Information and Communication Technology and Education: Meaningful Change Through Teacher Agency

25

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Contents

Abstract

The quality of teachers is a very strong influence on the quality of education. In an era when societies and technologies are changing rapidly, both the nature of the education that is appropriate and the means available for its delivery are also changing rapidly. Hence, if teachers are to contribute to the ongoing transformation of societies by transforming education through the use of technologies, they will need to engage in personal transformation through ongoing learning. The wide variety of contexts in which teachers work with differing resources, the variability in their prior learning and in the needs of learners, the rapid changes in technologies, and the shifting expectations of society make it impossible for

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central authorities to prescribe educational experiences that will be suitable for all circumstances. Teachers must be empowered to practice their profession by orchestrating resources and activities to match educational provision to learners' needs. Recognizing the agency of teachers as professionals is essential to enlisting them as contributors to the ongoing transformation of education through application of ICT. This chapter addresses the essential role of teacher agency in the transformation of teachers and the education systems in which they work.

Keywords
Teacher agency · Professional development · Professional learning community · Educational transformation

Transformative Effects of ICT in Society

Evidence of the transformative effects of information and communication technology (ICT) is widely visible in the changing ways that people around the world live and work. Over the past half-century, computers, laptops, and tablets have changed common practices in most work environments and in many homes. Smartphones are practically ubiquitous in developed countries and increasingly prevalent everywhere, enabling almost continuous connection to people and sources of information around the world. Significant changes in the ways that people access information and interact with each other have laid foundations for broad changes in society (Lim et al. 2013). As a consequence, there will be changes in the education required to prepare young people for full participation as citizens (Hawkridge 1990; Spector 2010). The transformative effects of ICT in most aspects of modern life can be seen in changing patterns of communication and commercial activity as well as in the processes and products of manufacturing. These developments have contributed to the "flattening" associated with globalization (Friedman 2006) and initiated changes in the composition and requirements of the workforce, resulting in the hollowing out of the middle class in developed countries (Milanovic 2014).

Professional and service occupations have generally been sheltered from the disruptive effects of ICT because they required intellectual or manual capabilities that were not replaceable in the same way as the skills typically employed in manufacturing. Now there are signs that sheltered status may be disrupted by new developments in artificial intelligence (AI) and robotics that will constitute a fourth industrial revolution following the prior revolutions based on the widespread adoption of steam power, electricity, and electronics (Peters 2017). Developments in data science open the possibility for ICT to substitute for humans in a variety of nonroutine cognitive tasks while advances in sensing and manipulation are enabling robotics to perform an increasing range of manual tasks.

New forms of ICT including AI and robotics are expected by some to reduce the need for human labor in widening areas of activity (Peters 2017), potentially constraining choices about how we live. Nevertheless, there are voices that question the breadth of recent claims made about the coming revolution in AI and robotics.

Some question the extent of the capabilities that can be developed by machines and some argue for the importance of human society playing its proper role in creating the future rather than accepting the inevitability of outcomes flowing from technological determinism (Wajcman 2017). Regardless of the extent to which a fourth industrial revolution catalyzed by ICT through AI and robotics changes the nature of work and how much work remains available to humans, it seems certain that there will be changes in both the quality and quantity of work required for society to function.

Education System Responses to Developments in ICT and Society

Whether education is regarded from a utilitarian perspective as preparation for work or more holistically as developing the full potential of human beings, it must change in response to broader societal change. As Peters (2017) notes, ICT will not spontaneously transform education in the ways required to adapt to these changes. That will require educators, policy makers, and societal leaders to seek and implement appropriate solutions to transform education in parallel with developments in ICT (Aesaert et al. 2013). Almost 30 years ago, Hawkridge (1990) discerned four different rationales that drive educational policies related to the integration of ICT in education: (1) an economic rationale: the development of ICT skills is necessary to meet the need for a skilled work force, because learning is related to future jobs and careers; (2) a social rationale: this builds on the belief that all pupils should know about, and be familiar with, ICT in order to become responsible and well-informed citizens; (3) an educational rationale: ICT is seen as a supportive tool to improve teaching and learning; and (4) a catalytic rationale: ICT is expected to accelerate educational innovations.

These rationales continue to be relevant and are visible in the policies and actions of governments around the world. To illustrate, in Australia by the turn of the century, statements from the national and state governments had expressed expectations that young people would leave school as creative and productive users of ICT and that ICT would transform learning and teaching in Australian schools (DEEWR 2008). The expectations were accompanied by substantial investment but progress has been acknowledged as uneven. Similar aspirations have been voiced in other countries and by international organizations promoting transformation of education for the global good (UNESCO 2011).

The past decade or so has seen developments in school computing curricula around the globe. Fluck et al. (2016) described the incorporation of computer science in the curricula of Cyprus, the United Kingdom, and Australia as examples of what is happening in many countries. They made a case for inclusion of computer science in school curricula and suggested how it might be implemented. The Australian Curriculum includes, within the Technologies learning area, a Digital Technologies subject with a focus on creating digital solutions by applying computational, systems, and design thinking in addition to an ICT General Capability intended to develop ICT skills across all learning areas (ACARA 2015a). Similarly, in 2008 the

Flemish government responded to the expectations of the society by providing a set of ICT attainment targets, formulated as ICT competencies (Aesaert et al. 2013). Besides the importance of competencies to direct or support teaching and learning, the Flemish government also emphasizes the importance of ICT as catalyst to innovate teaching and learning approaches (catalytic rationale): ICT can boost the creation of a powerful learning environment. Other countries have engaged in similar educational reforms with the intention of embedding ICT in curriculum and pedagogy.

Nevertheless, several studies have observed incongruence between national ICT curricula and the actual level of adoption of integrated ICT use (e. g., Hatzigianni et al. 2016; Tondeur et al. 2008). For instance, a large-scale study found that Australian children aged 8–9 years were using ICT at school in conventional ways with little evidence of use to support creative and project-based activities (Hatzigianni et al. 2016). This suggests that children may be acquiring basic skills with ICT as envisaged in the ICT General Capability but are less likely to be developing as creators of digital solutions as envisaged by the Digital Technologies subject (ACARA 2015a). Moreover, there is evidence from a national assessment of ICT skills (ACARA 2015b) that, far from improving over time, skills measured by that assessment have decreased. One plausible explanation for such a decrease is that the skills measured in the assessment relate mostly to the use of applications on personal computers but the focus of schools and students has shifted to emerging forms of ICT such as tablets and handheld devices like smartphones. New technologies require different skillsets and the rate of change in ICT is sufficiently rapid that attempts to compare very specific skills over time may be futile if they have been made less relevant by changes in ICT.

Even where children are developing relevant ICT skills in school, they may not be experiencing learning and teaching transformed by ICT. Some lag in implementation of new curriculum imperatives is to be expected but the changes promoted by new curricula including elements of computer science will require substantial changes in the practice of teachers (Sentance and Csizmadia, 2017). In the USA, a recent survey of 700 teachers found that, although a majority regard themselves as risk takers or early adopters of ICT, their most frequent classroom uses of ICT were for conventional applications such as drill and practice (Rebora 2016). Creative and transformative applications were less frequently reported. Although the survey was not statistically representative, it did include teachers from varied schools across the USA and is indicative of the broad patterns of ICT use in education. The major challenges to more extensive ICT use were reported as limited access to digital devices, lack of training, curriculum demands, and unreliable Internet access.

From the research findings, it seems that the aspirations of national educational authorities do not automatically result in changes in classroom practices. These results raise questions as to how the priorities of ICT policies can be implemented. In this section, we challenge policy makers and schools to develop a vision about teachers' professional learning within the field of ICT for teaching and learning. In this respect, Lim et al. (2013) noted that the expectation of educational transformation through application of ICT had driven extensive investment by governments

and others to provide ICT for use in schools. They cited international research that demonstrated some successes but concluded that transformation had not happened on the anticipated scale and that, like many previous innovations, ICT had scarcely affected the practice of most teachers. They identified two gaps in educational use of ICT. The first relates to usage; the breadth and depth of students' use of ICT in school are much less than outside school. The second relates to outcomes; compared to sectors beyond education, the effects of ICT on schooling are much less. Although they suggested paths to improvement, including development of effective policies and plans and provision of effective leadership by principals, there is no universally applicable solution to effecting transformation of education through ICT.

Nevertheless, the imperatives for change stemming from the broader transformational effects of ICT described in the first paragraphs (Friedman 2006; Milanovic 2014; Peters 2017; Wajcman 2017) remain. Neither the content nor the process of education as conceived to meet the needs of the earlier industrial revolutions can suffice to meet the challenges of the present time. Hence it is appropriate to consider how teachers and educational institutions respond to ICT and what may be done to support their roles in effecting the transformation of education to more effectively meet the needs of our time.

Understanding Teachers' Responses to ICT

Consistent with the findings described above, Ertmer and Ottenbreit-Leftwich (2013) observed that most teachers are using ICT primarily as aids to content delivery rather than to effect meaningful change in classroom activity and student outcomes. They described the most common experiences of students as learning *from* ICT through online searches for information and preparation of written assignments. They ascribed the problem to schools and systems placing emphasis on technology when the solution rests with pedagogy. In their view the goal should be to shift the conversation to *technology-enabled learning* so that the focus is on learning *with* technology rather than ICT integration as an isolated goal.

Even in developed countries, some teachers still report limited access to ICT or its unreliability as barriers to use (Rebora 2016). However, the significant investments by governments over recent decades have enabled access in most classrooms in the developed world (Ertmer and Ottenbreit-Leftwich 2013; Hatzigianni et al. 2016; Rebora 2016). That is also true in many parts of the developing world, although in some instances, provision of ICT has apparently taken priority over employment of teachers to use it (Livingston 2016). As noted by Ertmer and Ottenbreit-Leftwich (2013), access to ICT is no longer a significant barrier to transformation of education in most contexts. In this respect, the quality of teaching and teachers seems to be the most important determinant of student achievement (Hattie 2008). Clearly, if education is to be transformed by the application of ICT, then the manner of that application will depend upon the presence of teachers who are appropriately prepared to apply ICT to enhance learning and teaching.

Consequently, the benefits of teacher preparation for working with ICT will depend upon teachers implementing that learning in their classrooms. However, as noted above (Ertmer and Ottenbreit-Leftwich 2013; Ertmer et al. 2014; Hatzigianni et al. 2016; Lim et al. 2013; Rebora 2016), when teachers use ICT in their classrooms the applications tend to be mostly routine rather than transformational. Thus, it becomes important to consider what factors enable or retard transformational use of ICT in education. Numerous studies of factors influencing teachers' use of ICT have been conducted over recent decades. There have been extensive developments in the availability and capability of ICT over that period but there are some consistent themes in the responses of teachers.

Like the more recent studies cited above (Hatzigianni et al. 2016; Rebora 2016), an earlier study of a representative sample of more than 4000 teachers across the USA found that most computer use in classrooms was relatively mundane. Computer use mostly occurred in specific courses in computer education or business education or for word processing work for presentation but, under the right conditions, computers were an effective instructional tool (Becker 2000). Those conditions were convenient access to equipment, a degree of teacher skill and comfort with technology, support by teachers for constructivist pedagogies, and freedom within the scheduled curriculum for students to use computers.

Ertmer (1999) distinguished between first-order barriers, external to teachers such as resources, training, and support, and second-order barriers, internal to teachers such as confidence and beliefs. Of the four conditions identified by Becker (2000) as favoring computer use, constructivist beliefs fit the category of second-order barrier, internal to teachers, but the others are external, first-order barriers. In more recent work, Ertmer et al. (2012) suggested that, in the USA at least, the first-order barriers such as access to resources had been reduced in significance, making it opportune to examine the effects of second-order barriers in the form of teacher beliefs. Their study of 12 teachers selected for their award-winning technology practices found alignment of pedagogical beliefs with practices and that, consistent with earlier findings about constructivist beliefs (Becker 2000), student-centered beliefs were associated with enhanced use of ICT in classrooms. Change in teachers' behaviors is more likely to occur when professional development experiences are situated within the context of teachers' own curricular needs (Koehler and Mishra 2009).

Teacher Agency and ICT Use

A useful concept in this context is teachers' agency, that is "their active contribution to shaping their work and its conditions" (Biesta et al. 2015). Similarly, Martin (2004) defined agency as the capability to make choices and act on these choices in a way that makes a difference in their lives. In the field of ICT, agency can be described as the ability for individuals to control and manage their use of ICT and online presence, including managing identity, initiating interactions, using technologies for self-identified purposes, and modifying or developing digital tools (Starkey 2017). As a consequence, requirements for developing digital agency are very

closely aligned with earlier conceptions of uses of digital technologies that are differentiated into "consumer" or "producer" activities and outcomes (Shonfeld et al. 2017).

The concept of teachers' agency stresses the importance of professional development as an iterative process, aimed at extending and updating the professional knowledge and beliefs of teachers in the context of their work (Tondeur et al. 2016b). Several studies suggest that the involvement of teachers in collaborative design constitutes an effective strategy to develop digital resources in line with their pedagogical beliefs (cf., Kafyulilo et al. 2015; Sang et al. 2010; Voogt and Tondeur 2015). These types of initiatives also have the potential to bolster teachers' self-efficacy, which in turn has been found to influence teachers' beliefs about ICT use (Holden and Rada 2011).

Although Becker (2000) did not use the term, his fourth condition might be interpreted as corresponding to *agency*, which is a way of describing how teachers engage with policy and enact their professional practice (Priestley et al. 2015). Becker reported that teachers who were bound by fewer specific constraints about how they should teach could exercise professional judgment about their use of ICT and were more likely to find ways in which they could use it. Around the same time, Cuban (2001) studied primary and secondary school teachers in Silicon Valley, where it might be presumed that positive dispositions to ICT would be unlikely to restrict use. He found that teachers at all levels used computers for research and preparation but that classroom integration was more common in primary school classrooms than in secondary. The simple explanation related to timetable constraints in secondary schools limiting teachers' capacity to adjust to technical issues within a single teaching period compared to primary schools where the teacher was with a class all week and could rearrange activities to accommodate issues when or if they occurred. Again, more teacher agency to make and implement decisions was associated with more integrated use of ICT.

Almost two decades later, in a period of rapidly changing technologies and diverse classrooms, it is more important than ever that teachers can exercise professional judgment about the application of ICT to meet the needs of learners. ICT presents challenges because of the rapid pace at which it continues to develop. As new hardware and software appear in classrooms they bring new possibilities for learning and teaching and sometimes result in the disappearance of familiar capabilities and changes in the skillsets required by teachers and learners (ACARA 2015b). Preparation of teachers for working with ICT must be ongoing and will ideally prepare them to adapt to changes in ICT as they appear in their classrooms. Teachers, learners, and the classroom contexts in which they work differ widely so that there is no universally applicable approach to achieving educational goals. Professional development can address the knowledge and skills of teachers but what they learn must be applied to support learners who differ widely on dimensions including facility with ICT, and the ICT available in schools is far from uniform. It is the work of skilled teachers to plan and implement instruction that matches their own skills with the needs of the learners in their context to achieve the educational outcomes specified by the curriculum. Teacher professional agency is important to

both the application of ICT in their classrooms and the provision of appropriate opportunities for professional learning about ICT.

Teacher Agency and Accountability

There are good reasons for education at all levels to be directed toward equipping graduates with the knowledge and skills required for full participation in society. That necessarily entails a degree of standardization around outcomes to be achieved and methods for assuring that achievement. That is, education systems and educators should be accountable to the societies that establish and fund them. In reviewing the apparent lack of progress in teacher professionalism over the past decade, Sachs (2016) noted that teachers tend to identify their accountability as being to students they teach and the communities in which they work, what can be described as *responsive accountability*. On the other hand, governments and employers focus on *contractual accountability* for learning outcomes that may be measured by performance on standardized tests.

The latter entails management of performance against standards and can lead to tightly regulated regimes in which teachers have little apparent agency and may be constrained into monitoring behavior of colleagues as well as themselves. The consequent erosion of trust develops habits of risk aversion and reluctance to stray from established practices regarded as safe. Bahia et al. (2017) studied the reactions of a group of university teachers in Portugal to the changes resulting from the Bologna process which is intended to ensure that higher education produces comparable outcomes across Europe. They found that the teachers struggled with reconciling the assessment requirements of the process with their focus on promoting learning by students. Achieving an appropriate balance between the standardized outcomes and attention to the needs of individual learners is challenging.

When, as appears to be the case in many countries, educational policy is directed toward improving achievement as measured by standardized tests, teachers may be constrained in how they approach their work. Buchanan (2015) argued that the emphasis on standards and accountability does not value teacher autonomy. She cited Hargreaves' (2000) conceptualization of teacher professionalism progressing through four historical phases (pre-professional, autonomous professional, collegial professional, and post-professional or postmodern) and expressed concern that the current circumstances match Hargreaves' dystopian vision of a post-professional phase in which the work of teachers is devalued and their autonomy eroded. In many contexts teachers and the schools in which they work are constrained by requirements of accountability against standardized tests and other measures to maintain legitimacy. In her study of nine elementary teachers across three schools in the USA, Buchanan (2015) found that agency was linked to whether their context supported teaching in ways consistent with the professional identity they had developed through their career histories. Where there was a good fit of identity with school culture, agency was expressed by going beyond expectations. Conversely, where there was not a good fit, teachers resisted requirements that did not match their

professional identities. In her view, teacher agency could be understood as an expression of teacher identity in action but those identities were constantly being reconstructed in response to teachers' experience of practice. Teachers whose entire professional experience is in contexts with very limited professional autonomy will interpret that as normal and develop professional identities with limited expectations of agency.

Hargreaves and Fullan (2012) argued for education to move beyond the industrialized model to models that promote innovation and creativity for the information age. Pressing for teaching to be recognized as a profession if that transformation is to be achieved, they described the qualities of a profession in terms of professional capital, which they presented as an amalgam of three forms of capital: human, social, and decisional. Human capital embodies individual talent and encompasses the knowledge, skills, and dispositions developed through teacher preparation and experience. Social capital emerges from interactions with others, especially professional colleagues, which increases human capital by enabling access to the human capital of others. Decisional capital is the essential quality of a profession in which individual professionals have discretion to make decisions without constant reference to superiors. Nolan and Molla (2017) identified decisional capital with teachers' professional agency and linked it to the degree of autonomy and empowerment teachers have in day-to-day practice. It is this agency that empowers teachers with the relevant knowledge and skill to make decisions about how best to meet the needs of learners in their context rather than merely implementing some generalized practice received from higher authority.

Biesta et al. (2015) have argued that agency is not a property or characteristic possessed by individuals but is manifest in the actions that they perform. That is, agency exists only insofar as it is exercised and does not exist in the abstract. In this view agency is a phenomenon that emerges as an actor engages with a situation. They suggest that it is best understood as a fusion of past influences, future intentions, and present engagement. In their view, teachers too often lack a sense of longer term purpose for education, focusing instead on short-term goals and thus limiting their agency to implementing policy directives rather than contributing to developing vision for educational transformation. The focus on short-term goals may result from a combination of the need to deal with day-to-day activity and limited opportunities to affect broader aspects of their work.

Teacher agency is visible in the actions of teachers and potentially in tension with accountability requirements. Governments and other stakeholders are entitled to expect that education systems and educators will be accountable for providing the education appropriate to the needs of future citizens, but a too tightly constrained view of what is appropriate and how it should be delivered may be counterproductive. In a rapidly changing world, even among those who argue for a traditional curriculum and pedagogy, there is likely to be a degree of acceptance that future citizens will need to be prepared to be innovative and creative in the face of ongoing change. Consequently, there is potentially a paradox of expectations in seeking to maintain a highly accountable system that will prepare students to be innovators. Educational contexts involve complex human systems, and teachers need flexibility

of action if they are to respond appropriately to the needs of individuals in their class within a changing technological and social environment.

The twin imperatives for technology identified in Australian Government documents (DEEWR 2008), namely developing children as fluent users of ICT and enhancing learning and teaching through application of ICT, are important in any modern education system. Both are affected by rapid changes in ICT. Teachers require current knowledge in both domains, the operation of ICT and application for learning and teaching. They also require appropriate degrees of agency to enable them to deploy available ICT effectively. The pace of change does not permit sufficient time for centralized systems to assess the potential of emerging ICT and prescribe its use in ways that will be equally applicable in widely varying contexts.

Teacher Agency in Educational Systems

A focus on teachers' agency could lead to "individual blame" rather than "system blame." Therefore, one should also stress the role of the school or institutional level (see e.g., Aesaert et al. 2015; Mouza et al. 2014). In this respect, Priestley et al. (2015) preferred to regard agency as emerging from the ecology of teachers' practice as they engage with their environments. Clearly, educational institutions differ with respect to performance levels, innovation capacity, and contextual characteristics (Tondeur et al. 2016a, b). This implies that agency should consider to a large extent the "power of site or place" (cf. Fullan 2007).

But although there is a strong belief among educational leaders, this does not always translate into "digital agency" (Starkey 2017). Therefore teachers should be engaged in ICT policy planning in their schools (Tondeur et al. 2008; Vanderlinde et al. 2010). It seems that successful ICT implementation depends upon goals shared by different actors and at different organizational levels. System and school administrators have power and responsibility for provision of ICT and other resources, often including the resources necessary for teachers' professional development, but may engage teachers in the decision-making processes. Ketelaar et al. (2012) argued that effective school leadership for innovation requires careful balancing of collaborative activity and respect for the individual identities of teachers. By enabling teacher agency and encouraging collaboration, leaders can draw upon the creative energies expressed through teachers' agency to implement an innovation more effectively. Thus, teachers' agency is related to actions taken at the institutional level as well as those taken individually. Examining institutional characteristics associated with teachers' professional development has the potential to lead to a greater understanding of the systemic nature of ICT integration in education.

The characterization of agency as an emergent phenomenon rather than an individual capacity (Priestley et al. 2015) invites investigation of the conditions under which teachers can achieve agency. Priestley et al. noted that agency is often linked to the idea of "change agent" in the context of school improvement agendas, but in many such cases teachers are merely implementing policy determined by others and have very limited scope for genuine professional agency. Past educational

reforms have often failed due to a mismatch between the innovation and the meanings attached to the innovation by those involved in the instructional process (Hermans et al. 2008). But technological innovation in the classroom is not independent and isolated; it is situated in the ecological system of the school and connected to its broader systems. It also affects the relationships within and outside the school, and the ongoing interaction catalyzes changes in social relationships (Lim et al. 2013).

According to Zhao and Frank (2003), the dynamic coadaptation and coevolution of teachers' agency, school leaders, and students with technology and the system determines whether the affordances of technology for teaching and learning can be realized in schools. In this respect, the literature about school improvement (e.g., Reynolds et al. 2000) stresses the importance of "leadership" in developing a commitment to change (see also Dexter et al. 2016). The capacity of (teacher) leaders to develop and articulate, in close collaboration with other actors from the school community, a shared vision about educational technology use is considered a critical building block in this process. Therefore, professional development and/or learning of these leaders is crucial. This perspective adds to the holistic approach to teachers' agency.

Teacher Agency and Professional Learning

The ICT available to teachers and learners is evolving rapidly but is unevenly distributed. The technical features and operating procedures for new hardware and software change frequently; some changes are subtle but others are more substantial, such as the change from mouse-driven interfaces to touch screens. At the same time, the affordances of the devices and software for learning and teaching are changing. Teachers need to continually update their knowledge and skills for both technical operation and pedagogical application of emerging ICT available in their contexts.

Traditional professional development prepared and delivered from central authorities inevitably struggles to match the rate at which ICT is changing because of the lead-time required to design and implement programs updated for new hardware and software. Moreover, availability of ICT varies across contexts, even within the same system, possibly requiring multiple versions of professional development to ensure relevance (see, e.g., Lim et al. 2014). Pedagogical applications are prone to be even more challenging because the educators responsible for producing professional development must first master the technical aspects of emerging ICT before they can explore the educational affordances and only then can they prepare related professional development.

The mechanisms by which new forms of ICT enter classrooms range from system-wide initiatives to the actions of teachers who introduce their own ICT for a specific educational purpose. In recent years, there has been a growing trend toward "bring your own" approaches in which students in the one classroom may be using devices with very different capabilities (Prestridge and Tondeur 2015). That presents teachers with both challenges in managing the variety of ICT and

opportunities to explore their affordances for learning and teaching. Hence, professional learning in situ is an important enabler for their application of ICT to enhance and transform learning and teaching.

Research has established connections between teachers' agency and their professional learning. Heikonen et al. (2016) noted that teacher agency enables teachers to manage their own learning with the intention to enhance student learning in response to contextual variables and that a sense of agency has a positive effect on intentions to remain in the profession. In a study of more than 1200 Chinese teachers, Liu et al. (2016) found that teacher agency and the sense of being trusted in their school positively mediated the effect of principals' leadership on professional learning. Moreover, higher levels of trust had a positive effect on teacher agency. Thus, feeling trusted as a professional encourages teachers to exercise agency by taking initiatives, and both trust and agency encourage engagement in professional learning. A small case study in a New Zealand high school reported evidence of the value of teacher agency for driving professional learning through teacher inquiry specific to the context as more effective than instrumental professional development sourced from outside providers (Charteris and Smith 2017).

The importance of balancing teacher agency with collaboration among teachers (Ketelaar et al. 2012) was noted above but it is also important when considering teacher agency in relation to professional learning which increasingly occurs in the context of professional learning communities and networks in which teachers share experiences and ideas. In a study involving 2300 Finnish primary and secondary teachers, Pietarinen et al. (2016) used structural equation modeling to investigate the relationship between teacher agency in professional community and classroom. They reported that agency does not automatically transfer between contexts but that learning in a professional community does affect learning in the classroom, and agency in the classroom is significantly dependent on agency in the community. Thus, it seems that teachers who feel supported by a professional community may be empowered to act with greater agency in their own classrooms. This appears to be supported by a study of professional learning communities in Scotland (Philpott and Oates 2016) where it was found that robust evidence obtained from classrooms supported teacher agency by enabling teachers to authoritatively evaluate practices.

Teachers' agency is important for empowering them to explore the possibilities inherent in new ICT and make decisions about whether and how they can enhance learning and teaching in their context. When that individual exploration is coupled with sharing through professional learning communities or similar venues, its potential for enhancing learning and teaching and for transforming the broader educational landscape through the application of ICT is multiplied. Access to the experiences of other teachers in professional learning communities can provide teachers with the authentic evidence they need to validate or modify their practice (Philpott and Oates 2016), and learning through professional communities has a positive effect on teacher agency and learning in the classroom (Pietarinen et al. 2016). In a time of rapidly changing ICT, trusting teachers as professionals and harnessing their contextualized learning about emerging ICT is likely to be more

effective for realizing its potential for educational transformation than centrally mandated practices supported by packaged professional development.

Conclusion

Technology, especially information and communication technology (ICT), is changing rapidly. The transformational effects of those changes are visible in many areas of social and commercial activity but there is widespread concern that education is not being transformed at the same rate as other sectors. If children are to leave school equipped to thrive in the modern world then the content of their education must evolve to ensure they acquire knowledge and skills necessary to make effective use of ICT in a wide variety of activities. Moreover, there are widespread expectations that the introduction of ICT should transform education in ways parallel to those experienced in other sectors, but there is little evidence of that happening on a broad scale. If the content and experience of education are to be transformed through ICT then it seems evident that the challenges must be approached differently than they have been until now.

Across many parts of the world a consistent response to a perceived need to improve educational provision has been to increase accountability of schools and teachers. The expectation is that the desired outcomes can be achieved by clarifying standards to be reached, testing achievement against those standards, and in some cases mandating practices to be adopted by teachers. It is ironic that what is an essentially industrialized approach is being adopted to solve a problem in the postindustrial world without notable success in many contexts.

In this chapter we have argued that, in a time of rapid and variably dispersed technological change, top-down solutions emanating from a centralized authority are unlikely to be able to respond as quickly as necessary to the highly contextualized needs of learners and teachers. Rather than further constrain the actions of teachers by mandating practice it will be more effective to recognize their professionalism and support teacher agency for professional learning and classroom application of ICT. By encouraging teachers to explore the possibilities of emerging ICT and share their findings in professional learning communities, the crowdsourcing facilitated by networked ICT can contribute to solution of the challenges it presents.

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