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Class sizes: The elephant under the carpet of ICT integration

Frank Bate

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 Western 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 resonated with contemporary learning theory and demonstrated ICT competence did not result in practices that synergized technological and pedagogical knowledge. It is proposed that embedded systemic processes, beyond the control of teachers and schools, have a role in creating this state of affairs. This paper draws upon the experiences of three beginning teachers, from early childhood, primary and secondary education, exploring how large class sizes can often be antagonistic to the creative use of ICT.

Index Terms — ICT, Information and communications technologies, ICT integration, ICT transformation.

1 Introduction

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 drawn up. 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-centred theories of learning, are tracked through their first 3 years in the profession. This paper unpacks the experiences of three early career educators showing that the systemic constraints can have a profound impact on their practices.

2 Research method

The study focused on beginning teachers as they establish themselves in the profession. 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).

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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.

3 BUILDING BRIDGES: A FRAMEWORK FOR UNDERSTANDING HOW ICT ARE USED IN SCHOOLS

Drawing upon the work of Fullan (2001), the study conceives education as a rich tapestry of micro and macro change forces. At the micro level, 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 how to best facilitate the academic and social development of their students. 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. Engaging in pedagogical reasoning provides an avenue for teachers to realise their moral purpose.

Shulman's (1987) ideas have recently been extended to help explain the thinking that underpins decisions about how to use 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 (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 communicative potential of ICT (e.g. Web 2.0), building their knowledge-base and reflecting upon their own practices in the process. 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 extend students' learning and creativity. Other teachers may hold beliefs about learning that emphasise the importance of efficiently 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.

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 unlikely that a teacher's beliefs about the student-centred use of ICT across the curriculum will 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.

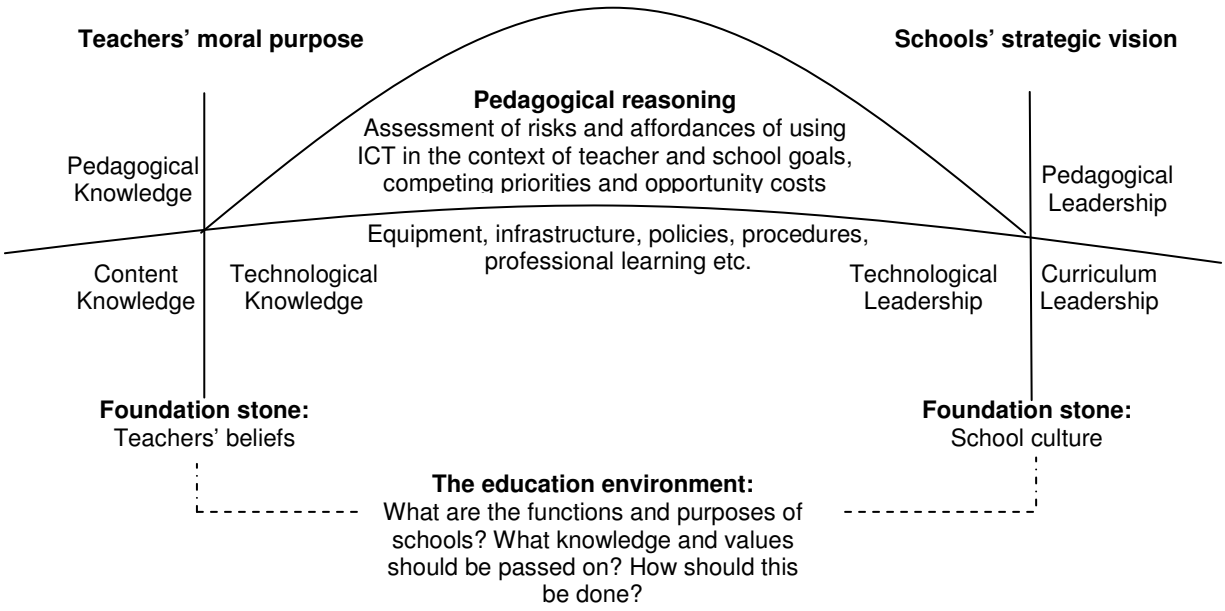

Fig. 1. Innovation through ICT expressed as a bridge between teacher and school.

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 organization. The research that underpins this paper generally found beginning teachers open to using ICT in their classrooms. Further, most schools indicated an appetite for exploring ways in which ICT could be harnessed for the benefit of student learning. However, when participants were asked whether they used ICT to push the boundaries of student learning, the response was generally a shake of the head, laughter, or simply amazement that such a question could be posed. This prompted the research to consider some structural realities that are deeply embedded into the educational system. One of these is class sizes.

The contemporary mass education environment has developed over many years, but has its roots in paradigms of certainty and efficiency. Expert teachers were viewed as authority figures with a considerable knowledge-base that needed to be passed on from one generation to the next. Students that attended schools in the twentieth century learnt to live with these power relations. The teacher was typically situated at the front of the class with students being located in rows facing the front. There was an expectation that students would pay attention, listen and absorb knowledge from limited sources.

The advent of ICT, where students are empowered to inquire, communicate and create using a variety of tools accessed from many sources, has stimulated an appetite for change amongst teachers and policy makers. However, realizing the potential of ICT-integrated learning requires greater financial and intellectual energy than simply providing equipment or even professional development. A re-think of how teachers and students interact and function with ICT is required.

Whereas a teacher in the twentieth century could hold the attention of 30+ students through a combination of sound organizational skills, discipline and well-honed oratory abilities, teachers in the twenty-first century have a different set of challenges not least in encouraging students to be self-directed, taking the locus of control over a range of tools (including ICT) to enable them to construct their own understandings.

It is posited that the challenges of the twenty-first century are complex, and that having to physically manage large numbers of students in ICT environments can severely inhibit creativity. This research has found that most teachers have responded by adopting traditional didactic teaching methods albeit with elegant ICT tools.

This paper tracks the experiences of three beginning teachers. Stella has worked in two catholic schools in metropolitan Perth in both instances teaching at Year 2 level. Bernard is a primary school teacher who has worked in two metropolitan public schools, a high school teaching Japanese to Year 9-12 and a primary school teaching at Year 4 level. Genji is a secondary English teacher who has enjoyed a relatively stable beginning to her career having worked in a rural public sector school since graduating. She teaches at all year levels from 8-12. These participants in the research were selected because they represented early childhood, primary and secondary education environments in metropolitan and rural contexts. The stories of Stella, Bernard and Genji are representative of other participants in the research.

4 FINDINGS

Background information on each of the participants, including the socio-cultural context in which they were set, is provided as Table 1.

Mean scores for all three beginning teachers on the Pedagogical Beliefs Questionnaire at the inception of the study broadly equated with the overall mean of the sample which was 3.6 (Stella, 4.0; Bernard, 3.7 and Genji, 3.4). This indicates that these participants held pedagogical beliefs that resonated with the attributes of meaningful learning as described by Jonassen et. al. (1999).

TABLE 1

BACKGROUND OF PARTICIPANTS

Participant	Sector	Year Level	Avg class size	Equipment/Infrastructure	Features of the school leadership
Stella Age: >24 Female Year 1	Catholic Metropolitan	2	30	Poorly equipped for teacher- or student-directed learning. One computer provided in the classroom which was deemed insufficient for students to engage in self-directed work. Access to a shared laboratory (12 computers) once per week.	School leadership was supportive of ICT integration and were examining options to increase its use.
Year 2 & 3	Catholic metropolitan	2	29	Equipped for teacher-directed learning (e.g. a projection device provided in the classroom along with an interactive whiteboard). Five computers provided in the classroom but only used for students as part of rotational activities.	School principal was enthusiastic about ICT (particularly the potential of interactive whiteboards) and has recently committed to providing an interactive whiteboard in every classroom.
Bernard Age: >24 Male Yr 1 & 2	Public Metropolitan	9-12	22	Equipped for teacher-directed learning (e.g. a projection device and interactive whiteboard provided in the classroom). Three internet-connected computers provided in the classroom along with a television. Access to a shared laboratory (15 computers) once per week.	School situated in an area of low socio-economic status. The school principal is excited about the potential of ICT and has embarked upon a program of purchasing equipment such as interactive whiteboards, Clickers and desktop computers for laboratories.
Yr 3	Public Metropolitan	5	25	Equipped for teacher-directed learning (e.g. a projection device provided in the classroom). Two computers provided in the classroom but rarely used for students to undertake self-directed work.	School located in a growing area. School principal is switched on to the potential of ICT and has actively responded to funding opportunities at state and national levels.
Genji Age: 25-30 Female Years 1-3	Public Rural	9-12	25-30	Access to a shared computer laboratory on demand for student-centred activity (10 computers). A mobile interactive whiteboard and projector was provided to the teacher at the conclusion of the research.	School leadership active in soliciting involvement of teaching staff in ICT decision-making via representation on school committees.

The three participants articulated teaching philosophies indicating a knowledge of, and commitment to, contemporary learning theory. For example, Stella emphasized empathy for students, believing that lifelong learning was critical in her role as a teacher. Bernard also highlighted the importance of lifelong learning and suggested that:

> …learning must occur through collaboration, experience, self-investigation and reflection.

Genji believed that critical thinking was the most worthy of teacher goals. Her philosophy of teaching centred on:

> Trying to help students discover and realize their already existing knowledge, and to build on that knowledge through student-centred learning (Genji).

In summary, these beginning teachers (a) had access to a reasonable level of ICT and (b) articulated beliefs about teaching that might suggest the possibility of creative and

innovative application of ICT in the classroom. However, this did not occur. An example of observations conducted in each of these classrooms now follows.

4.1 Stella

In the final year of the study, Stella was observed using ICT in a literacy class with 29 Year 2 students. The class was split into 4 groups that rotated every 15 minutes. Stella gave a lesson on the interactive whiteboard whilst a second group played games on the five computers in the classroom. Group three engaged in a board game which was supervised by a teaching assistant; whilst group four listened to audio tapes before completing a worksheet.

The class was sometimes difficult to manage with two of the groups largely left to their own devices. In particular, students working at the five computers tended to skip from one page to the next without understanding (or sometimes even reading) the content of the pages that were displayed. By Stella's own admission, she had difficulties in being able to respond to the individual needs of her students:

> The biggest hurdle in teaching is being able to be there for 30 children at the same time.

4.2 Bernard

In Year 3 of the study, Bernard was observed taking a science class with a group of 25 Year 5 students. The lesson involved showing a multimedia presentation to the class on the subject of volcanoes. The presentation lasted approximately 15 minutes and was followed by a worksheet activity to test students' comprehension of the multimedia presentation. Bernard was comfortable in using ICT in this way, and only attempts to shift the locus of control to students when he is able to access support from others (e.g. parents):

> When I first started I planned to gradually release responsibility to the learner so they can take ownership. But I find that I can't do that. I am forever bound to them. That is why I ask for the assistance of volunteers to go in to my classroom because it is just too great a mass of people to deal with for one person.

4.3 Genji

Genji was observed in year 2 of the study taking an English class with 32 Year 9 students. The class was split into 2 with half the students going to the computer lab to develop a pamphlet using Microsoft Publisher and the other half staying in the classroom to plan out the pamphlet in written form. The computer lab was situated next door to Genji's classroom and she quite often has:

> …half the kids in the classroom and half in the computer room. I just pop in and out, which isn't really desirable, but it's the only way you can do it.

The students in the classroom were keen to go to the computer lab to work with Publisher and ended up rushing the planning phase; the students in the computer lab, largely unsupervised, tended to become distracted going to a variety of social networking sites (e.g. Facebook, YouTube) even though they were specifically asked not to do this. Perhaps because of experiences like this, Genji sees her enthusiasm for using ICT waning:

> I think I have gone downhill, because of the difficulty and the frustration of wanting to do something, but not being able to. Last year, I was of the view that it doesn't matter, I just stumbled through it as best that I could. Whereas this year I think, is it worth it? If it is not, then I find a way that I could do it almost as well.

Genji puts her waning enthusiasm mainly down to the stress grounded in managing classroom environments where students have more autonomy than they can cope with:

> You want to do all this student-centred activity but the kids just can't cope with that sort of environment. They are much better when the teacher gives them the instructions to copy down from the board working with books, working independently, that sort of thing is what they are used to. If you try to take them out of their comfort zone they start running amok or they get too excited and it just falls into a heap.

The teachers in this study tended to use ICT in ways that supported traditional teaching, a finding which is consistent with other studies (e.g. Cuban, 2001).

5 DISCUSSION

One of the themes that emerged from the research was a sense, amongst participants, that they were initially somewhat naïve, and had become more realistic about using ICT in their teaching. For example:

> I used to see ICT as a way of students constructing knowledge where they would find out information by themselves. Now I have more realistic perception. I know that theoretically, you should be letting kids find out and construct their own learning, and I know that computers are supposed to be a great way of doing that.

> But I find that it is a major consumption of time (Bernard).

> I think when I left university I was very idealistic. I am a bit more of a realist now. I am a little bit more aware of how things work. The feasibility of doing different activities with kids (Genji).

To return to the bridge metaphor, although the system (and the schools within the system) strongly supports the use of ICT in the classroom, in this study creative implementation broke down during pedagogical reasoning where teachers assessed the risks of using ICT in student-centred ways as too high. Specific risks noted during the research included increased potential for behaviour management problems, the seductive nature of (mainly) social networking sites leading off-task conduct, the inability of teachers to closely monitor the learning benefits stemming from students' interactions with computers, and difficulties associated with splitting classes with students moving to different physical locations. With smaller groups to work with, these risks would almost certainly be reduced.

Using ICT in class sizes above 25 was shown to be problematic in this study, particularly in situations where infrastructure was not robust. A recent Turkish study (Kurt, 2007) came to similar conclusions identifying crowded classrooms as a significant barrier that inhibited the implementation of ICT in primary settings.

It is interesting that the teaching philosophies expounded by participants centred on developing higher order attributes in students such as critical thinking and engendering a love of learning. Although ICT could have been useful in achieving these objectives, these philosophies were not enacted in the early years of the participants' careers. The research found that pragmatic concerns got in the way.

Class sizes of 25+ may be appropriate for transmissive models of teaching (e.g. lecturing), but as schools move towards 1:1 student-computer ratios, empowering students with ICT may require a re-think of how to best support this level of empowerment. These concerns resonate with other research. For example, Goodson and Mangan (1995) point out that more individualised approaches to learning are necessary when introducing computers into the classroom. The authors concluded that most subject cultures are fundamentally incompatible with the pedagogical and organisational changes that are required for ICT use. More recently, Kompf (2005) noted that ICT has contributed to larger class sizes and that further increases will complicate teacher-learner-knowledge interactions exponentially.

Recent literature suggests that ICT can be used to achieve more individualized learning. For example, the UK research and development agency BECTA (2004, p. 7) suggested that:

> ICT offers teachers the opportunity to provide personalised programmes of study for every learner in mainstream school.

The research that underpins the current study indicates that it will be difficult to achieve this goal without considering ways in which to support teachers with large class sizes.

6 CONCLUSION

In Australia, the recent policy response to the slow uptake of ICT, as described in the Building the Digital Education Revolution initiative (Gillard, 2008), has focused on hardware, infrastructure, e-content and professional development. The issue of how student-centred use of ICT can be best supported in the classroom, from a human resources perspective, has received scant attention. This study suggests that more research into the pragmatics of achieving student-centred learning through ICT in large classes, including models of teacher-parent, teacher-librarian and/or teacher-administrator partnerships, and development of appropriate benchmarks for teacher-student ratios across subjects and year levels, would be useful. There is an elephant under the carpet of ICT integration and some intellectual energy is required to make it go away.

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