Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century — Source link

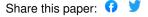Jo Tondeur, Koen Aesaert, Bram Pynoo, Johan van Braak ...+2 more authors

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Developing a validated instrument to measure pre-service teachers' ICT competencies: Meeting the demands of the 21st-century

ICT competencies for pre-service teachers

Developing a validated instrument to measure pre-service teachers' ICT competencies:

Meeting the demands of the 21st-century

Abstract

The main objective of this study is to develop a self-report instrument to measure pre-service teachers' ICT competencies in education. The questionnaire items of this instrument are based on an existing comprehensive framework and were created with input from experts in the field. The data were collected from a sample of 931 final-year pre-service teachers in Flanders (Belgium). A first subsample was used for an exploratory factor analysis, and a second one to verify the identified factor structure via confirmatory factor analysis. A two-factor structure of ICT competencies was identified: (a) competencies to support pupils for ICT use in class and (b) competencies to use ICT for instructional design. This two-factor structure was confirmed in the confirmatory factor analysis. Recommendations are made on how this reliable instrument can help assess the level and progress of pre-service teachers' ICT competencies.

Introduction

With the rapid development of technology in recent decades, it has been widely recognized that pre-service teachers should be prepared to adequately integrate Information and Communication Technology (ICT) into their educational practice. Teacher training institutions (TTI) are thus expected to provide pre-service teachers with the necessary competencies to teach with ICT. In other words, pre-service teachers' ICT competencies can be set as one of the primary benchmarks for teacher education programs (Kirschner, Wubbels, & Brekelmans, 2009). Several initiatives have been taken to provide frameworks with competencies that (pre-service) teachers should acquire in relation to the use of ICT in teaching and learning processes (e.g., ISTE, 2008). Recently, in Flanders (Belgium), a new comprehensive framework for pre-service teachers' ICT-competencies has been developed (ENW AUGent, 2013). This ICT competence framework (ICT-CF) has integrated existing frameworks and aims to establish a useful format for the development of pre-service teachers' ICT competencies.

The introduction of the abovementioned framework assumes that it is crucial for pre-service teachers to develop the necessary ICT competencies. Although similar frameworks designed by government agencies are available (e.g., Kennisnet, 2012), they were conceived mainly at a conceptual level and have not always been empirically validated. Hence, it is still not always clear whether and to what extent pre-service teachers possess the necessary competencies to integrate ICT into their educational practice. This study intends to provide TTIs, the research community, as well as policy makers with a validated self-report instrument that can be adopted to assess the level and progress of pre-service teachers' ICT competencies.

Background

Pre-service teachers' ICT competencies

The 21st-century has set considerable demands concerning ICT competencies (Griffin, McGaw, & Care, 2012). The effects of such demands can also be observed in teacher training programs, in the sense that TTIs are expected to provide new teachers with the necessary competencies to integrate ICT into education and to educate pupils to become ICT competent. To respond to this expectation, many institutions have included introductory ICT courses in their curriculum, primarily focused on the development of ICT knowledge and skills (Polly, Mims, Shepherd, & Inan, 2010). However, empirical evidence shows that pre-service teachers often still do not feel adequately prepared to effectively incorporate technology into their classrooms (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Tondeur et al., 2012), mostly owing to a gap between technical ICT skills and the knowledge of good pedagogical practice.

As directed by the concept of Technological Pedagogical Content Knowledge (TPACK), Koehler and Mishra (2009) have suggested that pre-service teacher education should not only focus on how to use technology but that it should also examine how technology intersects with pedagogical and content knowledge. Their concept of TPACK stems from Shulman's (1987) notion about pedagogical content knowledge and his belief that teaching boils down to understanding what is to be learned and how it is to be taught. In line with this reasoning, the development of TPACK capabilities should be infused into the entire curriculum so that pre-service teachers can experience how these can support teaching and learning (Tondeur, Pareja Roblin, van Braak, Fisser, & Voogt, 2013). Without such integrated approaches, the ICT

competencies acquired by pre-service teachers are likely to remain isolated and unexploited (Polly et al., 2010).

ICT-competencies frameworks

Many organizations have provided frameworks with ICT standards that need to be met by (pre-service) teachers (see Appendix). In these frameworks, different terms are used, such as ICT literacy, digital literacy, and ICT competence (Markauskaite, 2007). ICT skills refer to the technical use of ICT, whereas ICT competencies are conceptualized as the integrated and functional use of digital knowledge, skills, and attitudes (Ananiadou & Claro, 2009); as such, digital skills are a part of digital competencies (Erstad, 2013). In the present study, however, the term ICT competence is used, because it offers a more comprehensive view of the use of technology.

In several countries, frameworks on ICT competence were first implemented for students in schools, and have only recently started targeting teachers. For instance, in Norway the emphasis is on competence in using ICT in educational practices, and specifications of standards and measurement instruments are under development (Norwegian Centre for ICT in Education, 2015). The implication is that most Norwegian TTIs have been slower in cultivating ICT competence strategies among pre-service teachers than in-service teachers (Erstad, 2013). Similarly, in the United States, the International Society for Technology in Education (ISTE) standards and performance indicators (2008) have been applied as important guidelines for in-service teachers on ways of implementing and using ICT as part of their teaching practices, promoting innovation, engagement, and professional growth.

ICT competencies for pre-service teachers

More recently, a framework for teachers has been developed in the Netherlands to describe "which skills teachers need to integrate ICT in such a way that it makes their education more attractive, more efficient, and/or more effective" (Kennisnet, 2012, p. 4). The challenge with respect to ICT frameworks is that new technologies and tools are constantly being produced. It is therefore often argued that ICT competence should not simply consist of specific technological skills, as these will vary according to the hardware and software that is used (Tondeur, van Braak, & Valcke, 2007). Instead, more generic competences should be fostered, as these involve ways of using technology for teaching and learning across technologies and subject domains.

Measuring ICT competencies

Ways of measuring ICT competencies have been an issue among researchers for years. Several efforts have resulted in measuring ICT competencies at both national and international levels (e.g., Pynoo, Kerckaert, Goeman, Elen, & van Braak, 2013). The most common group of such initiatives using questionnaires are focusing on frequency of use and pedagogical approach linked to ways of using ICT in schools (Pelgrum & Law, 2003). However, another group of these initiatives have been emphasizing more complex conceptual frameworks and ways of using ICT for learning. For example, in Norway tests have been developed reflecting aims in the curriculum to approach digital competence as a cross-curricular area, such as information processing, creating, communicating, ethics of use, and how this is taken up in TTIs (Gudmundsdottir, Loftsgarden, & Ottestad, 2014). A third group of measuring initiatives on ICT competence are using performance assessment-based tasks (e.g., Aesaert et al., 2015). Some test items in the International Computer and Information Literacy Study (ICILS) study (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014) have such 'authoring tasks' in order to measure what students can do with ICT. Nevertheless,

validation challenges have been a key concern in many of these initiatives on measuring ICT competencies.

Similarly, several studies have reported challenges with TPACK construct validation (Fisser, Voogt, Tondeur, & van Braak, 2015; Sang, Tondeur, Chai, & Dong, 2015). Ever since the TPACK framework was adopted to describe the required knowledge and skills for effective ICT integration into teaching and learning, many researchers have aimed to determine whether pre-service teachers already have sufficient TPACK and whether any growth in TPACK can be measured. Most self-assessment surveys that have been used divide TPACK into a subset of the knowledge domains and measure the components of the TPACK framework among pre-service students (e.g., Schmidt et al., 2009). Yet, a major difficulty with instruments to assess TPACK is that the components of the TPACK framework cannot be reproduced. A clear example of this can be found in Archambault and Barnett (2010), who found that their survey items loaded onto only one single construct in an exploratory factor analysis of a TPACK survey. Another hurdle that often needs to be tackled in developing instruments to assess TPACK is that not all arguments behind methodological choices are clearly described (Fisser et al., 2015). In conclusion, considering construct validation challenges in previous similar studies, in the current study we will strive for transparency by describing the development process step-by-step.

Context and purpose of the study

Following a review of the various ICT competence frameworks (see Appendix for an overview), the Expertise NetWork at the Ghent University Association (ENW AUGent) developed an ICT competence framework (ICT-CF) for pre-service teachers that is both applicable and adaptable for TTIs (ENW AUGent, 2013). Its goal was to integrate the

complex stipulations from the different ICT frameworks within the fast evolution of ICT and to construct a useful format that could be used in concrete situations. The ICT-CF was designed around three significant domains in the teacher profession: (a) instructional and pedagogical tasks, (b) professional development, and (c) the school in a broader context.

On the basis of the ICT-CF, the purpose of the present study is to develop a validated self-report instrument that measures the competencies pre-service teachers should possess at the end of their initial training in order to integrate ICT into education. More specifically, we will focus on the instructional and pedagogical tasks associated with the organization of ICT within the learning environment. By doing so, we intend to gain insight into the level and progress of pre-service teachers' ICT competencies in view of their teaching and learning activities.

Research design

Procedure and sample

The research was set up along distinct phases, involving specific groups of respondents. In a first phase, the analysis of the ICT-CF helped to define questionnaire items. In the next step, 15 stakeholders (i.e., pre-service teachers, teacher trainers, ICT coordinators, and researchers) evaluated the first version of the questionnaire items. This evaluation focused on identifying relevant items to measure the ICT-CF, fine-tuning the wording of the items, and reducing item complexity. For example, the ICT-competence "supporting pupils to communicate, collaborate and work with ICT in a safe, responsible, and effective way" was changed into two items: "supporting pupils to communicate with ICT in a safe, responsible, and effective way" and "supporting pupils to work together with ICT". According to the stakeholder group, communication and collaboration by means of ICT should be considered as a different

competence. This step refined the instrument considerably, leading to a pool of 19 essential

competencies to be attained by pre-service teachers at the end of their initial training. This

new version of the instrument is presented in Table 1.

The final item set was surveyed online with a sample of last-year pre-service teachers from

TTIs in Flanders in May 2014. The heads of department from 20 TTIs in Flanders (Belgium)

were willing to participate in this study. All respondents received an email invitation to fill in

the survey, which was completely voluntary. In the end, 931 last-year pre-service teachers

(72.4% female and 27.6% male) completed the online questionnaire anonymously.

Measure and data analysis

Each item in the questionnaire was presented as a statement revolving around one of the three

dimensions of the ICT-CF: (a) to educate pupils to become ICT competent; (b) to support and

strengthen learning and development processes by means of ICT; and (c) to organize ICT

appropriately in the learning environment. Respondents were asked to rate each statement on

a five-point Likert scale, anchored between (0) *strongly disagrees* and (5) *strongly agree*.

To check the quality of the developed instrument, an exploratory (EFA) and confirmatory

factor analysis (CFA) was conducted with two subsamples. A simple random sampling

procedure was used to derive both subsamples from the total student sample.

Representativeness of both subsamples was checked for gender. More specifically, the results

of a chi-square test for independence with a Yates' correction for continuity indicated that

males and females were equally distributed across both subsamples (χ^2=0.51, p=.48).

Furthermore, the ratio between both subsample sizes (n_1=466 and n_2=465) and the number of

items (19) met the minimum requirement of 10 participants per item (Floyd & Widaman,

1995). The questionnaire items ran through three stages of scale development. First, a Maximum Likelihood EFA (in SPSS 21) was conducted on subsample 1 (*n*=466) to identify the number of latent factors underlying teachers' pedagogical-didactic ICT competencies. Because it seemed unlikely that the latent factors underlying pre-service teachers' ICT-competencies would not correlate, Oblimin oblique rotation was used (Reise, Waller, & Comrey, 2000). Factor extraction was based on the K1 rule (eigenvalue>1), analysis of the scree plot, and parallel analysis (Floyd & Widaman, 1995). In the second stage, a Maximum Likelihood CFA (Amos 21) was applied to subsample 2 (*n*=465) to investigate whether the identified exploratory factor structure fit the data. For this purpose, the following fit measures were reported: (a) the Goodness of Fit Index (GFI), (b) the Adjusted Goodness of Fit Index (AGFI), (c) the Tucker-Lewis Index (TLI), (d) the Comparative Fit Index (CFI), and (e) the RMSEA (Floyd & Widaman, 1995). These measures should all exceed .90, except for RMSEA whose value should be below .05 for a close fit and between .05 and .08 for an adequate fit (Finch & West, 1997). In the third and final stage, we checked the reliability of the developed scales by calculating Cronbachs' alpha for subsample 1, as a measure of internal consistency.

Results

Exploratory factor analysis

To identify the number of factors that underlie the 19 items, we conducted an EFA on subsample 1 (*n*=466). All items were normally distributed, which means that no items were deleted due to a high skewness (>2) or kurtosis (>7) (Finch & West, 1997). The eigenvalues (K1-rule), analysis of the scree plot (Figure 1), and the parallel analysis all yielded a two-factor solution, which accounted for 56.3% of the common variance.

<Fig. 1>

Table 1 indicates that the 19 items duly load on two factors, with factor loadings varying between .57 and .85. The two factors are labelled "Competencies to support pupils for ICT-use in class" (ICT competence Pupil Use: ICTC-PU) and "Competencies to use ICT for Instructional Design" (ICT competence Instructional Design: ICTC-ID). The 11 items on ICTC-PU were designed to measure the extent to which pre-service teachers are competent to educate pupils in the use of ICT for learning processes. The eight items on instructional design (ICTC-ID) measure the degree to which pre-service teachers are competent to use ICT to support and strengthen their instructional practice. As such, the items on ICTC-ID combine the theoretical dimension of (a) supporting and strengthening learning and development processes by means of ICT and (b) organizing ICT appropriately in the (electronic) learning environment into one factor.

<Table 1>

Confirmatory factor analysis

In order to confirm the hypothesized two-factor structure of ICTC-PU and ICTC-ID, a CFA was conducted on subsample 2 (*n*=465). The results show a relatively good to good fit between the two-factor model and the data (GFI=.91; AGFI=.88; TLI=.95; CFI=.96; RMSEA=.06). Figure 2 shows that all items load well on the two factors with factor loadings between .65 and .84. In order to improve model-data fit, the residuals of items 3 and 4 were allowed to correlate, because both items refer to the pre-service teachers' competence to let pupils independently use ICT in an educational context. Similarly, the correlation between the

residuals of item 15 and 16 can be explained, as both items refer to the pre-service teachers'

competence to use ICT for tracking and evaluating the progress that pupils make.

<Fig. 2>

In the final stage of scale development, we checked the psychometric quality of the designed

instrument by conducting a reliability analysis on subsample 1. Cronbach's alphas indicate

that the internal consistency of the items of ICTC-PU (α=.94) and ICTC-ID (α=.89) is

satisfactory, and thus two scales were created. Both scales were calculated as the mean value

of the items, with a theoretical minimum of 0 and a maximum of 5.

Table 2 presents some descriptive information of the ICTC-PU and the ICTC-ID as well as

the Pearson product-moment correlation between the scales. The results indicate a reasonable

positive correlation between ICTC-PU and ICTC-ID. Moreover, they also reveal that pre-

service teachers' competencies in using ICT to support pupils' ICT use in class (M=3.53) are

comparable with those to support the design of their instructional practice (M=3.38).

<Table 2>

Discussion and conclusion

Empirical evidence has shown that pre-service teachers feel that they lack experience in

integrating ICT effectively into their classrooms (e.g., Kay, 2006; Ottenbreit-Leftwich et al.,

2010). To tackle this issue, many TTIs and researchers are currently examining various

alternatives that may resolve a range of issues related to the development of pre-service

teachers' ICT competencies in ICT integration (Tondeur et al., 2012). The current study aims

to contribute to understanding these competencies by providing an empirically tested instrument to measure them. The results revealed that the teachers attained two types of ICT competencies: (a) the ability to use ICT for facilitating student learning competencies in using ICT (ICTC-PU) and (b) the ability to manage ICT for their own teaching purposes (ICTC-ID). These categories identified in the results replicate empirical typologies developed by, for instance, Kennisnet (2012) and ENW AUGent (2013). Similarly, van Braak, Tondeur, & Valcke (2004) have delineated two main categories of educational ICT use by in-service teachers: (a) supportive ICT use and (b) classroom ICT use.

Clearly, these results highlight the importance of distinguishing between competencies desired to design an ICT-rich learning environment and those to support pupils in the use of ICT in the classroom. At the same time, a reasonable positive correlation is found between ICTC-PU and ICTC-ID. This relationship between both types of ICT competencies can also be found in the study of Sang et al. (2010), who contend that the supportive use of ICT is the most significant predictor of classroom ICT use. Research can further explore the relationship between both types of ICT competencies and examine potential determinants, as the development of pre-service teachers' competencies for ICT-integration seems to be a complex process requiring various capabilities (Polly et al., 2010).

The quality and quantity of pre-service ICT experiences has been identified as a crucial factor influencing pre-service teachers' development of ICT competencies (Ottenbreit-Leftwich et al., 2010). For instance, it seems that observing a teacher using technology proved to be an important motivator for future technology integration in the classroom (Kaufman, 2015). However, simply having pre-service teachers watch examples of technological applications is helpful but not sufficient (Tearle & Golder, 2008). As pre-service teachers should also be able

to interpret these examples in a specific educational context, the discussion concerning the ways in which pre-service teachers can become better prepared to integrate ICT into classroom practice should also be seen as part of the evolution of the entire teacher education program (Tondeur et al., 2012). Many TTIs have recognized the challenges associated with developing pre-service teachers' competencies for educational ICT use and have proposed original, innovative strategies (Ottenbreit et al., 2010). Koehler and Mishra (2009), for instance, have advocated the collaborative design of curriculum materials to cultivate pre-service teachers' ICT competencies. They have also argued that pre-service teachers have to work in collaborative groups and actively engage in the research on and design of tangible, meaningful ICT-related curriculum materials as end products of the learning process (ICT-ID).

Another point of importance is related to applying pre-service teachers' ICT competencies in authentic experiences (e.g., Tearle & Golder, 2008). These types of engaging experiences can provide them with greater insight into the link between knowledge about the role of technology, on the one hand, and teaching practice, on the other hand (ICT-PU). In implementing such strategies, the ICT-CF scale could be used to measure the (development of) pre-service teachers' ICT-competencies and to better structure the professionalization of the teacher trainers. Some studies use performance-based assessment instruments to measure ICT competencies (Aesaert et al., 2015; Harris, Grandgenett, & Hofer, 2010). Future research can use the ICT-CF scale in combination with performance-based assessments, preferably over a longer period of time, in order to triangulate findings. This would make it possible to measure pre-service teachers' self-perceived, planned, and observed competencies in using ICT in educational processes. These instruments will potentially help develop a more

transparent understanding of pre-service teachers' ICT competencies and will facilitate TTIs

to better prepare them to integrate ICT into education.

Ethics, data access and conflicts of interest

The library of Ghent University will provide free and open access to the SPSS-file of the

study through the catalogue lib.ugent.be as soon as the manuscript is published online. Open

Access, free access to scholarly information, is a spearhead of the university library.

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Table 1: Factors loadings for the ICT competence items

	Factor 1 ICTC-PU	Factor 2 ICTC-ID
I am able to…		
Item 1: motivate pupils to use ICT in a positive way	**.77**	.02
Item 2: stimulate pupils to use ICT in a critical manner	**.83**	-.14
Item 3: provide pupils with activities to exercise knowledge/skills by means of ICT	**.74**	.08
Item 4: provide pupils with activities on subject matters to learn with ICT	**.57**	.26
Item 5: offer pupils opportunities to express ideas in a creative way by means of ICT	**.64**	.12
Item 6: support pupils in searching information by means of ICT	**.76**	-.03
Item 7: support pupils in processing and managing information by means of ICT	**.80**	.04
Item 8: support pupils to present information by means of ICT	**.76**	.02
Item 9: support pupils to communicate with ICT in a safe, responsible and effective way	**.81**	-.07
Item 10: support pupils to work together with ICT	**.79**	.03
Item 11: educate pupils to use ICT in a conscious way (respecting ergonomics, intellectual property, etc)	**.61**	.15
Item 12: select ICT-applications in view of a specific educational setting	-.00	**.80**
Item 13: (re)design ICT-applications in view of a specific educational setting	-.05	**.71**
Item 14: use ICT to differentiate learning and instruction	.09	**.63**
Item 15: track the learning progress of pupils in a digital way	.06	**.59**
Item 16: evaluate pupils with the help of ICT	.07	**.61**
Item 17: use ICT appropriately to communicate with pupils	.07	**.70**
Item 18: design a learning environment with the available infrastructure	-.02	**.77**
Item 19: select ICT-applications effectively in creating a learning environment (e.g. in view of the group size)	-.07	**.85**

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Table 2: Reliability coefficients, descriptive statistics and correlation coefficients for the ICT competence scales; **p<.01

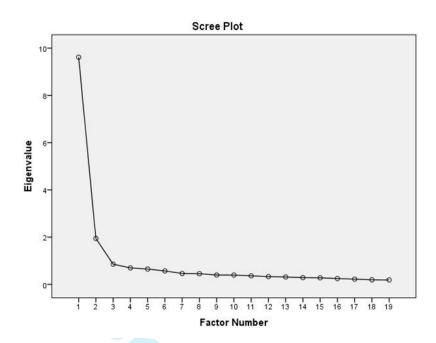|	α	M (SD)	(1)	(2)
ICT-competencies to support pupils for ICT-use (ICTC-PU)	.94	3.53 (0.75)	1.00	
ICT-competencies for instructional design (ICTC-ID)	.89	3.38 (0.79)	.66**	1.00

Figure 1: Scree plot of factors underlying the students' ICT-competencies
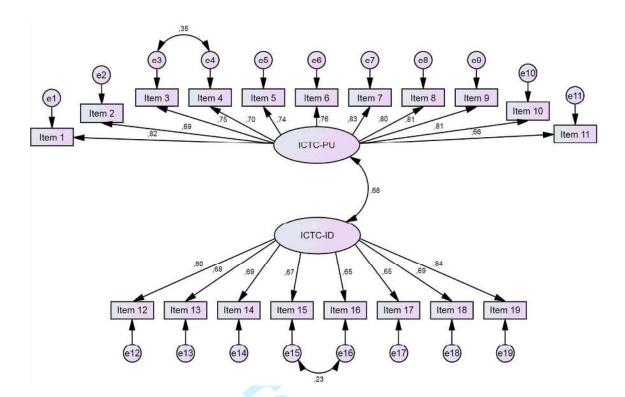
Figure 2: Structure/pattern coefficients for the ICT-competence items

Appendix: Overview of sources consulted while developing the ICT-CF

Country /Institution	Reference	Webpage
Flanders (Belgium)	ICT eindtermen: primary[1] and secondary[2] education Concept paper media literacy[3] European Computer Driving License[4]	[1] http://ond.vlaanderen.be/curriculum/basisonderwijs/lager-onderwijs/leergebiedoverschrijdend/ict/eindtermen.htm [2] http://www.ond.vlaanderen.be/curriculum/secundair-onderwijs/eerste-graad/vakoverschrijdend/a-en-b-stroom/ict-a-stroom/eindtermen.htm education [3] http://ond.vlaanderen.be/ict/beleid/conceptnota-mediawijsheid.pdf [4] http://www.ecdl.be (Belgium)
the Netherlands	SBL Competences[5] Knowledge Base ECT – ADEF 2009 [6] Kennisnet: ICT competences of teachers[7]	[5] http://www.onderwijscooperatie.nl/?nl/onderwijscooperatie/bekwaamheid/&art=408 [6] http://www.leroweb.nl/docs/lero/130308_concept_kbict_2013.pdf [7] http://www.kennisnet.nl/themas/ict-bekwaamheid/: ICT competences of teachers
Unesco	ICT-enhanced teacher standards for Africa[8] ICT competency standards and framework for teachers[9,10,11,12,13,14] Towards information literacy indicators[15] ICT in education toolkit[16] Teachers' Professional Development toolkit[17] ICT in education[18] The partnership for 21st Century Skills P21 Framework Definitions[19]	[8] http://doc.iiep.unesco.org/cgi-bin/wwwi32.exe/%5Bin=epidoc1.in%5D/?t2000=031299/(100) [9] http://unesdoc.unesco.org/images/0015/001562/156210E.pdf [10] http://siteresources.worldbank.org/EDUCATION/Resources/UNESCO-Miao_TeacherTrainingonICT-pedagogyIntegration.pdf [11] http://knowledgecommunity.ph/pdf/Mel_Tan_UNESCO_ICT_CFT_25Oct2012.pdf [12] http://portal.unesco.org/ci/en/ev.php-URL_ID=25734&URL_DO=DO_TOPIC&URL_SECTION=201.html [13] http://www.unesco.org/new/en/unesco/themes/icts/teacher-education/unesco-ict-competency-framework-for-teachers/ [14] http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/unesco-ict-competency-framework-for-teachers/ [15] http://unesdoc.unesco.org/images/0015/001587/158723e.pdf [16] http://www.ictinedtoolkit.org/usere/login.php [17] http://ccti.colfinder.org/toolkit/ict-toolkit/ [18] http://www.uis.unesco.org/Communication/Pages/ict-education.aspx [19] http://www.p21.org/
Australia	National professional standards for teachers[20] ICT elaborations for graduate teacher standards[21] Teacher ICT skills[22]	[20] http://www.aitsl.edu.au/verve/_resources/AITSL_National_Professional_Standards_for_Teachers.pdf [21] http://acce.edu.au/sites/acce.edu.au/files/TTF - Graduate Teacher Standards - ICT Elaborations - 200411.pdf [22] https://www.det.nsw.edu.au/proflearn/der/docs/wherenow/teachict.pdf
Europe / International	CEF-Common European Framework – Teachers U teacher[23,24] Digital European Literacy: Analysing digital literacy frameworks annexes[25] Digital Transformation – ICT literacy panel[26] EIfEL: E-learning Competency framework for Teachers and Trainers[27]	[23] http://www.egger.ac/1docs/booklet2b.pdf [24] http://www.univirtual.it/uteacher/default.htm [25] http://lire.ish-lyon.cnrs.fr/IMG/pdf/FilesFrameworksDigEuLit.pdf [26] http://www.ets.org/Media/Tests/Information_and_Communication_Technology_Literacy/ictreport.pdf [27] http://www.eife-l.org/competencies/ttframework
UK	QTS Model and QTS skill tests[28] Teach There[29] Teaching English[30]	[28] http://webarchive.nationalarchives.gov.uk/20120203163341/tda.gov.uk/trainee-teacher/qts-skills-tests.aspx [29] http://www.britishcouncil.org/malaysia-download-about-us-careers-teacher-tech-skills-behaviours-2012.pdf [30] http://www.teachingenglish.org.uk/sites/teacheng/files/TeachingEnglish_Learning_Technologies_for_the_Classroom.pdf
ISTE	NETS Teachers 2008[31]	[31] http://www.iste.org/standards
China	China educational technology standards for teachers[32]	[32] http://www.it.iitb.ac.in/~vijaya/ssrvm/dokuwiki/media/unesco-china.pdf

USA	Virginia Technology Standards for Instructional Personnel[33] iSkills: ETS Higher Education iSkills Assessment Fit with ACRL Standards[34]	[33] http://www.educate.vt.edu/teeps/vastandards.htm [34] http://www.ets.org/Media/Tests/ICT_Literacy/pdf/acrl_standards.pdf

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Practitioners Notes

What is already known about this topic:

- Pre-service teachers still do not feel adequately prepared to effectively integrate ICT into their classrooms

- Several initiatives have been taken to provide frameworks with standards that future teachers should meet in relation to ICT

- Most frameworks are conceived merely on a conceptual level and there is a dearth of validated instruments to measure future teachers' ICT-competencies

What this paper adds:

- Better understanding of the competencies future teachers need for the use of ICT in education

- A new comprehensive framework for pre-service teachers' ICT-competencies

- An empirically validated instrument (ICT-C) to measure the competencies pre-service teachers should possess at the end of their initial training to integrate ICT in education

Implications for practice and/or policy

- The ICT competencies proposed potentially as the requirements for pre-service teachers can frame and improve on the training of future teachers to effectively integrate ICT in their teaching and learning practices

- The ICT-C scale can be used to measure (the development of) future teachers' ICT competencies and to facilitate structuring the professionalization of the teacher trainers

- The ICT competencies of the ICT-C scale should be infused into all aspects of teacher training