technology and how it is used. Cultural appropriation links to the ways in which users adapt digital technologies to their purposes and practices, perhaps even using a tool in ways not envisioned by the makers, while structures relate to the mechanisms which either help or hinder the practice of agency and cultural appropriation. Schools can also be a help or a hindrance, and Pachler et al (2010) describe the multiplicity of forces acting in and on schools as an 'educational complex', a term designed to indicate something of the myriad tensions, contradictions and complications at play. The integration of ICT tools and affordances for learning within and across schools is part of this complexity and complication.

In education contexts, the role of teachers in structures, agency and cultural practices can also be understood in terms of where their own knowledge and practices are positioned, particularly in relation to their technological, pedagogical and content knowledge. This can be understood as their TPACK status. TPACK arose through Mishra and Koehler (2006) extending Shulman's (1987) PCK (pedagogical content knowledge) framework after examining the disjuncture between PCK and teachers' capabilities with new technologies. In turn, this extends Schon's (1983) view of reflection as a professional development activity. Mishra and Koehler (2006) argued that professional development about using technologies in education had traditionally separated learning about these technologies from teachers' professional contexts. Overall, this professional development consequently failed to translate to educational practices in the classroom that integrated these technologies. The TPACK model argues that teachers' professional skill and knowledge development in terms of proficiently using digital tools is most likely to succeed long term when sited close to their classroom practices. The focus on how these tools can be used in subject, topic, and class-specific ways thus has greater meaning for teachers if they can experiment with their existing practices and insert new ones to

achieve the same learning ends. Classroom practices then become the site of both experimentation and a deliberate reflection on evidence gathered and generated about that practice.

The *New Zealand Curriculum* (Ministry of Education, 2007) suggests that teachers operate most thoughtfully and deliberately when they engage in reflective practices, suggesting it can be fostered through using Teaching as Inquiry as an evidence-informed, robust process. For the purposes of this study, the curriculum document model has been stripped and simplified to better reflect what was possible to achieve in single lessons by novice teachers (the diagram of this stripped model is included under the heading Research Design below). This model is a framework for examining what is done in one's own classroom in order to understand the evidence of the designed/intended and actual practices. In turn, the analysis of, plus reflection on, the evidence informs the design of subsequent learning steps and lesson design, thus developing a spiral of personal professional development about targeted learning. Risk-taking is implied in this: since digital tools change so quickly, it is common for teachers to be using a digital tool for the first time or applying it to a specific learning purpose for the first time. And since each class of students is different, there is little certainty that specific outcomes or intentions that teachers design for will necessarily eventuate. This is why an inquiry process can be so helpful—both teachers and students can contribute to knowledge about how well the resource or affordance suits the learning purpose and the learners. This helps all involved to have an agentic stake in this process.

Teaching as Inquiry is thus a useful framework for teachers to investigate their own practices. This is because Teaching as Inquiry as a process of investigation is flexible and adaptable to circumstance, context, purpose and topic. It can help investigate questions such as, How can teachers be digitally smart? What motivates some teachers to use digital tools for learning purposes, and continue to use them?

Investigating the continued use of digital technologies in classrooms is an under-researched topic. Many articles from 2004-2009, for example, describe initial use of a technological tool/resource. This indicates the newness of the field. And, as I have argued (Wright, 2010b), initial use can mask the Hawthorne Effect at work. In other words, by using something new, the novelty changes how participants respond. It may mean that there is more willingness to consider its use positively rather than critically, and its novelty can be the drawcard to participation rather than its value to practising critical thinking or deepening conceptual knowledge in some way. Finding a way of understanding continued use is therefore timely. Continuance theory is a possible lens for understanding these questions, especially in relation to reflective practices developed through Teaching as Inquiry processes.

Finally, the term 'digital technologies' is used mostly throughout this chapter, since ICT (information communication technologies) is no longer adequate to describe the explosion of mobile, wifi and web-enabled devices, as well as the opportunities cloud computing offers education.

Continuance theory and education

This theory, first applied to business in relation to the Technology Adoption or Acceptance Model, was an information systems theory initially developed by Davis (1989), who identified two key factors which apparently influence users' decisions about their continued use of a technology. These are:

- *Perceived usefulness*: Davis defined this as the extent to which people think that using a particular technological system enhances their job performance
- *Perceived ease-of-use*: This links to the idea of being relatively effortless or straightforward to accomplish or get used to (Davis, 1989).

Bhattacherjee (2001) later considered this model when examining why bank customers and users kept on using specific online tools for banking. He was interested not just in the adoption of the technology but what led to its continued use. He suggested that while continuance theory is characterised by usefulness and ease as key motivations, it nevertheless did not fully explain continued use of the technology as a phenomenon. Bhattacherjee (2001) argues that the intention to continue using a tool also involved affect. In other words, it linked to a positive emotional response. This was usually a sense of satisfaction, perhaps for a job well done. So in industry terms, satisfaction, ease of use and usefulness can predict someone's continued use of a digital tool to achieve some aspect of work. It is, essentially, about getting the job done well, easily and with less effort than before. In turn, this leads to the user of the tool feeling satisfied about doing a good job.

In education, however, even the addition of affect (that is, the experience of an emotional response like satisfaction) isn't enough, for a teacher is never just using a tool for getting a job done. Teachers most likely expect that a tool or technology will enhance learning; perhaps improve a student's chance for having that light bulb moment when deep understanding makes sense; or when new knowledge is finally linked to existing knowledge or concepts; or perhaps, enjoying the learning process through the medium of the tool/technology.

In these kinds of classrooms, students are encouraged to use a variety of resources or tools that help solve learning problems, complete tasks or understand something that would otherwise remain in the abstract. For example, a science concept might be best understood through a simulated animation. This might be an animation algorithm that students can change the variables of—such as the application of forces or electricity circuits. Or a mathematical time series graph can be manipulated to achieve different results. The consequences of those manipulations can become much more visible to learners via digital technology means than a static image in a textbook or a teacher's diagram or workings on the board. Digital tools might also help in contexts where dissections of real animals are not possible, or for geographical mapping, virtual tours of Antarctica, examining volcanoes (for example, through http://www.sciencelearn.org.nz/Contexts/Volcanoes) or the curation and annotation of selected artefacts for later analysis, such as through scoop.it or Pearltrees). In literature, students could experience a virtual tour through The Globe Theatre, while a reading of a novel could be given depth by providing access to different online resources about the social context of the time. These opportunities are especially important for students who do not live in the same country or time period as the setting of a novel.

This preamble is an orientation to the focus and context of this chapter, which is about examining how continuance theory might apply to an initial teacher education cohort who were required to include some digital technology in some way in a lesson while on practicum. This requirement expected them to design a lesson using a purposefully selected digital tool inserted in the learning, wrapped inside a Teaching as Inquiry (expanded on below) framework. This framework gave the intervention a deliberate focus through creating a specific question. It led to deliberately designing a means to collect feedback data from the specific group of learners. In turn, the data were

key to the evidence available for reflection and analysis. This process meant the pre-service teachers experienced and learned from evidence-led reflective practice.

How does 'digital smarts' apply?

The theme of this book is to highlight smart use of digital technologies in education, specifically in a tertiary education context, hence the title *Digital Smarts*. While the term can evoke a range of connotations, in this chapter it refers to the kind of creativity that can occur when teachers link digital technologies to learning in classrooms—even in circumstances where the infrastructure and policies within a school mean there are impediments. 'Smart' can also be like being hurt—we 'smart', for example, when we get pricked or cut. So 'smart' is about the slings and arrows of things going technologically awry, as they can do in classrooms. Being digitally smart also refers to the ways digital technologies have, in the contexts described here, engaged and motivated students to produce better quality in their thinking and the products of their work. And, as Thomas (2011) noted, 'smart' can be applied to a tool itself or refer to learners' (whoever these learners are) cultural appropriation and agency when using digital tools. Teachers, therefore, may simultaneously or serially perform a range of these meanings of enacting digital smartness, for teachers are learners too. This links into our efforts to understand what motivates them to persist in designing learning with and through digital technologies.

This extends continuance theory, implicating teachers' conscious pedagogical actions that occur through deliberate acts of teaching based on their reflections on past practices and consequent decisions for future practices. These principles implicate PCK and what it means to be a reflective practitioner, both of which are addressed next.

Pedagogical content knowledge and reflective practice in education

Timperley, Wilson, Barrar and Fung's (2007) best evidence synthesis that centred on teachers' professional learning suggests that professional, reflective, evidence-informed learning is best situated close to teachers' professional contexts. They argued that this proximity to better understanding practice is likely to initiate, prompt, promote and sustain changes. Closely looking at what teachers and their learners do in specific classroom settings is thus an important part of teachers' professional capability.

If this capability is important for teachers on the job, then it is also important for pre-service teachers to develop for the job. These points link directly to the Teaching as Inquiry framework (addressed later), but also suggest the importance of locating new digital practices in classroom settings and examining their impact on learning.

There are strong suggestions in research literature that when digital technologies and resources are available to teachers to use in lessons, pedagogical practices alter, often in positive, student-centred ways (Ainley, Enger, & Searle, 2009; John & Sutherland, 2006; McLoughlin & Lee, 2008; Somekh, 2008; Wright, 2010b). My e-learning literature review, for example (Wright, 2010b), argues that socially oriented pedagogies support positive learner outcomes, and these tend to arise when digital technologies help students fully engage in learning. Through extended and repeated facilitation of putting the digital tools in the hands of their learners, changes to teachers' pedagogical practices are precipitated. Teachers will repeat these practices when they perceive positive benefits to their learners, particularly when learners themselves respond in positive ways. These benefits or

outcomes might include noticing greater learner engagement, motivation, concentration, willingness to take the learning beyond the lesson, a desire to share expertise with peers, and a desire to produce high quality digital assessment artefacts.

When pre-service teachers experiment with digital technologies in their practicum lessons, they too experience similar effects on learners, judging by the evidence of their reported Moodle postings. Documenting those effects is a crucial part of pre-service teachers' development, and an analysis of their reports of their experiences is central to this chapter. Just as Robinson (2003) argues that examining one's own practices is a professional necessity for teachers in New Zealand, initiating pre-service teachers into such practices is a duty of care for pre-service programmes.

Links between reflecting on pedagogy, content and technology resonate strongly with Mishra and Koehler's (2006) TPACK[8] model. This model adds to Shulman's (1987) pedagogical content knowledge (PCK) framework by extending teachers' knowledge in situ (i.e., their classrooms) as they experiment with digital technologies and deliberately and systematically reflect on this practice (Schon, 1983). Teaching as Inquiry helps with this deliberation.

Mishra and Koehler argue, just as Timperley et al. (2007) suggested about sustained professional development, that teachers' sustained, continued technological uptake is likely to occur through guided classroom experimentation, analysis and reflection, since it also enhances their PCK. Their argument resonates with Penuel and Fishman's (2012) view regarding teachers' curriculum and pedagogical thinking in adopting, designing or adapting resources for learning. As Leiff (2009) asserts, "until participants learn a language of practice, their thoughts about perceived needs in education can be constrained" (p. 127), indicating the importance for teachers to research and deliberately reflect on their own practices.

These ideas form the backdrop of this chapter, setting the scene for an analysis of ITE students' reporting on practices regarding their digital experimentations on practicum. They also, as will be shown later, have connections with continuance theory.

Research design

As mentioned earlier, the question under discussion is: *What do secondary graduate ITE students learn and understand about the value of of ICT tools in learning?* Teaching as Inquiry provided the research frame for the ITE students' tasks. This framework arises from an adaptation of the model in the *New Zealand Curriculum* (Ministry of Education, 2007). The adapted model makes it much easier for a teacher to build a question that directly relates to instances of practice which can be undertaken in one or two lessons. For the purposes of the ITE students' task, this adaptation was necessary to avoid unnecessarily complicating the key focus, given they had limited time in which to undertake the task. The diagram is noted below as Fig. 1.

[8] TPACK: Technological, pedagogical and content knowledge

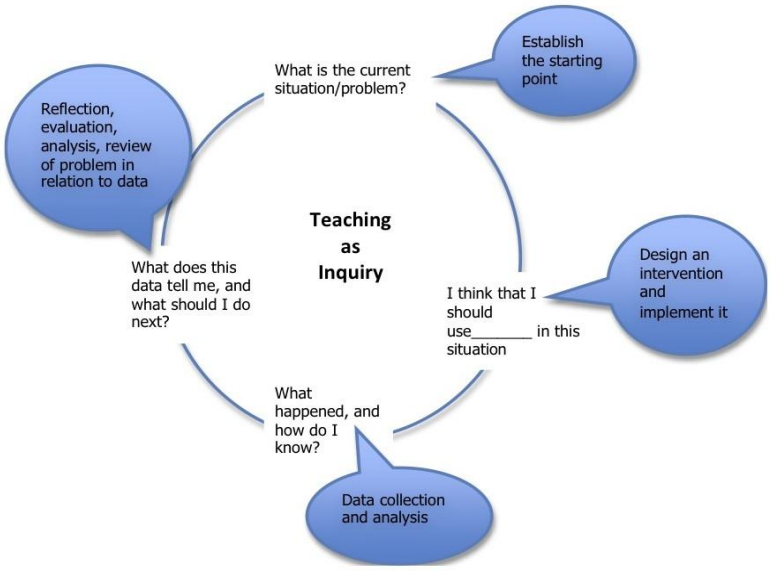

Figure 1: Teaching as Inquiry

While the diagram is shown as a circle, it is intended to *initiate* a spiral of action/research/reflection/action. The ITE students' initial use was mainly of a singular instance in order to practise the process of undertaking an evidence-led self-evaluation of lesson design, learning potential and digital tool use. As long as they addressed all four components and came back to their question in their reported reflections, the pre-service teachers gained experience in a Teaching as Inquiry process that remained true to the spirit of the NZC (Ministry of Education, 2007) model, even if not all of the original component parts were addressed.

Another non-negotiable in the task was to include in their lesson design a method for gathering feedback data from their learners. This ensured they had more than their own observations and assumptions as data in order to post a robust analysis in Moodle, plus it gave them experience in using evidence to inform practice.

And in order to reduce anxiety about the task, the ITE students were provided with hints about what to consider as part of their preparation. These hints included not leaving the task too late in the practicum, keeping good records about the lesson, devising simple ways of documenting their learners' feedback, and providing sample questions to ask their learners. The pre-service teachers were also reminded that it didn't matter if the lesson was successful or not. Instead, what mattered was their ability to analyse what happened, how, and what they made of it in the light of their observations about the lesson coupled with an analysis of their learners' feedback. In order to allow enough distance from the event and their practicum, the due date for completing the postings was two weeks after the practicum ended. The ITE students could, if they chose, post a number of Moodle messages to focus on specific parts of the task, or do it all at once.

Analysis and findings

Analysis

Data analysis took place after the ITE programme had ended, reducing potential ethical issues that could have resulted from the power imbalances of my lecturer/assessor role during the programme. The analysis process consisted of initially categorising data according to tool, subject, year level and purpose within a spreadsheet. This resulted in an easily viewed and manipulable list. By changing sort parameters, various options created different emphases of the data. For example, sorting by tool type as a category made it easier to see the wide variety of appropriations and contexts the pre-service teachers applied them to different purposes, levels and subjects, crossing subject and topic boundaries. See Table 1 for this. Thus, we can label many tools as 'smart', as well as the creativity of the pre-service teachers' appropriation.

Table 1: The range of technologies/tools, year levels, purposes and subjects

DIGITAL TECHNOLOGY	CURRICULUM SUBJECT	YEAR[9] LEVEL (9-13)	TOPIC/ LEARNING PURPOSE
1. AUDIO/VIDEO RECORDING FUNCTIONS			
mobile phone: camera & audio recording functions	dance music PE English	10, 12 & 13	● self- and peer- evaluation of performance/rehearsal
ipad: video recording function	PE	13	● energy systems, ● before/after exercise responses
Facebook and video function on mobile devices	dance Spanish	9 & 10, 12	● on-going pair work on creating short choreographed phrase ● practise certain verb forms/create Spanish identity in Facebook
creating 20 sec video	science	9	● ginger-beer making: role of microorganisms
digital camera	art	10	● animate toy sculptures students have created
peer videoing	PE	11	● functions of the body
video recording device	social studies PE	10	● social issues: create video clip to raise awareness

[9] Year levels in New Zealand schools: years 9-13 indicate the five years of secondary schooling, and an age range from about 13-18.

		10,13	● aerobics—record and analyse sequence ● dance unit: self and peer critique of rehearsal
YouTube clips; video cameras; Facebook	hard materials	11	using and caring for machine tools; Unit Standards 7529 & 7530
YouTube clips	social studies food studies drama biology dance history English photography PE	10 12 12 9 9 12 9 13 11	● Parihaka ● knife sharpening skills ● dramatic techniques revision ● food chains ● identifying dance style techniques ● Vietnam War: contextual understanding of Tet Offensive ● language differences in English accents ● artists models for folio work ● anatomy: bones and muscles
Flip video	health	10	● dangers of being a teen: create own ad about one issue in topic
2. SPECIFIC PROGRAMS OR APPS			
Anatomy Arcade	sports science	11	● bones and muscles identification
Angry birds	art	10	● papier mache unit: idea of bird characteristics and concept of artists model
creating podcasts	classical studies	13	● Virgil's *Aeneid*: read aloud + analysis of passage; shared and used for revision
domo animate	Te Reo (Maori language)	not specified	● sentence structures: creating conversations
fitness apps	PE	10	● large ball unit: developing and implementing coaching session
goanimate	history	12	● perspectives on women's franchise: ability to see multiple perspectives and convey them to others
Inspiration	social studies	10	● systems of government unit: revision for unit test
Language Perfect	Spanish	13	● vocabulary

Prezi	social studies	9	● topic revision
Photoshop	photography	12	● personalised editing processes (actions): editing software and processes to speed this task up for folio boards
specific websites	science	10 10	● weights and forces ● unit on genetics—understanding inheritance traits
specific websites: (a) supermarket online shopping website (b) health & wellbeing sites	PE/health, food & nutrition PE/health, food & nutrition, health, recreation & health	12 12 10 12	● budgeting: costing menus for families ● food planning for high performance athlete + Achievement Standard link ● sexual anatomy: naming of parts ● drug and alcohol effects
Wallwisher	Te Reo English (x3)	10 9, 11, 12	● tenses: post images and verbs ● thematic connection/compare ideas; critical feedback tool; student voice linked to essay writing
Webquest	science	10	● ecological issues/controversial topic
Wikispaces	physics	12	● static electricity: space for sharing information and questions
3. SPREADSHEETS			
Excel	mathematics	10	● statistics: time series graphs
Excel	mathematics	10	● measures of spread in box & whisker graphs: checking if knowledge linked to visualising median, quartiles, understanding data ranges and changes in data
4. ONLINE PROGRAMS OR SIMULATIONS			
Flash animation	science	9	● digestive system
Java applet	physics	10	● waves and sounds
Pinterest	design art	13 13	● collecting design ideas; critical thinking and evaluation ● artists models: influences for own folio

			boards
5. GOOGLE OPTIONS			
Google searches; slide presentation software	social studies	10	• search a particular issue related to 'blood diamonds' trade; learn from each other's presented issue
Google Docs	art	11	• digital media: shared task to share knowledge
online searches	junior health drama sports science social studies drama music health history Food technology science	10 12 13 10 10 11 9 11 11	• drug and alcohol awareness • features of Elizabethan theatre • investigation of health standards • • South America: collaborative task to focus on producing poster about a specific country • Elizabethan theatre: presentation to peers • musical knowledge: specific analysis of one musician's style; musical language; some social history about era • effects of drugs/alcohol on body • Greek mythology: argue a case for replacing Zeus • reports on foods (culture, eating patterns, foods) in 4 countries: Achievement Standard 90958
6. OTHER DIGITAL TECHNOLOGIES			
IWB	mathematics	11	• algebra: factorising
QR codes in worksheet	hard materials	11	• developing a whirligig using engineering materials: how mechanical cams work: Unit Standard 22924, curriculum level 6
text polling (polleverywhere)	art health	10 12	• feedback from students about unit • knowledge about effects of alcohol on body

Findings

Tools/devices

Some tools were used across subjects although often for similar learning purposes. The audio/camera tools on mobile devices, for example, were used in English, dance, physical education and music to develop self-critique in rehearsing movement, speech, composition or characterisation. YouTube clips also had multiple uses: as a resource for understanding specific social studies contexts, such as a topic on Parihaka[10]; as a how-to of learning knife-sharpening skills in food classes; using clips to understand more about contextual influences related to the Tet Offensive in the Vietnam War for history; using anatomy clips to help examine bones and muscles for physical education; or using clips to listen to and identify language differences in English accents. By applying these relatively common tools to specific learning purposes, the pre-service teachers demonstrated creative levels of agency in their appropriation. This appropriation also demonstrated how adaptable for deliberate learning intentions these tools were.

Purposes

The end purposes to which digital tools were appropriated often included having an eye on providing practice contexts for formal assessment tasks. One ITE student, for example, used the program Inspiration to help a Year 10 social studies class better understand and revise content for a unit test on systems of government. Because Inspiration is a tool for graphically organising information, it helped students categorise information to see how parts of the system linked together. In a Food Technology class, the pre-service teacher got learners to develop reports on foods (culture, eating patterns, foods) in four countries. They did this by finding and selecting from browser searches using keywords and strings. Both of these tasks incorporated a literacy focus of one kind or another, demonstrating considerable creativity in adapting the required task to suit their teaching contexts and integrating literacy approaches with available resources. This resourcefulness demonstrated smart use of the technologies.

Students discovered that for learning to be retained over time, the pedagogical design of any lesson has to be sound. One pre-service teacher, for example, wanted students to understand more of the concept about food chains and interdependence. To do so, he used a clip from the movie *The Lion King*. What he realised afterwards was that he did not do the pre-teaching necessary to prime students to actively notice how the information in the clip linked to the concept of food chains. In a later lesson, he found this out when he asked them what they had learned about food chains from the clip. Students had not made this link. Luckily, he discussed this with his associate teacher[11], who pointed out that since the concepts were new to students, they needed some prior explanation in order to make the connections. The pre-service teacher had not accounted for students' ZPD—their zone of proximal development (Vygotsky, 1978)—by checking what their knowledge starting point was before adding to their understanding. Some students were therefore mystified.

[10] Parihaka: see for example http://www.teara.govt.nz/en/maori-prophetic-movements-nga-poropiti/page-4

[11] An Associate Teacher is the term applied to teachers who mentor pre-service teachers in their classes during practicum.

The image below better illustrates this idea of starting point and the role of the teacher in supporting new knowledge development as the 'more knowing other'. Had the ITE student thought more about structuring the learning around clear goals rather than focusing on the clip itself, it is possible that his learners may have more easily been able to link the concept of food chains to something as seemingly unrelated as *The Lion King* clip.

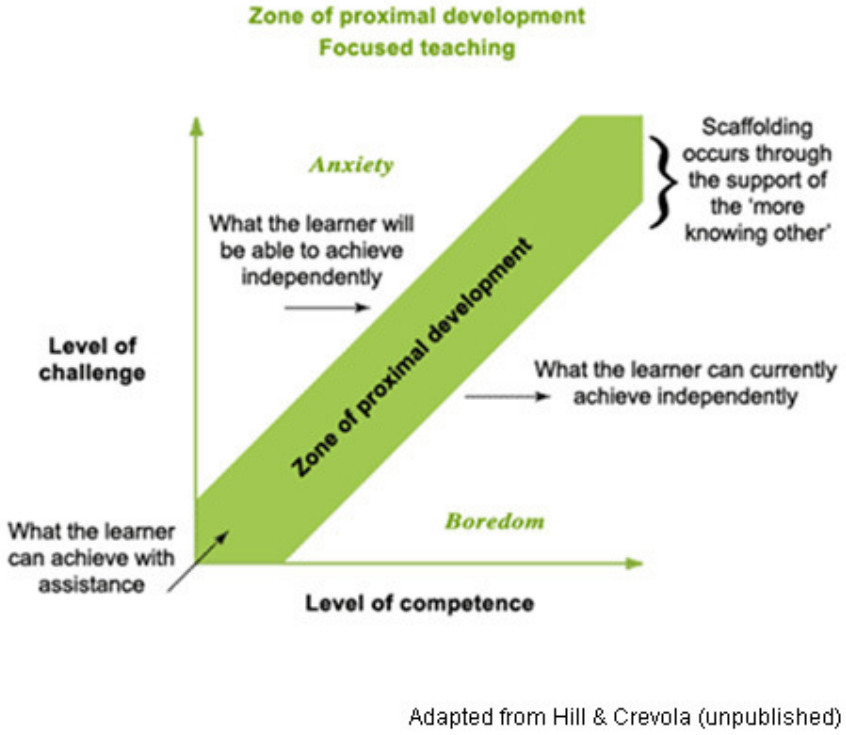

***Figure 2*: Zone of Proximal Development**

Also, by having a Teaching as Inquiry question to investigate while using his chosen resource, he discovered more than he might otherwise have done. He learned that the resource had merit but that the pedagogical organisation and context in which it was used required more thought and re-design than he had originally undertaken. He said on reflection that:

> In future I would develop a worksheet for the students to fill out based on the video. This would get students to reconstruct what they had watched into a form they could understand.… The students had turned off when writing notes … and appeared to be simply getting the notes down, [not] thinking about what they had watched and how that related to the notes they were taking.… perhaps by reinforcing the video clip … long term retention of student engagement could be achieved. (ALS 6/6/12)

Because of this experience, ALS (the pre-service teacher) better understood the role of deliberate pedagogical design in relation to digital resource use. He was not put off—instead he used the experience and the Teaching as Inquiry process to think ahead to better lesson planning when next he incorporated a digital tool of some kind. And while the tool he used was highly teacher-centric and

the copying task was essentially meaningless for his learners, he later understood that this kind of practice was actually counter-productive to learning by reflecting on the evidence he had in front of him.

What the ITE students learned from their learners' feedback

The requirement to collect feedback from their learners had a profound effect on the ITE students. In observing that students were happy to use both school and their own devices in class, one commented that:

> It [the lesson] worked well; students were engaged and interested which makes a huge difference. I would adapt the lesson … to give them a whole lesson for research and writing down their opinion, instead of expecting them to do it simultaneously.… I got them to do this for homework because the [school COW[12]] computers were unreliable... but in hindsight, getting them to complete this in their own time for homework meant they could put more effort into the essay so it turned out to be more positive. [AS[13] 5/6/12]

Another ITE student commented on eliciting her learners' feedback after a lesson in which they filmed themselves then analysed their tennis movements in physical education. She said:

> Reviewing and analysing really helped them recognise their strengths and weaknesses and [they] were easily able to identify areas they needed to work on … and a few other students commented that by completing this activity they have grasped a greater concept of what muscles are used in different movements … by putting these movements into action, they are able to remember it better. [AT 13/9/12]

AT's associate teacher, who observed the lesson, is reported as admitting surprise at the "in depth answers and participation the students put into the task".

Both of these pre-service teachers, as a result of their experiences, their learners' feedback and their associate teacher's responses, were adamant that this increased their determination to continue using digital tools when they began their teaching the following year. They also remarked how important their learners' feedback was to them. One noted that the "students' feedback was really beneficial for me as a teacher as they really reiterated my thinking behind this tool. I am really happy that they saw this as a learning tool." [AT 13/9/12].

In quite a different context, in a physics class about standing waves and the production of sound from musical instruments, the ITE student used a Java applet to demonstrate the concept of 'beating'. She described the introduction of the applet to the class thus:

> This class is normally chatty and not very focused for a year 13 group [year 13 is the final year of secondary school]. This period though, students seemed to be engaged and on task. They were interested in the applet and several wanted the URL for the site. They

[12] COW: Computers on Wheels. A class set of computers moved from class to class

[13] AS, AT and AT2 are the code identifiers I used to refer to specific students in the cohort.

> were also interested in the frequency range of the beating effect.… Students engaged in the frequency calculations and offered suggestions for patterns and relationships. [AS2 3/6/12]

The feedback to AS2 from her learners was also revealing. She reported comments such as: "I now know more than before", "It was very helpful, hearing the sound with the diagram", "The examples through the applet helped to give insight to the topic." These responses helped confirm for this pre-service teacher that while there were aspects of the lesson to develop and adapt, essentially the applet helped with conceptual understanding. Therefore, with adaptations to her pedagogical design, she would use it again, partly because a week after she had used the applet, she checked the extent to which the students had retained the learning and discovered that, indeed, they had remembered key points. And notwithstanding issues of access for students (they were blocked by firewalls, which required some pre-planning to address), she considered that pursuing the use of such tools benefited learners. She intended to persist and pay particular attention to how she scaffolded the learners.

This insight raises a consistent theme emerging from this data: that the pedagogical design of the lesson is as important as the tool and the learning purpose. The ITE students learned this through the feedback from their students. It heightened their awareness of their role in carefully designing learning and choosing appropriate tools for the task. These few examples from the cohort indicate the readiness these ITE students had to persist with digital learning practices. This segues to a focus on continuance theory.

Continuance theory, reflective practices and education

Pachler et al. (2010) discussed the notion of agency when describing how young people appropriated mobile digital devices for their own purposes. The ITE students demonstrated agency in their decision-making: the tools, the lesson design, the class and the learning purpose. They worked within the structures the school provided and found ways to address hindrances (such as firewalls, poor equipment, untrustworthy wifi connection) and obstacles. In doing so, they discovered pleasing degrees of success when class behaviour and levels of concentration changed along with the depth of their learners' conceptual thinking. For example, in a drama class, AM [7/6/12] had provided YouTube clips as resources for examining dramatic techniques in a play. She was impressed by the way these clips 'triggered their thinking' and how they "became more conscious about their use of drama techniques". Consistently, such outcomes positively disposed these pre-service teachers to developing opportunities for incorporating digital tools in future lessons. Allied to this, the pre-service teachers' own reports indicated that if they had *not* been *required* to ask their learners for feedback, they may not have arrived at such a point: the feedback gave them confidence to believe that using these tools was not only smart but necessary for enhanced learning.

In the end, this experimentation led many of the ITE students to know something of the positive value digital technologies can have for their students' learning. Most (approximately 90%) made explicit mention about how important this was in motivating them to pursue developing their expertise and lesson design experimentation with such tools in the future. They were keen to address adverse or restrictive policy decisions in schools so that they could better embed digital technologies in learning. The framework of a Teaching as Inquiry process also had value. It was a common organising tool that linked to the *New Zealand Curriculum* and was a means by which they could

reflect on and evaluate the quality and value of their lesson with a digital tool from not just their own perspective but also that of their learners via the documented evidence they collected.

Conclusion

The task attempted to create an authentic experience in which the pre-service teachers not only designed learning but also designed a method of eliciting feedback from their learners. It showed them one way of evaluating their pedagogical practices when they tried something new—in this case, using a digital technology for learning purposes. This process linked to the curriculum and what it means to provide evidence of practice and mechanisms for self-critique.

Combined, these processes may have influenced the extent to which the ITE students exhibited agency in their lesson design, and it may have influenced how they felt about continuing to use digital technologies for learning. However, the influence of their learners' feedback on their practices with digital tools was profound and was probably a key factor in these pre-service teachers' decisions about the extent to which they would persist with using digital technologies professionally. And so, while ease of use and efficiency were key drivers in earlier business-oriented studies regarding continued use of technologies, they are insufficient reasons for pre-service teachers to want to persist in these educational contexts. So, to be a digitally smart educator, checking the value of the learning with and through digital tools with one's learners is crucial to decisions about persisting with digital technologies in smart learning.

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