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The role of ICT in the pedagogical transformation of primary teachers: Dream, aspiration, reality

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Abstract

This paper discusses findings from a recent longitudinal study that examined how 35 beginning teachers used information and communications technologies (ICT) in the first 3 years of their teaching. The research, set in Australia, adopted a mixed method approach to help understand the role that ICT played in the evolving pedagogical identities of the teachers involved. The study found that beginning teachers articulated pedagogical beliefs that aimed to engage their students in active meaning making. It also found that these teachers were competent in the use of a basic suite of ICT software. However, pedagogical beliefs that resonate with contemporary learning theory and demonstrated ICT competence did not necessarily guarantee practices that synergize technological and pedagogical knowledge. The relationships between teachers' beliefs and their technological and pedagogical knowledge are discussed within the context of three different school settings.

Background

The goal of transforming education in Australia through creative use of ICT remains illusive despite supportive policies at national and local levels. The Australian Ministerial Council for Employment, Education, Training and Youth Affairs (MCEETYA, 2005, p.3) proposes that ICT "have the potential to transform all aspects of school education and contribute to the achievement of all learning goals". To help achieve this, Statements of Learning for ICT, requiring that students are afforded opportunities to use ICT for inquiry, creative work and communication have been implemented. However, even within a policy environment that encourages teachers to use ICT in their classrooms, recent research reveals a high degree of scepticism about ICT integration (Pegg, Reading, & Williams, 2007). An evaluation in Western Australia (WADT, 2006) suggested that 82% of teachers have low or medium levels of ICT integration and are not tapping into the potential of ICT on a weekly to daily basis. The Australian schools context is clearly not immune from the deluge of published research into ICT integration which argues that few teachers take advantage of the significant opportunities ICT present (Becker, Ravitz, & Wong, 1999; Harrison, et al., 2002). While current students engage with digital media in staggering numbers at home (Prensky, 2006), teachers generally exhibit a lukewarm inclination to use ICT in their classroom. For Somekh (2007), this disparity is a measure of the lost potential of ICT to transform schooling.

The research that underpins this paper posits that beginning teachers may be ideally placed to integrate ICT into their teaching in innovative ways. A cohort of 35 graduating teachers from 2006 who are digitally literate and familiar with student-centered theories of learning, are tracked through their first 3 years in the profession. By adopting analytical tools established by Jonassen, Peck and Wilson (1999), Fives and Buehl (2005) and Mishra and Koehler (2006), this paper unpacks the beliefs of three different teachers showing that the interplay between various beliefs can have a profound impact on their practices.

Building bridges: a framework for understanding how ICT are used in schools

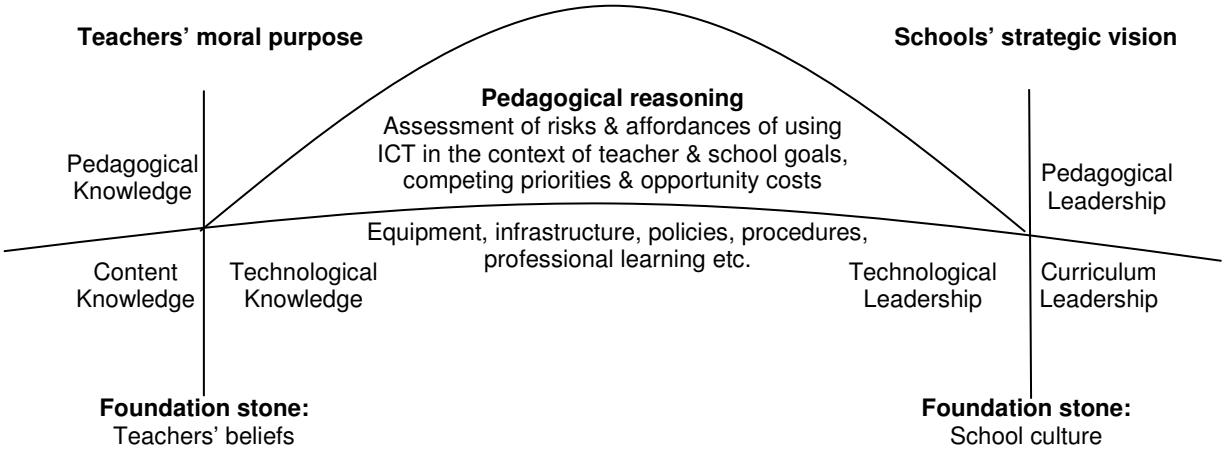
The concept of pedagogical reasoning, originally conceived by Shulman (1987), embodies the idea that autonomous teaching professionals are empowered to make moment-to-moment decisions on what is in the best interests of their students in terms of their academic and social development. In a study of 220 student teachers Fullan (1993, p. 12) found that most entered the teaching profession with a "moral purpose" - to make a difference to students' lives. It is suggested that pedagogical reasoning is a vehicle that provides avenues for students to achieve their potential and teachers to realise their moral purpose.

Shulman's ideas (1987) have been recently extended to help explain the thinking that underpins decisions around the use of ICT (Harris, Mishra, & Koehler, 2009; Mishra & Koehler, 2006; Webb & Cox, 2004), particularly as this relates to the synergy between pedagogical, content and technological knowledge. Teachers engage in pedagogical reasoning in planning, implementing and reflecting upon their use of ICT where affordances and risks are considered in the context of their goals, student capabilities, available resources, competing priorities and opportunity costs. Pedagogical reasoning provides opportunities for teachers to make connections with their schools by accessing equipment, infrastructure and support, following procedures and so on. The concept of pedagogical reasoning is situated at the centre of the framework that guided the research that underpins this paper (shown as Figure 1).

It is proposed that the beliefs that teachers hold about teaching, learning and ICT itself forms an important foundation stone for the way in which their various types of knowledge are given expression. For example, teachers with beliefs about learning that emphasise collaboration may choose to explore the transformative potential of ICT, building their knowledge-base and reflecting upon their own practices in the light of the communicative opportunities that ICT might present (e.g. Web 2.0). Teachers with this orientation may see students' engagement with ICT as an intellectual partnership in which ICT is used as a cognitive tool (Jonassen & Tessmer, 1996) to extending students' learning and creativity. Other teachers may hold beliefs about learning that emphasise the importance of the teacher as an efficient means of distributing knowledge. In these circumstances it is likely that ICT is equated with productivity (Maddux, LaMont Johnson, & Willis, 2001), as an opportunity to amplify existing teaching approaches (Hughes, Thomas, & Scharber, 2006), or simply as a reward for early finishers. Of course many teachers use both teacher- and learner-centred pedagogies in the classroom or adopt a shifting

approach in response to their context (e.g. student capabilities, needs and preferences or the demands of specific content areas). To optimise the use of ICT in these circumstances requires a high level of pedagogical and technological knowledge in being able to harness the ICT options available for the benefit of student learning.

Figure 1: Innovation through ICT expressed as a bridge between teacher and school



How teachers' beliefs impact upon their pedagogical, content and technological knowledge, and ultimately their practices is best understood in the context of their socio-cultural setting. For example, if a school adopts an approach to ICT integration based upon student access to a computer laboratory once per week, it is likely that a teacher's beliefs about the student-centred use of ICT across the curriculum will not be enacted. Teachers, enthused about using ICT at the point of need (i.e. the classroom) may experience feelings of isolation and frustration without the support of their school. Hofer (2006, p. 90) proposes that teachers may feel some "cognitive dissonance" arising from endorsing worldviews that are incongruent with the practices adopted by the educational systems in which they are placed. The research literature on ICT integration cites many examples of small scale innovations that are ultimately unsustainable (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004). It is useful, therefore, where possible for teachers to build bridges between their own beliefs and practices and the school's strategic vision. Similarly, it is useful for schools to build bridges with their constituents to achieve their strategic vision. It is suggested that the culture of the school provides an important foundation stone for the way in which its curriculum, pedagogical and technological support are expressed. In the same way teachers' beliefs shape ICT practices at the level of the individual, a school's culture sets the conditions for ICT practices at the level of the organisation.

Methodology

To attain an empathetic understanding of beginning teachers in their workplaces, the research that underpins this paper tracked a cohort of 35 beginning teachers over a 3 year timeframe. These 35 teachers voluntarily self-selected themselves into the study, all being new to the teaching profession having graduated in the year before data collection commenced. The focus on beginning teachers as they establish themselves in the profession was purposeful. It is proposed that beginning teachers are a potentially fruitful cohort to investigate as they might provide a window into the future use of ICT in education. Many teaching graduates now enter the profession with a basic ICT skill set having undertaken targeted learning that deals with ICT skills and pedagogy as part of their undergraduate studies (Steketee, 2005). In addition, most of the recent generation of teaching graduates have grown up with digital technologies (Prensky, 2006) and it was thought that these individuals may be open to using ICT in their own teaching. The research used a mix of methods comprising of a quantitative approach for gathering baseline data on beginning teachers' pedagogical beliefs and a qualitative approach for helping to understand how participants' beliefs related to their knowledge, attitudes, self-perceptions and skills within their socio-cultural context.

A Pedagogical Beliefs Questionnaire was administered at the inception (n=35) and conclusion (n=20) of the study. The questionnaire, which was based upon instruments developed by Frid (2000), Goos and Bennison (2002, 2007) and Fives and Buehl (2005), provided useful baseline data on participants' beliefs about teaching, learning and ICT. Cronbach's Alpha was used to calculate the reliability of both iterations of the questionnaire which was 0.724 at inception and 0.717 at conclusion.The questionnaire contained 35 statements grouped under five sub-scales that equate with the attributes of meaningful learning as described by Jonassen, Peck and Wilson (1999): learning is active, cooperative, constructive, authentic and intentional. Participants were invited to indicate their level of agreement with each of the statements in the questionnaire by responding to a five point Likert type scale (strongly agree, agree, undecided, disagree, strongly disagree). Responses to each statement were given a score where 5=strongly agree, 4=agree, 3=undecided, 2=disagree, 1=strongly disagree. Statements were designed to both support and contradict the identified attributes of meaningful learning. The questionnaire contained 19 statements which supported the identified attributes of meaningful learning and 16 which did not. Responses for the 16 items that contradicted the identified attributes of meaningful learning were inverted and mean scores calculated for participants. The maximum possible mean score was 5.0 and to register this, a participant would have strongly agreed with the 19 items that complied with the identified attributes of meaningful learning and strongly disagreed with the 16 items that challenged these attributes.

The research also embraced a qualitative-interpretive approach through interviewing and observation. The primary purpose of the interview process was to understand participants' pedagogical and technological knowledge, and their dispositions towards ICT in the context of their stated pedagogical beliefs. To provide an authentic depiction of the way in which beginning teachers use ICT in their teaching, a proportion of participants in the sample were also observed in their naturalistic classroom settings. Interviews and observations were conducted on an annual basis during the study in an attempt to discern changes to participants' pedagogical identities and also in their use of ICT. In all, 56 interviews and 30 observations were conducted over the 3 years of the study. During visits to schools, other key personnel were interviewed including principals, deputy principals, ICT coordinators and teacher librarians. Data were also collected on the infrastructure and equipment that was available to the teachers involved in the study.

The research participants operated in unique physical and socio-cultural settings, dealt with different challenges, and had a range of experiences with ICT over the period of the study. The school settings of most participants changed during data collection (e.g. some participants changed school and some schools changed leadership) and this contributed to the uniqueness of each participant's experiences. A sub-set of 14 of the cohort of 35 participants contributed in each year of data collection. This created a number of rich cases that could be analysed in depth. Dawn, Rashmi and Nick provide examples of such cases.

Discussion

This paper considers the inter-relationships between three constructs: teachers' pedagogical beliefs, teachers' beliefs about the source of their teaching knowledge, and teachers' beliefs about ICT. However, following the advice of Goos (2005) and Hew and Brush (2007), these constructs are considered within the socio-cultural setting in which teachers operate. Table 1 provides a summary of each teacher's socio-cultural environment.

The socio-cultural setting

Table 1: Demographic information for three participants: Dawn, Rashmi and Nick.

Participant	Sector	Yr level	Class size	Equipment/Infrastructure	Features of the school leadership
Dawn Yr 1 & 2 Age: <24 Female	Public	9	10	Poorly equipped for teacher-directed learning (e.g. no projection device provided in the classroom). One computer provided in the classroom which was deemed insufficient for students to engage in self-directed work. Access to a shared laboratory (8 computers) once per week.	The school is geographically isolated and has a focus on increasing literacy and numeracy outcomes. Challenges associated with building and maintaining appropriate technical infrastructure have proven to be a significant barrier.
Dawn Yr 3	Public	1 and 2	26	Poorly equipped for teacher-directed learning (e.g. no projection device provided in the classroom). Two computers provided in the classroom which was sometimes sufficient for students to rotate and undertake self-directed work.	The school is located in an area of low socio-economic status and other issues (e.g. maintaining buildings, air-conditioning bullying, truancy, attracting and retaining staff) have taken priority.
Rashmi Age: <24 Female	Catholic	4	28	Equipped for teacher- and student-directed learning. A laptop computer and a fixed interactive whiteboard are available to the teacher in addition to access to six computers in the classroom for students to engage in self-directed work. Access to a shared laboratory (31 computers) on demand.	The leadership of the school is supportive of ICT integration and provides ample opportunities for professional learning and discussion of ICT ideas. A 1:1 laptop environment is now supported for year 5 and above.
Nick Age: <24 Male	Montessori	7	27	Equipped for teacher- and student-directed learning. A laptop computer and a fixed interactive whiteboard are available to the teacher in addition to 10 mobile wireless laptops in the classroom for students to engage in self-directed work.	There is a clear focus on self-directed learning and ICT is seen as a way of achieving greater levels of student choice and ownership in the learning process.

Rashmi and Nick operated in adequate technological environments and were supported by their schools. Both of these teachers remained at the same school over the period of the study. Dawn on the other hand, worked in two schools, both of which focused on priorities that did not include ICT. The leadership in these schools did not see ICT as having a role in the achievement of other outcomes (e.g. raising literacy and numeracy standards or reducing truancy rates).

Pedagogical beliefs

Dawn, Rashmi and Nick responded to a Pedagogical Beliefs Questionnaire in Years 1 and 3 of the study. As discussed, the questionnaire offered an overall index of the extent to which participants' pedagogical beliefs resonated with the attributes of meaningful learning as described by Jonnasen, Peck and Wilson (1999). Table 2 provides mean scores for each of the three teachers.

Table 2: Mean scores on the Pedagogical Beliefs Questionnaire: Rashmi, Nick and Dawn (year 1 and year 3 of the study)

Subscale	Year 1			Year 3		
	Dawn	Nick	Rashmi	Dawn	Nick	Rashmi
Active						
Cooperative						
Constructive						
Authentic						
Intentional						
Overall mean	3.3	3.6	3.8	3.4	3.6	3.7

These results indicate that at the inception and conclusion of the study, all three participants claim to have held pedagogical beliefs that resonate to a fairly substantial degree with the attributes of meaningful learning as described by Jonassen, Peck and Wilson (1999). Two of the three participants claimed to have become particularly attracted to cooperative approaches to learning. In year 3 of the study Rashmi scored 4.7 on this subscale and Dawn scored 4.0. Nick recorded a lower score on this subscale (3.7) but a higher than average score on the constructive learning subscale (4.1). Dawn and Rashmi both recorded 3.3 on this subscale. These results suggest fertile ground for the creative use of ICT. For example, Rashmi and Dawn's beliefs about cooperative learning may lead to exploration of Web 2.0 tools like wikis to promote collaborative problem-solving.

Beliefs about the source of knowledge of how to teach

The study that underpinned this paper also probed teachers' beliefs about knowledge of how to teach. The Pedagogical Beliefs Questionnaire posed an open ended question derived from Fives and Buell (2005): *Where does knowledge of how to teach come from?* Buehl and Fives (2009) recently analysed answers to this question in a later empirical study. Three categories describing possible sources of knowledge were established: external sources, in which knowledge of how to teach is seen to come from legitimate sources such as universities, books or professional development; socially constructed sources, where knowledge of how to teach is derived through observing, interacting or collaborating with others; and external sources where knowledge of how to teach is forged through experience and reflection. Responses for Dawn, Nick and Rashmi are provided in Table 3.

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Table 3: Dawn, Rashmi, and Nick's responses to the question: Where does knowledge of how to teach come from?

Participant	Response Year 1	Response Year 3
Dawn	A range of resources such as books, professional development, Internet but most importantly through the experience of teaching in the classroom.	Experience, collaboration with colleagues, reflection.
Rashmi	Going to university; own personal experience with teaching.	Through study and experience and sometimes personal ability.
Nick	Question not answered.	Self-reflection and trial and error.

Rashmi exhibited consistent views about the source of knowledge of how to teach throughout the first 3 years of her teaching. Although appearing to strongly support cooperative learning, Rashmi believes that her own knowledge of how to teach comes from a mix between external legitimate sources and experience/innate abilities. In other words, her beliefs about the source of pedagogical knowledge are at odds with her stated pedagogical beliefs. Nick's pedagogical beliefs emphasised the active construction of knowledge which appears consistent with his beliefs about the source of knowledge of how to teach. Dawn shifted her beliefs about where knowledge of how to teach comes from. In Year 1 she recognised the importance of legitimate external sources and experience; in Year 3 she still viewed experience as important but also acknowledged the value of collaborating with colleagues and reflection.

One of the recent advances in thinking about teachers' beliefs lies in the distinction between domain-generality and domain-specificity. Whilst there is some definitional debate over these terms (Hofer, 2006), the thrust of the distinction is that beliefs about the nature of knowledge (domain-general) can be different from beliefs about the nature of knowledge *as this relates to* specific discipline areas and other phenomena like pedagogy and ICT (domain-specific). For example, a teacher could believe that knowledge is subjective, changeable, best acquired through active construction (i.e. adopt a relativist perspective at the domain-general level), but equally hold that knowledge about a subject like mathematics is factual, stable, best acquired from experts through transmission (a realist perspective at the domain-specific level). It is suggested that teachers who understand their own beliefs at domain-general and domain-specific levels, including the relative weight which they may ascribe to these domains in various contexts, may be more equipped to enact their pedagogical beliefs.

Beliefs about ICT

Dawn, Nick and Rashmi exhibited different beliefs about ICT. Rashmi was located in a technology-rich setting. However, although she exhibited technical proficiency, her beliefs about ICT were grounded in the notion that it was simply a tool and her primary role was to teach her students how to use it. For example, at interview in year 3 of the study, Rashmi remarked that ICT is simply "a tool which is needed for students to enter the workforce." Rashmi emphasised efficiency in using various software applications, and devising learning

events that focus on using ICT for skills development. Lessons observed included teacher use of an interactive whiteboard to mediate content and student use of wordprocessing software in response to a worksheet.

Likewise, Dawn saw ICT as a mechanism to make teaching easier for her rather than deepen learning for her students. At an interview in year 3 of the study Dawn suggested that ICT "makes teaching a lot easier. You have a lot of resources through the Internet at your disposal." Dawn had limited ICT infrastructure available to her in the first 3 years of her teaching, but used the laboratory time that was allocated primarily for ICT skills development.

Nick saw ICT as a vehicle in which to respond the variety of student learning styles that he viewed as inhabiting his classroom:

> I think a lot of people have that idea that ICT is computers. It is much more than that. I think it is trying to cater for multiple intelligences. Some kids will pick up knowledge in a verbal presentation, and other kids need the visual or hands-on, or the digital (Nick).

Whilst Rashmi and Dawn held a worldview of ICT that equated to productivity and amplification - Type 1 uses according to Maddux LaMont, Johnson and Willis (2001), Nick actively used ICT to enhance student thinking and creativity - Type 2 uses. For example, in lessons observed students collaboratively developed a video on the topic of bullying (observation 1) and students worked together in groups to solve an online environmental crime (observation 2).

Implications for professional learning

The implications of these findings for Dawn, Rashmi and Nick are now discussed in relation to the bridge metaphor introduced in Figure 1.

A key challenge for Dawn is that her enthusiasm for ICT is not shared by her school. Dawn recognizes that her students are more motivated when ICT are introduced. However, if she wishes to align ICT with her pedagogical beliefs she needs to convince the leaders at her school that it can make a difference to other school priorities like increasing literacy outcomes. Dawn sees ICT as a means to amplify her current teaching and may derive benefit from professional learning that focuses on presenting concepts in novel and interesting ways. She is particularly interested in the potential of the interactive whiteboard. This may be a useful platform in which to harness her interest in ICT and build a bridge between her beliefs and her school's strategic vision. Without building this bridge, ICT integration for Dawn, will probably remain a dream.

For Rashmi, integration of ICT into her teaching is an aspiration that may be realized in the future if she is allocated more time. There appears to be a lack of congruency between her pedagogical beliefs and her beliefs about the source of teaching knowledge. While her stated pedagogical beliefs emphasize collaborative learning, her beliefs about the source of teaching knowledge suggest that her own ongoing learning takes place through a combination of experience and with procuring knowledge from legitimate sources. Her pedagogical beliefs are also not well aligned with her beliefs about ICT which seem to be largely used for presenting information in ways that are entertaining for her students. Although situated in a technology-rich environment, Rashmi is constrained by deficiencies in technological-pedagogical knowledge and a lack of coherency in her various beliefs. The school needs to articulate its strategic vision to Rashmi and show her how ICT can enhance learning outcomes in her classroom.

For Nick, integration of ICT into his teaching is a daily reality. His pedagogical beliefs, beliefs about the source of teaching knowledge, and beliefs about ICT are aligned and he is constantly looking for ways in which to transform his teaching through ICT. The Montessori ethos of students taking responsibility of their own learning in a supportive environment provides an ideal setting for Nick to integrate ICT. His only constraint is the time that he needs to implement creative, cognitively rich classroom activities. His future professional learning is probably most suited to joining a wider network of ICT innovators.

Conclusion

This paper has discussed three sets of teachers' beliefs in different socio-cultural contexts. It has found intrinsic and extrinsic barriers (Ertmer, 2005) that constrain the use of ICT in the classroom. Buehl and Fives (2009) suggest that teachers' beliefs are multi-dimensional and multi-layered and that there are inherent difficulties in separating the complex web of beliefs that teachers hold. The variability of any given context will also demand that different weights are afforded to each set of beliefs depending on the context. In these circumstances it is difficult to discern or predict which beliefs will most influence the actions of the teacher, and difficult to understand why some beliefs are enacted whilst some remain espoused. The relationship between teachers' actions and their beliefs is, therefore, complex (Wild, 1996). This paper has attempted to unravel and explain some beliefs that teachers hold at the intersection of technological and pedagogical knowledge. This has proven useful in interpreting the actions of beginning teachers and has led to a better understanding of why some beliefs become a reality whist some remain aspirations or dreams.

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