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Teachers' changing practices with information and communication technologies: an up-close, longitudinal analysis

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While digital technology has become a significant resource for contemporary schooling, we still have little understanding of how these resources shape teachers' scholarly practices and what support is needed to improve and move forward. This paper reports on a 5-year qualitative, longitudinal study on the scholarly practices of a small number of Australian primary and secondary school teachers in their use of digital technology. The study aimed to understand the complexity of their changing practices. Four categories of change were evident in the teachers' practice with digital technology over time: knowledge, learning organisation, pedagogy and core approaches to teaching. The changes each teacher demonstrated reflected their distinct knowledge sets and beliefs. Tracing their changes longitudinally showed that some teachers demonstrated faster and more consistent change in their practices with digital technology than others and that visible change in their practices was not evident over the short term. This study highlights that change in digital scholarship is a personal and complex process and worthy changes are those that meaningfully respond to the context and also contribute to the teachers' commitment to reflection and renewal of practice. Significant support is therefore that which provides the space and opportunity for teachers' individualised professional understandings and aspirations to be acknowledged and built on.

Keywords: digital technology; teachers; change; longitudinal; digital scholarship

Introduction

This paper contributes to developing an understanding of teachers' changing scholarly practices with digital technology. In recent years, educational and governmental stakeholders have regarded digital technology as the holy grail for revolutionising teaching and learning (Buabeng-Andoh 2012). As a result, we have seen the physical presence of technological devices and programmes increase at an extraordinary rate in schools. As with all major school initiatives, teachers' scholarly practices are vital to capitalising on the pedagogical potential of these resources; however, there remains limited understanding of how teachers' practices are changing with the adoption of digital technology in schools and what support is needed to move forward.

An analytical framework has been used to track the teaching practice that digital technology is expected to afford and promote (Drenoyianni 2006; OECD 2006). However, this framework limits deep understanding of change because it simplifies digital scholarship as three discrete, observable behaviours: (1) how often teachers

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use digital technology (Bauer and Kenton 2005; OECD 2006); (2) whether digital technology is used to teach curriculum content rather than information and communication technologies (ICT) skills (Watson 2001) and (3) whether teachers use a constructivist style of teaching when using digital technology (Wong, Li, Choi, and Lee 2008). This framework places technology as the primary focus of analysis and many studies interpret teachers demonstrating any of these three characteristics in particular ways over a short time period (often 1 year or less) as having accepted digital technology and changed their practice in ways that technology is expected to facilitate. Research (Drent and Meelissen 2008; Hermans *et al.* 2008; Mueller and Wood 2012) shows that most teachers are not changing in terms of these three behaviours. An important criticism of this framework is that the expected behaviours it stipulates have not been based on empirical research but instead on hopeful imaginings of how teaching practice might change with digital technology in classrooms (Selwyn 2010). While this information is relevant to our understanding in this area, the question of whether things have improved in particular, imagined ways becomes a more difficult issue and perhaps one that is less important than understanding how things have changed and what the implications are for teachers and learners. Continued use of this framework is problematic because it allows little space for understanding change that may actually be panning out in teachers' digital scholarships outside these anticipations.

In order to overcome the limits of this descriptive framework, an emerging body of literature explores particular aspects of teachers' knowledge and/or contexts that influence their practices with digital technologies (Windschitl and Sahl 2002). These studies identify singular, individualised factors such as teacher beliefs and school organisational structures to significantly influence changes teachers made to their practices with digital technologies. However, there remains little collective understanding of how teachers interpret the many (often competing) contextual factors relevant to teaching with these devices. For example, policy makers expect teachers to use creative student-centred learning methods when teaching with digital technologies. On the contrary, the same voices also prioritise standardised testing regimes that require traditional teaching methods (Orlando 2013). The ambiguous contexts in which teaching practices with technology takes place prompts asking how teachers interpret their multi-faceted contexts over time, which voices they value and why, and how this contributes to the development of their digital scholarship.

This paper offers an alternative analytical framework for understanding how teachers' scholarly practices with digital technology are changing. This framework focuses on four categories of change in their practices: (1) Changes in knowledge which are shifts in teachers' knowledge of digital technology as a learning resource, (2) Changes in learning organisation which are new processes the teachers introduce to support the development of their practice with technology, (3) Changes in teaching practices which are new teaching strategies, curriculum content, classroom organisation, and/or use of resources teachers introduce into their practices with technology, (4) Changes in core approach which are fundamental changes to the way teachers understand the process of learning. This framework emerged as an iterative, simultaneous movement between an extensive review of literature and inductively from data analysis from a qualitative, longitudinal study (Orlando 2009). Longitudinal studies are uncommon in research on teachers' practices with technology (Webb and Cox 2004), or for that matter in educational research as a whole (Thomson,

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Plumridge, and Holland 2003), yet importantly, can provide the evidential weight that cross-sectional studies cannot provide (Underwood 2004).

The benefit of this analytical framework is that it does not conceptualise teaching practice with digital technology as a universal phenomenon but instead as an intricate interplay between knowledge, context and practice (Boyer 1990; Kemmis 2009). The four categories of change embedded in the framework acknowledge that teachers' interactions are influenced by their distinct knowledge set and beliefs which contribute to particular teaching strategies, classroom management and conceptualisations of children that teachers adopt in their uses of digital technology. The next section elaborates on the use of this framework in relation to how teachers' practices with digital technology change can over a period of 5 years and why.

Method

The paper draws on a 5-year, grounded theory examination of the technology practices of a small group of five teachers to facilitate addressing the gap in the literature for holistic and subjective understandings of change in teachers' scholarly practices with digital technology. The research questions this study addressed were: (1) How do teachers' practices with digital technology change over time? (2) What induces change or continuity in teachers' practices with digital technology? (3) What ways do teachers think about and interpret their practices with digital technology?

There is a particular focus in this study on the development of practices with computers because these comprised the digital technology resources used by the teachers presented here. This paper has a particular focus on the first research question and presents the types of changes teachers demonstrated in their practices with technology and how these changed over time for individual teachers and as the participant group.

Grounded theory facilitated staying close to the data and opened up new ways of understanding the teachers' technology practices. Grounded theory methods were selected for data collection, coding to inform subsequent data collection and analysis, and using theory to build the categories of concepts developed in coding. This type of use is reflective of more recent interpretations of grounded theory, which facilitates and recognises a freer use of the approach, rather than strict adherence to guidelines (Charmaz 2006).

This paper reports on findings drawn from two studies involving these five participant teachers. The first data collected as part of a longer government funded study and the second as a close up in-depth additional 2-year study involving these participants. Thematised data, which were continuously and iteratively analysed over time, facilitated rich and complex findings.

The first study was a 3-year qualitative study funded by the Australian Research Council, tracking 40 teachers in seven case study schools across Sydney, Australia, and focused on the impact that technology was having on: pedagogical practices, student learning and schools' organisation of resources. Findings showed schools were struggling with how to be systematic with the major change of integrating technology into learning. The selected schools were known to have good teachers and practices but most often observed were malfunctions of equipment, teacher frustrations and lack of resources. There was an over-emphasis on hardware and inadequate attention to student inequalities (Hayes 2007; Hayes *et al.* 2005).

The schools in the first study were comprehensive, co-ed, government primary and secondary schools, in low- and mid-SES locations that were known by local educational departments to be making a concerted effort to develop technology practices. The 40 teachers were diverse in their technology experiences, teaching approaches, years teaching, ages and gender. Principals invited teachers to participate at varying points throughout the study. Three week-long data collection periods occurred annually. Data included classroom observations, teacher interviews, analysis of planning documentation, student focus groups and interviews with key school technology personnel.

Of the 40 teachers in the original study, five had a data set that spanned the 3 years of the study and were available to participate in this present study. On this basis, I continued to examine the practices of those teachers in even greater depth over a further 2 years. The five teachers stemmed from schools of varying sizes and locations, taught a variety of subjects and year levels and varied in their expertise with digital technology, experience and approaches to using it in their teaching. A brief description of each teacher is given below, the years teaching refers to the years they had been teaching at the onset of the study.

Beth: A primary school teacher teaching for 25 years. She describes her priority as teaching the prescribed syllabus content and uses highly structured teaching methods to teach the syllabus.

Vanessa: A primary school teacher, teaching for 22 years. She stated her priority was to teach the syllabus and develop her students' collaborative skills. Her lessons were characterised by students working in groups.

Philip: A secondary school digital technology teacher, teaching for 12 years. He explained his priority was to teach the syllabus and also to prepare his students to work in the Information Technology (IT) industry. Philip spends a large part of the lesson informally addressing individual students' questions.

Lisa: A primary school digital technology teacher, teaching for 25 years. She was previously a primary school teacher. Lisa describes her philosophical understanding as students need teachers in order to learn. Her teaching was characterised by well-established, teacher-centred routines focusing on explicit instruction and leaving nothing to chance.

Fran: A secondary school English teacher, teaching for 20 years. She stated that her priority was teaching the syllabus. Fran's teaching is characterised by teacher instruction followed by group work or time for students to share knowledge and help each other with lesson activities.

It is evident that four of the five had been teaching for 20 years or more. Their veteran status is a significant factor in an analysis of change in practices with digital technology as it is likely that their ages played an important role in how they approached technology and professional learning in that area and their conceptualisation of 'teacher' (Orlando 2013). Five newer teachers might have yielded very different results. In addition, the teachers all worked in schools well regarded by the state Education Department for their efforts in this integrating digital technology into teaching and learning. Opportunities offered to these teachers to develop their practices might not be those offered to teachers in schools with a lesser technology focus. While the sample could not be described as representative of the experiences of all teachers, it seems unlikely that the findings presented here would be limited to the five teachers.

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Data collection and analysis was an iterative and layered process (Orlando 2009). It began with building a rich historical picture of the teachers' technology practices for the period of the first study against which their practices could be compared, and change could be traced. Line by line reading of data facilitated the development of three themes: practices, context and identity. A matrix was created to document teachers' coded data longitudinally. What stood out at this stage was that the participants' technology practices were distinct and influenced by the established meanings and ways of working around pedagogy, curriculum and assessment practices (Kemmis 2009).

The second layer of analysis involved the collection of new data to expand the longitudinal component of the study to 5 years. Further qualitative data were collected (as per the first study). There was continuous shifting between coded data and new data collection, analysis and coding, to trace and examine change in the participants' technology practices (Connelly and Clandinin 1999). Keyword analysis of the data was informed by the questions and themes developed in the first layer of analysis. This method also generated further data and facilitated the refinement of themes developed in the first layer of analysis.

The third layer of analysis focused on gaining greater depth of data by providing the opportunity for each participant to retrospectively talk about their technology practice over the 5 years of data collection. This layer contributed to the collection of more data, particularly personal biographical details that teachers referred to explain changes in their practice.

In the final layer, theory was selected to locate and address gaps in the analysis. Standpoints from professional practice theory, particularly from authors theorising practice in terms of teaching, for example Kemmis (2009) and Green (2009), were also selected because they centred on the core concern of the study and assisted in deepening the analysis.

The findings are presented in the next section. The practices of four of the teachers are described in detail. Less explanation is given of Vanessa's practices as her practices are presented extensively in another paper (Orlando 2014). Finally, given the relatively small size, with only a couple of exceptions, I have completely anonymised data the data presented below. No information has been given about the respondents since, along with their comments, it is not inconceivable that their sex, age or core beliefs about teaching might be enough to reveal their identity to some readers.

Findings

The teachers demonstrated change in their scholarly practice with digital technology in all four categories of change: teaching practices, learning organisation, knowledge and in core approaches to teaching

Over the 5 years of the study, four of the five teachers demonstrated changes to well-established practices with digital technology as they increasingly used these resources in their teaching. Changes demonstrated included: a shift from teacher planning units of work to co-planning with students, the introduction of multimedia strategies for researching and presenting projects, including technology skills as a new aspect of teaching context and changing classroom organisation routine. For example, interview and observation data indicated that in the first 4 years of the study, Lisa always divided her primary-school technology classes into two groups. She explained that she had been involuntarily seconded to the position of technology

teacher by the education department and at the time of secondment had little knowledge of computers or any other type of digital technology. She described feeling overwhelmed supporting a whole class of students using digital technology. To manage the situation she taught technology skills to half the class, while the other half played computer games without her assistance. Lisa continued with this strategy in her daily teaching for 8 years until the final 6 months of the study when she, for the first time, taught technology skills to the whole class (with the older classes only). This change in her practices was associated with a change in knowledge, that is, Lisa's greater familiarity with these resources. While she had taught technology skills for 8 years, Lisa stated she had never felt confident in her ability to teach in this area. She explained she now felt confident enough in her own technology skills to make the change in classroom organisation.

Changes in learning organisation were new processes that the teachers introduced to support the development of their practice with digital technology. All teachers relied on their professional and personal networks to start a process of extending their knowledge in ways they considered were important. For many teachers, the processes they initiated were separate from compulsory school-based professional learning, which they considered were not connected to their needs. For example, Fran, a secondary school English teacher did not attend school-based professional learning focusing on teaching with digital technology as she considered such technology was not important to her teaching needs. However, when a particular computer application was explicitly referred to in the new English syllabus, she stated she did not have the knowledge to teach that component of the syllabus and this worried her, so she arranged for colleagues to teach her how to use it. Data from Fran and her colleagues showed that she had not approached professional learning in this way at all in the previous 4 years of the study.

Changes in knowledge were shifts in the teachers' knowledge of digital technology as a learning resource. By the final stage of the study, all participants stated they had increased knowledge of digital technology, which contributed to a greater valuing of, and thoughtfulness of the pedagogical use of digital technology. All the teachers expressed pride in this change in their scholarly practice with these devices. Vanessa, a primary school teacher proudly announced in her final interview, 'We can teach well with technology, because we have evolved'.

A change in teachers' core approach to teaching was an increased valuing of children as capable, independent learners. This was evident to varying degrees in the data of all teachers. Lisa's change in this category was significant because she had expressed many strong views about the explicit structure that students needed to be able to learn. In the final year of the study, Lisa began using the Internet with Year 1 classes (aged 6 and 7 years). Until this time, she stated that young children would not be capable of such a complex task and did not want to risk classroom management issues that may result. Lisa explained this change in practice as greater confidence in her own digital technology skills, which stimulated her to be more willing to take risks in her teaching. She stated, 'I would never have done that with the littlies a couple of years ago ... whoever said you can't do Internet searching with Year 1 is wrong!'

The types of change the teachers demonstrated in each category were distinct as they reflected how each teacher understood the process of learning and their ability and motivation for developing themselves within their profession. Teachers drew on both these factors to reflect on how they wanted to develop in their scholarly practice

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with digital technology, the actions they undertook associated with this and the skills they brought to these actions (Kemmis 2009), a primary school teacher, discussed learning as a controlled and independent process. In lessons observed, this teacher used highly structured teaching methods, often beginning with the provision of content information to students, students then completing a closed-questioned worksheet independently and the lesson concluding with the teacher marking the worksheets. The students were rarely permitted to talk in class. The categorical changes demonstrated by this teacher reflected the controlled and independent process she centred her teaching practice on. The knowledge changes she engaged with centred on a development of precise and particular knowledge of digital technology use she identified as important. Learning organisation changes focused on autonomously setting goals for learning to use digital technology, which she completed independently at home. When needed she initiated discussions with staff she knew had high levels of technology knowledge, regarding particular aspects of her tasks. Changes to teaching practice involved integrating digital technology into her current teacher-centred practices.

Changes in four categories longitudinally

When compared longitudinally, teachers differed in the category of change they engaged with over the years. Change in pedagogy was not evident in the practices of any teacher until the third year of the study. Changes in teaching practices were contributed to by changes to knowledge and learning organisation. Teachers differed in the pace and consistency of change they demonstrated and their individualised path was dependent on what they interpreted as a reason to change. Table 1 lists each category of change in the left column and each year of the study (years 1–5) horizontally across the top of the table. The number of teachers demonstrating each category of change each year of the study is listed for each year and each category, for example, in Study Year 4, two teachers demonstrated changes in the category of 'Teaching Practices'. Each cell also lists the teachers who demonstrated each category of change in each study year. Tabulating the data in this form foregrounds the category of change most prominently demonstrated by the participant teachers as a group and how this developed over time both as a group and individually.

Table 1 demonstrates three important findings regarding change in teachers' practices with digital technology. First, changes in teaching practice did not occur over the short term. The majority of participant teachers did not demonstrate change in their classroom teaching until the fourth or fifth year of the study. This is an important finding because as stated earlier, there is a substantial body of literature that positions change in practice to occur over a relatively short period of time (often 1 year or less) and concludes teachers are not changing their practices. Comparing the teachers' paths of change over the 5 years shows that a time period of at least 4–5 years is needed before observable changes in teaching with digital technology are evident.

A second finding highlighted by Table 1 is that unlike change in teaching practice, change in learning organisation and knowledge occurred much earlier in the study and continued throughout the 5 years. Their changed teaching practices were embedded in and contributed to by the knowledge and learning organisation changes they initiated. Changes in learning organisation and knowledge were in many ways gradual and unnoticed and depended on the teachers' level of knowledge and

Table 1. Category of change comparison for individual teachers over time.

Category of change	Study year 1	Study year 2	Study year 3	Study year 4	Study year 5
Teaching practices	0	0	1 Beth: integrated ICT into current teaching practices	2 Beth: integrated ICT into current teaching practices	4 Beth: planned, explicit integration of technology and English curriculum content (English) Lisa: taught ICT skills for the first time with the whole class Philip: introduced new teaching units and used student knowledge to assist in planning and teaching
Knowledge	0	2 Beth: increased knowledge of aspects of ICT she considered important Philip: increased knowledge of ICT use in IT industry	3 Beth: increased knowledge of aspects of ICT she considered important Vanessa: developed knowledge of selected aspects of ICT related to syllabus Philip**:** increased knowledge of ICT use in IT industry	4 Beth: increased knowledge of aspects of ICT she considered important Vanessa: developed knowledge of selected aspects of ICT related to syllabus Lisa: developed knowledge of selected ICT applications Philip: increased knowledge of ICT use in IT industry	5 Beth: increased knowledge of aspects of ICT she considered important Vanessa: developed knowledge of selected aspects of ICT related to syllabus Lisa**:** developed knowledge of selected ICT applications Philip**:** increased knowledge of ICT use in IT industry Fran**:** increased knowledge of a selected computer application related to syllabus

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Table 1 (*Continued*)

Category of change	Study year 1	Study year 2	Study year 3	Study year 4	Study year 5
Learning organisation	1 Beth: autonomously setting goals for learning to use aspects of ICT, use of home and school resources to assist achieving goals	2 Beth: autonomously setting goals for learning to use aspects of ICT, use of home and school resources to assist achieving goals	3 Beth: autonomously setting goals for learning to use aspects of ICT, use of home and school resources to assist achieving goals Vanessa**:** organised team planning with teaching team Philip: drew on IT industry resources to develop knowledge of ICT	5 Beth: autonomously setting goals for learning to use aspects of ICT, use of home and school resources to assist achieving goals Vanessa: organised team planning with teaching team Lisa: asking one staff member to assist in her use of ICT Philip: drew on IT industry resources to develop knowledge of ICT Fran: initiated her own learning of a computer application in relation to syllabus requirements	5 Beth: autonomously setting goals for learning to use aspects of ICT, use of home and school resources to assist achieving goals Vanessa: organised team planning and team teaching with teaching team Lisa: asking one staff member to assist in her use of ICT Philip: drew on IT industry resources and student knowledge to develop knowledge of ICT Fran: initiated her own learning of a computer application in relation to syllabus requirements
Core approaches to teaching	0	0	0	0	2 Lisa: increased valuing of children as capable, independent learners Vanessa: increased valuing of children as capable, independent learners

commitment. For example, Philip, a secondary school computing teacher, did not demonstrate change in teaching practice until the final year of the study. In the fourth year of the study, Philip observed that students in his senior classes consistently knew syllabus content before he taught it. Philip was of the opinion that by the time a new syllabus for his subject was implemented, it was out of date, or quickly became out of date in terms of the IT industry. Philip understood his role was to prepare his students to work in the IT industry and increasingly experienced this aspect of the syllabus as frustrating for both himself and his students. It inspired a lack of trust in the syllabus as a suitable pedagogical guide. Philip experienced an ethic–moral conflict between what the syllabus stated students in this subject should learn, and what he considered they should learn (Green 2009).

To address this disconnect between syllabus and up-to-date IT knowledge, Philip made learning organisational changes beginning the third year of the study, by drawing on a different range of resources – IT industry's websites and publications – to build his knowledge of how he could supplement syllabus content. He stated that while his experiences were from an outsider's perspective he enthusiastically followed industry changes. Philip also became aware of one student who demonstrated high expertise in a new graphics application that was quickly gaining momentum in the IT industry. He had extensive discussions with the students about the application.

Philip's learning contributed to changes in his teaching practices in the final year of the study, with the introduction of new teaching units, which aimed to make a meaningful link between industry practices and student learning. Philip worked with the student in developing a teaching programme for senior technology classes. Philip stated the combination of resources was effective because the student was well respected by his peers and also brought valuable new knowledge to the classroom. He explained that while teaching the syllabus was his priority, it was also his responsibility to keep school learning relevant and the development of supplementary teaching units addressed this.

Philip's decision to draw on a student's expertise facilitated further organisational change for other teachers in his faculty. The other technology teachers also drew on the students' expertise and developed new content for their teaching. In the final interview when reflecting on his practice with digital technology in previous years, Philip explained his increased knowledge of digital technology influenced the changes he made in his teaching practice.

A third finding signalled by the table is that teachers varied in the pace and type of change they demonstrated. No teacher demonstrated change in all four categories any year of the study. Beth, a primary school teacher, demonstrated more change than other participant teachers. She was the only teacher to demonstrate change (learning organisation) in the first year of the study and by the final year had demonstrated change in three categories (learning organisation, knowledge and teaching practices). On the contrary, Fran, a secondary school English teacher only demonstrated change (learning organisation and knowledge) in the final year of the study. The difference can be traced to a reason to change. Teachers experienced a situation (a change in their context) that struck a chord in terms of their professional status and role. Importantly, the teachers perceived the need to respond to the situation (Carr 2009) and initiated a process of reflection, learning and change in their practice. Many changes were evident in the teachers' context over time that could potentially apply pressure to change practice, for example a new principal and employment in a

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new school. However, these situations did not necessarily compel teachers to initiate and sustain change in their practice with digital technology.

Fran's reason to change occurred late in the study. A consistent theme in Fran's data was her lack of motivation for using digital technology in her teaching. The longitudinal data made it possible to identify that lack of change was contributed to by a discord between how she understood her role as a teacher and her context. Fran's motivation for developing herself professionally focused on developing her ability to teach English and this influenced the way she engaged or did not engage with aspects of her context. For many years throughout the study, Fran did not conceptualise digital technology as part of her role as an English teacher. While she participated in consistent school-based professional learning on digital technology practices, she justified her lack of use by explaining she perceived the syllabus did not require her to use it much. While she had participated in a variety of professional learning activities including one-on-one mentoring with a school executive who aimed to enhance her motivation to teach with ICT, these had minimal impact on her practice. It was only when the English syllabus changed to include digital technology that she started to make changes in her practice. A difference Fran identified in the new syllabus was that it made explicit reference to teaching with and about digital technology to fulfil outcomes. She perceived that her digital technology skills were inadequate for such teaching, and this was confronting for her as she considered herself an experienced and capable English teacher. This occurred in the final year of the study and the situation stimulated changes in knowledge and learning. She identified staff that could assist her learning and drew on their knowledge to facilitate her own learning.

Beth, described above, experienced a reason to change much earlier in the study. Her priority was ensuring she could fulfil her role as leader of knowledge in the classroom. The integration of digital technology into her school made it clear to Beth that there was now a significant gap in her professional knowledge which she perceived made it difficult for her to be considered a knowledge leader by students and staff at the school. She perceived this as a loss of status and took steps early on in the study to address this.

Discussion

Over the course of the study, the teachers increasingly demonstrated change in four aspects of their scholarly practices with digital technology – teaching practices, learning organisation, knowledge and core approaches to teaching – however, an important question is whether the changes they demonstrated were worthwhile. Teaching practice takes place within a particular space and time. Good scholarly teaching is that which meaningfully responds to the contexts in which these practices are situated (Kemmis 2009). Therefore, high-quality teaching is that which iteratively and continually responds to the contextual and professional factors that influence student learning outcomes (Munns, Hatton, and Gilbert 2013, p. 55). A useful way for considering the worthiness of the changes the teachers developed in their practices is to discuss whether the changes supported learning and achievement in the context in which they took place.

The changes the teachers made to their teaching with digital technology centred on their reflection of their context and how well they were responding to it. The four categories of change developed in the process of analysis indicate that the teachers

problematised the context and their own teaching, gathered relevant data (such as the work of other educators), and tested this against their understandings of the process of learning and their role as teacher. Reflection has long been cited as an important aspect of teachers' professionalism (Orlando and Sawyer 2013, p. 23), and for the teachers in this study, reflection was embedded in their teaching with digital technology and facilitated their 'reframing' and improvement of their practice. For example, Lisa, Philip and Fran explained that the changes in their teaching allowed them to become more informed, engaged and responsive to the needs of children.

Central to the 'worthiness' of the teachers' responses to their context is the understanding that they were localised, individualised responses, which the teachers interpreted to be meaningful. One might argue that many of the teachers presented here did not use technology in creative, student-centred ways before or after they made changes to their teaching, or that some teachers such as Fran had low level change compared to Philip who was extensively and creatively integrating digital technology into his teaching by the end of the study. However, the design of this study facilitated understanding the contextual and intellectual resources the teachers drew on to inform their choices. For example, Fran who made minimal change to her teaching drew on a wide range of resources to inform the change she made including: her professional knowledge, her experiences as a teacher and her core approaches to teaching. Simultaneously, she discussed educational uses of digital technology with her teaching peers and students. At the same time, she interacted with other teachers, students and teaching documents almost every day in intellectual, academic, political and creative ways and in multiple contexts such as staff meetings and teaching in the classroom. The individualised knowledge and experiences Fran drew on had been layered over the years through professional and personal experiences. From these resources she interpreted what improved digital scholarship should be in this situation. The historical dimensions of teaching with digital technology (Kemmis 2009) provided the foundation for changes in practices in Fran's classrooms. Her improved practice was different to the other teachers documented in this paper because they each drew on their own repertoire of contextual and intellectual resources.

A teacher's meaningful response to a context suggests learning will be enhanced (Green 2009; Kemmis 2009). While assessment of student learning was not within the scope of this study, the teachers were able to report that the changes they developed in their ICT practice led to an improvement in children's interests and results. Lisa's reference to the capabilities of her young class, and the willingness of Philip's student to participate in lesson planning are evidence of this. Students' positive response substantiates the worthiness of the changes teaching practices. Teachers' reporting of their students' responses also suggests a continued reflection of their context, of what is working well and what needs further improvement.

The value of the changes the teachers made to their ICT teaching can also be understood in terms of the contribution the process of change made to the teachers' commitment to their teaching. Beth did not demonstrate constructivist practices and the primary focus of her ICT practice was to teach ICT skills. However, she proudly identified herself as ahead of those teachers who had not changed their practice. What was particularly important was that the teachers were proud that they took control of their teaching and made worthwhile changes. This sense of achievement motivated the teachers to continue to reflect on and refine their teaching and this was apparent throughout the study.

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The teachers' sense of achievement has important implications for supporting ICT teaching practices in schools. This can be understand as simply assuring that technology can make their teaching interesting (Buabeng-Andoh 2012); however, the teachers in this study showed assurance was not enough. As already stated, the teachers were all in schools that were supporting the uses of technology but they dismissed the professional learning that was available to them as irrelevant to their needs. This study shows that reflection based on the teachers' own professional interpretations encourages them to take risks to enhance their teaching (CERI 2002). Research shows (Flint *et al.* 2010) that formalised change processes, (such as new policies or professional learning programmes) do not produce immediate or significant change in teaching. In this light, instead of conceptualising teachers as ignoring ICT or resisting change, one might consider that support does not recognise the individualised nature of teaching with ICT and what teachers consider important. Fullan (2008) proposes that school leaders need to tap into what motivates teachers. The teachers' experiences here suggest that space and opportunity for reflection based on their individualised professional understandings and aspirations be valued and built on. This acknowledgment will support a deeper reflection on their practice, a reflexive search for knowledge and self-improvement in these areas. Similarly, acknowledging the varied understandings each teacher has of the learning process, would be a more meaningful approach to supporting and guiding practice than one which ignores the centrality of individualised understandings (Connelly and Clandinin 1999), or that solely focuses on technical expertise such as learning to use a new computer application.

Conclusion

This paper presents change in ICT as a complex process; this is different from much of the research in change in teachers' ICT practice, which presents change simply in terms of visible classroom practice. The four categories of change more aptly reflect the knowledge and context that inform their use of ICT and therefore provides a useful platform for supporting teachers' ICT practices. These categories foreground the understanding that professional learning does not need to focus on observable pedagogical change alone but also can support teachers in others categories of change. The mechanism that teachers work through in these categories also highlights the value of acknowledging and building on the individualised ways teachers reflect on and work through these changes.

Firm recommendations from a small study like this one are unwise. However, the idea that change in pedagogy with digital technology is a long-term, complex process appears to be an important missing ingredient in the literature on teachers' changing practice with technology. Certainly, the anxiety that educational and governmental stakeholders feel regarding teachers' lack of response to digital technology could surely be ameliorated if research at least problematised the assumption that teachers should be changing their practices in uniform and limited ways. However, it was noticeable in this study that the teachers did not give in to contextual pressures to change their teaching in particular ways because the teachers did not consider the expected changes resonated with how they understood their professional status and role. This is probably not surprising given that many contextual pressures are not based on an understanding of why teachers' uses technology in the ways they do in classrooms. It also makes it easier for all governmental and education stakeholders to

conceptualise the problem of teaching with technology as primarily a matter of teachers not living up to expectations and that teachers need to use technology more often, or with a particular teaching approach.

Digital scholarship is a personal and complex process and changes that teachers identify to be worthy are those that meaningfully respond to the context and also contribute to the teachers' commitment to reflection and renewal of practice. Significant support is therefore that which provides the space and opportunity for teachers' individualised professional understandings and aspirations to be acknowledged and built on.

This paper does not aim to make generalisations based on the findings of a small sample group but instead to highlight the worth of taking a more intricate approach to understanding change in teachers' ICT practices and the need to continue to take such an approach if stakeholders want ICT to support teachers to make a difference to student learning. Methodologies that facilitate understanding teaching with ICT from the subjective and distinct perspective of individuals are necessary for this move. A continued openness to developing such methodologies will support understanding how this practice is actually panning out in today's classrooms and why.

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