Responding to Challenges in Teacher Professional Development for ICT Integration in Education

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ABSTRACT

There is wide agreement that teacher professional development (TPD) is a necessary element in educational change, especially for the more effective application of technology to enhance learning. The research literature reports many examples of successful TPD but there remain many challenges to wider and deeper success in the variety of different contexts. Discussion by the thematic working group on TPD at EDUsummIT 2015 in Bangkok identified several challenges to successful TPD. This paper discusses those challenges, describes four cases of successful TPD from varied contexts, and derives a model for TPD based on observed commonalities in the cases.

Keywords

Teacher professional development, ICT integration, Case study

Introduction

Teacher learning for ICT integration was an important topic in the International Handbook of Information Technology in Primary and Secondary Education (Voogt & Knezek, 2008), which initiated the EDUsummIT meetings that included working groups on teacher professional development (TPD). In 2011, Thematic Working Group 3 (TWG3) on TPD at EDUsummIT highlighted the necessity of aligning action at multiple levels in order to ensure a shared vision of what is desirable and possible (Twining, Raffaghelli, Albion, & Knezek, 2013). Working from the recommendations of EDUsummIT 2011, the working group on TPD at EDUsummIT 2013 began with three foci for discussion, namely, engaging all stakeholders in developing a shared vision for ICT in education, engaging more teachers in communities and networks for PD, and reducing the gap between educational research and practice. Their discussions reaffirmed the importance of engaging all stakeholders in decisions, promoting networks and communities for TPD, and integrating ICT in authentic TPD. A paper developed from those discussions presented a set of illustrative cases and a conceptual model for linking research with practice (Albion, Tondeur, Forkosh-Baruch, & Peeraer, 2015).

The working group on TPD (TWG3) at EDUsummIT 2015 in Bangkok had the deliberations from previous meetings as background and was conscious of the challenges of ensuring that TPD for ICT integration in education meets the needs of teachers across a wide variety of contexts and cultures. Lack of suitable TPD may exacerbate the digital divide that already exists at multiple levels between and within countries and even within individual schools (Anderson, 2010). Hence, merely providing ICT does not inevitably improve learning, but beyond access, it is how teachers use ICT that makes a difference, and TPD is critical to achieving valued outcomes. This paper addresses the challenges to effective TPD identified during those discussions by presenting a set of cases that have highlighted the challenges in different contexts and abstracting lessons learned to suggest a model for effective TPD.

Challenges for TPD

ICT implementation in education systems should be accomplished systematically, following evidence-based diffusion models (Kozma & Vota, 2014). Technology utilization de facto, however, is far from being a means for systemic change: It rather facilitates “islands of innovation,” based on stellar cases carried out by excellent teachers, who practice innovative pedagogy using technology unrelated to TPD (Forkosh-Baruch, Nachmias, Mioduser, & Tubin, 2005). Extending and diffusing these individual excellent practices may occur by constructing professional learning communities within schools, in a model of networked communities of practice that facilitate sharing of

experiences (Twining et al., 2013). Currently, allocation of resources for the improvement of the quality of teacher professional knowledge is insufficient in scope and in quality (Leask & Younie, 2013). At the same time, ICT is expected to transform education, thereby promoting 21st century skills. Hence, the need for effective TPD is crucial, but we must ask what TPD would be most beneficial and how should it be most effectively delivered, so that the digital divide is overcome, and the gaps identified in usage and outcomes are addressed.

Determining teacher effectiveness, specifically when using ICT, is challenging. Ministries of Education worldwide expect ICT to be used to enhance the quality of education; nevertheless, there is insufficient ICT-utilization to assist teachers in gaining professional knowledge to improve their practice (Leask & Younie, 2013). Modeling technology utilization for professional development may serve as a powerful means of facilitating teachers' use of technology innovatively in class (Ertmer et al., 2012). These are among the numerous challenges to TPD for ICT in education. In their discussions, the EDUsummIT thematic working group identified the five challenges described below as a focus for activity.

Challenge 1: Contextualization with sociocultural awareness

Technology enables us to create, collect, store and use information; to connect with people and resources all over the world; to collaborate in creating knowledge; and to distribute and benefit from knowledge products (OECD, 2015). However, many people lack access to technology, resulting in a new form of exclusion often described as the "digital divide." Lack of access to the Internet is one of the most damaging forms of exclusion (Tondeur, Sinnaeve, van Houtte, & van Braak, 2011). However, there are many variations and levels of access. They suggested that those concerned should be thinking of a "gradation" instead of a divide between those who can use ICT to access, adapt and create knowledge and those who cannot (Warshauer, 2003; Gorski, 2005). Hence, globalization should not imply homogenization of culture. TPD in support of technology use in education should be both sensitive to, and enabling of, differences in historic, social, cultural, economic, and political contexts. Technology integration is also influenced by specific school cultures that require careful alignment of content and pedagogical knowledge. These differences should be seen as assets within TPD.

Challenge 2: Sustainability and scalability of PD

Providing continuing TPD about technology integration in education is challenging because of the large numbers of teachers to be reached and the need for frequent updates in response to continuing developments in ICT. Sustainability, meaning regular and long-lasting renewal and efficient use of available resources, and scalability, meaning capacity to reach all and disseminate ideas, are key characteristics for success (Albion et al., 2015; Voogt et al., 2015). Barriers for scaling and sustaining PD include social and cultural factors, lack of teachers' technological, pedagogical, and content knowledge (TPACK) (Mishra & Koehler, 2006), inadequate infrastructure, limitations of Internet diffusion, linguistic differences, and geographical separation (Edirisinghe, 2015).

Working with teachers to develop their knowledge, beliefs, and attitudes can build a sustainable culture that supports ICT as integral to learning and teaching (Ertmer & Ottenbreit-Leftwich, 2010). Enabling teachers to share their ideas and provide examples of their good practices, facilitates understanding, sharing and negotiating, and consequently transference into local settings (Prestridge & Tondeur, 2015). Opportunities for TPD available through online communities of practice, social networking and online environments can provide both sustainable and scalable outcomes across geographical and cultural contexts.

Challenge 3: Empowering pedagogy through ICT

Supporting the effective application of technology to enhance learning and teaching in novel ways may serve as a foundation for successful TPD. Utilizing ICT in novel ways within TPD may facilitate innovative pedagogical practices that will, in turn, bring into practice innovative teachers who may affect the education system as a whole, thereby leveraging efforts in the field and establishing Professional Development 2.0 (Prestridge & Tondeur, 2015). Education evolves in parallel with innovative pedagogical practices using technology so that novel ICT-empowered pedagogies are emerging constantly. These include new approaches to content delivery and merging of content from

different disciplines, which may in turn create a new curriculum. In short, what is expected of the TPD process (effective application of ICT to enhance learning and teaching), is not simply to be a process of transformation and/or innovation but a process of social change in the transaction of pedagogy and content. It is assumed that "history is on the side of change" (Cobb, 2007, p. 14).

Challenge 4: Technology discernment

Educational decision makers—whether teachers, principals or policy-makers—have to make wise decisions about the selection and deployment of ICT and about the content and delivery of TPD to support applications of ICT in order to ensure that the outcomes are enhanced education for all. Critical analysis of available data may not necessarily lead to a clear decision and may need an additional perceptive judgment, "psychological or moral in nature," (Albion et al., 2015a, pp. 25) called discernment.

Trauffer (2008) asserts that "discernment represents a multidimensional concept of decision making by logic and reason, by empathy gained through understanding, and by moral ethics" (p. 13) and "the ability to regulate one's thinking in the acquisition and application of knowledge to make decisions that are right, fair, and just (p. 90)." This notion is more than simple critical thinking required of an educational leader when deciding about the technological inputs, and can be described as technology discernment. The power of discernment when applied to the choice of technology in the form of products, services or processes involved in the TPD, can ensure the real working needs of the TPD participants are met and thus keep them engaged and motivated in a sustainable manner.

Challenge 5: Systemic and systematic TPD

Professional development of teachers requires a lifelong learning approach, beginning with pre-service teacher education programs, and continuing throughout their professional lifespan. During the discussions among TWG3, several projects were showcased addressing the importance of systemic approaches to change. In this respect, effective preparation of pre-service teachers for technology integration requires attention to (1) all the stakeholders at different levels in the education system and (2) local factors (cultural and structural), but also demands similar attention toward the relationships between the themes (Kay, 2006; Tondeur et al., 2012).

At the same time several TWG3 members stressed the importance of systematic (gradual and evolving) change efforts. This aligns with the results of Seels et al. (2003) who concluded that it should take a long period with constant reiterations to see substantial change in technology integration (see also Albion et al., 2015a; Tondeur et al., 2016). Underpinning this conclusion is the understanding that teacher participation in the learning "process" and the development of learner autonomy (and self-regulation, especially online) are considered outcomes of professional development (Prestridge & Tondeur, 2015). Systematic PD also refers to the need for lifelong professional processes.

Four cases with different challenges and solutions

The four cases described below are drawn from contexts with varied geographic and economic characteristics, and refer to different emphases, e.g., target population (teachers or teacher educators), scope (regional, national), focus (ICT tools, educational initiatives) and diffusion patterns (face to face, online or mixed, synchronous or asynchronous). They may not be representative of all possible contexts; however they provide insights applicable to other contexts. Each case responds to the particularities of its context, and yet there are commonalities, both in the challenges to which the cases respond and the methods embodied in those responses. By considering the similarities and differences it may be possible to identify patterns that will point to an integrated framework to guide future work in teacher professional development for ICT in education.

Case 1: TPD for technology integration in Kenyan schools

The main objective of TPD was to enhance the capacity of Kenyan secondary schools to achieve change associated with effective application of ICT into the curriculum. This was primarily done through peer learning and sharing of

ideas and experiences between schools in combination with intra-school learning. In the development phase a team was appointed to set up an intervention designed by bringing together the Ministries' experiences from previous ICT integration initiatives, lessons learnt from benchmarking, and literature relevant to ICT integration in education. In the second phase, school-level sensitization workshops were organized where representatives from the Ministry visited each school with the aim of demystifying ICT integration and getting teachers informed about the possibilities ICT would bring. To manage the process of ICT integration, schools were encouraged to form small teams comprised of teaching and non-teaching staff to oversee planning and implementation in school. Phase 3 started with a three-day workshop on development of ICT school policies. Each school delegated a representative and the interactive workshop was facilitated to encourage peer learning, inter and intra school learning. The teams returned to their schools to brief their colleagues and to prepare for more comprehensive capacity building workshops. Each school was expected to use the knowledge gained to develop an ICT-policy plan.

To facilitate the start of the implementation of their ICT school policy, each school was provided with 14,500 euros. Each school made informed choices on how they would use the funds to invest in ICT equipment. The first activity in the school-based training (Phase 4) was a five-day training on the development of ICT integrated lessons, held in the participating schools for all teachers. In the training sessions, teachers organized themselves in subject working groups for the duration of the training, to encourage peer learning. The trainers in the workshop would help the teachers brainstorm and then train them on the ICT skill(s) required to accomplish the task. Next, each team presented ICT integrated lessons they had developed to the plenum and received feedback. Finally, monitoring visits were conducted to establish the progress the schools were making and to inform a second training in schools to increase the understanding and making of ICT integrated lessons. The teachers once again worked in Teacher Design Teams in consultation with the trainers who followed them to class to observe how they managed the lesson with students. All teams would then convene for a feedback session and improvements were made. Findings of a longitudinal study (Tondeur, Krug, Bill, Smulders, & Chang, 2015) identified a range of challenges such as the importance of the context (theme 1: contextualization). This Kenyan case illustrates how schools are influenced by multiple historic, social, cultural, economic, and political contexts (Krug & Arntzen, 2010), e.g., school leadership faced daily challenges produced partially by the Kenyan Ministry's new curriculum policy on ICT integration, but also because of the specific social, physical and cultural conditions of each school's context (e.g., lack of electricity or power breakdowns; lack of time, the number of pupils).

The starting point of this project was to explore the context specific processes of ICT integration within secondary schools in Kenya, and to identify various conditions that influence the success and/or failure of technology integration in these schools. This perspective was informed by researchers who have argued for a more holistic approach (Challenge 4: systemic) (e.g., Krug & Arntzen, 2010). Clearly, the process of ICT-integration should not be facilitated as stand-alone events. Rather, PD should be part of a cycle of inquiry that supports teachers learning, try out and receive feedback. One of the main failures of many past programs, not only in Kenya, was that schools were provided with expensive equipment, but with little or no support for teachers' PD (Challenge 2).

Case 2: Social networking for self-generating TPD in Australian schools

A TPD program focused on enhancing technology-enabled practices was implemented across geographically removed schools in Australia. The underlying premise was to enable teachers from any location in Australia an opportunity to form and contribute to a networked learning community. No face-to-face contact occurred but teachers could access and work within the online space at any point in their professional working day. An inquiry-based professional development model was adopted to shift the approach of professional development from content delivery to content generation, such that the teachers were collaborating, reflecting and analyzing self-practices, in conjunction with independent inquiries to build greater understandings about what good technology-enabled teaching looks like.

Four phases were aligned with the four school terms in Australia. Term 1 involved the professional development provider-mentor setting up the online space, welcoming teachers, initiating "getting to know you" activities and dealing with administrative requirements. The mentor's was to support the teachers in making conscious their current beliefs about the use of technologies, their current practices and how these related to one another. Term 2 involved teachers in planning for an innovation in their teaching described as the teacher's "Action Learning Project." With the help of the mentor and the community of teachers, each teacher developed a plan for implementing a new

technology into their classroom. Term 3 became the implementation phase where each teacher enacted their plan and shared, monitored and reflected on it through the online community. Term 4 involved the redesign of their Action Learning Plans with clearer connection to their pedagogical beliefs.

Multiple communications and web 2.0 tools were used to support the PD program: online collaborative discussion space, individual teacher profile pages and a repository for shared resources – any technologies that enabled teacher engagement, e.g., email, text messaging, real time chat software, blogs and Twitter. The mentor played a key role in facilitating professional learning in response to individual teachers' needs, e.g., support and nurture engagement; provide ideas, opportunities, and activities; and direct teachers to specific prospects but there was no requirement for teachers to engage. In this way the professional development was considered self-directed by the teachers, what could be called "demand-driven," with free-flowing pathways rather than staged tasks that were sequential and controlled.

The approach illustrated in this case responds in some degree to each of the challenges identified by TWG3 during its discussions in Bangkok. Taking the TPD online addressed issues of geographical equity for teachers separated by the long distances in Australia and that recognition of diversity was reinforced in the structure of the program that enabled teachers to tailor their learning to meet their own professional needs in their local school context. Perhaps the greatest contribution of this case in relation to the identified challenges is in the area of sustainability and scalability. Using technologies to enable teachers working in varied locations and socio-economic environments provided opportunities for cross-boundary, cross-cultural national and potentially international collaborations. This model of PD can leverage opportunities for teachers from different countries to learn from one another. At the heart of the PD is a virtual learning community that offers a place for teachers to engage and learn professionally. Teachers sharing, challenging and co-creating a deeper understanding of the issues, barriers, enablers and, importantly, varied pedagogical beliefs and practices that inform the use of technologies in classrooms is the lifeblood of long-lasting pedagogical renewal. A networked learning community can also grow and evolve over time with the inculturation of new members and the movement of participants in and out. Considering that teacher professional development can be episodic, with teachers moving in and out, focused or on the periphery as their needs change and grow, the responsive opportunities provided by networked learning communities are eminently well suited.

At the same time, TPD that uses ICT in ways that model the pedagogical possibilities in their classrooms and expose teachers to thoughts and practices of diverse colleagues can, at the one time, challenge them and empower them to address the unique needs of their own context, thereby addressing the third challenge of empowering pedagogy through ICT. The role of the mentor is critical in this TPD model for assisting each participant to navigate a personal path to learning. In the best cases the guidance from the mentor will depend upon knowledge of the participant and available opportunities allied with the sensitivity to encourage engagement without alienation. This balance goes beyond mere technical knowledge to constitute the discernment identified in the fourth challenge. Finally, this case of TPD also addresses the systemic and systematic challenge through its attention to the local context and development of teachers' capacity for autonomy and self-regulation of professional learning.

Case 3: Professional development through teacher initiatives using ICT in Israeli schools

Israeli teachers are requested to engage in PD in order to receive teaching degrees for becoming expert teachers. ICT is defined as a pillar theme for this advancement in their professional degree. To this day, ICT implementation was achieved mostly be ICT coordinators, which were assigned to promote mostly students' ICT skills, but also to implement ICT in several subject areas learned within schools at across the elementary, lower-secondary and higher-secondary levels. PD focused on ICT coordinators' sense of empowerment and viewpoints of the change elements that the National Computerization Program creates within the schools (Avidov-Ungar & Magen-Nagar, 2015). Since empowered educators assume high motivation for action and change, and may be driven by a need for constant lifelong learning. As a result, recommendations that were relevant to ICT coordinators were scaled to all educators, encouraging them to expand their personal knowledge on developing ICT-based instruction that uses digital tools in a wise decision-making process that promotes educational processes altogether (i.e., ICT discernment). This initiative was also aimed at ensuring sustainability of PD in the field of ICT-based practices in schools.

As part of a general reform of the Israeli Ministry of Education, lifelong learning paradigms were implemented in TPD in general, as it is part of the professional agenda for Israeli teachers, in which PD is considered an integral component of teachers' identity and job requirements, allowing development of autonomy and self-regulation. Hence, PD reform according to this 2-year program is obtained via a process in which teachers initiate a project which is to be implemented in their school. The PD 2-year course is carried out by academic teacher education institutes (Avidov-Unger, 2013). The process is accompanied by mentoring the participants, from the design phase to the implementation phase. The mode of PD is mostly using the project-based learning method which allows teachers to better link content, pedagogy and technology (i.e., discernment). The project may be carried out with small groups of teachers, which allows collaboration between teachers within the same institute or between institutes. The face-to-face PD is accompanied by a Moodle course website, in which all projects are uploaded and open to other PD participants. This creates a community of practice, which in turn has an impact on improving the quality of each project.

ICT skills are practiced as part of the ongoing activities within the planning of the project itself. Teachers are required to explore the issue of focus in their project, and following the project design – to explore technological tools which may assist them in achieving their goal. For example, in a project for children with special needs, the project managers (i.e., the teachers) aimed to assist the students in their orientation and mobility outside the school; hence, they searched for applications to utilize for this project. Teachers were challenged via this mode of PD to empower their pedagogy using ICT and to explore novel pedagogy, and vice versa – to attain the required ICT skills and to study new digital environments suitable for their initiatives.

The projects are managed and documented using a blog throughout the professional development, with the goals being twofold: (a) to enable precise documentation of the process, not only of the final product which is handed in for assessment of the PD, and (b) to allow reflection of the learning process, in terms of ICT skills and competencies as well as disciplinary issues and implementation recommendations.

The end of the PD is celebrated by presentation of all projects. Outstanding projects are awarded prizes for excellence, and are disseminated widely throughout the district. Accessibility to all initiatives was enhanced by constructing a Google interactive map connected to data which points to locations and essence of each project, allowing participants to learn from successful cases country-wide, and to search for relevant initiatives according to subject matters, target populations and pedagogical principles. This map is located within a college portal and is accessible also to the general public, including educators, policymakers and other interested parties. All projects require a research component, to be administered when implementing the initiatives, in order to ensure conclusions and recommendation, thereby creating a body of knowledge that is useful in turn for further systemic and systematic PD. Research includes a research question which is stated within the project proposal, as well as benchmarks for assessment of the success of the project, in terms of the pedagogical impact, teachers' and students' roles, the novelty of the initiative, as well as the modes of assimilation and dissemination.

To summarize, engaging teachers in projects that have immediate value in their workplaces as well as engendering learning for the future supports sustainability. This maximizes the value obtained from teachers' initiatives, making their work scalable by sharing these projects with the wider educational community. Teachers are enabled and encouraged to explore different approaches to applying ICT both in their own projects and through being able to see the results of work by others. Deciding which ideas to adopt, either self-generated or inspired by the work of others, develops technological discernment required to select the most suitable matches between content, pedagogy and technology.

Case 4: Professional knowledge sharing in a Sri Lankan pre-service internship

In Sri Lanka, the focus on ICT in teacher education has shifted from preparation for teaching specific courses about hardware and software toward promoting the use of ICT as a tool for learning and teaching across the school system (Edirisinghe, 2007). That change has been challenging because, although Sri Lanka is geographically compact, there are ten thousand schools in the state sector, with almost 250,000 teachers and over 4 million children. Balancing provision of ICT equipment to schools and professional development of teachers presented logistical challenges; without TPD, equipment would not be used effectively, but without equipment teachers could not apply what they learned in TPD.

Commencing in 2004, a needs analysis was undertaken in 122 schools and a TPD was developed to assist teachers in adopting ICT to create new learning environments (Edirisinghe, 2007). Recognizing the complexity of changing teachers' practice, the research team developed the TPD around a KASP model, addressing teachers' Knowledge (K) about ICT and pedagogy, Attitudes (A) toward the application of ICT in pedagogy, and practical Skills (S) for working with ICT as a foundation for reshaping Practice (P) and life-long learning for professional growth.

Although the TPD had promoted constructivist approaches to learning and teaching, instructivist practices were deeply rooted in societal traditions and the most common uses of ICT were for digital presentations of lesson content rather than as a stimulus to learner activity and engagement. In cases where equipment issues prevented digital presentation, printed copies of the presentation material were distributed. Such uses were supported by authorities through awards for good digital production. Although there was some sharing of digital presentation resources by teachers, there was little movement toward the professional knowledge sharing (PKS) envisaged by the developers of the TPD. Hence a new approach was needed to achieve educational change supported by ICT.

In 2012 the Sri Lankan government commenced a new national program of transforming schools to ensure the achievement of knowledge-based development. The program was designed to provide schools with ICT for use across the curriculum, beginning with 405 Phase 1 schools. As described above, TPD for pedagogy with ICT had not been successful in promoting the desired changes in pedagogy and PKS. Hence a new approach was planned for trial in a pilot program with provision for a research team to validate the model and inform improvements ahead of wider adoption. The study has adopted a knowledge management model based on socialization, externalization, combination, and internalization (SECI) in which the four modes of knowledge conversion form a spiral (Nonaka & Toyama, 2003). The pilot group comprised 20 final-year students preparing to be English teachers working with mentor teachers during an intensive "internship" in schools. The initial stage of socialization enables interns and mentors to build relationships through tacit-tacit exchange of knowledge. In the second stage, the mentor externalizes (tacit-explicit) knowledge of pedagogy based on experience enabling combination (explicit-explicit) with the knowledge brought by the intern as they plan together. Finally, both are able to internalize (explicit-tacit) knowledge shared and developed. In this way the contextual and pedagogical knowledge of the mentor is blended with the new knowledge the intern brings about ICT and with new approaches to teaching. Early indications are that the approach is effective and it will be developed for wider implementation among the 3000 teachers who graduate each year.

This case addresses each of the challenges identified above to varying degrees. By facilitating collaboration and knowledge exchange between interns and mentors, the model respects both and supports the melding of the intern's new knowledge about ICT in pedagogy with the mentor's experiential knowledge of teaching in the local context. If the approach is successful and can be replicated with all graduating teachers, it offers a sustainable and scalable method of disseminating new approaches as they become available while remaining sensitive to the accumulated knowledge among teachers in schools. By promoting the intergenerational exchange of knowledge the project offers opportunities to blend the best of old and new to generate novel pedagogical approaches while exercising technology discernment to make choices that are attuned to local contexts. The approach is also systemic and systematic, having the potential over time to reach all corners of the education system and, by engaging interns with mentors in knowledge exchange, establish the importance of lifelong professional learning for all.

Discussion

Based on comparisons across cases, it is possible to identify some common characteristics that appear to contribute to their success in achieving enhanced application of ICT in education through coupling provision of resources with effective TPD. Teacher inquiry leading to development of projects that are sensitive to local context can be effective for promoting teachers' professional learning at the same time as enhancing learning in their classrooms. Collegial sharing of those projects with professional networks and communities propagates successful innovation to other teachers and informs future adaptation by the originators of those projects. Such sharing needs to value the contributions of all participants by making space for each to both give and receive, even if that is sometimes the only comment that may contribute to future developments. Respecting the professionalism of teachers by allowing them agency to respond to local needs and valuing their contributions to the profession motivates them to engage more fully. Systemic inputs including hardware, software and training can be directed into the system by way of the teacher projects with increased likelihood that the resources will be applied to enhancing learning in classrooms.

Figure 1 represents this process in a simple model that places teacher inquiry between loops representing learning for teachers and the learners in their classrooms. Each loop informs the other through feedback cycles. Teacher learning is driven by teachers' agency in the process and supported by collegial interactions and inputs from the wider education system. Teacher agency is typically viewed as a quality within educators, a matter of personal capacity to act (Priestley et al., 2012).

Engaging teachers in learning through inquiry, especially using ICT, is a powerful way to move them from a traditional view of education as transmission of knowledge from the expert teacher to the learner and toward understanding of education as a lifelong process of learning with and from each other.

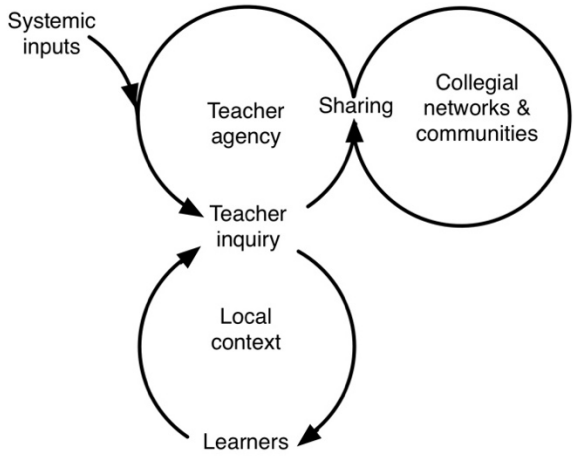

Figure 1. A model for TPD through teacher inquiry learning

Each of the cases presented above attended to the specific conditions in its schools or other locations by engaging participants in development of teaching plans and resources tailored to their own needs (cf. Kozma & Vota, 2014). Such approaches are respectful of the participating teachers as professionals and give them agency in the process rather than delivering solutions from external experts that devalue the insights that teachers have developed through experience. In the case of Sri Lanka, the connection between pre-service interns and experienced mentors recognizes that teachers at all stages of their careers can contribute something of value but are also able to benefit from professional learning.

Although it is implemented in different ways across the cases, encouraging sharing among teachers is a powerful strategy for addressing the challenge of making TPD sustainable and scalable. The focus in the Kenyan schools on developing a shared vision for ICT on which to build new practice together (see also Tondeur, van Keer, van Braak, & Valcke, 2008), the adoption of social networking in the Australian case to facilitate sharing across distance, the wide sharing of individual projects in the Israeli case, and the involvement of teachers at varying career stages in Sri Lanka case all engage teachers in exchanging knowledge and experience. By creating environments and processes to facilitate that exchange and validating it through official support and recognition, these cases are developing the conditions to enable sustainable and scalable change through networks and communities (Prestridge & Tondeur, 2015). Both the creation of the means for sharing and validation by school and system authorities are important for encouraging teachers to engage. This creates a mixed bottom-up and top-down diffusion process, in a twofold manner: first, in creating a climate of sharing ideas and initiatives, thereby allowing the scaling of ideas and initiatives, and secondly, in exercising ICT-skills and competencies, thereby practicing 21st century literacies which are crucial in facilitating meaningful learning processes.

Engaging teachers in a form of inquiry learning is another common characteristic across these cases. The nature of the projects varies but typically teachers are engaged in inquiry leading to planning and developing resources for teaching with ICT and subsequently sharing what they produce with colleagues (cf. Agyei & Voogt, 2012). Project-based learning, problem-based learning, and challenge based learning are among the variety of learner-centered constructivist pedagogies based on inquiry (Larmer, 2014) and which are widely recommended for adoption for teaching with ICT. When teachers participate in inquiry learning around ICT they experience firsthand the style of

pedagogy that they are being encouraged to adopt in their classes. In this way TPD can assist teachers to adopt pedagogical forms that are empowered by ICT to engage learners in authentic activity rather than replicating more traditional instructivist practices.

Education is inevitably about more than technical processes, invoking questions of value about what should be learned and how. For change in education to take root and persist, teachers must be persuaded that it aligns with values and will be beneficial for learners (Sang et al., 2010). By granting teachers agency in the change process, each of these cases has gone beyond simply disseminating technical knowledge and skills to exercising the wisdom of discernment that enables negotiation of change that responds to the exigencies of each context. The message from these cases emphasizes the importance of those charged with promoting change exercising sensitivity to the context of change and the people within it.

The challenge of making PD systemic and systematic has also been addressed by these cases. Engaging teachers in developing and sharing workplace projects ensures systemic effect through consideration of local conditions and initiation of ripple effects that intersect with teachers at all career stages (Lim et al., 2014). The inquiry learning approach allows teachers agency in determining the specifics of their professional learning and opportunity for collegial feedback that informs future iterations of their projects. In this way the professional learning meets the challenge of being systematic by evolving gradually as part of a lifelong professional process.

Conclusion

The model presented in Figure 1 has been developed through reflection on how the diverse cases presented above responded to the challenges for TPD identified by thematic working group 3 at EDUsummIT 2015. The discussions of TWG3 were informed by the deliberations of previous EDUsummIT meetings (Twining et al., 2013; Albion et al., 2015b), continued immersion in the literature, and the experiences of members drawn from a variety of contexts around the globe. Each of the cases responded in its own way to the challenges identified by TWG3 in developing TPD for ICT-integration. Despite the wide variations in details of the TPD it was possible to discern common threads that are embodied in the representation of Figure 1.

As noted above, it is not the mere presence of, or access to, ICT-resources that will transform education. Transformation will be effected through what teachers do with the technology that is available to them. Because technology and the local context are changing it is necessary for teachers to engage in an ongoing process of inquiry through which they appropriate the affordances of technology to develop creative responses to local needs. The cyclical process of teacher inquiry is central to the model and is informed by systemic inputs, contextual factors including the needs and responses of learners, and the wider professional networks and communities within which teachers share their experiences and from which they draw inspiration for their own continuing learning. Teacher agency is a critical element for motivation through the sense that their contribution is valued and their professionalism trusted. The cycle of inquiry at the heart of this model is consistent with the recommendation for design-based research that arose from EDUsummIT 2103 (Albion et al., 2015b). Teacher-researchers adopting inquiry learning and working close to the context of learning are well placed to discern what works well for learning and to adopt or adapt practices as appropriate to their context. There is no claim that this model is the solution to all the challenges of TPD for ICT in education but it does encapsulate principals from successful cases and points the way to future developments.

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