Abstract

Information Communication and Technology (ICT) using teachers have developed special pedagogical reasoning skills for using ICT in their teaching. Shulman’s (1986, 1987) work on pedagogical reasoning is extended to include technology and the researcher proposes that this special process should be termed Technological Pedagogical Reasoning (TPR). This study has looked into the reasoning processes of ICT using teachers across the career stages as defined in the National Professional Standards (Australian Institute for Teaching and School Leadership, 2011) and attempts to answer - How do teachers technological pedagogical reason across career stages and what influences teachers in developing their technological pedagogical reasoning? This research will provide rich description of how TPR is developed and evolves over a teacher’s career. The purpose of this design is to reveal the voices of teachers to determine how they develop TPR in their lesson planning and practice. The study involved collecting data using video stimulated and thinks aloud protocols on their lesson planning and lesson delivery. This data has been analyzed using the thematic analysis with constant comparative method to identify themes. This paper outlines this research project, with a brief introduction to the preliminary results from this study. Further results will be presented at the conference.

Introduction

There has been an increasing push for teachers, through the teaching professional standards (Australian Institute for Teaching and School Leadership, 2011a) and policy initiatives (Department of Education Employment and Workplace Relations, 2011), to use Information Communication and Technology (ICT) in the classroom with the purpose of preparing students to live and work in a digital world. One key principle suggested in the Digital Education Revolution (DER) Roadmap (Australian Information and Communications Technology in Education Committee’s (AICTEC), 2009) is that “educators require the pedagogical knowledge, confidence, skills, resources and support to creatively and effectively use online tools and systems to engage students” (p.6). This study proposes that some teachers have developed special pedagogical reasoning knowledge and skills through teaching with ICT and it is suggested that this should be termed Technological Pedagogical Reasoning (TPR). This study will look into the reasoning processes of ICT using teachers across career stages as defined in the National Professional Standards (Australian Institute for Teaching and School Leadership, 2011b). Looking at teachers across career stages will help understand what TPR is and what influences its development. The study will look how TPR translates from graduate teachers to proficient, highly accomplished and lead teachers.

This paper provides an outline of research currently being completed. The purpose of this study is designed to reveal the voices of teachers at multiple career points to determine how they develop TPR through their professional practice and their lesson planning. Various models of pedagogical reasoning will be discussed to provide the theoretical framework for this study and then a brief outline of this research project will be presented. Finally a brief description of the preliminary results will be discussed with further details presented at the conference.
Pedagogical Reasoning

Pedagogical Reasoning was first suggested by Shulman (1987) in his justification for the existence of Pedagogical Content Knowledge (PCK) where he introduced pedagogical reasoning as:

“Pedagogical content knowledge is not simply a repertoire of multiple representations of the subject matter. It is characterized by the way of thinking that facilitates the generation of these transformations, the development of pedagogical reasoning” (p.115).

Shulman (1987) suggests that this special kind of ‘teacher thinking’ is developed “through the process of planning, teaching, adapting the instruction, and reflecting on the classroom experiences, (teachers) acquire new types of knowledge” (p. 117). Shulman went further to define pedagogical reasoning in the Model of Pedagogical Reasoning and Action.

Model of Pedagogical Reasoning and Action (PRA)

This model is described in six processes: Comprehension; Transformation; Instruction; Evaluation; Reflection; and New Comprehension. Comprehension is based on the idea that teachers need to understand what they are going to teach. Transformation is about transforming the content or what needs to be taught into a format that will motivate the learner. Shulman suggests the following processes for Transformation: Preparation; Representation; Selection; and Adaptation. Instruction is the act of teaching including the many aspects of pedagogy including “organizing and managing the classroom; presenting clear explanations and vivid descriptions; assigning and checking work; and interacting effectively with students through questions and probes, answers and reactions, praise and criticism” (1987, p. 17). Evaluation occurs as teachers check for student understanding. Reflection is what teachers do when they “look back at the teaching and learning that has occurred, and reconstructs, re-enacts, and/or recaptures the events, the emotions, and the accomplishments” (1987, p. 17). New comprehension represents what the teacher has learnt as they have completed all previous processes, that is their new understanding of what works and what doesn’t. Shulman’s processes are used as a basis for understanding the pedagogical reasoning a teacher uses when deciding to embed ICT in their teaching.

Wilson et al (1987) further developed the model after studying pre-service teachers making the transition into classrooms. Wilson et al (1987) confirmed Shulman’s initial thoughts of a linear relationship among the constructs. There was an obvious starting point and process of pedagogical reasoning that the pre-service teachers were able to demonstrate. This model is shown in Figure 1.

![Figure 1 - Model of pedagogical reasoning (Wilson et al, 1987, p.119)](image)

There have been studies that have drawn on Shulman’s PRA model with a view of understanding the impact of ICT. The research by Webb et al (Webb, 2002, 2011; Webb & Cox, 2004) and Starkey
(2010a, 2010b, 2011) are significant here.

Model of pedagogical reasoning with ICT

Webb (2002) suggests that the teaching of ICT requires teachers to reassess their pedagogical skills and used Shulman’s model because it provided “a more detailed description of educational processes… (as) a basis for examining the range of issues and problems associated with teaching and learning ICT” (p.240). The model not only includes the processes but data flows to highlight the knowledge required for each process. The model also shows the linear relationships between the processes as first suggested by Wilson et al (1987). Webb (2002) highlights that the strength of this model is the transformation of knowledge throughout all processes.

Figure 2 - Model of pedagogical reasoning (based on Shulman, 1987) (Webb, 2002, p.242)

Webb explains that Comprehension involves identifying the ideas to be taught and using knowledge of education purposes, content knowledge and previous experience of teaching the topic. Webb highlighted the debate between teaching ICT separately or being embedded as part of a subject. She also highlighted the poor specification and vagueness of ICT in the UK National Curriculum leading to the confusion of where ICT was placed by teachers. A further problem with the comprehension process is “that many (teachers) may have inadequate content knowledge because they lack specific training to teach ICT and may lack qualifications in ICT” (Webb, 2002, p.244).

Transformation is broken into the following sub-processes: Preparation; Representation; Instructional selection; Adaptation; and Tailoring (Webb, 2002). In the Preparation process a teacher may examine the syllabus, to determine what they actually need to teach, selecting from their knowledge base or textbooks. Representation is the process to think about the different ways that the required knowledge can be taught to the students. This is where Shulman’s PCK contributes to the process. In the Instructional selection process, teachers use their knowledge of learners as influenced by their ideas, beliefs and values, to select teaching strategies for teaching the content. Adaptation is modifying the content to suit the students, taking into account all equity issues, prior knowledge, motivation and
skill. **Tailoring** is the final process and involves fitting the plan for a particular group of students.

**Instruction** involves the delivery of the content in a lesson and Webb (2002) highlighted in 2002 that there was little research on effective teaching with ICT. She goes further to say that “ICT lessons involve management of a complex range of sources of software and hardware” (p.250). ICT impacts **Evaluation** in the assessment processes where teachers “need the pedagogical knowledge to be able to predict problems, identify signs and be ready for key questions to enable students to make progress” (p.251) when using ICT tools.

Webb and Cox (2004) in further work, add a framework for pedagogical practices relating to ICT use (shown in Figure 3). Again using a flowcharting template, this framework “represents the processes involved in pedagogical practices and the main flows and stores of data” (Webb & Cox, 2004, p.239). This model highlights the importance of teachers’ knowledge, belief and values on their pedagogical reasoning and how that influences their behaviour and the development of lesson plans.

**Figure 3 - Framework for pedagogical practices relating to ICT use (Webb & Cox, 2004, p.239)**

Webb’s (2004) *Framework for pedagogical practices relating to ICT use* provides support for the idea of looking into teacher’s lesson plans to understand teacher’s knowledge and the pedagogical reasoning practices that teachers use. Webb (2011) has completed further work to refined her Framework for pedagogical practices relating to ICT use. From the framework shown in Figure 3, the new revised framework (Figure 4) includes details of Technological Pedagogical Content Knowledge (TPACK) and new emphasis on the relationship between Teacher, Student and ICT behaviours. Webb suggests that “this framework combines individual and group regulation of learning where pedagogical reasoning is transparent as possible and shared between students, teachers and others involved in students’ learning’”(Webb, 2011, p.11). With the introduction of TPACK, Webb suggests that teachers will need to use their PCK and elements of TPACK to plan activities.
This framework provides an insight into teachers’ thinking with technology and the influence of TPACK on pedagogical reasoning processes that teachers use when planning for lessons. From this framework there are many data flows around the process of Teachers’ Pedagogical Reasoning highlighted in the snapshot represented in Figure 5. The data flows around Teachers’ Pedagogical Reasoning and suggests many ideas. Firstly teachers’ professional knowledge including TPACK is required for the process of pedagogical reasoning. Secondly, teachers need to know what resources are available to them for the process of teaching. Thirdly, teachers need to consider what assessment is required to check for student understanding. Fourthly, teachers’ behaviours influence their pedagogical reasoning, as it is their belief, values and ideas about ICT and education that will enable them to use ICT in teaching. Finally, Teachers’ Pedagogical Reasoning is stored in lesson plans.

Model of teacher pedagogical reasoning and action for the digital age

Another attempt to show the influences of ICT on Shulman’s PRA model is presented by Starkey (2010a, 2010b, 2011). She has proposed a model of teacher pedagogical reasoning and action for the digital age (see Figure 6). This model is founded on Shulman’s (1987) Model of PRA but modified for action in the digital age. From Shulman’s PRA, Comprehension is demonstrated using substantive and syntactic knowledge to influence what set of ideas should be taught. Enabling Connections replaces Transformation and its sub-processes but elements of the five sub-processes remain although not named specifically. Teaching and Learning replaces Instruction and incorporates the elements of

Figure 6 - Model of teacher pedagogical reasoning and action for the digital age (Starkey, 2010a)

This work has been included in this literature review as it shows an attempt to use Shulman’s pedagogical reasoning from an ICT perspective. These models highlight the importance and influences on pedagogical reasoning but do not define teacher’s pedagogical reasoning. Although there is theoretical support for these models, to date, little research has been found to confirm them. This study may be able to elaborate on these models and add further description of the elements of each model. From this foundation, a view of Technological Pedagogical Reasoning will begin to emerge. This view has been fundamentally based on Shulman’s PRA Model but influenced in the work completed by Wilson, Webb, Cox and Starkey. These studies provide a sturdy theoretical framework on which to build this study. The research aim driving this project is to:

To investigate how teachers reason with technology and what influences their development of technological pedagogical reasoning.

This study

The research is designed to gain an understanding of the development of TPR over career stages and identify the influences on the development of TPR with the purpose to help conceptualise TPR. The opportunity to document the ‘rich’ descriptions of teachers’ thinking with technology and the opportunity to uncover influences are valuable aspects of the research. Since the methodology chosen to investigate any research should be guided by the research purpose, a qualitative approach set in a naturalistic paradigm was therefore deemed appropriate. The use of naturalistic inquiry is based on context where context is viewed as a “complex web of unique interrelationships” (Erlandson, 1993, p. 16) within which the researcher participates, co-constructing the reality. Teachers will work with the researcher to co-construct the meaning of TPR. This research will collect the voices of experienced and graduate teachers as Ornstein (1995) describes the teachers’ voices as “what teachers do, how they do it, and how they react to their teaching” (p. 127). These voices are critical for this research in that they will provide ‘rich’ and ‘thick’ data necessary for understanding how teachers think. A
naturalistic researcher aims to give these teachers a voice rather than clouding the research with their own research agenda. There is naturalistic research that uses a teacher’s voice within classroom settings (Livingston & Lemelin, 2001; Mortera-Gutierrez & Beatty, 2000). There is also evidence of naturalistic enquiry that used teachers’ voices with ICT educational setting (Fitzpatrick & Faux, 2002; Franklin & Lowry, 2001).

Method

The investigation into the reasoning experiences of experienced ICT using teachers will use qualitative methodology. This will provide a powerful lens to observe the level of reasoning across the various career stages. The teachers, at various career points, will provide perspectives associated with diverse teaching contexts, gender, previous careers and age variations. The methodology to be used for this study is consistent with a qualitative framework, requiring interviews, observations and the collection of data in the form of audio files, transcriptions of conversations, video stimulated discussions and preparation of concept maps. This will allow many sources of rich data to be collected.

Data Analysis

Thematic analysis will be used because it “is highly inductive, that is, the themes emerge from the data and are not imposed upon it by the researcher” (Rudolph, 2006). In this type of analysis, the data collection and analysis take place simultaneously. Closely connected to thematic analysis is comparative analysis and this will be used to compare the results of each teacher. Using this method, data from all teachers will be compared and contrasted within and across groups until no new categories arise. Close examination will be made for the concepts of TPR and the links to career stages with a focus of identifying similarities and differences.

Preliminary Results

An initial review of the results highlighted the technical difficulties faced by teachers at two different schools. The first school was a primary school under five years old with modern architecture and classrooms designed for ICT use. Classrooms were fitted with new technology including electronic whiteboards and Wi-Fi connectivity. The teacher had planned a lesson using a variety of technologies including: iPods, Learning Management Systems (EdStudio) and video conferencing tools (Eluminate). The class had been participating in a ‘Beyond your back door’ project with other schools in South East Queensland. The technical difficulty experienced for this class was the inability to contact the other classroom (located <100kms away) to join the video conference at the required time. The prep teacher (who was highly competent in using and leading ICT at the school) improvised allowing the students to continue with a connected activity while waiting for the other class to join. To the researcher’s disappointment, this did not occur for the observed lesson.

The second school, located in a small country town (< 100kms from Brisbane), was a high school just over 30 years old, where there is an investment program to develop the ICT resources available at the school. The teacher, a recent graduate who has been teaching at the school from the beginning of 2012, was observed delivering a year ten mathematics class where the students were being introduced to a new topic. The teacher elected to use YouTube video embedded in a PowerPoint presentation to introduce the new topic. The teacher attempted to use the Wi-Fi network to download the video, which halted the lesson sequence, as the video did not download. The teacher did not stop the download and after sometime (later in the lesson) the video proceeded to play snippets as it continued to download. The teacher stopped the video at this point but missed the opportunity to show the students. The teacher later explained to the researcher that the Wi-Fi was a major issue at the school and was not expected to improve until the following year when a telecommunication supplier was going to upgrade the connection and the school was going to upgrade the servers.
Using ICT in a school can have difficulties as shown in the examples above. Both teachers are competent in using ICT and were able to demonstrate some of the reasoning processes they have used in deciding to use ICT in their classroom. This project is expected to interview and observe 14 teachers from a variety of contexts (early childhood, primary and high school including distance education) at various career points (graduate, proficient, highly accomplished and lead) to seek to understand their TPR knowledge and skills and the influences to developing TPR. As each situation is unique and all contextual aspects need to be explained, each teacher will be presented in a case study.

Significance

This study will provide descriptions of how teachers think with ICT at various career points as defined in the National Professional Standards. This study has the potential to make several contributions to scholarship and practice in the field of teacher thinking. From a practice standpoint, the results will be relevant to the Australian education system, as they will:

a) Provide teachers a definition and understanding of Technological Pedagogical Reasoning;

b) Provide an understanding of the technological reasoning knowledge and skills that teachers need to translate the National Professional Standards and AITSL ICT Feature Statements into a practical way of using ICT; and

c) Provide teachers at various career points with an understanding of the TPR knowledge and skills to incorporate ICT into their planning and professional practice.

This research also has the potential to make the following contributions to scholarship as it will:

a) Provide a definition for Technological Pedagogical Reasoning (TPR) and expand the current knowledge on pedagogical reasoning with technology. It should identify the main aspects of TPR and in doing so, it should improve the theory of Technological Pedagogical Content Knowledge (TPACK) proposed by Mishra and Koehler (2006) and Pedagogical Reasoning by Shulman (1987).

b) Make an original contribution to how TPR knowledge and skills are developed over the beginning career of a teacher.

c) Will be available online as a digital thesis and therefore open to scrutiny by other researchers, employing authorities and tertiary education providers.

Limitations

ICT is constantly changing which may impact the longevity of this research, as new teachers who have grown into a culture of ICT proliferation may not have the same issues raised by the teachers used in this study. This study will recruit teachers known to the researcher for participation in this study. These teachers will be selected because they have advanced ICT skills and use ICT as part of their teaching practices. They are unlikely to be representative of all ICT using teachers. It is anticipated that at least one teacher will represent each career stage. Teachers will self-nominate for the career stage but will have been identified by the researcher as someone that would be perceived to fit that career stage. A justification for this will be presented from both the teacher and researcher in the results section of the completed thesis. The goal is to identify at least one teacher for each career stage but this is dependent on teachers being available for the research and interested in participating in the research. The teachers participating in this research could raise their awareness of their TPR and this could impact on the quality of the information provided in their planning, interviews and artifacts provided.

The researcher has developed many professional friendships with experienced technology teachers. This is recognized as an influence on the research. However it is also a positive in that the researcher and the experienced teachers already have a relationship built on trust and respect. The position of the researcher will be explained and justified in the final thesis. There could be personal bias as the researcher is a high ICT using teacher and may need to be mindful of the impact on the influence over the data collection. To overcome this bias the research will use the data to allow the theory to emerge using the constant comparative method. An additional positive of having lived the experience is that
the researcher is familiar with the contextual issues of practising ICT using teachers.

**Conclusion**

This paper has provided an outline of research currently being completed to understand how ICT influences teachers’ development of TPR. The purpose of this study is designed to reveal the voices of multiple teachers at different career points to determine how they develop TPR through their professional practice and their lesson planning. Various models of pedagogical reasoning have been presented to provide a theoretical framework for this study. An outline of the current research project has been discussed in this paper. A brief introduction to the finding has been offered and it is planned that more data analysis will be completed and discussed at the conference presentation.
References


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