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Teacher educators' and pre-service teachers' confidence toward the use of ICT in education

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Abstract

Todays' teacher education needs to provide pre-service teachers with readiness to integrate ICT in education. Teacher educators are expected to serve as role models for pre-service teachers, providing them with examples and meaningful experiences of learning with ICT. The aim of this study is to provide an insight into teacher educators' and pre-service teachers' confidence toward

using ICT in education. In this study, both groups assessed their Technological Pedagogical Knowledge (TPK). The aim was to study the possible differences between teacher educators' and pre-service teachers' TPK assessments, and based on their assessments, to provide insights into teacher educators' readiness to act as role models for pre-service teachers. The participants of the study were 123 pre-service teachers and 83 teacher educators. The results indicate that the assessments of teacher educators were higher than pre-service teachers' assessments at the sample level. The results also indicate that pre-service teachers and teacher educators can both be divided into two aligning sub-groups, with higher and lower assessments. However, the comparison of these sub-groups showed that the assessments of the pre-service teachers in the higher sub-group were higher than with the assessments of the teacher educators in the lower (modest) sub-group. This study provides evidence for variation among teacher educators and pre-service teachers in terms of their TPK. This implies a need for more tailored ways to develop TPK in teacher education.

Keywords: teacher education, technology enhanced education, teacher educator, pre-service teachers, ICT, TPACK

Introduction

Preparing students for digital citizenship is one of the core tasks of today's schooling. Students are expected to gain so called 21st century skills that emphasize the abilities for collaborative working and problem solving, creative and critical thinking and the use of Information and Communication Technology (ICT) (Binkley et al., 2012; Voogt & Pareja Roblin, 2012; Lindfors, Pettersson, & Olofsson, 2021). Similar goals can also be seen in the Finnish curriculum that emphasizes collaborative learning practices, students' active role in learning and especially the role of ICT. ICT is seen as a tool and target for learning, students need to be provided with skills to use ICT as a tool for learning and working (FNBoE, 2014). These needs pose expectations for schools, teachers, and teacher educators. ICT in education is a challenging area because of its rapidly developing nature (Freeman, Adams Becker, Cummins, Davis, & Hall Giesinger, 2017; Weller, 2020). New applications and pedagogical practices are constantly developed, providing different possibilities for supporting learning but also needs for familiarizing oneself with the technologies. Currently technologies such as Artificial Intelligence (AI) and Learning Analytics (LA) challenge teachers and teacher educators to consider their role and potential in education (Vartiainen, Tedre & Jormanainen, 2023; López-Pernas et al., 2022). In-service teachers (teachers working in the field), as well as pre-service teachers (teacher students) and teacher educators have a key role in taking advantage of these new possibilities and in building pedagogically meaningful practices of using ICT in education.

In order to meet these needs, pre-service teachers need to be provided with examples and authentic learning experiences of teaching and learning with ICT (Tondeur et al., 2012). Still, previous research has indicated that pre-service teachers face challenges in using ICT for supporting students' learning (Gudmundsdottir & Hatlevik, 2018; Tondeur et al., 2013). Despite the expectations related to today's pre-service teachers being an ICT-ready generation (Lei, 2009), we know that building pre-service teachers' competencies to use ICT in education is a challenging task demanding different strategies (Tondeur et al., 2012). Despite the common learning pathways during teacher training, there are differences between pre-service teachers in their ability to use educational technology (Schmid et al., 2021; Valtonen et al, 2019). Aligning with Tondeur et al. (2019), this poses demands for teacher educators since they have a gatekeepers' role when developing pre-service teacher preparedness to integrate ICT in education. According to Tondeur et al. (2012), teacher educators are supposed to be the role models for pre-service teachers, i.e. to model the use of ICT in education and to reflect positive attitudes toward the use of ICT. Still, this can be challenging also for teacher educators who may not be trained for using ICT in education.

The integration of ICT for learning has been studied using various theoretical frameworks. One actively used framework is the Technological Pedagogical Content Knowledge (TPACK) by Mishra and Koehler (2006). TPACK framework focuses on ICT integration from the perspectives of technology, pedagogy and content taught. Since its introduction, the TPACK framework has been used actively worldwide for studying ICT integration. Altogether, the ICT integration has received considerable research attention when considering pre-service teachers, but when it comes to teacher educators, the research efforts are scarce. Especially the studies focusing on differences and similarities of pre-service teachers and teacher educators are scarce. The aim of this study was

to investigate both teacher educators' and pre-service teachers' confidence toward the use of ICT in (five) Finnish teacher education departments by utilizing the modified elements of the TPACK framework.

Theoretical background

ICT integration in the educational context has been studied from variety of perspectives with several theoretical models deriving from different disciplines. Studies have been conducted focusing on the usefulness and ease of ICT use (Davis, 1989; Marangunić & Granić, 2015), pedagogical beliefs (Ertmer, Ottenbreit-Leftwich & Tondeur, 2014), facilitating conditions and acceptance factors for using ICT (Kyllönen, 2020; Venkatesh et al., 2016). In addition, attitudes, self-efficacy and expectations of others affect the educational use of technology (Kyllönen, 2020; Teo, 2015; Venkatesh et al. 2016). Altogether, it is somewhat agreed that teachers' ICT use is a complex entity exposed to various factors. TPACK framework was developed solely for the educational context to target the specific combination of pedagogical knowledge (PK), content knowledge (CK) and technological knowledge (TK). TPACK was built on the Pedagogical Content Knowledge framework by Shulman (1986) indicating vast research within educational context. TPACK model considers the ICT integration from the three knowledge areas TK, PK and CK covering the areas relevant for the ICT integration in educational settings (Mishra & Koehler, 2006). As these core knowledge areas intersect, four combining areas: Technological pedagogical knowledge (TPK), Technological content knowledge (TCK), Pedagogical content knowledge (PCK) and Technological-pedagogical-content knowledge (TPACK) are composed.

In the TPACK context, the TPK is the area that focuses on combining pedagogy and technology without specific reference towards certain subject matter (Chai, Koh & Tsai, 2013). TPK refers to knowledge of existing technologies and pedagogical practices as well as the abilities to combine the suitable ICT tools for certain pedagogical purposes, targeting pedagogically meaningful learning with ICT (Chai, Koh & Tsai, 2013; Mishra & Koehler, 2006). TPK also refers to understanding about how technology may change the teaching and learning process (Schmidt, et al., 2009). This study focuses on TPK since the target groups of this research include pre-service teachers and teacher educators from different disciplines, i.e. TPK without reference to any specific subject matter, is well suited for the study. The primary school teachers in Finland have a major in educational sciences but are obligated to study multidisciplinary subject studies consisting of subject didactics and pedagogy of these all together 60 ects (Malinen, Väisänen & Savolainen, 2012). From the perspective of pedagogy, TPK has typically been measured with very general level statements (Valtonen et al., 2023). In this article, TPK will be focused with fine-grained items in terms of pedagogical aspects. The aim is to better highlight the role of pedagogy affecting the use of ICT (see. Tondeur et al. 2017).

Several studies have focused on pre-service teachers' TPACK areas conducted with self-assessment instruments. Results on how pre-service teachers assess their confidence and unconfidence in TPACK areas are contradictory. The study by Schmidt, Brianza and Petko (2021) indicated that the most confident areas among pre-service teachers were CK and PCK. TCK and TK were assessed lower. In study by Valtonen et al. (2018), pedagogy-related TPACK-areas were assessed highest by pre-service teachers, whereas technology-related areas, especially TCK were assessed lowest. Again, in the study by Koh, Chai and Tsai (2010), the PK was assessed as the highest area and the CK as the lowest. In the study by Deng, Chai, So, Qian and Chen (2017), CK

was assessed as the area of lowest confidence. It seems that in these studies the confident areas are typically pedagogy-related areas, whereas the areas related to TK or TCK are seen as more unconfident. A common feature with the TPACK studies is that the differences between TPACK areas are small. Still, based on study by Valtonen et al. (2019), when considering the development of separate TPACK areas, the differences between TPACK areas were bigger, and the development was faster in the areas related to pedagogical knowledge (PK and PCK) compared to the areas related to technology (TK and TCK).

Although teacher educators have not always been trained for using ICT in education, their role is highly important for supporting pre-service teachers' readiness to use ICT in education (Ertmer, 2005; Tondeur et al., 2012). In the study by Tondeur et al. (2019), teacher educators' attitudes towards ICT in education and self-efficacy to design an ICT-rich learning environment were investigated. The results indicate that teacher educators had a positive attitude and rather positive self-efficacy towards using ICT. In addition, Tondeur et al. (2019) outlined two teacher educator profiles, one with low assessment and one with high assessments, indicating variation among teacher educators. As the results indicate strong correlation between teacher educators' competencies to use ICT in education and the way they provide support for their students to use ICT in education, it is important to reveal teacher educators' skills to use ICT in education (Tondeur et al., 2019). According to Kirschner et al. (2018), teacher education programs should stimulate the pedagogical use of ICT to improve the existing teaching practice with ICT in schools. Teacher educators' deficiency of digital competence may lead to the situation in which they cannot act as competent mentors for the pre-service teachers (Judge & O'Bannon, 2008).

Based on previous studies, teacher educators are supposed to serve as role models for pre-service teachers (Ertmer, 2005; Kirschner et al., 2018; Tondeur et al., 2012; Uerz, Volman, & Kral, 2018) to provide meaningful learning experiences with ICT (Valtonen et al., 2023). What is missing are the studies comparing the pre-service teachers' and teacher educators' confidence for using ICT in education. This research responds to this need by comparing the confidence toward the use ICT in education among the sub-groups of teacher educators and pre-service teachers.

Aims and methods

Aim and research questions

The aim of this study is to provide insights into teacher educators' and pre-service teachers' confidence toward their readiness to use ICT in education, especially in terms of TPK readiness subfactors and levels of teacher educators' and pre-service teachers' confidence in these subfactors. The research questions are:

1. How teacher educators and pre-service teachers assess their confidence toward using ICT in education?
2. Are there differences between teacher educators' and pre-service teachers' TPK self-assessments?

3. What types of clusters can we identify within the teacher educators and within pre-service teachers?

Context of the study, research data and analysis

This research scrutinizes perceived technological pedagogical knowledge among the participants of a nationwide project carried out in teacher education departments in five Finnish universities. Project was a joint learning and teaching project of pre- and in-service teachers and teacher educators to enhance the use of ICT in pedagogically meaningful ways in different school levels. The project aimed to enhance communication between teacher education departments and schools to put research-based teaching and learning activities into practice.

The target group (N=201) of this research contains pre-service teachers (n=118, 59%), and teacher educators (n=83, 41%). The data collection was conducted in 2018 as part of a teacher education development project they all participated. Over 90% of the students were pre-service primary teachers. One fourth of the students were the first year, one half of the students were studying for the second year, and the rest were third to fifth year students. Permission for data collection was received from participants and participation was voluntary. Participants were well informed about the aims and methods of the research. Data was collected from teacher educators as a part of the staff meetings using online questionnaire. The pre-service teachers' data and teacher educators' data were collected as a part of their reflective assignments during the planning of teaching activities. One half of the teacher educators had worked as teacher educators less than 10 years.

The questionnaire used in this study focused on TPK with 15 items using scale of 1 to 7 (1=totally disagree and 7=totally agree). The questionnaire was built using items from previously validated instruments: Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT), by Schmidt et al. (2009) and the TPACK21 questionnaire by Valtonen et al. (2015). Combining the SPTKTT and TPACK21 instruments for the TPK, the instrument covered statements such as *where ICT is used according to the curriculum.* At the other end, there were statements focusing on certain pedagogical practices such as *where ICT is used for problem solving and inquiry.* In addition, there were statements focusing on the use of ICT for assessments such as *where ICT is used for peer assessment*. This combination of SPTKTT and TPACK21 of instruments, targeting the TPK was well suited for the purposes of this study. TPK targets only the combination of pedagogy and technology, providing us with a more general level perspective, instead of content specific focus. Also, the extension of SPTKTT with TPACK21 instrument provided a more profound perspective of different pedagogical purposes of using educational technology. The instrument is shortly demonstrated in Table 1.

The analysis was conducted using the Statistical Package for the Social Sciences (SPSS). The first step of the analysis was evaluating the validity of the TPK instrument used to outline different TPK subareas. This phase consolidated the 15 separate items for subscales to outline the connections between different variables (Afifi & Clark, 1996). This was done by using principal component analysis. Since the 15 items dealt with different TPK features, the oblimin rotation was selected.

TPK is seen as a one entity (Mishra & Koehler, 2006), i.e. the measured TPK areas are assumed to correlate, making the oblimin rotation as a well justified solution (Afifi & Clark,1996; Hair, Black, Babin, & Anderson, 2010). Furthermore, the inquiry factor and 21Skills share the element of inquiry, and therefore the also the same item, which was considered appropriate (see Byrne, 2010, p.125). The correlation matrix was found to be suitable (KMO =.966; Bartlett's test p<0.001) for the analysis. The total variance explained by the four-component solution was high (85.5%). The indicated four TPK subscales were: 21Skills, Assessment, Instruction and Inquiry (Table 1).

Cronbach alpha (α) was used to define the internal consistency of the measured subscales, and the adequate reliability of a scale was 0.7 (Nunnally, 1978).

Table 1

TPK subscales

TPK Subscales	Example items	Alpha (Number of items)
21Skills	I know how to plan and execute learning situations ...where ICT used for problem solving and inquiry …where ICT is used in self-directed working. …where ICT is used for brainstorming and planning of the working. …where student work in small groups or pairs utilizing ICT …where ICT is used to enhance action-based learning	.96 (5)
Assessment	I know how to plan and execute learning situations …where ICT is used for peer assessment. …where ICT is used for learner self-assessment. …where ICT is utilized to support learners' individual needs.	.93 (3)
Instruction	I know how to… …find use technologies supporting my work …use ICT to support my teaching …use ICT for illustration of difficult to learn topics. …use ICT according to the curriculum.	.94 (4)
Inquiry	I know how to plan and execute learning situations …where ICT is used for problem solving and inquiry.	.90 (3)

TPK Subscales	Example items	Alpha (Number of items)
	…where ICT is used for documenting the activities …where ICT (mobile devices, smartphone, for instance tablet, laptop) is used for learning outside the school premises	

In the second phase, the descriptive statistics (*M, SD*) were used for outlining the TPK areas from the teacher educators' and pre-service teachers' perspectives. The differences between teacher educators and pre-service teachers were studied using independent sample t–test. The third phase of the analysis was k-means cluster analysis to outline the differences first among teacher educators' group and also among pre-service teachers' group. The aim of the cluster analysis is to indicate different sub-groups, so that the differences among members of a specific subgroup are small and the differences between the clusters are big (Hair, Black, Babin, & Anderson, 2010; Jain, 2010). Cluster analysis was conducted using the four TPK factors, ending at two subgroups with teacher educators and pre-service teachers.

Results

All the participants showed rather modest assessments on their TPK areas, namely none of the measured mean values of the items (n=15) reached the value given for the strong confidence i.e. assessments over five (scale from one to 7). The differences were the biggest in subscale related to 21st century skills (*21Skills*, difference M= 0.99). The results indicate that both groups assessed the *Inquiry* as their strongest area (teacher educators M = 4.74, pre-service teachers M = 3.91). In addition, both groups assessed the *Assessment* as the weakest area (teacher educators M = 4.34, pre-service teachers M = 3.39). Altogether, the differences between the four TPK areas were small, within both groups.

The results of the further analysis suggest that compared to pre-service teachers, teacher educators are altogether more confident in their TPK areas. Differences between the groups in all measured areas were statistically significant. The biggest difference among groups were in *21Skills*, the lowest in *Inquiry.* Altogether, the difference between TPK elements was not very big, varying from 0.68 to 0.97. However, the effect sizes vary from medium (d=0.66) to large (d=0.82).

Table 2

Descriptive statistics of the data

TPK Subscales	All data Mean(SD)	Teacher educators Mean(SD)	Pre-service teachers Mean(SD)	Mean difference	t (df=198)	Cohen's d
Inquiry	4.24(1.26)	4.74(1.14)	4.06(1.24)	0.68	4.62***	0.66
21Skills	4.04(1.27)	4.64 (1.18)	3.67(1.16)	0.97	5.75***	0.82
Instruction	4.02(1.27)	4.57(1.29)	3.66(1.12)	0.91	5.35***	0.77
Assessment	3.77(1.32)	4.34 (1.16)	3.40(1.28)	0.94	5.32***	0.76

Note. M Mean, SD Standard Deviation. *** $p<0.001$, ** $p<0.01$ level

While the differences between the TPK areas were small, the variations among respondent groups were bigger, implied by standard deviations varying from the smallest SD. 1.1 to the biggest SD. 1.3. To provide better insight into the assessments in both groups, the cluster analysis was conducted. The most meaningful solution with reasonable size groups illustrating the differences was achieved with two cluster models for both groups (Table 3). The clusters contain groups for the ones with high assessments and the ones with lower assessments in all TPK areas.

Table 3

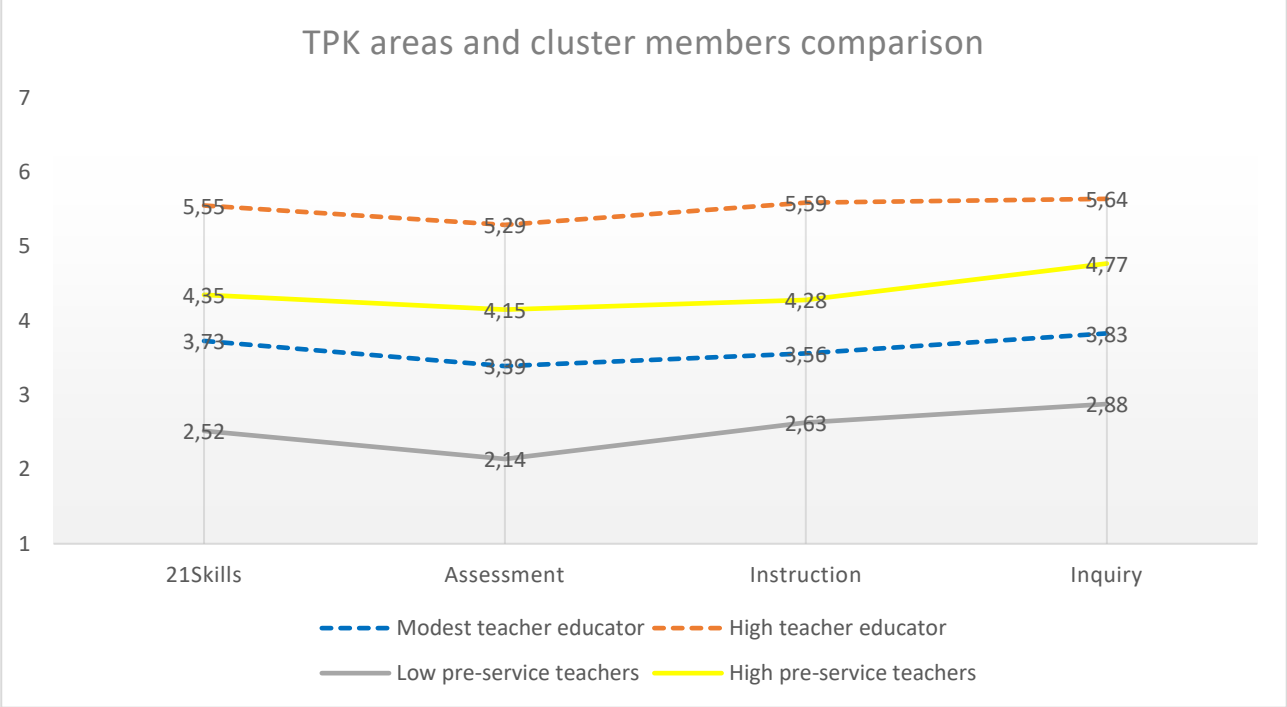
Teacher educator and pre-service teacher subgroups

	Teacher educators		Pre-service teachers	
	Modest (n=41, 50%)	*High* (n=41, 50%)	*Low* (n=44, 37%)	*High* (n=74, 62%)
21Skills	3.73	5.55	2.52	4.35
Assessment	3.39	5.29	2.14	4.15
Instruction	3.56	5.59	2.63	4.28
Inquiry	3.83	5.64	2.88	4.77

The clustering of teacher educators produced two equally sized sub-groups, one with higher TPK assessment (High, n=41) and one with lower TPK assessments (Modest, n=41). The clustering of pre-service teachers also resulted in two sub-groups, the smaller sub-group with lower TPK assessments (Low, n=44) and the bigger sub-group with higher assessments (High, n=74). The teacher educators in the High sub-group had the highest TPK assessments altogether; all TPK areas were assessed above five. The pre-service teachers' sub-group High had the second highest TPK assessments, higher than the assessments of teacher educators in Moderate sub-group. The lowest TPK assessments were in the pre-service teachers' sub-group Low; all TPK areas were assessed below three. The assessments of different TPK areas within all clusters align with the results of all respondents' data (Table 3 i.e. the highest assessments were for the 21skills and the lowest assessments for the Assessment.)

Figure 1.

Cluster comparisons between pre-service teachers and teacher educators



Discussion

The aim of this article was to study teacher educators' and pre-service teachers' confidence toward the use ICT in education based on self-assessment. *All the participants showed rather modest assessments in their TPK areas* as none of the measured items or factors were assessed over five. Results indicate that the strongest TPK areas were *ICT for inquiry and ICT for 21st century skills, whereas ICT for instruction got slightly lower values, and the use of ICT for assessments gained the lowest values*. These results align with the results from Carpenter et al.'s (2020) study, where the use of digital tools for assessment were among the ones least mentioned, still being highly important in terms of teachers' technology competencies. Altogether, *the structure of the*

TPK of the teacher educators and pre-service teachers were quite similar, but the assessments of the teacher educators were higher than the assessments of the pre-service teachers, and the differences were statistically significant. Clustering of respondents showed two subgroups within both teacher educators and pre-service teachers, sub-groups with higher and lower assessments. The sub-group level showed that there was a group of pre-service teachers with higher confidence for their readiness to use ICT than the teacher educators in the lower confidence sub-group. Despite the expectations of the younger generations' fluent ICT skills, this study shows that when self-assessing confidence to use ICT for teaching and learning purposes this is not necessarily the case. These results align with the results from previous studies conducted separately for pre-service teachers (Schmidt et al., 2009; Valtonen et al., 2019) and for the teacher educators (Tondeur et al., 2019), indicating differences within confidences in both groups.

Teacher educators with low TPK assessments may cause challenges for teacher education. Teacher educators should be able to offer meaningful authentic examples and to act as role models on how to use ICT in education for pre-service teachers (Kirschner, Wubbels, & Brekelmans, 2018; Tondeur et al., 2012; Uerz et al., 2018). According to Tondeur et al. (2019), teacher educators' ICT competences correlate with their way to support the pre-service teachers' readiness to use ICT in education. Based on the results of this study, half of the teacher educators assessed their TPK areas lower than 62% of the pre-service teachers. This result poses the question of how much and what way they can integrate ICT for their teacher education courses and whether they can act as role models for pre-service teachers, i.e., who are the role models and who are the co-learners. And again, do we need to be concerned if everyone is not fully competent and highly willing to integrate ICT in education, or could we see their strong role and expertise within some other areas of education and schooling. We can assume that during the age of platformization of education (Kerssens & Dijck, 2021) and AI (Vartiainen et al., 2023), also the more critical voices may be important.

We assume the results targeting the use of ICT for different purposes, relates with the Finnish national core curriculums and its emphasis on using ICT for creative and inquiry activities, not explicitly for assessment purposes (FNBoE, 2014). For the future, we believe that teacher educators could also be considered as co-learners and co-developers of ICT in education as a way of offering the possibility of continuous professional development requested by Lindfors et al. (2021). This could mean testing and developing new pedagogically sound ways to use ICT in education together with the pre-service teachers, focusing especially on assessment purposes. Altogether, in this study the focus was on self-assessed TPK areas which is one limitation of this study. For the future, it will be important to study the actual use i.e. for what purposes and how actively the teacher educators use ICT during their courses, and what are the actual differences between teacher educators with high and low TPK assessments.

This study provided a new perspective for the use of ICT in the teacher education context by combining the results of teacher educators and pre-service teachers in terms of their perceived TPK. The challenge of this research is rather small size of the target groups. For the future, there is a need for bigger sample size to possibly gain more sub-groups with different characteristics /

dimensions, instead of just the strong and weak TPK. With bigger target groups also, more sophisticated methods, such as latent profile analysis, are needed. In addition, other methods such as performance-based methods will be needed to gain insights into the actual use of ICT in education. Still, despite the rather small sample size, the study was able to highlight teacher educators' and pre-service teachers' confidence levels toward the use of ICT in education and especially the deviations within the results in both groups.

Conclusion

This study provides insights into teacher educators' and pre-service teachers' knowledge related to the use of ICT in education. The results suggest important questions concerning the teacher educators' position and possibility to act as role models for pre-service teachers. Instead of mere role models, it is also important to consider teacher educators as co-learners and developers of the ways to use ICT in education, providing space for pre-service teachers' possibly innovative and creative ideas. This could be especially the case when teacher educators have low confidence in using ICT in education and possibly are in the risk of neglecting the use of ICT altogether.

This study also showed the nature of TPK as a suitable framework for assessing teacher educators' and pre-service teachers' confidence towards using ICT for various educational purposes. There are several instruments designed for measuring the TPACK (Koh & Sing, 2011; Smith et al. 2009; Valtonen et al., 2023). These instruments are typically rather copious, especially when covering several content areas. In this study, we were able to focus on confidence toward combining certain pedagogical entities and ICT, still with rather short instrument. Especially with subject teachers, we can use the instrument for assessing their confidence without the need for content specific areas. We see this important as a way for bringing the different pedagogical approaches and goals for the target of the research.

From the perspective of ICT integration, we argue that the use of TPK can be seen as a well justified, short instrument to probe the confidence toward combining certain pedagogical entities and use of ICT. Especially concerning a mixture of pre-service teachers and teacher educators, both can assess their confidence, with high consistency of the instrument, and without the need for targeting the content specific areas.

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