Teachers' pedagogical reasoning and action in the digital age.

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Abstract

Beginning teachers are entering the profession with increasing confidence in their ability to use digital technologies which has the potential to change the way teachers of the future make pedagogical decisions. This paper explores how pedagogical reasoning and action might occur in the digital age, comparing Shulman's 1987 model with the reality for a small sample of digitally able beginning teachers as part of the emerging generation of teachers. The latter were examined through a multiple case study during their first year of teaching as they made decisions about using digital technologies within their teaching practice which gave an insight into pedagogical reasoning and action through the use of open ended interviews and observation. The conclusion drawn is that while the pedagogical reasoning and action model remains relevant, it was based on an assumption that teaching involves knowledge being passed from a teacher to their students, which was found to restrict innovation by digitally able teachers. A broader interpretation of knowledge and teaching within this model building on emerging learning theory could help reform practice once again, providing a framework for teachers in the digital age.

Keywords: pedagogical content knowledge; pedagogical reasoning; beginning teachers.

Digital age learning theory

The digital era is a time when technology has become available that allows access to information, ideas and people from a wide range of locations at anytime. The introduction of a networked world, where information can be found in seconds (with the right key words), mashed, connected, further developed and shared using web 2.0 applications, is contributing to increasing value being placed on the ability to critique information and sources, be creative and make connections.

Beginning teachers are joining the profession experienced in the use of digital technologies in their personal and academic lives, but much of the research to date has focussed on experienced teachers as they learn to use digital technologies and explore the use in their own classrooms. For example Mishra & Koehler (2008), proposed a separate category of pedagogical content knowledge based on studies of practicing teachers new to digital technologies, they named it technological content knowledge. The digitally able teacher, familiar with digital technologies before learning about pedagogical practices are unlikely to separate their technical knowledge from their pedagogical content knowledge when making teaching decisions.

The nature of knowledge or what it means to be 'knowledgeable' is evolving (Bereiter, 2002; Gilbert, 2005; Siemens, 2006) and this change in perception has led to the development of connectivism, a learning theory which considers where and how knowledge is created in a digitally enhanced society. Connectivism has emerged from the notions of complexity thinking, chaos, network and self-organising theories (Siemens, 2004). The theory considers how learning occurs through connecting specialised information sets which can occur between or within, organisations, individuals and digital technology. A central idea in the learning theory of connectivism is the continual expansion of knowledge as new and novel connections open new interpretations and understandings to create new knowledge which contrasts with constructivism where the focus is on individual learners constructing meaning.

Pedagogical reasoning

Shulman's (1987) model of pedagogical reasoning and action was developed as a foundation for teaching reform. It was designed to identify the professional practice of teaching that was specific to teachers, building on an earlier article (1986) which proposed pedagogical content knowledge. The model comprises actions that a teacher undergoes during the teaching process including; comprehension of subject knowledge, transformation of subject knowledge into teachable representations, instruction, evaluation of students' learning and teacher's performance, reflection, and new comprehensions. Thus it was an attempt to illustrate reflective practice during the teaching process, a model that was useful for initial teacher education and influential in subsequent writing about teacher education (Darling-Hammond, 2006; Grimmett, 1988; Loughran, 2004). The current curriculum in New Zealand requires teachers to undertake teaching as an inquiry (Ministry of Education, 2007), hence a model for reflecting on pedagogical reasoning and action remains relevant today.

Over time ideas about teaching and learning evolve, and after twenty years it is appropriate to revisit Shulman's model of pedagogical reasoning and action to ascertain its relevance for the digital age. Two approaches were undertaken in this evaluation; the study of decisions made by digitally able beginning teachers as the future of the teaching profession and application of digital age learning theory to the model.

The decisions made by digitally able teachers were examined to explore the relevance of Shulman's (1987) model of pedagogical reasoning within the context of the digital age and connectivism.

A study of digitally able beginning teachers

A multiple case study based on constructivist philosophy that acknowledged the complex context of secondary schooling, was the methodological approach taken in this research. Six volunteering self-identified digitally able beginning teachers from a pool of 120 were selected to be examined through interviews and observation during their first year of secondary teaching. Case study teachers were interviewed three times using semi-structured interviews at the start of the year, as they used digital technologies and at the end of the year. Data was gathered through observation and student think alouds (Ericsson, 2006) as students used digital technologies in one of each of the beginning teachers' classes. The research explored pedagogical choices the case study teachers made when integrating digital technologies into their teaching practice. To enable the measurement of learning activities, a 'digital age learning matrix' (Table 1) was designed, tested and applied. A logic model and grounded theory analysis was used to examine the case study interview data. Participant identities were kept confidential through the use of pseudonyms. This approach allowed an in-depth analysis of the experiences of a group of digitally able beginning teachers.

The teachers in the study applied pedagogical reasoning as outlined by Shulman. An example from one of the case studies follows to demonstrate how teaching decisions typically aligned with aspects of the model during the integration of digital technologies into teaching practice. One example is outlined in detail to illustrate the pedagogical reasoning process in depth. Any of the case studies could have been included as the underpinning priorities in decision making was similar across the studies. The intention in this example was for students to understand how muscles function during physical activity. The decisions made are discussed within the framework of the 1987 pedagogical reasoning and action model which included; comprehension of subject knowledge, transformation, instruction, evaluation, reflection and new comprehensions.

Comprehension of subject knowledge

Shulman (1987) identified the importance of the teacher understanding subject knowledge, noting that; 'to teach is first to understand' (p14). Barry had gained a deep understanding of muscle function within a bachelor's degree in physical education, a study that included examining cadavers and movement through the use of a digital biomechanical package using attachment sensors. Evidence in the data suggests that he had extensive substantive (how muscles function) and syntactic content knowledge (how this knowledge can be applied to physical activity and why knowing this is important in physical education).

Level of learning:	Doing	Thinking about connections	Thinking about concepts	Critiquing and evaluating.	Creating knowledge.	Sharing knowledge.
Explanation of level of learning: **Digital technology use:**	**Isolated information. Focus on completing a measurable task.**	**Connecting thinking. Simple connections made within a context. Compare and share.**	**Develop conceptual understanding of 'big ideas'**	**Evaluating and critiquing to explore the limitations and potential of information, sources or process.**	**Creativity-Applying ideas, processes and/or experiences to develop a new reality.**	**Sharing the new knowledge through authentic contexts and gaining feedback to measure value.**
Accessing information	Accessing: Pictures Graphs Movies Data Information	Information from more than one source is connected or compared in analysis.	Information explicitly develops conceptual understanding.	Information and sources are critiqued and evaluated.	New conceptual understanding is developed. Building on or linking accessed information.	The value of the product is determined by the quality and quantity of feedback from beyond the classroom environment. Learning occurs when the feedback is considered and analysed.
Presenting	Present information using: Sound Pictures Words Video	Presented information has clear connections across formats or ideas.	Presentation (or explanation of presentation) has explicit conceptual underpinning.	The presentation, methods and results are critiqued and evaluated.	Critiqued and developed ideas or new knowledge is presented.	
Processing information	Information is processed or data/images are manipulated in isolation.	Connections are made between or within processed information/data or images and relevant concepts.	Processed data or information has clear conceptual underpinning.	Process and product are critiqued and evaluated.	Ideas and new knowledge are developed.	
Gaming or interactive programmes	Play a game Take a quiz Enter a virtual world	Links made between the game/ quiz/ virtual world and other knowledge.	The relevant concepts within the game, quiz or virtual world are identified and explained.	The game, quiz or virtual world is critiqued and evaluated within a conceptual context.	Original ideas are used to create a knowledge product in any medium.	
Communicating	Send a communication Receive a communication Read a communication	Ideas compared and shared with other learners through a two way conversation (written or verbal)	Communication explicitly develops conceptual understanding.	Critique other peoples' work or ideas.	Through interaction and communication new knowledge is constructed.	

Table 1. Digital Age Learning Matrix.

Source: Starkey, L. (2011). Evaluating learning in the 21st century: a digital age learning matrix. *Technology, Pedagogy and Education*, *20*(1), 19-39.

Transformation

Transforming subject knowledge into teachable content is a key aspect of the model of pedagogical reasoning and action. This involves some sort of combination or ordering of the processes of preparation, representation, selection, and adaptation to student characteristics as a group and for individual students. Preparation according to Shulman is the critical interpretation of the text materials, whether the resources will fit the teaching and learning purpose. While Shulman put emphasis on the use of text books, the same idea can be applied to the wide range of resources teachers use in the digital age. Barry undertook a number of decisions as he prepared to teach the students about muscle function. He began with the teaching intention, then he considered the teaching resources that he could use, critically analysing each for suitability of purpose. From his own learning experiences Barry knew that manipulating bones and muscles in a laboratory was an effective way to learn, but this was not feasible in the school context due to ethical, financial and management reasons. A former work colleague had shown him a website with three dimensional interactive images which were the closest representation which was manageable alternative to the hands on experience he was familiar with. Hence access to a teaching resource provided a representation and guided the instructional selection to align with the teaching intention.

Adaptation of the representations to fit the general characteristics of the children being taught was not directly possible as the interactive website was unable to be adapted, however the planning considered individual and group learning needs of the student. In planning the teaching activity Barry included careers information as he was aware of his students' motivations and interests:

> The goal for today's lesson is to let the students get into the website, I want them to have a look at the anatomy stuff, we have covered a lot of anatomy and this gives them a chance to bring it into a 3 dimensional perspective and see how it looks. I want them to also test themselves. I have also added in some aspects for their own interests as a lot of them have a lot of interest in careers in this area. For example if they can't see the context of why we are doing this, they can go into the careers sites and see where it leads to at University and the New Zealand institute of sport.

He thought this was likely to engage one particular student who was in the process of leaving school. He prepared the lesson using a single web page with five links to limit students being distracted or getting lost as he was aware that this was a probability given the limited access to computers his students had experienced at school:

> I found that using the Protopage kept them on track. If I said that you can go to these five websites, then it is hard to manage whether they are going to those sites, doing the right thing, but it is quite easy to tell if they are doing the right thing as they are either on the starting page or one of the links. There were not too many links, so it was manageable for the students.

This decision was also based on familiarity with the digital tools:

> I had used Protopage in the digital technologies course[at University] and I went and checked out my old one from then, that had some useful stuff, so I shared some information across from that

The lesson was planned so that students were seated close to peers to encourage discussion about their learning and support each other, reflecting Barry's knowledge of how his students preferred to learn.

In summary, Barry did not transform his subject knowledge, instead he selected resources and teaching methods that he thought would be appropriate for his students to use to understand the specific concepts he was teaching. His judgements were based on his pedagogical content knowledge.

Instruction

The model of pedagogical reasoning and action specifies a variety of instructional techniques, all of which focus on the observable aspects of delivering content or getting students to engage in activities.

Barry's instructional decisions included a number of features worth noting. He followed a constructivist approach, encouraging students to build on the knowledge they had, which was evidence of the teacher scaffolding the students to construct their understanding of the concepts. For example a student chose to look at activities involving the skeleton initially saying: 'I know about the skeleton, don't know much about the muscles.' This student felt more comfortable examining content which was familiar to him before exploring the unfamiliar muscle activities; the muscle activities followed a similar format so beginning with the familiar skeleton activities scaffolded his learning.

The researcher used think aloud interviews (Ericsson, 2006) with the students as they were learning. In this lesson the students made connections between the learning and the use of the content knowledge beyond school, making links to sports they play and possible careers where this information would be useful. It was evident from the interviews that the learners used the resources to develop their conceptual understanding of the body and how it functions:

> "(I have learnt) where your muscles are, and where the voice box is. It is pretty interesting. You understand it more."
>
> "I have learnt where the muscles go… I am [now] trying to learn about muscles."
>
> "I found out that not everything goes to the brain, like the knee joint is connected to the base of the spine, that is where the nerves go so that was really interesting."

During the lesson Barry was aware of what each student was doing;

> The only one who wasn't on it was Adam who was making his own stencil things. He had a tab open on word. I kept an eye on what he was doing, he was just writing out the alphabet as he was making a poster next period... He had the tab hidden under the internet one and would bring it up when he thought I wasn't looking. Besides that it was quite easy to manage….

When making decisions about instruction, he considered the students' learning and behavioural needs. He based his teaching practice decisions on what he understood to be effective practices to engage students in constructing knowledge. Effective teaching practices as outlined in a best evidence synthesis (Alton-Lee, 2003) were observed reflecting strong pedagogical knowledge and application of the knowledge. Barry expected each student to achieve in his class. The students were told the learning intention and how to go about using the site. They were encouraged to learn collaboratively, the teacher was familiar with the individual learning needs of his students who could go at a pace appropriate to their needs and students received feedback on their learning from the teacher and through self assessment.

Barry had established an effective learning environment based on careful pedagogical decision making and having high expectations of the students' ability to learn. He was aware of how to keep the students focussed on the learning. He understood the diversity within the classroom, the dynamics, behaviours and how to focus the students on learning. He planned the lesson with this in mind, was vigilant throughout the lesson, he gave time to each student in the class as they accessed the major muscle group activities and he set up the lesson to minimise predicted off task behaviour.

Evaluation

Shulman (1987) separated evaluation from instruction. Evaluation included checking for student understanding during instruction, testing student understanding at the end of lessons or units and evaluating the teacher's own performance. As part of the teaching process Barry integrated student self-assessment, peer support and teacher feedback. A link to an online interactive test allowed students to check their individual learning progress and Barry spent some time with each student during the lesson to give feedback, check progress and identify any misconceptions. These types of evaluation practices reflect effective teaching praxis.

Reflection

The teacher reflected on the lesson in three ways. He examined his pedagogical decision making, how the students engaged in the lesson and the effectiveness of the lesson.

He reflected on his transformation decisions including the use of one webpage that contained links to the anatomy and physiology sites and tertiary/career possibilities enabled the student to keep focussed on task:

> I found that using the Protopage kept them on track. If I said that you can go to these 5 websites, then it is hard to manage whether they are going to those sites, doing the right thing, but it is quite easy to tell if they are doing the right thing as they are either on the starting page or one of the links. There were not too many links, so it was manageable for the students.

Barry considered *how* students as a group engaged with the teaching resource:

> I watched all of them have a go at the muscle game. I watched at least half of them do the test on that. Which was good to see. They did look at the skeleton and I didn't mind them doing that as we have done this, we have looked at the bones, as this goes with the muscles. I have no problems going with the bones as we have done it.

He also considered how individual students responded to the learning activity:

> The students did as hoped. I was worried that the students would get bored, the activities wouldn't sustain them and they would get off task. But really only two of the students got off task, they are the least mature in the class, I expected that, they focussed on the brain sex aspect, which is useful information, but not anatomy which they needed to focus on, they did go back to the anatomy. They were interested in it, which was one of the aims- have them interested in finding out more.

The reflection went deeper than what the students were doing. By talking to the students Barry was able to reflect on what the students learnt compared to his teaching intention:

> Part of the goal was to give them the other context to learn it in. I know that some of the students will have learnt it all really thoroughly in the classroom. I was hoping that by giving them a different context that showed them lots of information in a different way it would help them learn. Gaming- they were making the links between the game and what they were learning. They should be identifying and explaining the stuff next lesson.

Barry evaluated engagement through his discussions with students and observations. He found that the lesson was engaging as the students could learn at their own pace, follow their interests, get instant feedback on their learning and the interactive three dimensional resources kept them focussed. The content was also seen as immediately useful with one student saying (unprompted) that he would apply what he had learnt to the stretches he did while playing rugby league. Barry's reflection included reviewing and analysing his own and his class's performance using evidence which aligned with Shulman's model.

New Comprehensions

Shulman noted that gaining new comprehensions was part of the process of pedagogical reasoning. Barry gained new comprehensions, or increased knowledge, of his students and the teaching process through the learning activity which included using the interactive websites. There were no revelations, though in reflection he appeared to have built on his existing knowledge.

Discussion

Examining decisions made in the teaching and learning process continues to be an important aspect of teaching and Shulman's model of pedagogical reasoning and action provides a useful framework to explore how decisions are made. In the example outlined, Barry's pedagogical reasoning aligned with Shulman's (1987) model of pedagogical reasoning, apart from the emphasis that Shulman put on texts at the transformation stage and the integration of evaluation into the instruction or teaching process. The pedagogical reasoning in the other learning activities across the six case studies followed a similar alignment with Shulman's model. The greatest variation appeared to depend on the resources the teachers chose to use. All the digitally able beginning teachers in the study drew on a range of resources to help their students learn. The resources included; artistic DVDs, field trips, digital learning objects (such as *stack your fridge, virtual hangi*), interactive websites (maths challenge) and a variety of static websites (such as patterns for sewing, information about the Moulin Rouge, international examples of symbols and information about Roman civilisation). In the digital age Shulman's model could be altered to acknowledge the broad range of resources teachers have at their disposal, to select from using their professional judgement.

The teachers in the case studies drew on a range of learning theories and in most cases the pedagogical decision making processes aligned with the existing model of pedagogical reasoning and action (Shulman, 1987). However, while the digitally able teachers could see potential in using web 2.0 applications such as wikis or social networking sites (for example Facebook) they were unsure how to do this in a way that would help their students' learning. This was evident from the interviews of the teachers and through analysis of the learning activities using the digital learning matrix. In this aspect they lacked knowledge of a relevant learning theory or pedagogical model to guide their teaching practice. There was a gap between the digital applications and the conceptual understanding of learning and knowledge creation in the digital age. The beginning teachers in this study were working from theoretical models that pre-dated the digital era.

The changes in knowledge and emerging theory of connectivism alter the position of the teacher from the source or conduit of knowledge to a role of a learning expert. Pedagogical content knowledge in the digital age includes knowledge of the subject including content, approaches and perspectives, and knowledge of how to teach the subject so that students are able to create and critique knowledge through connections (Starkey, 2008). This is more than transforming existing knowledge as outlined in Shulman's model of pedagogical reasoning and action. A teacher in a connectivist learning environment would transform existing knowledge as outlined in Shulman's model, but would also encourage students to go beyond the teacher's existing knowledge base by making or enabling connections.

Pedagogical content knowledge was found to be an important influence in how and whether beginning teachers used digital technologies. When teachers were teaching a subject in which they had strong pedagogical content knowledge, the

learning activities that they had designed for students which included digital technologies had a greater depth of learning on the digital age learning matrix. Activities where students were critiquing, evaluating and creating knowledge were where the beginning teacher had a thorough grasp of the subject content and methodologies in the subject being taught. The depth of pedagogical content knowledge influenced the teaching decisions.

Pedagogical content knowledge is unique to teachers and separates a subject expert from a subject teacher, for example a history teacher from an historian. Curricular knowledge varies depending on the nation's policy about control and resourcing of the curriculum. Shulman includes software, text books and other resource as curricular knowledge. In New Zealand curricular knowledge is more commonly associated with knowledge of implementing curriculum documentation, department schemes and teaching aims as developed by the state, school or department. Teaching resources and learning tools are selected by the teacher or teaching department therefore an understanding of when and how to use digital technologies would be categorised as pedagogical content knowledge.

Shulman's (1987) model is an appropriate framework for digital age thinking about knowledge development in that it recognizes that the teacher and students will be gaining new comprehensions or understandings which could include creating knowledge as a result of the teaching and learning process. Shulman acknowledged the diversity that exists within teaching, noting that the actions in his model are not a fixed sequence and sometimes some may not occur which aligns with complexity thinking. However, from a digital age perspective on learning, the concepts underpinning the transformation action are problematic. The emphasis on the capacity of a teacher to transform the content knowledge he or she possesses infers that the teacher learns or knows the content then repackages it to teach it to students, which appears to be a transmission perspective of the teaching process. I suggest that transforming the content knowledge is one aspect of teaching under the action of 'enabling connections' rather than the only way of teaching. An alternative model of pedagogical reasoning, cognisant of the features of teaching and learning in the digital age is presented in Figure 1.

The two major differences between the original developed by Shulman in 1987 and Figure 2 are the change from transformation to enabling connections and the integration of evaluation and instruction into one teaching and learning aspect. A fundamental change since 1987 is the underpinning idea of students creating knowledge in the digital era through connections in an open and flexible curriculum, rather than the teacher transmitting the 'truths' and methodologies of a subject according to a prescribed curriculum. Both models assume that the students will construct an understanding of the content through a variety of pedagogical approaches to build on their existing knowledge, though in the last 20 years assessment or evaluation has been recognised as being integral to the teaching process, hence the combining of these aspects.

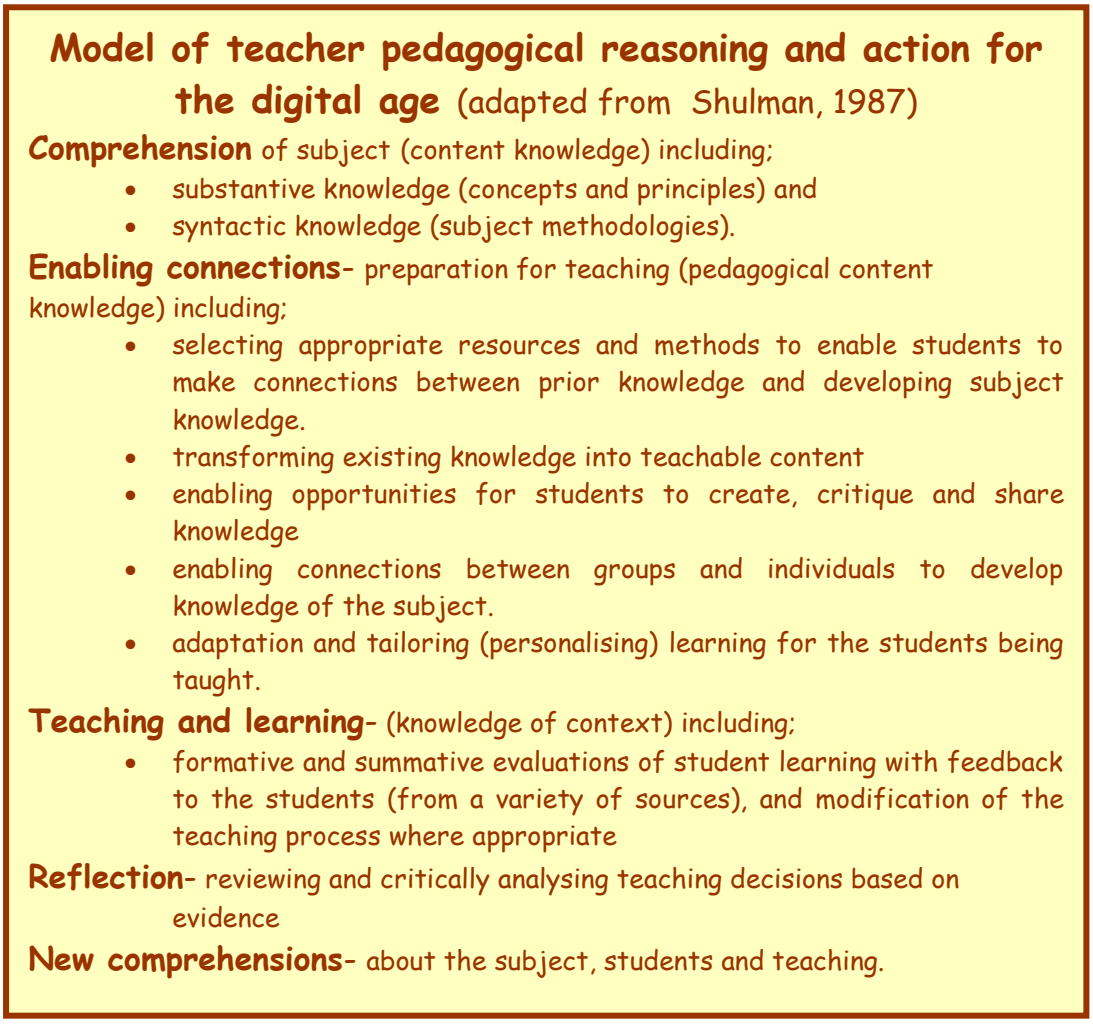


Figure 1. Model of teacher pedagogical reasoning and action for the digital age

Summary

The model of pedagogical reasoning and action was developed within the context of the professionalisation of teaching over twenty years ago. The modification of Shulman's (1987) model outlined in this article reflects the evolution of learning theory since that time due to increased access to ideas and information through the internet, the ability to participate in knowledge development through web 2.0 technologies, and greater understanding of effective teaching practices. The original model is grounded in constructivist learning theory, while the proposed model includes connectivism. Both models assume that the students will construct an understanding of the content through a variety of pedagogical approaches to build on their existing knowledge, that the teacher will consider the learner and the context and reflect on the teaching process. Connectivist learning theory has an underpinning notion that learning includes students creating knowledge through connections in an open and flexible curriculum, rather than the teacher transmitting the *truths* and methodologies of a subject. This is reflected in the modified model.

The digitally able generation is joining the teaching profession and examples of their pedagogical reasoning were reported in this article. It was found that their decisions were based on learning theories predating the digital era and this was limiting their ability to use pedagogical content knowledge innovatively. Connectivist

learning theory can be applied to the use of web 2.0 technologies in the teaching and learning process and a greater familiarity of this may have helped the beginning teachers in the study. More importantly, to put theory into practice the teachers in the study could have benefited from experiencing the implementation of a pedagogical reasoning and action model that was aligned with ideas about knowledge, teaching and learning in the digital age.

References

Alton-Lee, A. (2003). Quality Teaching for Diverse Students in Schooling: Best Evidence Synthesis Iteration (BES). Wellington: Ministry of Education.

Bereiter, C. (2002). Education and mind in the knowledge age Mahwah, N.J:Lawrence Erlbaum.

Darling-Hammond, L. (2006). Powerful teacher education: Lessons from exemplary programs. San Francisco: Jossey-Bass.

Ericsson, K. A. (2006). Protocol analysis and expert thought: Concurrent verbalizations of thinking during experts' performance on representative tasks. In K. A. Ericsson, N. Charness, P. J. Feltovich & R. R. Hoffman (Eds.), The Cambridge Handbook of Expertise and Expert Performance. (pp. 223-241). New York: Cambridge University Press.

Gilbert, J. (2005). Catching the knowledge wave? The knowledge society and the future of education. Wellington: NZCER Press.

Grimmett, P., & Erickson, GL (Eds.). (1988). Reflection in teacher education. New York: Teacher College Press.

Loughran, J., Hamilton, ML, LaBoskey, V, & Russell, T (Eds.). (2004). International handbook of research of self study of teaching and teacher education practices. Amsterdam: Kluwer.

Ministry of Education (2007). The New Zealand Curriculum. Wellington: Learning media.

Mishra, P., & Koehler, M. J. (2008). Introducing technological pedagogical content knowledge. Paper presented at the AERA annual meeting, New York.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, 57(1), 1-22.

Siemens, G. (2004). Connectivism: A learning theory for the digital age. Retrieved 15 March, 2006, from http://www.elearnspace.org/Articles/connectivism.htm

Siemens, G. (2006). Knowing knowledge. Retrieved November 18, 2006, from http://ltc.umanitoba.ca/KnowingKnowledge/index.php/Main_Page

Starkey, L. (2008). Evaluating learning in classroom activities using digital technologies. Paper presented at the ACEC 2008, Canberra.