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Enhancing future teachers' competencies for technology integration in education: Turning theory into practice

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Abstract

The main aim of this conceptual paper is to provide an overview of effective strategies to support pre-service teachers to adequately integrate ICT in teaching and learning activities. Specifically, the focus is on the strategies included in the SQD (Synthesis of Qualitative Evidence) model: 1) using teacher educators as role models, 2) reflecting on the role of technology in education, 3) learning how to use technology by design, 4) collaboration with peers, 5) scaffolding authentic technology experiences, and 6) providing continuous feedback. To turn this model into practice, the approach of teacher design teams is adopted. A teacher design team can be described as a group of two or more (pre-service) teachers who design (ICT-rich) curriculum materials. Based on the SQD model – theory - and the implementation of the key themes emerging from this model via teacher design teams – practice -, this conceptual paper provides recommendations to improve the potential of pre-service training to enhance future teachers use of ICT in their educational practice.

Keywords: ICT, Teacher education, TPACK, Teacher Design Teams, SQD model, pre-service teachers

Introduction

It has been seen increasingly important that starting teachers are able to adequately use technology in schools (Robinson & Aronica, 2015; Spector, 2010). Consequently, teacher training institutions are expected to prepare new teachers to integrate technology in their educational practice. Several studies suggest that to develop pre-service teachers' effective technology integration knowledge, teacher training institutions need to help them connect their technological, pedagogical, and content knowledge (including skills and attitudes) (Mouza, Nandakumar, Yilmaz Ozden & Karchmer-Klein, 2017; Sun, Strobel & Newby, 2017). In their Technological Pedagogical Content Knowledge (TPACK) framework, Koehler and Mishra (2009) argue that for technology

integration to occur, (pre-service) teachers must be competent in these three types of knowledge, and more importantly, they must be able to integrate all three forms of knowledge in their practice (see Fig. 1).

The TPACK model was developed by Mishra and Koehler (2006) to guide technology integration in teacher education, brings different competences together. The core of the TPACK model consists of the integrated components "knowledge of technology" (TK), "pedagogical knowledge" (PK) and "content knowledge" (CK). ICT integration in teacher education is facilitated when pre-service teachers understand how these three knowledge domains are interrelated and how they interact. But research literature reveals that transition from TK to TPACK is not that simple (e.g., Niess, 2008). Individual courses in which teachers and teacher educators acquire ICT skills have shown to be insufficient (Kay, 2006).

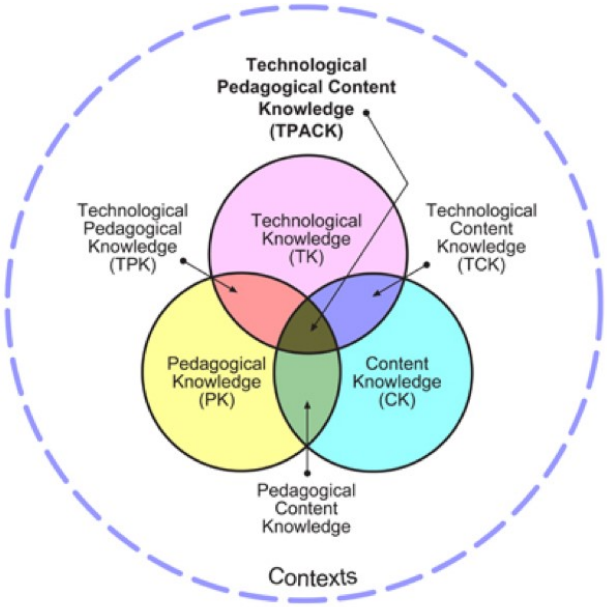

Fig. 1: The TPACK framework (Koehler & Mishra, 2009)

This requires the adoption of various strategies by training institutions to develop teachers' TPACK (Polly, Mims, Shepherd & Inan, 2010). These strategies were identified and reviewed by Tondeur, van Braak, Sang, Voogt, Fisser and Ottenbreit-Leftwich (2012), and an overarching Synthesis of Qualitative Evidence (SQD) model was developed to present how they relate to each other (see Fig. 2). Other reviews identified similar strategies as Tondeur et al. (2012), including Kay (2006) and Røkenes and Krumsvik (2014). The main aim of the current paper is to 1) present these effective SQD strategies and 2) illustrate how these strategies can be implemented in teacher training institutions (TTI) by student teacher design team.

Strategies to enhance future teachers' TPACK

There are different strategies to prepare pre-service teachers for educational ICT use (see e.g., Mouza et al., 2014). As stated above, Tondeur, van Braak, Sang, Voogt, Fisser and Ottenbreit-Leftwich (2012) reviewed the literature

aiming to synthesize strategies on how to best prepare pre-service teachers to integrate technology into pedagogy, and content areas (TPACK). According to the findings of this review, different key strategies need to be integrated in the teacher training institutions (see Fig. 2). The two outward circles in the SQD model include the strategies necessary at the institutional level such as technology planning and leadership, training staff, access to resources, or cooperation within and between the institutions.

The inner circle includes six micro level strategies such as using teacher educators as role models, or scaffolding authentic technology experiences. These six strategies of the inner circle are focus of the current conceptual paper and will be linked to the introduction of teacher design teams.

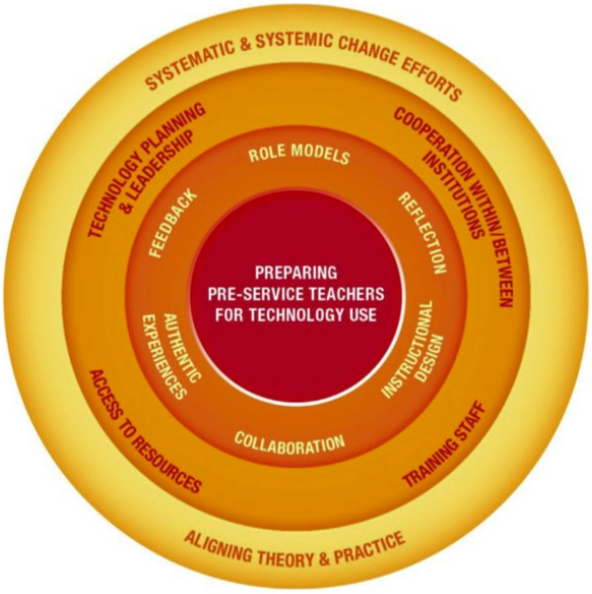

Fig. 2: The SQD model to prepare pre-service teachers for ICT use (Tondeur et al., 2012)

The first strategy at the inner circle of the SQD-model (Role models) stresses the need of teacher educators acting as role models in view of ICT integration in education. Providing practical examples and inspiring pre-service teachers has proven to be a crucial motivator for the development of pre-service teachers' ICT competencies. But having pre-service teachers watch practical examples of adequate educational ICT-use is helpful but not sufficient (see e.g., Kaufman, 2015; Tondeur, Scherer, Siddiq & Baran, 2017).

The second SQD-strategy (Reflection) involves discussing and reflecting about the opportunities and the risks of ICT uses in education (Ching, Yang, Baek & Baldwin, 2016). This can help them see the values and /or risks of using a ICT in relation to a teaching and learning approaches (see Mouza et al., 2017). Empirical evidence also suggests that providing the opportunity to learn about technology integration by designing ICT-rich curriculum materials can be a promising strategy (Tondeur, van Braak, Siddiq & Scherer, 2016), as illustrated in the next section of this paper (Strategy 3: Instructional design). Koehler and Mishra (2009) recommend that learning to design ICT enhanced materials is a key strategy for pre-service teachers' development of their TPACK (see Voogt, Fisser, Pareja Roblin, Tondeur & van Braak (2013) for an overview).

Research also demonstrated that collaboration can mitigate feelings of insecurity when pre-service teachers need to design ICT related curriculum (Strategy 4: collaboration) materials (cf. Koh & Chai, 2016). An online environment seemed to be useful in giving (future) teachers a forum to discuss and exchange points of view with others and to explain their opinions and thoughts. As a fifth strategy (Authentic experiences), pre-service teachers should experience the value to use ICT in education in authentic settings (cf. Valtonen et al., 2015). In this respect Tearle and Golder (2008) stressed that "watching" technology being used could not substitute for "doing". Finally, the sixth SQD strategy (Feedback) at the micro level involves on-going feedback, which has been proven to be beneficial for pre-service teachers' abilities to realize ICT competencies to utilize ICT in their education practice (e.g., Tondeur, Scherer, Siddiq & Baran, 2017). One of the recommendations in the Tondeur et al. (2012) review study was to use an ICT portfolio to integrate evaluation and feedback throughout the training process.

From the review of the six SQD strategies mentioned above, it was clear that effective preparation of pre-service teachers for educational ICT use required attention to not only the separate strategies in the model depicted in Figure 2, but the relationship between each of the key strategies. These key strategies are linked together in a way that made it difficult to address them separately. It is important to note that learning to teach with technology is a constructive and iterative process. Clearly, competencies needed for technology integration are not only related to technology but also to pedagogical attitudes and content planning (Sang, Valcke, Van Braak & Tondeur, 2010; Tondeur, Scherer, Siddiq & Baran, 2017). In order to implement the strategies, technology integration needs to be infused as a systemic and systematic process, as demonstrated in the SQD model (see Fig. 2). This brings us to the next section of the paper.

Linking SQD strategies and teacher design teams

In the current paper, we focus on (pre-service) teacher design teams (TDT) as a specific intervention to integrate the six SQD strategies mentioned above. A TDT can be described as a group of two or more teachers who (re) design curriculum materials together (Handelzalts, 2009; Voogt, Pieters & Handelzalts, 2016), in this case ICT rich curriculum materials. An important characteristic of TDT is the emphasis of the design task (Main, 2012). It is an increasingly used strategy to familiarize teachers, pre-service teachers and teacher educators with the various components of the TPACK model to let them design their own courses in (teacher design) teams (e.g., Angeli & Valanides, 2005; Boschman, McKenney & Voogt, 2015; Polly, 2011).

Koehler and Mishra (2006) call this pedagogical approach "learning technology by design". It means that pre-service teachers reflect together on how ICT can support the content and pedagogical aspects of their practice in order to attain TPACK (Stoll, Bolam, McMahon, Wallace & Thomas, 2006). Next, they design or re-design ICT-rich curriculum materials, experiment with them and, finally, reflect on the results. All these strategies are also identified in the inner circle of the SQD model to prepare pre-service teachers for technology use (Tondeur et al., 2012): 1) Role models, 2) reflection, 3) Instructional design, 4) collaboration, 5) Authentic experiences, and 6) Feedback.

To illustrate, the Kafyulilo (2015) study adopted TPACK as a framework for describing the knowledge and skills that pre-service teachers need to develop in order to effectively integrate technology in science and mathematics teaching. Pre-service teachers participated in hands-on training, collaborative lesson design in design teams, microteaching and reflection with peers. The findings showed significant changes in technology related components of TPACK. Kafyulilo (2015) concluded that opportunities for pre-service teachers to participate in teacher design teams that involve lesson design, teaching,

evaluation and re-design, can be effective for the development of pre-service teachers' knowledge and skills of integrating technology in education (cf. Agyei & Voogt, 2016). The work process with Teacher Design Teams seems very similar to that of design-based research (see McKenney & Reeves, 2013). An important difference however is the focus of design-based research on theoretical implications (e.g., new design principles). The focus of working in design teams is on the improvement of educational practice, in this case on the development of ICT-rich curriculum materials.

Implementation of teacher design teams

Supporting a design team is not an easy task. It requires competent teacher educators who are able to respond to the needs of the pre-service teachers in a flexible way (see Becuwe et al., 2017). Based on the findings of a Delphi study Becuwe et al. (2017) conclude that creating an atmosphere of trust is an important condition for the effective implementation of TDT. Results of their Dephi study also revealed consensus about the importance of participants who are open-minded about innovation, who trust each other and who have confidence in each other's expertise.

Another condition emphasized as critical is the feeling of ownership over the (design) process. All pre-service teachers need to feel responsible for the design task. Previous research also indicates the importance of a shared feeling of responsibility (e.g., Stoll et al., 2006). If team members do not feel responsible themselves for the outcomes to a rather great extent, they may need additional support (Handelzalts, 2009). Such support can be provided by a coach, such as the teacher educator. In this respect, flexibility seems to be the most important characteristic of a coach as also indicated by previous research (e.g., Petrone & Orquist-Ahrens, 2004; Huizinga et al., 2014; Polly, 2011).

For pre-service teachers to be able to work together there needs to be a simultaneous balance between using team processes (e.g., setting regular meetings, assigning specific roles, etc.), to complete the design tasks (e.g., knowing how to plan, complete a special project) and maintaining the relationships (Main, 2012, 2017). Clearly, for the successful implementation of TDT, several conditions need to be taken into account (Voogt, Westbroek, Handelzalts, Walraven, McKenney, Pieters & de Vries, 2011).

The discussion about how to implement and sustain programs to prepare pre-service teachers to integrate technology in classroom practice should be seen as part of the vision of the entire teacher education program (Polly, Mims, Shepherd & Inan, 2010). This leads to a focus on the institution as a unit of change and pays additional attention to the conditions at the institutional level. The institutional level factors, as expressed in the SQD model, included "technology planning and leadership", "training staff", "access to resources" and "co-operation within and between institutions". These key strategies emphasized that the effective integration of technology in teacher education was possible if future goals were set and implemented in a planned manner (Seels, 2003). The two overarching SQD strategies "Aligning theory and practice" and "Systematic and systemic change efforts" were clustered together as overarching themes, identified as important at both micro and institutional levels (see Fig. 2).

To implement the key strategies of the SQD model via TDT, access to resources needs to be guided by the administrative, financial, and teaching needs. Therefore, an "ICT plan" is needed that integrates the vision and strategic direction of the entire teacher education programme (see e.g., Lavonen et al., 2006). Technology planning can be challenging because teacher educators do not have similar technology knowledge, attitudes or skills (Goktas et al., 2008; Tondeur et al., 2017). As a result, teacher educators should be provided with

training to become role models for their pre-service teachers (Barton & Haydn, 2006) and a facilitator in the TDT.

An interesting option is to organize TDT including both pre-service teachers and teacher educators in order to increase the learning experience of both the pre-service teachers and teacher educators. Moreover, it could be useful to collaborate with other teacher training institutions (cf. SQD model). In addition, collaboration with the practice field and in- service/mentor teachers where the pre-service teachers do their school practicum could be a useful contribution to the field (cf. Kay, 2006; Røkenes & Krumsvik, 2016). Through these collaborations, pre-service teachers could observe and take part in authentic ICT-rich teaching with experienced digital role models.

Finally, using an online platform can enable the pre-service teachers in the study to collaborate across time and place, and the process of providing feedback and suggestions for improvement on lesson plans and delivery was considered by the teachers beneficial for linking theory to practice and exchanging information. Lin, Lin and Huang (2008) explored virtual teacher teams who were collaborating on developing ICT lesson plans (see also Prestridge & Tondeur, 2015).

This attention on the institution as a unit of change must recognize the importance that learning to teach with technology via TDT is a systematic process (Lim & Hang, 2003; Seels et al., 2003) that requires the engagement of pre-service teachers in investigating role models, designing lesson plans, practicing in authentic settings, and providing feedback. As stated earlier, effective preparation of the teams requires attention to the separate key strategies, but also demands similar attention toward the relationships between these strategies (cf. Kay, 2006). Furthermore, teacher design teams need to be infused as a systemic aspect throughout the entire program rather than presented in separate intervention (cf. Polly et al., 2010). Otherwise, the knowledge and the skills pre-service teachers gained from the design teams are likely to remain isolated and unused (Tondeur et al., 2017).

Conclusion

Collaborative design in TDT has been shown to contribute to the development of pre-service teachers' competencies necessary to integrate technology in education (e.g., Agyei & Voogt, 2016; Alayyar, Fisser & Voogt, 2012). The integration of the SQD strategies via TDT can only be effective for preparing (future) teachers when taking a number of conditions both on team and institutional levels into account. The combination of the theoretical SQD model together with the practical translation into TDT can hopefully be used by policy makers, practitioners, and program planners to better prepare pre-service teachers to use technology in their teaching practices.

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