Mapping support strategies for pre-service teachers' ICT integration; SQD in Finland.

Teemu Valtonen
Nhi Hoang
University of Eastern Finland
Anneke Smits
Windesheim University of Applied Sciences
Jo Tondeur
Vrije Universiteit Brussel
Jari Kukkonen
University of Eastern Finland
Jari Laru
University of Oulu
Jenni Kankaanpää
Erkko Sointu
University of Eastern Finland
teemu.valtonen@uef.fi
nhi.hoang@uef.fi
aeh.smits@windesheim.nl
jo.tondeur@vub.be
jari.kukkonen@uef.fi
jari.laru@oulu.fi
jenni.kankaanpaa@uef.fi
erkko.sointu@uef.fi

Abstract: This study focuses on pre-service teachers' experiences with the strategies used in teacher education to support their readiness to use Information and Communication Technology (ICT) for teaching and learning. The study is grounded in the SQD model by Tondeur et al. (2012). The SQD model defines six core strategies for supporting pre-service teachers' readiness to use ICT in education. The study has several aims to analyze how well the SQD instrument works in the context of Finnish teacher education and to assess how pre-service teachers experience the use of the SQD strategies in Finnish teacher education. Secondary aims are to study possible differences between men and women and differences between two Finnish universities. The target group consists of cohorts of second year pre-service teachers (N=203) from two Finnish universities. Results indicate that the SQD instrument works well in the Finnish context. Results also indicate differences among support strategies used in teacher education and differences between universities in only one SQD area.
Keywords: SQD-model, teacher education, pre-service teacher, ICT in education

Introduction

This research focuses on pre-service teachers' experiences of how teacher education supports the development of their readiness to use information and communication technology (ICT) for learning. Teachers need to be able to take advantage of the affordances provided by different technologies for specific learning purposes. The development of technologies for pedagogical practices is fast. The annual Horizon reports highlight technology development paths (see Freeman, Adams Becker, Cummins, Davis, & Hall Giesinger, 2017). Currently, examples of emerging trends are *Makerspace* thinking and learning analytics. While many technologies are part of the pre-service teachers' everyday life, the pedagogically meaningful use of technologies is not obvious, instead it requires training and support (Valtonen, Pöntinen, Kukkonen, Dillon, Väisänen, & Hacklin, 2011). Here, teacher education and skilled teacher trainers play a key role. Teacher trainers are required to know different technologies and to be able to appreciate the synergy between technology, pedagogy, and content.

This study examines the pre-service teachers' experiences of the support provided by teacher training for the development of skills to use ICT in education. The theoretical perspective of the study is the SQD (Synthesis of Qualitative Data) model (see Fig. 1) developed by Tondeur et al. (2012). The six key themes at the inner circle depict the strategies to prepare pre-service teachers for ICT-integration in education. The purpose of the study is 1) to validate the modified SQD instrument for the Finnish context 2) to provide insights into pre-service teachers' experiences of support for using ICT in education during teacher education.

Theoretical background

Pre-service teachers' confidence and their readiness to use ICT in education have been studied using various theoretical frameworks such as Technological Pedagogical Content Knowledge (TPACK) by Mishra and Koehler (2006), the Theory of Planned Behaviour (TPB) by Ajzen (1991), the Technology Acceptance Model (TAM) by Davis (1989) and several others. Several instruments, based on the different theoretical frameworks, have been used to provide insights into the ways pre-service teachers perceive their confidence in using ICT for teaching and learning. Results of the TPACK studies typically show more confidence in pedagogical knowledge than in technological knowledge (Koh, Chai, & Tsai, 2010; Valtonen, Sointu, Kukkonen, Kontkanen, Lambert, & Mäkitalo-Siegl, 2017). Whereas the knowledge about content specific technologies is typically assessed as weak (Koh, Chai, & Tsai, 2010), i.e. pre-service teachers have a weak knowledge of the technologies that are used by professionals of different disciplines like math, history, gym, arts etc. Based on TPACK studies we can also conclude that there are rather strong differences in pre-service teachers' readiness to use ICT in education (Valtonen, Kukkonen, Kontkanen, Mäkitalo-Siegl, & Sointu, 2018); about one fifth of the pre-service teachers find the use of educational technology a challenging area.

Within studies using the TPB framework, one of the measured areas is the perceived behavioural control or self-efficacy (Ajzen, 2002), both referring to the persons' confidence of using ICT for supporting teaching and learning (Teo & Tan, 2012). According to previous TPB studies, pre-service teachers assessed themselves as rather confident in their readiness to use ICT in education (Teo & van Schaik, 2012; Teo & Tan, 2012). Assessments were above the midpoints of the scales used. Similar results were found when assessing pre-service teachers' readiness to use ICT in education from the perspective of TAM model, i.e. the ease of use of the technology. Assessments have been slightly above the midpoint of the measuring scales (Teo & van Schalk, 2009). According to Sointu, Valtonen, Cutucache, Kukkonen, Lambert and Mäkitalo-Siegl (2017) and similarly to TPACK measures, the self-efficacy scale shows strong differences between pre-service teachers. However, authentic experiences of learning with ICT seem to provide good support for developing pre-service teachers' self-efficacy towards the use of ICT in education (Valtonen, Kukkonen, Kontkanen, Sormunen, Dillon, & Sointu 2015). The research findings discussed above suggest that pre-service teachers are generally somewhat confident with factors related to the use of ICT in supporting learning, while still showing the need for further development. In addition, the differences among pre-service teachers lead to the question of how teacher education can support pre-service teachers with different abilities and confidence. Aligning with Lei (2009), the pedagogically meaningful use of ICT seems challenging. In addition, based on Tondeur, Van Braak, Sang, Voogt, Fisser and Ottenbreit-Leftwich, (2012) and Gao et al. (2011) the use of ICT in education poses challenges for early career teachers and pre-service teachers.

The results above necessitate a focus on teacher education, on how teacher education supports the development of pre-service teachers' readiness to use ICT in education. There are several approaches for developing pre-service teachers' confidence for using ICT in education. Tondeur et al. (2012) conducted a qualitative review study of these approaches, presenting the SQD model that contains 12 key strategies for preparing pre-service teachers' effective technology use (See Fig. 1). These 12 strategies are divided in two levels: *the preparation of pre-service teachers* and *the institutional level*. The preparation of pre-service teachers' level contains six areas: 1) teacher educators as role models, 2) reflection on attitudes about the role of technology in education, 3) learning technology by design, 4) collaborating with peers, 5) scaffolding authentic technology experiences, 6)

continuous feedback. The institutional level contains five areas: 1) technology planning and leadership, 2) co-operation within and between institutions, 3) staff development, 4) access to resources, 5) systematic and systemic change efforts, 6) aligning theory and practice. The pre-service teacher level, i.e. micro-level (Tondeur et al., 2016), will be the main focus of this research in order to outline how pre-service teachers assess these areas and how these areas are actualized in teacher education.

Figure 1. SQD model (Tondeur et al. 2012)

Based on the SQD model, Tondeur et al. (2016) designed an instrument for measuring the six SQD micro-level strategies. The questionnaire contains 22 statements to measure how pre-service teachers assess the strategies used within teacher education to support their readiness to use ICT in education. This paper focuses on strategies used in the Finnish context. The research contains three phases: First, a validation of a modified SQD instrument. Secondly, descriptive statistics of the SQD areas will be discussed. Thirdly, the differences in outcomes for men and women are studied as well as the differences between the two Finnish universities.

Methods

Data were collected using a modified version of the SQD instrument that was introduced by Tondeur et al. (2016). The instrument was translated into Finnish with small modifications. The original questionnaire contained three statements that mentioned the internship periods, for example, *I was able to learn to use ICT in the classroom through the internships*. These references to the internship were removed and all statements were modified to focus on teacher education at a more general level. The response area was modified to contain two blocks, the first block for courses and lessons at the teacher education department and the second block for separate statements for the internship periods. The questionnaire was doubled from 24 statements to 48 statements. Within this paper, we focus on the support experienced at the teacher education department. The survey contained 24 statements using a one to six Likert-type scale 1 to 6 (*1=Totally disagree* and *6=Totally agree*). The research data consists of responses from a cohort of second year pre-service teachers from two Finnish universities. Research data were collected during the spring semester of 2018. Participation for the

research was voluntary, and data were collected during teacher education courses that focused on the use of ICT in education. The aims of the research were introduced to the pre-service teachers. Total number of respondents was 203, most of the respondents were women (167, 82.7%), the number of men was 35 (17.3%).

Teacher education in Finland consists of the Bachelor of Arts (Education) degree (180 ECTS) and the Master of Arts (Education) degree (120 ECTS). The pre-service teachers in the target group were doing their bachelor degree studies. These studies mainly contain courses categorized as basic and intermediate studies of education and multidisciplinary studies. Basic and intermediate studies of education focus on areas such as educational science, learning ethics, educational psychology, and research methods. Multidisciplinary studies focus on different subjects taught at Finnish schools at grades 1 to 6, e.g. mathematics, history, Finnish and literature, arts, music, etc. The aim of these courses is to provide pre-service teachers with skills and readiness to combine the content areas of different subject with pedagogical knowledge and with technology. From the perspective of the SQD framework the aim is to provide support for ICT integration during all courses primarily through meaningful experiences of learning with ICT.

In the current paper, we followed the footstep of Tondeur and his colleagues to examine the SQD model in the context of Finnish teacher education. The models were examined with confirmatory factor analysis. The fit of the model was determined by four goodness-of-fit indices: the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). According to Hu and Bentler (1999), the recommended cut-off values for a well-fitting model are close to .90 (for CFI and TLI) and below .08 (for RMSEA and SRMR). In order to study the internal consistency of the factors, Cronbach alpha (α) was used. We used alpha lower level 0.7 indicating an adequate reliability of the scale (Nunnally, 1978). Descriptives were calculated; (Mean [M] and Standard Deviation [SD]). Differences between men and women and differences between universities were studied using independent samples T-tests.

Results

Altogether, the modified SQD-instrument worked well in the Finnish context. First, we tested the six-factor model with all 24 items (Table 1). The results of the first attempt showed that the model did not fit the data well (CFI = 0.899, TLI = 0.883, RMSEA = 0.086, and SRMR = 0.059). After checking the modification indices, we correlated the residuals of REF3 with residuals of REF4, the residuals of AUT1 with the residuals of AUT2, and the residuals of AUT3 with the residuals of AUT4. The correlating errors were in the same factors suggesting that items have content overlap (Byrne, 2016). For the second model the model fit had improved (CFI = 0.922, TLI = 0.908, RMSEA = 0.077, and SRMR = 0.051) indicating a reasonable good fit.

Table 1
CFA Models with 24 items (N= 202)

Estimating model	Chi-Square test of model fit			Global fit indices			
	df	x^2	p	CFI	TLI	RMSEA	SRMR
SQD 1st attempt	237	594.855	0.0000	0.899	0.883	0.086	0.059
SQD 2nd attempt	234	511.921	0.0000	0.922	0.908	0.077	0.051

The goodness-of-fit information of the models above indicates that the six-factor model of SQD with 24 items worked well with the Finnish data, the factor loadings of each factor are presented in Table 2.

Table 2

Factor Loading (N=202)

Items	ROL	REF	DES	COL	AUT	FEE
ROL1	0.815					
ROL2	0.767					
ROL3	0.869					
ROL4	0.744					
REF1		0.783				
REF2		0.740				
REF3		0.697				
REF4		0.591				
DES1			0.828			
DES2			0.854			
DES3			0.862			
DES4			0.848			
COL1				0.788		
COL2				0.786		
COL3				0.803		
COL4				0.727		
AUT1					0.720	
AUT2					0.776	
AUT3					0.729	
AUT4					0.740	
FEE1						0.870
FEE2						0.929
FEE3						0.936
FEE4						0.362

Reliability of the SQD was measured by internal consistency reliability. The internal consistency reliability was estimated after examining the factor models of SQD. The internal consistency reliabilities (Cronbach's alphas) of six factors were as follows: ROL (α =.872), REF (α =.832), DES (α =.909), COL (α =.856), AUT (α =.857) and FEE (α =.953).

Descriptive statistics concerning SQD areas

The SQD model provides an overview of six strategies used in teacher education to support the development of pre-service teachers' readiness to take advantage of ICT in education. Results indicate that all areas of SQD were assessed above three, except the Feedback (mean 2.57). The highest assessments were for the *Role models* and *Collaboration*. Both areas were assessed at the same level; a mean value of 3.89 indicating experiences of teacher educators as role models in using ICT for education and possibilities for sharing ideas and experiences related to the use of ICT in education. The lowest outcomes were for *Feedback* (mean 2.57) indicating that pre-service teachers experience a low amount of continuous feedback, in comparison to other SQD areas. Also *Design* was assessed rather low (mean 3.16) indicating that there could be more support and help available for designing lessons and materials using ICT. The scores for *Reflection* and *Authentic* showed moderate means (3.68 and 3.78) indicating rather neutral experiences concerning the possibilities for discussing and reflecting about the use of ICT in education and about gaining experiences of using ICT for teaching and learning.

Table 3
Descriptives

SQD strategies	N	M	SD
Role models (ROL)	201	3,89	1,02
Reflection (REF)	198	3,68	1,02
Design (DES)	197	3,16	1,02
Collaboration (COL)	198	3,89	1,07
Authentic (AUT)	199	3,78	1,04
Feedback (FEE)	200	2,57	1,04

Differences in results between women and men were minimal, no statistical differences could be found on any of the six SQD areas. Differences between the two universities could only be found in the *Design* area (t(194)=2.44, p<.05). However, the difference between universities was small, only 0.36 (University 1, N=81, *M*=3.37, *SD* .98 and University 2, N=120, *M*=3.01, *SD* 1.03). This result indicates that pre-service teachers from the different universities differed in their assessment of the possibilities to learn to integrate ICT through (support for) the design of lessons and learning materials.

Conclusions

Based on the reasonable good fit for the model with the same six factors reported by Tondeur et al. (2016), we conclude that the modified version of the SQD instrument is a suitable instrument for the Finnish teacher education context. Results also indicated variance between the measured support strategies. Teacher educators as role models and collaboration with peers were the most actively used strategies for supporting the development of pre-service teachers' readiness to use ICT in education. On the contrary, continuous feedback and learning technology by design were the ones that were most rarely used during teacher education. All the assessments of strategies used varied between 2.57 and 3.98 indicating possibilities for improvement, especially in the areas with low values like continuous feedback. Results showed no differences in assessments among men and women. Interestingly, results were rather similar between the universities, and the only difference was in the use of design tasks and support provided.

The SQD instrument used in this study contained separate statements for normal teacher education courses and intern periods. This research focused only on the support at the teacher education department. This was because firstly, the target group, second year pre-service teachers, had rather limited experience of the intern periods, so validating the instrument in that context could have been problematic. Secondly, the results of this study are more comparable to the previous SQD studies (mostly focusing on teacher education generally). Still, for the future, the internship area will be important i.e. to show if there are differences among university studies and internship periods from the perspective of the SQD areas. Similarly, for the future the relations of SQD areas with areas of TPACK or TPB need to be studied. Baran et al. (2017) took the first steps in this area studying the relations between SQD strategies and TPACK showing positive relations with these areas. With more research, we can gain better understanding over the effects of different support strategies for pre-service teachers' perceptions of their skills. In addition, for the future the comparison of teacher education departments on a national level is needed. These studies would provide important insights into the possible differences among teacher education departments, providing valuable information for developing teacher training in order to meet the national goals. This research provided the first step of SQD research within the Finnish context. Results of the study are limited and show the need for the future SQD research in the field of teacher education.

Acknowledgements

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211.

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, 32, 665-683.

Baran, E., Canbazoglu Bilici, S., Albayrak Sari, A., & Tondeur, J. (2017). Investigating the impact of teacher education strategies on preservice teachers' TPACK. *British Journal of Educational Technology*, *50*(1), 357-370.

Byrne, B. M. (2016). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. New York, NY: Routledge.

Chai, C., Koh, J., & Tsai, C.-C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Educational Technology & Society*, *13*(4), 63–73.

Davis, F. D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, 13(3), 319–340.

Freeman, A., Adams Becker, S., Cummins, M., Davis, A., & Hall Giesinger, C. (2017). *NMC/CoSN Horizon Report: 2017 K–12 Edition*. Austin, Texas: The New Media Consortium.

Gao, P., Chee, T.S., Wang, L., Wong, A., & Choy, D. (2011). Self reflection and pre-service teachers' technological pedagogical knowledge: Promoting earlier adoption of student-centred pedagogies. *Australasian Journal of Educational Technology*, 27(6), 997-1013.

Hu, L. & Bentler, P. (1999): Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1-55

Koh, J., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore preservice teachers with a large-scale survey. *Journal of Computer Assisted Learning*, *26*, 563–573.

Lei, J. (2009). Digital natives as preservice teachers: what technology preparation is needed? *Journal of Computing in Teacher Education*, *25*(3), 87-97.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for integrating technology in teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Nunnally, J.C. (1978). *Psychometric theory* (2nd Ed.). New York, NY: McGraw-Hill.

Sointu, E.T., Valtonen, T., Cutucache, C., Kukkonen, J., Lambert, M.C., & Mäkitalo-Siegl, K. (2017). Differences in preservice teachers' readiness to use ICT in education and development of TPACK. In P. Resta & S. Smith (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2017 (pp. 2462-2469). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Teo, T., & Van Schaik, P. (2012). Understanding the intention to use technology by preservice teachers: an empirical test of competing theoretical models. *International Journal of Human-Computer Interaction*, *28*(3), 178-188.

Teo, T., & Tan, L. (2012). The theory of planned behavior (TPB) and pre-service teachers' technology acceptance: a validation study using structural equation modeling. *Journal of Technology and Teacher Education*, *20*(1), 89-104.

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.

Tondeur, J., van Braak, J., Siddiq, F., & Scherer, R. (2016). Time for a new approach to prepare future teachers for educational technology use: Its meaning and measurement. *Computers & Education*, *94*, 134-150.

Valtonen, T., Kukkonen, J., Kontkanen, S., Mäkitalo-Siegl, K., & Sointu, E. (2018). Differences in pre-service teachers' knowledge and readiness to use ICT in education. *Journal of Computer Assisted Learning*, 34(2), 174– 182.

Valtonen, T., Kukkonen, K., Kontkanen, S., Sormunen, K., Dillon, P., & Sointu, E. (2015). The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. *Computers & Education*, 81, 49– 58.

Valtonen, T., Pöntinen, S., Kukkonen, J., Dillon, P., Väisänen, P., & Hacklin, S. (2011). Confronting the technological pedagogical knowledge of Finnish net generation student teachers. *Technology, Pedagogy and Education*, 20(1), 1– 16.

Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., Lambert, M., & Mäkitalo-Siegl, K. (2017). TPACK updated to measure pre-service teachers' twenty-first century skills. *Australasian Journal of Educational Technology*, 33(3), 15– 31.