Teachers' professional development for ICT integration:

Towards a reciprocal relationship between research and practice

Abstract:

Teachers in the 21st century are facing new challenges as a result of the expanding possibilities of ICT integration in every aspect of the school milieu. Studies have shown the potential of teacher professional development (TPD) that is tailored to local conditions as well as global components and takes advantage of mutual support among teachers, as well as modeling of effective practices. The goal of the paper is to consider the issue of TPD with reference to the usage of ICT as a lever for educational change in a systemic manner, based on the application of local as well as international research. This paper will synthesize some key issues and challenges for TPD in the ICT-saturated 21st century, illustrated in four cases presented herein, which synthesize elements of practice and theory. Based on the literature and the four case studies, we suggest a conceptual model for identifying and evaluating TPD practices using ICT as a lever for educational change and innovation, accompanied by research aimed to develop TPD models. We include suggestions for more effectively linking research to practice and will lay out possible research directions, as a means of facilitating evidence-based decisions and policies.

Keywords:

Teacher professional development, ICT integration, technology enabled learning, design-based research, case study

1 Introduction

At EDUsummIT 2013 the working group (TWG3) on Teacher Professional Development (TPD) built on the work from EDUsummIT 2011 (Twining, Raffaghelli, Albion, & Knezek 2013). Three foci were identified for initiating discussion:

1) engaging all stakeholders in developing a shared vision about the role of ICT in education,
2) engaging more teachers in school-based communities of practice and professional learning networks, which have been shown to be effective for building ICT integration capability, and
3) reducing the gap between educational research and the practice of teachers through research that is more closely connected to teachers' practice .

In its report following EDUsummIT 2013, TWG3 offered recommendations about developing a shared vision for ICT in education and teacher education, the role of policymakers, the practice of TPD, and possible directions for research, together with suggestions for action at local, national and international levels (Albion, Forkosh-Baruch, & Tondeur 2013). This paper extends that work by reviewing recent literature and suggesting a conceptual model for identifying and evaluating TPD practices related to using ICT to transform education in response to wider societal change. Emphasis is given to the third discussion point above in recognition of the need to redress the disjunction that typically exists between research and practice in education. Cases from four different regions around the world are presented to illustrate key ideas and possible research directions for facilitating evidence-based future practice.

1.1 Exploring conditions for integrating ICT in education

Innovation has been a focus of research for decades. Innovative pedagogical practice using technology has been discussed in research and practiced in the education milieu for over two decades, since the emergence of ICT not only in computer science, but also as a lever for pedagogical change (Kozma 2003; Kozma & Vota 2014). Grunberg and Summers (1992) concluded that factors affecting technological innovation are often similar to those affecting other innovations and that much can be learned from other attempts to implement change (Rogers 2003). Hence, the integration of ICT in education is a case of educational innovation and likely to be governed by the same considerations as other educational innovations. Fullan (1991) lists a set of key themes considered to be particularly important for successful implementation of educational innovations: vision-building; evolutionary planning; initiative-taking and empowerment; staff development and resource assistance; monitoring, and coping with, problems; and restructuring.

Similar themes have been identified with regards to integration of ICT in education (Kennisnet Foundation 2011; Kozma 2008; Lim, Chai, & Churchill 2011; Tondeur et al. 2012). Kozma (in Wagner et al., 2005) highlights that if innovations are to be effective, policymakers and project leaders should think in terms of combinations of input factors that can influence their impact. To illustrate, in a study of innovative ICT usage in secondary schools in the UK, three key themes emerged: in addition to the need to incorporate new pedagogies when using new technologies and the use of these innovations for school public relations, the study highlighted the changing roles of teachers (Pearson & Naylor 2006). The changing roles of teachers were a factor in teachers expressing the need for in-service training programs concerning the pedagogical use of ICT in class practice in a recent Greek case study (Kalogiannakis 2010). According to additional research literature, introducing ICT for educational purposes requires balance between vision for ICT use and other aspects of educational activity (Vanderlinde, Aesaert & Van Braak 2014). Teachers play a crucial role in this, but there is also a need for leadership to guide the process and to create the right conditions for collaboration with other professionals (Kennisnet Foundation 2011).

There are several local studies (at the micro, meso and macro-level) regarding best practices in ICT integration, focusing on the teachers' perspective (e.g., Hughes 2005; Kozma 2003; Tondeur, Kershaw, Vanderlinde, & van Braak 2013). One macro-level survey of schools focused on ICT in education was cnducted by the European Commission in the years 2011-2012 with over 190,000 students, teachers and principals. This study introduced concepts of digitally supportive schools and digitally confident and supportive teachers (Wastiau, Blamire, Kearney, Quittre, Van de Gaer & Monseur 2013). However, according to Tondeur et al. (2008), teachers select applications of technology in line with their selection of other curricular variables and processes that fit into their existing beliefs about "good" education and about the nature of their roles as teachers. Although personal computers have been in schools for almost 40 years and networked computers are now available in most classrooms in the developed world, Ertmer and Ottenbreit-Leftwich (2013) note that most teachers are not using technology to effect meaningful changes in student outcomes but primarily as aids to delivering content. They characterize the most common experiences of students as learning *from* computers through searching for information online and writing assignments. In their view the problem arises from the emphasis having been placed on the technology while the solution lies in shifting the focus toward pedagogy, emphasizing *how,* rather than *what*. They suggest technology should be used to support meaningful learning *with* computers and that, rather than *technology integration*, the conversation should be about *technology-enabled learning* so that ICT is seen as the means for engaging in meaningful learning activities rather than ICT integration being adopted as an isolated goal. From the teachers' perspective, in terms of professional development, the implications include practicing *technology-enabled teaching* (or mediation, coaching or mentoring) and seeing ICT as a means for engaging students in learning.

In order to transform education with ICT, Ertmer and Ottenbreit-Leftwich (2013) suggest consideration of how contextual, cognitive and affective factors may act as barriers or enablers. Other researchers have also noted that adoption of ICT in classrooms is affected by multiple factors including capacity of resources and sustainability of the infrastructure or teacher skills and attitudes (Sang et al. 2010). However, these factors are insufficient to explain why the majority of teachers have not demonstrated successful technology integration. Teachers' pedagogical beliefs play an important role in the use of ICT in the classroom (Hermans et al. 2008; Prestridge 2010) and should be considered as major foci in any approach to teacher professional development (TPD). Hence, in exploring the conditions for integration of ICT in education, there is a need for better understanding of the teachers' role, and subsequently, a need to study professional development programs, models and strategies, as a means to improve their impact on teachers' practice.

1.2 Teacher professional development

Leask and Younie (2013) question why, if teacher quality is accepted as a critical factor in educational outcomes, there is so little attention paid to improving the quality of teachers' professional knowledge. Given the rapid changes occurring in ICT and the relative lack of related transformation in education the need for effective TPD relative to ICT is apparent but it is less clear what TPD would be most beneficial and how it should be most effectively delivered. The lack of transformation of education as a result of ICT integration as described above carries ramifications for TPD in both pre- and in-service career phases. Gaps in usage and outcomes are identified worldwide. Some of these gaps may be explained in terms of teachers' digital literacy, which is a complex concept. Examination of a possible broader view of the knowledge teachers need to acquire in the information era can be relevant for examining the "digital competence" of teachers, as well as taking it into consideration when constructing a TPD model; hence, the need to change traditional perceptions of ICT usage (Krumsvik, 2008).

Teachers' concepts of ICT usage can be compared with their students' use of ICT. In reality, their utilization of ICT in schools is much less intensive and extensive, and differs in usage patterns compared to their use outside school. Also, compared to the effects of ICT adoption in other sectors, the effects on education are less salient (Lim et al. 2013). Implementation of ICT in education systems seems often to be based on fashion rather than organized diffusion models, which develop from evidence-based decision-making based on previous experience (Martin et al. 2011). Technology, having catalyzed changes in society in general, offers the potential to transform education and teacher education. However, its usage is far from being a means for systemic change: it rather facilitates "islands of innovation", based on excellent teachers, who may have launched innovative pedagogical practices using technology regardless of TPD (Forkosh-Baruch, Nachmias, Mioduser & Tubin 2005). Approaches to extending the benefits of individual excellence include professional learning communities in schools, communities of practice, and networks that enable sharing more widely on the Internet (Twining, et al. 2013).

Teacher effectiveness, whether using ICT or not, is in general a problematic and challenging concept for multiple reasons that make its measurement and systematic efforts to improve it difficult (Campbell et al. 2003). The measurement in itself is one of the challenges: How does one measure effective teaching and learning? What should be measured? When should measurements be taken? – These questions are discussed with regards to international as well as local assessment, highlighting aspects such as standardization, assessment of learning versus assessment for learning etc. Despite government expectations that ICT should be used to enhance the quality of education there has been little movement toward using ICT to assist teachers with accessing the knowledge that might enhance their practice (Leask & Younie 2013). This is consistent with the conclusion reached by Ertmer and colleagues that "we should be utilizing the same technology tools for professional development that teachers are able to use in their classrooms" (2012, p. 434).

Recent research has demonstrated the importance of local school factors on changes in teachers' pedagogical use of ICT. In a study of 1076 teachers in 130 Hong Kong schools, Li and Choi (2014) found that the positive effect of professional development on teachers' pedagogical use of ICT was substantially less than the effect of social capital measured in two components. The first factor was the school climate and trust within the school, and the second factor was the existence of networks for accessing new information. Other recent research in Cyprus indicates that, although teachers believe that using ICT can transform education and are willing to use it, little real change is occurring in schools (Vrasidas 2014). The major barriers appear to be lack of time, lack of flexibility in curriculum, and lack of access to ICT and support. Vrasidas notes that, although TPD needs to be systematic and systemic, it needs to be conducted in the schools and to respond to the local context. An international study of implementation of interactive whiteboards confirmed the benefits of school-based TPD drawing upon the contributions of teachers (Hennessy & London 2013). Another study from a longitudinal intervention in seven primary schools in Australia concludes that the role of the ICT coordinator and school leadership in general can play a critical role in the success of TPD (Tondeur, Cooper & Newhouse 2010). These findings support previous research about the importance of local conditions for the success of TPD (Ertmer & Ottenbreit-Leftwich 2013) and the benefits of networking teachers to share knowledge (Ertmer et al. 2012; Leask & Younie 2013; Twining et al. 2013).

1.3 The role of research

Teacher professional development should address the multiple forms of knowledge required for teaching and involves the development of effective knowledge management processes (Leask & Younie 2013). One test of whether knowledge management is effective is whether educators can conveniently access research-based knowledge for improving practice. This is especially important in areas of rapid change such as the educational application of ICT and the use of networks and other ICT innovations to support the flow of knowledge that is crucial in enhancing teaching capabilities.

The relationship between research and practice in education has long been recognized as problematic. Bereiter (2013) characterizes the learning sciences as "an effort to overcome the much-lamented gap between research and practice in education" (p. 12) and argues that neither explanatory (theoretical) knowledge nor practical (experiential) knowledge can fill the gap alone. He proposes as a solution *principled practical knowledge*, a combination of *know-how* and *know-why* that can be developed through design-based research, an approach that tests educational innovations in practice while simultaneously developing theoretical understanding. Others have gone so far as to suggest that relevance to practice might be applied as a criterion for determining the rigor of educational research (Gutiérrez & Penuel 2014), and a case has been made previously that educational design-based research offers an approach that can sustain the necessary balance between rigor and relevance (Reeves 2011).

1.4 Toward a model of TPD for technology-enabled learning

Numerous research studies have investigated the factors that affect ICT integration in education and various typologies have been proposed (e.g. Kozma 2003; Tondeur, Valcke & Van Braak 2008). Some conditions, such as ICT infrastructure, seem to be absolute requirements for ICT to be used in classrooms. Some, including access to ICT, available time, and curriculum flexibility, are unlikely to be influenced by TPD. These might be considered to be foundational enabling conditions and are represented as such in the base of the model proposed in Figure 1 to represent teacher professional development for technology-enabled learning.

Discussions in TWG3 at EDUsummIT 2013 were initiated around three foci derived from analysis of the literature. The large vertical arrows in Figure 1 represent those elements, with some adjustments informed by the discussions in TWG3 and the literature presented above. Those factors, and others, are likely to be in complex reciprocal relationships with TPD as indicated by the smaller horizontal arrows. For example, shared vision for the use of ICT in a school may be developed through TPD but will also influence the content and style of TPD. Similarly, both networks and communities for informing teachers and design research may either provide subjects for TPD or be used as modes of delivery for TPD.

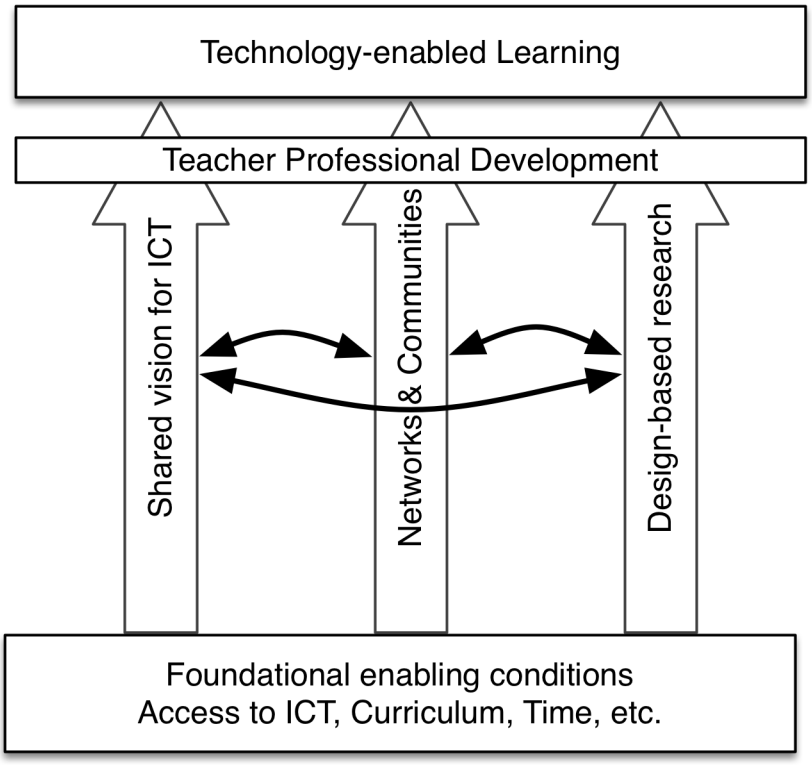

Figure 1: TPD for technology enabled learning model

The importance of ICT in teaching and learning has led several countries worldwide to provide ICT-enhanced training in various forms of professional development. Unfortunately, many teachers report inadequate training in their preparation to use technology effectively and in an innovative manner in their teaching. Still, there are extensive actions around the world in using technology for teacher training, intending to encourage teachers to use technology to improve their teaching (Collis & Jung 2003).

Using the conceptual framework above as a guide, in the following section we present four cases of TPD for technology enabled learning illustrating approaches that have been successful in varying contexts. Each case illustrates the reciprocal relationship between the core factors of TPD in the developed model. In addition, in each case, practice and research is integrated, thereby basing its development on evidence that arises from local studies.

In turn, this evidence base contributes to the further confirmation of a model for TPD that facilitates ICT as a lever for educational change.

2 Four cases under the magnifying glass

The four cases described herein present four modes of TPD either for pre- or in-service teacher professional development. They illustrate different aspects of the model for TPD as presented in Fig.1. The opportunity to learn from successful cases, illustrating effective practices of TPD focusing on ICT implementation as a lever for pedagogy, may lead to development of local-based TPD, in harmony with local beliefs and pedagogic orientation regarding education in general and ICT implementation in particular.

Case 1: Flanders - Team-based and school-based training for ICT-integration in primary education

Given the increasing importance of team-based and school-based professional development in the educational use of ICT, the online tool, pICTos (Planning for ICT in School), has been developed to support elementary schools in developing a shared vision for ICT (see Fig. 1). By using this tool, schools gain insight into their educational vision on how education is related to the use of ICT. The school team is expected to go through five steps. Some of these steps will be followed by each teacher individually, while others will be worked on together with the entire school team. Figure 2 is a screen shot of the start page of the online tool and illustrates the five steps schools should take while developing their ICT plan.

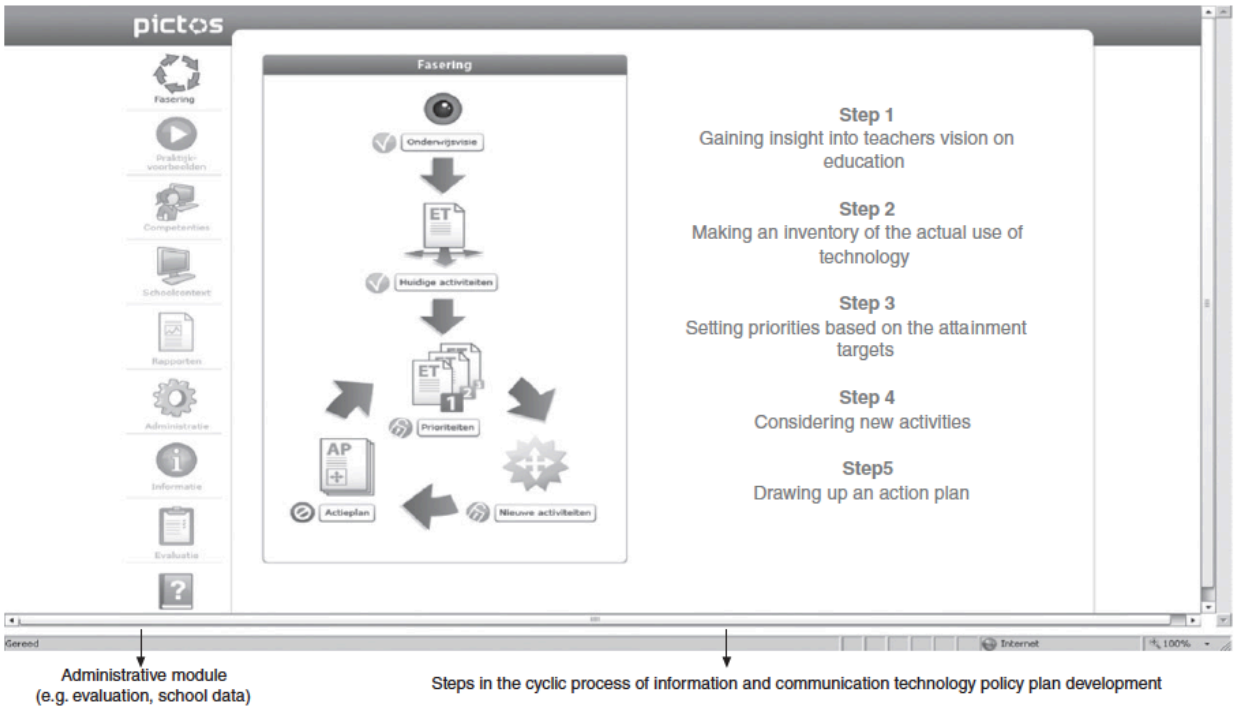

Figure 2: Screen shot of the opening page of pICTos (Vanderlinde et al., 2010)

The starting point of ICT-planning in pICTos is the formulation of a shared vision on the nature of 'good' education because this is a seen as a crucial condition for success. After completing a survey, teachers' beliefs about education are plotted in a graph that represents teachers' scores for orientation toward transmissive approaches, such

as direct instruction, or developmental approaches emphasizing students learning by doing. Once all teachers have made their educational beliefs explicit, they obtain both a personal score (teacher profile) and a group score (school profile). In this way, pICTos offers tools for a team discussion. Gaining insight into teachers' vision of education serves as a basis for debating a shared vision of education on the supportive role of technology in education in particular. In the next phase, each teacher registers individually which ICT activities are currently practiced in their classrooms. Once all teachers have entered their data, pICTos produces charts of the ICT activities. The school profile is an overview of the number of activities performed per final attainment level in the different grades. The idea is that this profile is evaluated in team so that teachers can see if the activities that are part of the current ICT final attainment levels are still under-performed. Next, a schematic outline is prepared of the final attainment levels prioritized by the various participants. This outline is presented for discussion to the entire team. Based on discussions, a common decision can be made on which final attainment levels deserve priority attention. In the next phase, teacher design teams are set up in order to add activities for their class as well as for classes in that same grade. The last phase invites the school team to create an outline of policy actions using results from the previous phases (cf. Networks & Communities in Fig. 1). The ICT coordinator, in deliberation with team members, determines what actions are needed to optimize the current ICT actions and provides a deadline for each action. pICTos creates a chronological chart for these actions. This way, the school team is ready with a plan to optimize ICT action according to a specific timeframe.

The study of Vanderlinde et al. (2010) about the pICTos professional development program demonstrates the decisions made by the case study schools concerning the development and the content of their school-based ICT plan and activities, and how this use relates to the specific strategies adopted during the different phases of the professional development activities. Based on a mixed method research approach, data were collected from multiple sources and triangulated to reveal the views of various stakeholders, e.g., questionnaires with teachers, interviews with school leaders and ICT coordinators, field notes and document analysis. Interestingly, the interviews took place before, during and after the pICTos staff development program. For each school a follow-up interview with the school leader and the ICT-coordinator was conducted one year after the school finished the pICTos staff development program in order to grasp the cyclical process of policy plan development. One of the main findings was that the professional development sessions supported teachers and schools to shape their ICT planning according to their educational beliefs (cf. Tondeur et al. 2008).

The reciprocity between research and practice in this case is evident in how the results of this study have led to the re-design of the pICTos environment. Interestingly, the (re-)design of the program was conducted in collaboration with researchers and practitioners. In this respect, tool developers and trainers can consult the design principles, the steps of the cyclic process, and the structure of the pICTos environment (Vanderlinde et al. 2010) in order to support the development of an ICT school policy plan.

Case 2: Australia - Teaching Teachers for the Future National Project

The *Digital Education Revolution* (DER) was a policy of the Australian Government elected in late 2007. It was intended to ensure that all students would complete schooling with knowledge and skills for using ICT in employment and that learning across the curriculum would be enhanced by the application of ICT. The most visible element of the DER was funding for provision of computers to all students in years 9 to 12 but the implementation roadmap recognized that "educators require the pedagogical knowledge, confidence, skills, resources and support to creatively and effectively use online tools and systems to engage students" (AICTEC 2009, p. 6). The document called for both professional learning for existing teachers and graduate teacher standards with requirements for ICT capabilities. To support the goals of the DER, the government established an ICT Innovation Fund and invited project proposals for pre-service teacher education, and professional development of teachers and school leaders (DEEWR 2010).

The Australian Council of Deans of Education (ACDE) collaborated with other relevant national bodies to develop a successful bid for the pre-service project and was awarded $8 million to implement the *Teaching Teachers for the Future* (TTF) project across all 39 Australian teacher education institutions (TEI). TTF had three components, namely, extending graduate teacher standards (aitsl.edu.au) to include ICT dimensions, demonstrations of ICT integration in the Australian curriculum (ttf.edu.au), and a National Support Network (NSN) to enhance treatment of ICT in teacher education. The NSN initiative supported each TEI to employ a full-time ICT Pedagogy Officer (ICTPO) with experience in K-12 classroom integration of ICT and to release a senior person as a half-time project manager for a year of project implementation in 2011-12. Each TEI nominated two of the four subjects (English, mathematics, science, and history) for which the national curriculum had been developed as focus areas in which the ICTPO would work with teacher educators to embed ICT. The intention was to revitalize teacher

preparation to better model learning and teaching with ICT and to share successful practices within and across TEIs through the NSN.

The Technological Pedagogical Content Knowledge framework (Mishra & Koehler 2006) was identified as a useful conceptualization of the knowledge required by teachers for ICT integration and was adopted as the framework for TTF. It informed development of professional learning packages and the quantitative component of the evaluation which used a purpose developed questionnaire administered to several thousand pre-service teachers (Jamieson-Proctor, et al. 2013) supplemented by qualitative methods using the Most Significant Change technique (Dart & Davies 2003; Heck & Sweeney 2013). Despite the short period between first and second administrations of the questionnaire, statistically significant increases in pre-service teachers' TPACK confidence were detected (Finger et al. 2103).

Reciprocity between research and practice in this case was manifest in the use of the research-based TPACK framework to inform the entire national project and subsequent collaboration using the large pool of data collected in the evaluation to drive refinement of the instruments used to measure TPACK (Cavanagh & Koehler 2013).

Case 3: Israel - The National Program for Adapting Teacher Education Colleges to the 21st Century

The development of Information and Communication Technologies (ICT) and the rapid growth of the Internet fundamentally influenced teacher pre-service training in Israel. It has developed as part of the Israeli Computerization Program from instrumental use of ICT in teaching to a genuine shift in pedagogical paradigms, massively influencing in teaching and learning (Mandinach 2005). The National Computerization Program had begun its course as far back as 1994, following a National Report (Harari 1992; MOE Israel 1993), followed by a recent upgrading of the program (the fifth round), titled "The National Program for Adapting the Education System to the 21st Century". While focus of the initial program was to instil computers in classrooms and train teachers in a large-scale manner, the focus of the current program is manifold: instilling 21st century skills, empowering teachers and teaching in schools, adapting education to variance between students, providing real-time feedback, arousing interest among students and facilitating communication between teachers and other stakeholders within the education system. The main goal is to lead novel pedagogy in the education system, ICT having a major role in this initiative (MOE Israel, 2011).

At first, teacher education colleges training pre-service teachers were not included in the National Computerization Program. As a result of a 3-year study focusing on the integration process of ICT in teacher education in Israel between the years 1993-2008 in light of theories of innovation and organizational change (e.g., Finley & Hartman 2004; Guri-Rosenblit 2002; Hall & Hord 1987; Surry, Ensminger & Haab 2003), since the year 2012, teacher pre-service education was included in this initiative, titled: "The National Program for Adapting Teacher Education Colleges to the 21st Century", i.e. within 3 years all colleges were granted a sum of approximately $150,000 each (altogether a sum of approximately $3,750,000) for executing ICT-based educational initiatives for pre-service training as well as for faculty training within each college. The initiative was funded by the Administration of Science and Technology as well as the Department for Teacher Training, both within the Israeli MOE.

This creates a continuum of professional development, beginning with pre-service and flowing to ongoing in-service TPD, facilitating reciprocal relationships between academia and practice (personal or professional), as well as between pre- and in-service teacher training (Newman & Mowbray 2012). This is in line with the notion of lifelong learning (Lim, Chai & Churchill 2011; Teo 2010), and also with the general perception of PDS (professional development schools), in which pre- and in-service teachers train together in order to create a two-way development process, between academia and practice (Bausmith & Barry 2011). The expectations were that the pre-service teachers take on the role of innovators, adopting the knowledge growth and diffusion of innovation approach, in correspondence to theoretical paradigms dealing with infusion of innovation and implementation of change (Rogers 2003; Shulman 1986). Specifically, factors and key themes that may facilitate ICT implementation as a lever for change were identified in each college on the institutional as well as the micro-level, in accordance with the relevant academic body of knowledge (Tondeur et al. 2012). Each college was requested to prepare a program for ICT implementation according to its educational vision of education as well as pre-service training, in line with the K12 computerization program, thereby being influenced as well as influencing K12 practice. Progress was monitored by annual reports that included mostly pedagogical aspects, but also a financial report on usage of funding (a fourth of which were required to be allocated for professional faculty development). Both K12 and education colleges carried out surveys and studies, examining the outcomes of the computerization programs.

In addition, an inter-collegial annual course was established at the MOFET institute, a national inter-collegial center for the research and development of programs in teacher education and teaching in colleges. The course was mandatory for 6 faculty members of each college participating in the National Program for Adapting Teacher Education Colleges to the 21st Century. These representatives were expected to be major position holders within each college, that serve as arrowheads to faculty altogether. This model, also corresponding to the K12 teachers' professional development, but unique in its nature, ensures the distribution of contents, competencies, skills and views on ICT implementation that were taught and discussed in the course in a gradual fan-like manner rather than a revolutionary process, that may prove to be sustainable, transferable and scalable (Kirkup & Kirkwood 2005). In this case the importance of networks and communities for sharing and distribution of learning from TPD is highlighted and there are elements of design-based research in the process of gradual implementation with opportunities to learn and adjust as the implementation progresses.

Case 4: Vietnam – Institutional Capacity development in Teacher Education Institutions

In 2008 the Vietnamese Ministry of Education and Training initiated a program on "Friendly Schools, Active Students", supported by the Flemish Association for Development Cooperation and Technical Assistance (VVOB) to develop the institutional capacity of teacher education institutions (TEI). The program had a focus on research, monitoring and evaluation, leading to "evolutionary planning" for integration of information and communication technology (ICT) in education. There was a reciprocal relationship between research and practice at different levels throughout the program as the processes of planning and TPD were informed by research and were, in turn, reported in research publications adding to the knowledge available to the wider field. Participating TEIs were instructed to develop a technology plan, following the Planning Guide on ICT in Teacher Education (UNESCO 2002). These technology plans were written by educational managers and ICT coordinators of the respective TEIs. The first essential condition of a technology plan was a shared vision: from the administration to the grounds personnel, there should be an understanding of, commitment to, and sense of advocacy for the implementation of technology (UNESCO 2002). The subsequent conditions were categorized in the five operational components of technology planning, as described by Kozma (2008): infrastructure development; teacher training; pedagogical and curricular change; content development; and technical support. By the end of the first phase of the program (in 2010) all participating TEIs had rewritten their respective technology plans twice. In the most recent versions, these plans reflected a comprehensive vision on educational innovation in which they gave importance not only to infrastructure development but also to professional development, pedagogical and curricular change (Peeraer & Van Petegem 2011b). These technology plans formed the benchmark for monitoring and evaluation of different aspects of integration of ICT. However, as observed elsewhere (Lee, Hung, & Cheah 2008), guidelines on ICT were often still too weak to spell out exactly how integration of ICT in teaching and learning should look like or what educators need to know or believe.

At the level of the teaching practice in the TEIs, a training program for teacher educators had been set up, while continuing reflection and learning was encouraged in communities of practice. A training needs assessment at the start of the program showed a lack of confidence of teacher educators to use ICT in teaching practice (Peeraer & Van Petegem 2011a). Teacher educators mostly used ICT to replace traditional, teacher centered teaching practice. Therefore, VVOB focused its support on the development and implementation of a comprehensive professional development program. The program focused on the interplay between technological, pedagogical and content knowledge (TPACK) (Koehler, Mishra, & Yahya 2007) of teacher educators. Even though the learning transfer was efficient, the impact of the training program as such was limited (Peeraer & Van Petegem 2012). A significant part of variance in the application of ICT for teaching and support of student learning was explained by additional engagement in action research and communities of practice. We agreed with others (Barton & Haydn 2006; Karagiorgi & Charalambous 2006; Latchem & Jung 2010) who have argued that it may be best to combine programmed professional development addressing TPACK of teacher educators with incentives for additional engagement with the topic, especially as encouragement for ICT enthusiasts to exchange with and encourage peers. VVOB supported the launch of a series of Communities of Practice (CoP) where teacher educators of different TEIs could exchange and share experiences. These CoPs consisted of enthusiasts that tried out new tools and methodologies in their teaching and learning practice and as such created islands of innovation that attempted to transform education from within. Albion, Knezek and Adubra (2011) acknowledge that there is still much to be learned about how best to initiate and support such learning communities and the change to the professional culture that is needed to facilitate their success. It is clear that apart from supporting staff in providing access to ICT, TEIs ideally support a culture of social and collaborative professional development to harness the full potential of their human resources.

3 Discussion

In this paper we initiate the development of a model for TPD that facilitates ICT as a lever for educational change (see Fig. 1). In the introduction we build up the argument that in exploring the conditions for integration of ICT, there is a need for better understanding of the teachers' role and subsequently, to study professional development programs, models and strategies, as a means to improve their impact on teachers' practice. After outlining the conceptual model identifying core factors of TPD, we presented four case studies in which the reciprocal relationship between these factors is illustrated.

In all cases, it seems that the human factor in education is of utmost importance. Hence, excellent teacher professional development, established as a continuum ranging from pre-service throughout in-service training is vital in the age of information technology, characterized by constant change and advancements. Indeed, two of the three foci that were identified to begin with as central to TPD were the engagement of stakeholders in developing a shared vision about the role of ICT in education, and engaging teachers in school-based communities of practice or professional learning networks, as an effective means of developing ICT-integrated pedagogy. The cases presented in our paper highlight the importance of TPD as a means of clarifying beliefs, vision and action regarding ICT integration in teaching and learning. All cases describe an attempt to reduce the gap between educational research and practice of teachers: the research conducted is closely related to teachers' practice as a result of professional development programs.

Without claiming to be exhaustive or prescriptive the model for teacher professional development proposed in this paper accounts for important components that have been identified in the research literature, i.e. research, TPD and practice, within a context of developing several modes and models for ICT implementation, based on factors such as a systemic vision, cultural diversity etc. The basic model should be very simple, allowing countries to add to any of its components additional sub-components. The focus of a possible model should be the term "technology-enabled learning", which can be defined globally, but also entails local elements defined by each country. The components of a possible model should reflect the different emphases of the cases illustrated in our paper. The case of Flanders focuses on school-based in-service professional development, in an attempt to enhance practice. The case of Australia combines a pre- and in-service top-bottom professional development policy, with direct practical implications. The Israeli case sees practice as a result of lifelong learning beginning in pre-service training and continuing during a teacher's professional lifespan as facilitating best pedagogical practices. Finally, in the case of Vietnam, the starting point is research, which enables the construction of a training program for teacher educators.

In the case of Flanders, highlighting team-based and school-based training for ICT-integration in primary education, the shared vision of ‘good’ education served as the foundation for a school-based ICT policy plan, and affected all other curriculum and policy planning initiatives (Vanderlinde et al. 2010). In a best-case scenario, such a plan will stimulate a dialogue among school managers, teachers and parents about technology use in the curriculum (Lim et al. 2013). School improvement perspective is a practice- and policy-oriented approach to strengthen schools’ capacities for managing change (Creemers 2002). Reynolds, Teddlie, Hopkins and Stringfield (2000) argue that a school-improvement approach to educational change embodies the long-term goal of establishing a self-renewing school. Schools differ with respect to performance levels, innovation capacity and contextual characteristics (Otto & Albion 2002). Longitudinal studies drawn from intervention can contribute to the improvement of professional development on the field of ICT integration on the one hand, and knowledge growth on the other hand (cf. Tondeur, Cooper & Newhouse 2010). The results of the Vanderlinde et al. (2010) study are of particular interest for developers of professional development activities. Developers can consult the design principles, the steps of the cyclic process, and the structure of the pICTos environment.

The Australian case is an example of a systematic and integrated approach to provision of ICT in schools accompanied by professional development for all phases, from pre-service through in-service to leadership. The pre-service element in particular had a reciprocal relationship with research, being informed by current research around the TPACK framework (Mishra & Koehler 2006) and contributing to the body of research-based knowledge through its evaluation (Cavanagh & Koehler 2013; Finger et al. 2103; Heck & Sweeney 2013). The project included review and adjustment of professional standards to include appropriate expectations for ICT. Although there was a common structure across the national project, it provided for customization to suit the needs of local teacher education

institutions while building links with teachers in the field. Finally it linked teacher educators around the country in a network for sharing effective practices.

The Israeli case illustrates the national program for adapting teacher education colleges to the 21st century, thereby emphasizing not only ICT integration, but rather rethinking the curriculum in teacher pre-service development at large, as a result of paradigmatic change in teaching and learning in the 21st century (Gibson & Brooks 2013). This strengthens the education system by a top-down process, funded by the Israeli MOE, but also, due to specific programs created by each college, in a bottom-up manner that is known in other sectors of higher education as well (Jaros 2014). This allows each institute degrees of freedom in constructing unique programs for pre-service development, all meeting criteria of ICT integration, in a process by which their technological knowledge is entwined in their content and pedagogical knowledge and skills (Koehler, Mishra, Akcaoglu & Rosenberg 2013). The inter-collegial annual course reflects the creation of communities of practice and professional learning networks between colleges' faculty, thereby serving as a model for pre-service teachers in their search for collaboration and joining communities of practice as future teachers (Sari & Herrington 2013).

The Vietnam case is an illustration of how research, monitoring and evaluation can play a role at various levels. On the management level, the participating TEIs have developed a yearly technology plan, starting from a shared vision on integration of ICT in education, forming the benchmark for monitoring and evaluation of different aspects of ICT integration. On the teaching level in the TEIs, a training program has been set up, while continuing reflection and learning was encouraged in communities of practice. As suggested by Walkington (in Lim et al. 2011), mentoring and peer coaching have become important components of the professional development of educators. Teacher educators have been motivated to share experiences and insight, to reflect and discuss with peers and to carry out action research. The capacity to monitor, evaluate and eventually learn is mostly in the hands of teacher educators. Bridging the gap between planning and practice requires that this group of innovators have a stronger voice in their respective TEIs.

The scientific contribution of the paper is, hence, manifold. First, it highlights the importance of *learning with ICT* as a major goal in an attempt to facilitate innovative pedagogical practices in a systemic widespread model, rather than *ICT integration* in general in a model of islands of innovation. Secondly, it illustrates case studies in which systemic change has occurred de facto, supported top-down by ministries of education in the countries in which a decision has been made to empower pre-service and in service training and professional development. Thirdly, the emphasis on the human factor, i.e. pre- or in-service teachers as well as teacher educators, illustrates a shift in allocation of resources and funding, from technology to pedagogy. And finally, the research frameworks detailed in the paper allows a tremendous contribution to the academic body of knowledge in the field of ICT in education, basing practice on evidence based studies.

The findings from the four cases helped in understanding how professional development facilitates teachers' use of ICT in education and how we can reduce the gap between educational research and practice. Yet another classification of TPD activities refers to a continuum between TPD that is related to ICT literacies on one end and innovative pedagogical practices on the other end, emphasizing a systemic level of ICT integration. The reciprocal relationship between research and practice is a necessity in teachers' professional development for ICT integration. The emerging theme from the cases described in our paper is the need for evidence-based decision-making. National plans as well as local ones require endless efforts – these should be planned carefully and based on facts and longitudinal evidence rather than notions. The cases presented in this paper illustrate the conceptual model on TPD. At the same time, these kinds of case studies of successful, but also failing practices, can inform further development of models and strategies for TPD. Implications and future directions may include utilizing a design-based research approach to investigate various possibilities of ICT-based TPD, alongside sharing the work and outcomes through networks and communities. Design-based research is a practical research methodology that bridges the gap between research and practice in education (Anderson & Shattuck 2012); hence it is the best paradigm for the context discussed in this paper. As an emerging paradigm, design-based research is accessible to pre- and in-service teachers, providing a framework for them to work at the edge of their evolving knowledge on the integration of ICT in their profession, and also providing a framework for teacher educators to develop models for enhancing their teacher training models.

4 Conclusion

The model presented in Figure 1 is based on the literature cited above and the discussions among TWG3 participants at EDUsummIT 2013 and afterward. It presents key factors for the success of technology-enabled

learning as identified in the published research and indicates some possible relationships among them. It is not intended as a model that could be tested by statistical methods such as structural equation modeling. It does, however, provide a simple conceptual map that can be used as a guide in the examination of cases from the field. The four cases presented in the body of the paper illustrate the presence of the identified factors and their relationships as general conditions for success of TPD intended to promote effective technology-enabled learning. In that respect the model is a useful heuristic for research and for those charged with designing and delivering TPD.

References

AICTEC. (2009). Digital Education Revolution Implementation Roadmap. Retrieved from http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/AICTEC_DER_ROADMAPAdvice.pdf

Albion, P., Knezek, D., & Adubra, E. (2011). *Teacher professional development*. Paper presented at the EDUsummIT 2011.

Albion, P., Forkosh-Baruch, A., & Tondeur, J. (2013).*Working Group 3: Summary Report and Action Agenda*. Retrieved from http://www.edusummit.nl/resources/results-edusummit-2013/

Anderson, T., & Shattuck, J. (2012). Design-Based Research A Decade of Progress in Education Research?. *Educational Researcher*, *41*(1), 16-25.

Barton, R., & Haydn, T. (2006). Trainee teachers' views on what helps them to use information and communication technology effectively in their subject teaching. *Journal of Computer Assisted Learning, 22*(4), 257-272.

Bausmith, J. M., & Barry, C. (2011). Revisiting Professional Learning Communities to Increase College Readiness The Importance of Pedagogical Content Knowledge. *Educational Researcher*, *40*(4), 175-178.

Campbell, R., Kyriakides, L, Muijs, R., & Robinson, W. (2003). Differential teacher effectiveness: Towards a model for research and teacher appraisal. *Oxford Review of Education, 29*(3), 347-62.

Creemers, B. P. M. (2002). From school effectiveness and school improvement to effective school improvement: Background, theoretical analysis, and outline of the empirical study. *Educational Research and Evaluation, 8*, 343-362.

Bereiter, C. (2013). Principled Practical Knowledge: Not a Bridge but a Ladder. *Journal of the Learning Sciences, 23*(1), 4-17. doi: 10.1080/10508406.2013.812533

Cavanagh, R. F., & Koehler, M. J. (2013). A Turn toward Specifying Validity Criteria in the Measurement of Technological Pedagogical Content Knowledge (TPACK). *Journal of Research on Technology in Education, 46*(2), 129-148.

Collis, B., & Jung, I. (2003). Uses of information and communication technologies in teacher education. In C. Latchem & B. Robinson (Eds.), *Teacher education through open and distance learning* (pp. 171-192). London: Routledge/Falmer.

Dart, J., & Davies, R. (2003). A Dialogical, Story-Based Evaluation Tool: The Most Significant Change Technique. *American Journal of Evaluation, 24*(2), 137-155. doi: 10.1177/109821400302400202

DEEWR. (2010). ICT Innovation Fund Guidelines 2010 – 2012. Retrieved from http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/DigitalStrategyforTeachers/Documents/ICTInnovationGuidelines.pdf

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423-435. doi: 10.1016/j.compedu.2012.02.001

Ertmer, P. A., & Ottenbreit-Leftwich, A. (2013). Removing Obstacles to the Pedagogical Changes Required by Jonassen's Vision of Authentic Technology-Enabled Learning. *Computers & Education, 64*, 175-182. doi: 10.1016/j.compedu.2012.10.008

Finger, G., Albion, P., Jamieson-Proctor, R., Cavanagh, R., Grimbeek, P., Lloyd, M., et al. (2013). Teaching Teachers for the Future (TTF) Project TPACK Survey: Summary of the Key Findings.*Australian Educational Computing, 27*(3), 13-25.

Finley, L., & Hartman, D. (2004). Institutional change and resistance: Teacher preparatory faculty and technology integration. *Journal of Technology and Teacher Education, 12*(3), 319-337.

Forkosh-Baruch, A., Nachmias, R., Mioduser, D., & Tubin, D. (2005). 'Islands of Innovation' and 'School-Wide Implementation': Two patterns of ICT-based pedagogical innovations in schools. *Human Technology, 1*(2), 202-215.

Fullan, M. (1991). *The New Meaning of Educational Change*. New York, NY: Teachers College Press.

Gibson, S., & Brooks, C. (2013). Rethinking 21st Century Professional Development.*Literacy Information and Computer Education Journal, 4*(2), 973-982.
Grunberg, J., & Summers, M. (1992). Computer Innovation in Schools: a review of selected research literature. *Journal of Information Technology for Teacher Education, 1*(2), 255-276.
Guri-Rosenblit, S. (2002). A Top-Down Strategy to Enhance Information Technologies into Israeli Higher Education. *International Review of Research in Open and Distance Learning, 2*(2), 76-91.
Gutiérrez, K. D., & Penuel, W. R. (2014). Relevance to Practice as a Criterion for Rigor. *Educational Researcher, 43*(1), 19-23.
Hall, G. E., & Hord, S. M. (1987). *Change in schools* (pp.1-22). Albany: SUNY Press.
Harari, H. (1992). *"Tomorrow 98"*. Report by the Committee of Science and Technology Education. Israel: The ministry of education. [Hebrew]
Heck, D., & Sweeney, T. (2013). Using Most Significant Change Stories to document the impact of the Teaching Teachers for the Future Project: An Australian Teacher Education Story. *Australian Educational Computing, 27*(3), 36-47.
Hennessy, S., & London, L. (2013). Learning from International Experiences with Interactive Whiteboards: The Role of Professional Development in Integrating the Technology: OECD Publishing.
Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education*, *51*(4), 1499-1509.
Hughes, J. (2005). The role of teaching knowledge and learning experiences in forming technologyintegrated pedagogy. *Journal of Technology and Teacher Education*, *13*(2), 277-302.
Jamieson-Proctor, R., Albion, P., Finger, G., Cavanagh, R., Fitzgerald, R., Bond, T., & Grimbeek, P. (2013). Development of the TTF TPACK Survey Instrument. *Australian Educational Computing, 27*(3), 26-35.
Jaros, M. (2014). Leadership and methodology challenges in higher education: Integrating personaldevelopment, skills and competences in the space of digital systems. *Global Journal of Information Technology, 4*(1), 1-6.
Kalogiannakis, M. (2010). Training with ICT for ICT from the trainee's perspective. A local ICT teacher training experience. *Education and Information Technologies, 15*(1), 3-17.
Karagiorgi, Y., & Charalambous, K. (2006). ICT In-Service Training and School Practices: In Search for the Impact. *Journal of Education for Teaching: International Research and Pedagogy, 32*(4), 395-411.
Kennisnet Foundation. (2011). *Four in Balance Monitor 2011. ICT in Dutch primary, secondary and vocational education*. The Hague: Kennisnet Foundation.
Kirkup, G., & Kirkwood, A. (2005). Information and communications technologies (ICT) in higher education teaching—a tale of gradualism rather than revolution. *Learning, Media and Technology, 30*(2), 185-199.
Koehler, M. J., Mishra, P., Akcaoglu, M., & Rosenberg, J. (2013). The technological pedagogical content knowledge framework for teachers and teacher educators. *ICT integrated teacher education: A resource book*, 2-7. Retrieved from http://cemca.org.in/resources/books.
Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*(3), 740-762.
Kozma, R.B. (2003). Global perspectives: innovative technology integration practices from around the world. *Learning and Leading with Technology, 31*(2), 7-54.
Kozma, R. B. (2008). Comparative Analysis of Policies for ICT in Education. In J. Voogt & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (Vol. 20, pp. 1083-1096). New York: Springer.
Kozma, R.B., & Vota, W.S. (2014). ICT in Developing Countries: Policies, Implementation, and Impact. In *Handbook of Research on Educational Communications and Technology* (pp. 885-894). Springer New York.
Krumsvik, R. J. (2008). Situated learning and teachers' digital competence. *Education and Information Technologies, 13*(4), 279-290.
Latchem, C. R., & Jung, I. (2010). *Distance and blended learning in Asia*. New York: Routledge.
Leask, M., & Younie, S. (2013). National models for continuing professional development: the challenges of twenty-first-century knowledge management. *Professional Development in Education, 39*(2), 273-287. doi: 10.1080/19415257.2012.749801
Lee, Y.-J., Hung, D., & Cheah, H.-M. (2008). IT and Educational Policy in the Asia-Pacific Region. In J. Voogt & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (Vol. 20, pp. 1119-1132). New York: Springer.

Li, S. C., & Choi, T. H. (2014). Does social capital matter? A quantitative approach to examining technology infusion in schools. *Journal of Computer Assisted Learning, 30*(1), 1-16. doi: 10.1111/jcal.12010

Lim, C. P., Chai, C. S., & Churchill, D. (2011). A framework for developing pre-service teachers' competencies in using technologies to enhance teaching and learning. *Educational Media International, 48*(2), 69-83.

Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S., & Tsai, C. C. (2013). Bridging the Gap: Technology Trends and Use of Technology in Schools. *Educational Technology & Society*, *16*(2), 59-68.

Mandinach, B.E. (2005). The Development of Effective Evaluation Methods for E-Learning: A Concept Paper and Action Plan. *Teachers' College Record, 107*(8), 1814-1835.

Martin, S., Diaz, G., Sancristobal, E., Gil, R., Castro, M., & Peire, J. (2011). New technology trends in education: Seven years of forecasts and convergence. *Computers& Education*, *57*(3), 1893-1906.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*, 1017-1054.

MOE Israel (1993). Policy for Action in Computers in Education. Israel: MOE. [Hebrew].

MOE Israel (2011). Adapting the Education System to the 21st Century – Master Plan 2011-2012. Israel: MOE. [Hebrew].

Newman, L., & Mowbray, S. (2012). 'We were expected to be equal': teachers and academics sharing professional learning through practitioner inquiry. *Teachers and Teaching, 18*(4), 455-468. doi: 10.1080/13540602.2012.696046

Otto, T. L., & Albion, P. R. (2002). Understanding the role of school leaders in realizing the potential of ICTs in education. In D. Willis, J. Price & N. Davis (Eds.), *Proceedings of Society for Information Technology & Teacher Education 13th International Conference* (pp. 506-510). Nashville, TN: AACE.

Pearson, M., & Naylor, S. (2006). Changing contexts: Teacher professional development and ICT pedagogy. *Education and information technologies, 11*(3-4), 283-291.

Peeraer, J., & Van Petegem, P. (2011a). Information and Communication Technology in teacher education in an emerging developing country: Vietnam's baseline situation at the start of 'The Year of ICT'. *Computers & Education, 56*(4), 974-982.

Peeraer, J., & Van Petegem, P. (2011b). Information and communication technology in teacher education in Vietnam: from policy to practice. *Educational Research for Policy and Practice*, 1-15.

Peeraer, J., & Van Petegem, P. (2012). The limits of programmed professional development on integration of information and communication technology in education. *Australasian Journal of Educational Technology, 28*.

Prestridge, S. (2010). *The alignment of digital pedagogy to current teacher beliefs*. Paper presented at ACEC2010: Digital Diversity. Melbourne, Australia: Australian Council for Computers in Education. Retrieved from http://acec2010. info/proposal/252/beliefs-behind-teacher-influences-their-ict-practices.

Reeves, T. (2011). Can Educational Research Be Both Rigorous and Relevant? *Educational Designer: Journal of the International Society for Design and Development in Education, 1*(4).

Reynolds, D., Teddlie, C., Hopkins, D., & Stringfield, S. (2000). Linking school effectiveness and school improvement. In C. Teddlie & D Reynolds (Eds.) *The International Handbook of School Effectiveness Research*, (pp. 206-231). London: Falmer Press.

Rogers, E.M. (2003). *Diffusion of Innovations* (5th edition). NY: Free Press.

Sang, G., Valcke, M., Braak, J. V., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education*, *54*(1), 103-112.

Sari, E., & Herrington, J. (2013). Using design-based research to investigate the design and development of an online community of practice for teacher professional development.In: *EdMedia 2013 World Conference on Educational Media and Technology*, Victoria, BC, Canada, 121-127.

Shulman, L. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Surry, D.W., Ensminger, D.C., & Haab, M. (2005). A model for integrating instructional technology into higher education. *British Journal of Educational Technology, 36*(2), 327-329.

Teo, T. (2010). A path analysis of pre-service teachers' attitudes to computer use: applying and extending the technology acceptance model in an educational context. *Interactive Learning Environments, 18*(1), 65-79.

Tondeur, J., Cooper, M., & Newhouse, C.P. (2010). From ICT coordination to ICT integration: a longitudinal case study. *Journal of Computer Assisted Learning*, *26*(4), 296-306.

Tondeur, J., Hermans, R., van Braak, J., & Valcke, M. (2008). Exploring the link between teachers' educational belief profiles and different types of computer use in the classroom. *Computers in Human Behavior*, *24*(6), 2541-2553.

Tondeur, J., Kershaw, L. H., Vanderlinde, R. R., & van Braak, J. (2013). Getting inside the black box of technology integration in education: Teachers' stimulated recall of classroom observations. *Australasian Journal of Educational Technology*, *29*(3).

Tondeur, J., Valcke, M., & Van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning*, *24*(6), 494-506.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. *Computers & Education, 59*(1), 134-144.

Twining, P., Raffaghelli, J., Albion, P. R., & Knezek, D. (2013). Moving education into the digital age: The contribution of teachers' professional development. *Journal of Computer Assisted Learning, 29*, 426-437. doi: 10.1111/jcal.12031

UNESCO. (2002). *Information and Communication Technologies in Teacher Education - A Planning Guide*. Paris: UNESCO, Division of Higher Education.

Vanderlinde, R., & van Braak, J. (2013). Technology planning in schools: An integrated research□based model. *British Journal of Educational Technology, 44*(1), 14-17.

Vanderlinde, R., Van Braak, J., & Tondeur, J. (2010). Using an online tool to support school-based ICT policy planning in primary education. *Journal of Computer Assisted Learning*, *26*(5), 434-447.

Vanderlinde, R., Aesaert, K., & Van Braak, J. (2014). Institutionalised ICT use in primary education: A multilevel analysis. *Computers & Education*, *72*, 1-10.

Vrasidas, C. (2014). The rhetoric of reform and teachers' use of ICT. *British Journal of Educational Technology*. doi: 10.1111/bjet.12149

Wagner, D. A., Day, B., James, T., Kozma, R. B., Miller, J., & Unwin, T. (2005). *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries*. Washington, DC: infoDev, International Bank for Reconstruction and Development / The World Bank.

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., & Monseur, C. (2013). The Use of ICT in Education: a survey of schools in Europe. *European Journal of Education*, *48*(1), 11-27.