Report

Supporting pedagogical ICT-competences

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Summary

Teacher education plays an important role in preparing pre-service teachers to use technology for teaching and learning. However, the literature states that teacher educators often struggle to model effective ICT integration. The Synthesis of Qualitative Data (SQD) model defines six core strategies for supporting pre-service teachers' readiness to use ICT in education, i.e., role modelling; reflection on the role of technology; learning technology by design; collaborating with peers; authentic technology experience; and continuous feedback. Readiness to use ICT in education concerns acquiring the knowledge, skills, and attitudes about the use of technology for teaching and learning. When this readiness is reflected in the actual use of technology in the classroom, and the ability to reflect on this use, it fits the conceptualization of 'pedagogical ICT competence'. A curriculum review at five locations of the Primary Education Teachers' Training Programme (Pabo) of Inholland Inholland University of Applied Sciences in the Netherlands prompted this study. The aim of this study is to measure pre-service teachers' perceived occurrences of the strategies used by teacher educators to support the development of effective information and communication technology (ICT) use in classrooms. The central question of this research is: How do pre-service teachers of five Teacher Training Institutes perceive the occurrences of the strategies used by teacher educators to support the development of their pedagogical ICT-competences?

A mixed-methods research design was used. The SQD questionnaire with 24 items (six-point Likert scale) was translated to Dutch and extended with six open questions, allowing for further elaboration for each of the core strategies. Five locations of the Primary Education Teachers' Training Programme (Pabo) of Inholland Inholland University of Applied Sciences in the Netherlands were involved. All pre-service teachers (N = 200) in the graduation phase in the academic year 2020 were approached to take part and 70 completed the questionnaire.

Results showed that the strategies "authentic technology experience" and "role modelling by the teacher educator" are recognized most. The majority of teacher-educators were not recognized as role models concerning ICT Integration. However, digital literacy teacher-trainers were. Although the internships provide a space for practice, the in-service teachers are not recognized as inspiring examples of ICT integration. Providing continuous feedback was the least recognized strategy because feedback was perceived as mostly summative in nature. Further research should address the question of how to increase recognized occurrences of the strategies, starting with "providing continuous feedback". Limitations: This research was not without limitations. It was carried out in one academic year. The instrument is based exclusively on self-reporting.

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1. Supporting the development of pedagogical ICT-competences

The use of digital tools in education continues to grow. Teachers with a broad pedagogical repertoire who use different Information and Communication Technology (ICT) applications more and more frequently are more likely to experience the desired benefits from ICT (Ten Brummelhuis & Binda, 2017). Teachers who use ICT in their teaching practice report that their students are more motivated and have a better overview of the progress of the students and teaching is more efficient (Smeets & Van der Horst, 2018). However: Teachers differ widely in their use of ICT applications and proficiency in them.

Teacher education plays an important role in preparing pre-service teachers to use technology for teaching and learning (Tondeur et al., 2012). Teacher educators should provide future teachers with the necessary entry qualifications, model pedagogy, and act as gatekeepers (Tondeur et al., 2019). However, teacher educators often struggle to model effective ICT integration (Becuwe et al., 2017). This poses a problem, as pre-service teachers have to develop a certain degree of pedagogical ICT competence during their teacher training program to use technology effectively for teaching and learning. A flow of professionals with vision, skill, and self-confidence in the pedagogical use of ICT should originate from teacher training institutes. At a micro level, teacher educators can support the will (positive attitudes) and skills (technology competence). We should assume that the new generation of teachers needs training to connect technology with pedagogical and subject matter content (Koehler & Mishra, 2009). This is a complex learning process, even for those that are experienced technology users (Valtonen et al., 2011). Even if preservice teachers have stronger technological knowledge compared to experienced in-service teachers, their limited pedagogical knowledge and content knowledge constrain their potential to integrate ICT (Becuwe et al., 2017). Moreover, the technology use of 173 pre-service teachers was found to have no significant relation to whether or not they had included digital technologies for teaching and learning in their lesson plans (Schmid et al., 2021). This indicates the need to support pre-service teachers in the development of their pedagogical ICT competence throughout the entire teacher preparation program. Pedagogical ICT competence concerns the knowledge, skills, and attitude of teachers about the use of technology for teaching and learning which is reflected in the actual use of technology in the classroom, and the ability to reflect about this use (Voogt et al., 2015).

Five teacher training institutes for primary education of Inholland Inholland University of Applied Sciences made efforts to integrate strategies for the development of pedagogical ICT competencies in the curriculum. In this curriculum, there is a focus on digital literacy in primary education and the development of pedagogical ICT competence by offering specific "ICT and education" units of study. However, the question is to what extent these curriculum components effectively contribute to the development of pedagogical ICT competence in students. Preparing pre-service teachers at the teacher training institute and internships is important (Trevisan et al., 2021). Studies have shown that the actual use of technology is mostly affected by ICT involvement in pre-/in-service teacher training programs (Agyei & Voogt, 2011; Ottenbreit-Leftwich et al., 2010; Tondeur et al., 2017; Tondeur et al., 2012). Research among starting teachers and pre-service teachers shows that designing and implementing effective strategies to prepare pre-service teachers in using technology for teaching and learning is not self-evident (Tondeur et al., 2012, 2017; Uerz & Kral, 2014; Vrijnsen et al., 2016). Because it is unknown to what extent this applies to these particular five Teacher Training Institutes at the Inholland Inholland University of Applied Sciences, it was important to gain more insight into pre-service teachers' perceptions of the extent to which they experience the necessary support and training to integrate technology into classroom activities. This is important because future teachers should develop a certain degree of pedagogical ICT competence during their teacher training program to use technology effectively for teaching and learning.

1.0 Objective

The objective of this research was to establish to which extent final-year preservice teachers perceive the occurrences of effective strategies, employed by the teacher-educators to support their students to gain adequate pedagogical ICT competence.

The research question central to this study is:

How do pre-service teachers of five Teacher Training Institutes perceive the occurrences of the strategies used by teacher educators to support the development of their pedagogical ICT-competences?

The following sub-questions were answered:

- Sub question 1: How can the development of pedagogical ICT competence of pre-service teachers be described?
- Sub question 2: Which strategies are effective in supporting pre-service teachers' development of pedagogical ICT-competences?
- Sub question 3. To what extent do pre-service teachers of the five Teacher Training Institutes recognize effective strategies for supporting the development of their pedagogical ICT-competences in the current curriculum?

1.1 Relevance

The results of this study may aid in further curriculum development. The curriculum of Teacher Training Institutes should support future teachers to develop pedagogical ICT competence and to use technology effectively for teaching and learning. Furthermore, this study may contribute to the theory on measuring the prevalence of strategies that teacher educators can use to help prospective teachers increase their didactic ICT competencies.

2. Theoretical exploration

This chapter focuses on (1) how the development of pedagogical ICT competence of pre-service teachers can be described and (2) which strategies are effective in supporting pre-service teachers' development of pedagogical ICT-competences. Section 2.1 corresponds to question 1, paragraph 2.2 corresponds to question 2.

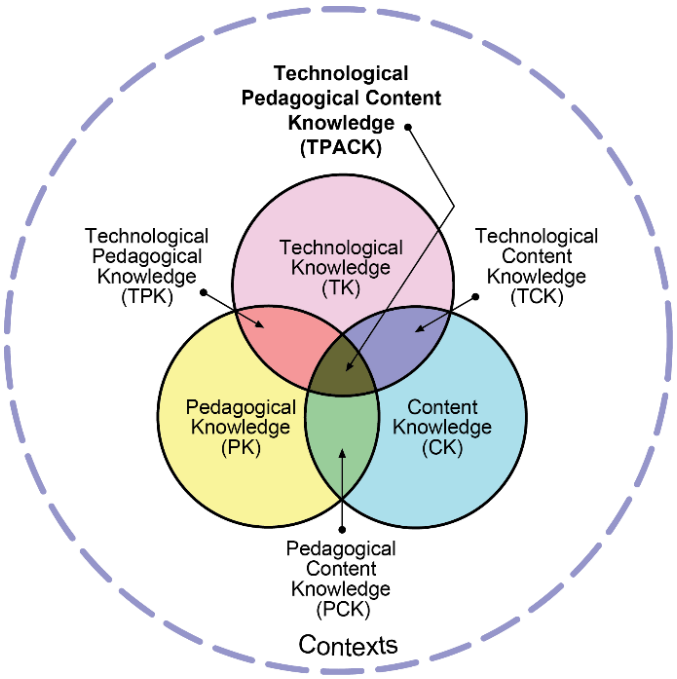
2.0 The development of pedagogical ICT competence of pre-service teachers

The Pedagogical ICT competence concern the knowledge, skills, and attitude of teachers about the use of technology for teaching and learning which is reflected in the actual use of technology in the classroom, and the ability to reflect about this use (Voogt et al., 2015). Teacher-educators, in-service teachers, and peers influence its development (Wang et al., 2018). Its development can be described as follows. Knowledge-building is central to the development of pedagogical ICT competencies of preservice teachers throughout teacher-training. Shulman (1987) reasoned that teaching requires the understanding of what is to be learned (content) and how it is to be taught (pedagogy). A fusion of knowledge which is "uniquely the province of teachers, their special form of professional understanding" (Shulman, 1987). Expanding on Shulman's concept of Pedagogical Content Knowledge, Koehler and Mishra (2006) argued that the inclusion of technology in pedagogy further complicates teaching. This increase of complexity is caused by the need for technological knowledge (TK). Therefore, TK was included in Shulman's concept of Pedagogical Knowledge (PK) and Content Knowledge (CK) to represent a teachers' knowledge of technology integration in teaching and learning.

The resulting conceptualization was named the Technological Pedagogical Content Knowledge Model (TPACK). TPACK is the emergent form of knowledge that goes beyond the three bodies of knowledge: Content (CK), pedagogy (PK), and technology (TK). Koehler and Mishra (2009) put forward that the interaction -both theoretically and in practice-, produces the type of flexible knowledge needed to successfully integrate technology use into teaching. By further adding “contexts” to the construct, Koehler and Mishra accounted for the complex, dynamic classroom contexts requiring teachers to constantly shift and evolve their understanding.

The resulting model can be seen in Figure 1.

Figure 1.
TPACK model



Note. The TPACK model is a prominent model of teacher expertise for effectively teaching with digital technologies. Copyright 2012 by tpack.org

The main strategy to apply the TPACK model in teacher-education is to design technology-enhanced lessons. Collaborative design of technology-enhanced lessons promotes active learning by pre-service teachers. It involves working collaboratively in small design teams, developing technological solutions to authentic pedagogical problems (Agyei & Voogt, 2012). Throughout this process, the teacher educator promotes reflection and discussion around the beliefs of the pre-service teachers. Beliefs about the nature of knowledge, effective ways of teaching, technology integration practices, and its perceived usefulness and ease of use (Scherer et al., n.d.). Teacher-educators can address these by increasing the capacity for pedagogical reasoning. Pedagogical reasoning is an ongoing process and reflective practice to assist in understanding why, how, and with what results educational technologies are used in conjunction with pedagogical practices (Forkosh-Baruch et al., 2021). Preservice teachers who perceived strong support at their teacher training institution were demonstrated to fit a profile of strong TPACK, more positive attitudes, and self-efficacy scores (Jo Tondeur et al., 2017).

This raises the question of the phases in which pedagogical ICT competence can be developed. Using the TPACK theoretical lens in interventions, researchers have shown that teachers must first master TK, CK, and PK before mastering TPK and then TPACK and can use ICT effectively for teaching (Chai & Koh, 2017).
Studies have shown that the actual use of technology is mostly affected by ICT involvement in pre-/in-service teacher training programs (Agyei & Voogt, 2011; Ottenbreit-Leftwich et al., 2010; Tondeur et al., 2017; Tondeur et al., 2012). This includes internship and training in authentic teaching situations. The human preconditions (vision and expertise) or material preconditions (educational content, software) needed to use ICT in education with optimum efficiency (Kennisnet, 2015), may differ between teacher training and internship. The practice pre-service teachers encounter at internships may not be coherent with teacher training (Forkosh-Baruch et al., 2021). Research in the Dutch context of primary education has shown that the teaching practice encountered by the pre-service teacher is mainly teacher-centred and drill & practice tools are used (Ed Smeets, 2020). As for their skills in the didactic use of ICT, the teachers in this study (n=207) say that they consider themselves more skilled in assessing which media is suitable for use in the classroom than in explaining their pedagogical choices to colleagues. Teacher-centred use of ICT is centred around presentation and knowledge transfer with instruction tools (Hughes et al., 2020). It is important that pre-service teachers encounter in-service teachers who understand and model ICT integration in their classrooms. When in-service teachers don't understand or model this , they potentially discourage pre-service teachers from using technology in learning and teaching (Graham et al., 2009). In summary, the development of Pedagogical ICT competence is complex (Reyes et al., 2017). This is why it has been referred to as a wicked problem (Segal & Heath, 2020). It is a staged process and is time-consuming but rewarding. Research emphasizes the notion of change as a staged process (Tearle, 2003). Somekh (2008) explains why it is rewarding: "Although the process was slow, it led to noticeable shifts in teachers' roles and the development of new practices" (Somekh, 2008).

2.1 Strategies necessary to support pre-service teachers in their development of pedagogical ICT-competences

The complexity of developing pedagogical ICT competence resulted in the need to identify effective strategies to prepare pre-service teachers for technology use. Tondeur et al. (2012) reviewed qualitative studies that focused on strategies to prepare pre-service teachers to integrate technology into their lessons. An overarching model was developed, to present how these strategies relate to each other: the Synthesis of Qualitative Evidence (SQD) model. The significance of this model to teacher education was further established in 2016 when a self-report instrument was validated. This instrument aims to measure pre-service teachers' perceptions of the extent to which they experience the necessary support and training in order to integrate technology into classroom activities (Tondeur et al., 2016). The SQD-model can be seen in Figure 2. The model consists of two outward circles and an inner circle, representing strategies at different levels. The two outward circles in the SQD model represent the strategies necessary at an institutional level. They include technology planning and leadership, training staff, access to resources, or cooperation within and between institutions. The inner circle of the SQD-model describes six strategies on a micro-level: using teacher educators as role models, reflecting on the role of technology in education, learning how to use technology by design, collaboration with peers, scaffolding authentic technology experiences, and providing continuous feedback.

Figure 2

SQD-model to prepare pre-service teachers for technology use (Tondeur et al., 2012).

The current study focuses on the six micro-level strategies employed by teacher-educators for support and training of pre-service teachers to integrate technology into classroom activities. They are the strategies for the development of pedagogical ICT competencies of pre-service teachers. The first strategy is to show good practice examples (teacher trainers acting as role models for pre-service teachers). Examples of the use of technology in a specific content area about a specific pedagogical approach can be an important motivator for the pre-service teacher to integrate technology into their practices (Valtonen et al., 2019). This incorporates the TPACK model (Mishra & Koehler, 2008). Teacher-educators should express their understanding by reasoning about their TPACK (Valtonen et al., 2019). Without this, preservice teachers may get discouraged with technology integration or even show no development improvement in the TPACK domains (Semiz & Ince, 2012). The second strategy is reflection. Teacher educators should reflect together with pre-service teachers on the role of ICT in education, its value and risks. Teacher educators should engage in conversations to discuss the value of using a particular technology for a specific teaching strategy in a content area and with a specific pedagogical approach (Baran et al., 2018). The aim is to influence the attitudes of prospective teachers. Reflection is not a separate strategy but is connected to other conditions and is not isolated.

A third strategy is instructional design. Preservice teachers still find it difficult to design ICT-rich lessons themselves. Student teachers need to work in teams that design or redesign lessons together (supported by a teacher) where ICT is supportive. Learning together to make rational decisions when selecting how to use technology when teaching specific content to a specific target group (Koehler & Mishra, 2009) is a key strategy for pre-service teachers' development of TPACK. A fourth strategy is collaboration. Working with other prospective teachers and sharing uncertainties or doubts is important. This strategy can mitigate feelings of insecurity when teachers design technology-rich lessons (J. H. L. Koh & Chai, 2016). The fifth strategy is to apply TPACK knowledge in authentic experiences: This gives the pre-service teachers a sense of achievement by applying their knowledge (Barton & Haydn, 2006). Designing education together that is enriched with technology is not enough. Pre-service teachers need to explore the potential of ICT in the class situation because watching technology being used does not substitute for doing. Here, too, pre-service teachers need support and feedback. Teacher education and internship schools should work together (Goktas et al., 2008). A sixth strategy is moving from traditional assessment to continuous feedback. Traditional assessment lacks the relationship between the tests and what is needed to make progress in using ICT in the classroom (Tondeur et al., 2012). Moving from traditional assessment to using an "ICT portfolio" to integrate assessment throughout the training process is a more integrated approach in which evaluation and feedback are systematic and systemic (O'reilly, 2003).

2.2 Summary of theory and implications for this research

Pedagogical ICT competencies concern the knowledge, skills, and attitude of teachers about the use of technology for teaching and learning which is reflected in the actual use of technology in the classroom, and the ability to reflect about this use (Voogt et al., 2015).

The development of pedagogical ICT-competences of pre-service teachers aids them to include technology in their teaching practice. Pre-service teachers must be trained to do so because their technology use does not predict their abilities to connect technology with pedagogy and learning subjects. It can neither predict positive attitudes nor high self-efficacy.

To develop Technological Pedagogical Content Knowledge (TPACK) the Teacher Training institutes, teacher-educators and in-service teachers and peers are important. Supported by teacher-trainers in a slow and staged process pre-service teachers must first master TK, CK, and PK. Then they must master TPK and then TPACK and can use ICT effectively for teaching (Chai & Koh, 2017). In summary, the development of Pedagogical ICT competence is complex (Reyes et al., 2017). It is a staged process and is time-consuming but also rewarding. It can lead to noticeable shifts in teachers' roles and the development of new practices. Pre-service teachers need strong support from their Teacher Training Institution to develop strong skills (TPACK), resulting in more positive attitudes and higher self-efficacy. This means that the Teacher Training Institutes must understand to which extent the SQD strategies are in effect to support pre-service teachers in their development of pedagogical ICT-competences. The six strategies (on a micro-level) support this development. This is why Teacher Training Institutes should gain insight on how the perceived curriculum relates to these strategies: using teacher educators as role models, reflecting on the role of technology in education, learning how to use technology by design, collaboration with peers, scaffolding authentic technology experiences, and providing continuous feedback. The SQD questionnaire is a suitable self-report instrument to measure pre-service teachers' perceptions of the extent to which they experience the necessary support and training to integrate technology into classroom activities. It is this support and training which form the basis for developing Pedagogical ICT competencies.

3. Methods

To answer the research questions, mixed-method research was conducted with a questionnaire on five Teacher Training Institutes. The research group, the instruments used, procedures of data collection, and the approach to data analysis are explained below in more detail.

3.0 Research characterization and research questions

The approach can be characterized as mixed-methods. In this study, both quantitative and qualitative data were collected, analysed, and integrated. The assumption is that mixed methods provide a better understanding of the research problem than either method by itself (Creswell & Guetterman, 2019). The collection of both quantitative and qualitative data in a questionnaire was done in one phase. The purpose of mixing quantitative and qualitative data in this study is complementarity. Greene et al. (1989) describe complementarity as a means for seeking elaboration, enhancement, illustration, or clarification of the results from one method with the results from the other method. This requires that the different methods assess the same conceptual phenomenon, which is the case in this study.
The central question of this research is:

How do pre-service teachers of five Teacher Training Institutes perceive the occurrences of the strategies used by teacher educators to support the development of their pedagogical ICT-competences?

3.1 Respondents

A total of 200 preservice teachers were purposively sampled (all final semester pre-service teachers of 2020-2021 of five primary teacher training institutes of Inholland University of Applied Sciences in the Netherlands). Seventy completed the online questionnaire. The average age was 33.5 years (*SD* = 10.2 years). 91% were female. 43% Were in the 2-year study program and 57% were in the 4-year study program.

3.2 Research instrument

SQD questionnaire

The SQD questionnaire (Tondeur et al., 2016) is used to measure pre-service teachers' perceptions of the extent to which they experience the necessary support and training to integrate technology into classroom activities. This quantitative self-reporting measurement tool has 24 items (Appendix 1). These were translated to Dutch to suit the language proficiency of the Dutch respondents (Appendix 2). This questionnaire focusses on the strategies included in the synthesis of qualitative evidence (SQD) 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.
The SQD questionnaire adopts a six-point Likert scale. The response categories are: totally disagree – disagree – slightly disagree – slightly agree – agree – totally agree.
The reliability and aspects of the validity of the SQD questionnaire have been validated and the researchers concluded this instrument leads to valid and reliable benchmarking of the support of future teachers' need for the use of technology in education in their sample (Tondeur et al., 2016).
The SQD questionnaire was expanded with a pre-section used to collect data for demographical characteristics such as age, gender, prerequisite, study program duration, and estimated year of graduation. It is also expanded with six open-ended questions, described next.

3.2.1 Open-ended questions (addition to the SQD questionnaire)

Six open-ended questions were added to the SQD questionnaire to allow respondents to elaborate on their answers on the SQD questionnaire. There are six sections of four questions each in de SQD questionnaire. The open-ended questions were added at the end of each. The topics correspond to de micro strategies of the (SQD) 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. Each of the six open-ended questions was identical:
"If you can elaborate on what you recognized or missed during teacher training in respect of the statements, then please do so below".
To analyse this data, an inductive and iterative process of coding was used to generate theories that explain, on a broad conceptual level, the processes, actions, or interactions about substantive topics (Creswell & Guetterman, 2019). This method was used to gain insight into the emergent themes to construct theories, grounded in the data. To form theoretical constructs that emerge from the data, grounded theory was chosen as the approach for analysis. Grounded theory is an approach to finding a theory grounded in the data (Strauss & Corbin, 1994). First, all text fragments were repeatedly read. Then, in an iterative process of open coding, axial coding, and selective coding the data was studied to construct theories grounded in the data. This data analysis resulted in emergent themes.

3.3 Data collection procedure

In the 2020-2021 academic year, the online questionnaire was distributed to the pre-service teachers through a hyperlink. To increase the response, a reminder was sent after two weeks.
Of the SQD scale items, means and standard deviations are reported, and expanded upon with the data from the open-ended questions.

3.4 Validity and reliability

This research has its limitations because it was carried out in one academic year. The data was gathered during the Covid-19 pandemic. Data was gathered using self-reporting. Self-reported data can provide important findings on the topic, in using self-report data there is always the potential for error in recall (Egbert et al., 2002).
The qualitative data were analysed using an interpretive process of coding and the subjective nature of this approach leaves room for bias on behalf of the researcher.
The original SQD questionnaire (Appendix 1) was translated from English to Dutch (Appendix 2: Translated item wordings of the SQD-scale) to suit the language proficiency of the Dutch respondents. Translation of instruments may have created differences in meaning. To check for its validity, exploratory factor analysis was used.

3.5 Ethical issues

In designing and conducting the research, the Code of Conduct for Practice-Oriented Research for HBO (Code of Conduct Committee for Applied Research in HBO, 2010) was used as a guideline. The results from the questionnaire have been processed anonymously.

4. Results

4.0 SQD questionnaire descriptive statistics

The extent to which Pre-service teachers of the five Teacher Training Institutes recognize the SQD strategies in the current curriculum in relation to the development of their pedagogical ICT-competences was measured with the SQD questionnaire (J Tondeur et al., 2012). Tondeur et al. (2015) reported on the SQD scale and validated it as a unidimensional model, consisting of a single factor being measured by all individual items on the questionnaire, with the exclusion of FEE2 and AUT2 in the final version of the scale to increase model fit. At the beginning of our analysis, we ran a confirmatory factor analysis to determine if the SQD scale as reported by Tondeur et al. could also be validated within our dataset. Findings indicated poor model fit (X2 = 672,442, RMSEA = .155, CFI = .668, CMIN/DF = 2,668, p .000, GFI = .548, AGFI = .462, PCFI = .610) for our dataset. As a result, we went back to do an exploratory factor analysis to see if we could explain our findings with a more suitable model. Under the assumption that factors would correlate, we ran principal axis factoring using a Promax rotation, looking for factors with an eigenvalue over 1. KMO Bartlett's test of sphericity was significant (.845, df =276, p = .000). In this configuration, a total of five factors were found, cumulatively explaining 73,238% of the variance. The resulting pattern matrix can be viewed in table 2. Several items correlated highly (above .30) on multiple factors in this version of the model. To determine if the model could be improved upon, first Cronbach's alpha was calculated for each factor as it was found. The first factor, which seemed to correspond with Tondeur et al.'s definition of the concept of role model had an α = .912, which could be improved to .917 if REF2 (one of the items loading high on two factors) was removed. Removing AUT3 would diminish the alpha value slightly. The second factor, corresponding to the concept of feedback when looking at the items incorporated into it, had an α = .889 that could be improved to .909 if COL2, the only item in that factor that was not meant to measure feedback was removed. The third factor we found had items originally allocated to measure several different concepts. Specifically, the design and reflection concepts seemed to have merged into a single factor in our dataset, with COL4, being an item originally measuring collaboration loading high on another factor as well. Cronbach's alpha was again high for this factor (α = .908), with no suggestions to improve on it from the reliability check. The fourth factor seemingly corresponded with the concept of authenticity/authentic learning environments. This factor had an alpha of .845, again with no suggestions for improvement. Removing AUT3 from this factor, however, would diminish the alpha value to .709, indicating it fit better in this factor than in the first factor, even though loadings were similar. The final factor, describing the concept of collaboration, consisted of 3 items with a combined alpha of .852. This could be slightly improved (to .853) if COL4 was removed from it. To summarize, with the removal of REF2 and AUT3 from the first factor, COL2 from the model entirely and COL4 from the fifth factor we found, the model as a whole would be a fairly good representation of five concepts, four of which can be directly linked to the original concepts as described by Tondeur et al. (2015).

Table 2

Pattern matrix

	Factor 1	2	3	4	5
ROL1	0,933				
ROL3	0,888				
ROL2	0,861				
REF1	0,709				
ROL4	0,688				
FEE3		0,810			
FEE2		0,802			
FEE4		0,780			
FEE1		0,749			
COL2		0,461			
REF3			0,748		
DES2			0,685		
DES4			0,677		
DES1			0,611		
COL4			0,593		0,439
REF4			0,590		
DES3			0,547		
REF2	0,363		0,433		
AUT2				0,960	
AUT1				0,643	
AUT4				0,432	
AUT3	0,398			0,399	
COL3					0,935
COL1					0,754

Note: Rotation converged in 7 iterations. *N*=70 Eigen plot, Promax rotation, sorted by size, excluding values under .30.

4.1 SQD questionnaire

The results of the SQD questionnaire and six open-ended questions are presented next. The open ended question was the same for each strategy: “If you can elaborate on what you recognized or missed during teacher training in respect of the statements, then please do so below”.

Authentic technology experiences (AUT). Table 3 shows the degree of recognition of authentic technology experiences (AUT) among the participants (*M* = 4,00). The participants indicate that the digital literacy teacher educators encourage them to apply their TPACK knowledge. There are sufficient possibilities for authentic technology experiences in practice. However, some internship schools withhold login accounts necessary for interns to practice teaching with the authentic tools Another respondent found the lack of equipment at the internship was limiting: “I was always given space, but unfortunately many schools don't have tablets and few laptops that have to be shared with the whole school. So, the options are limited.” Another respondent was not given access to authentic teaching tools:

> “I suspect that the teacher training institute is not sufficiently aware of the poor ICT skills and possibilities at the internships. This makes it difficult to develop and reflect on one's own ICT skills. Often, students do not even get the chance to look at the teachers’ computer in the classroom, no access to online student tracking systems and online teaching environments.”

Another respondent suggested the use of trainee accounts:

> “By not having access to the systems as a trainee, ICT can only be used in a web-based classroom setting. I would advise the teacher training institute to inform the trainee schools well about what is expected. A substitute trainee account would already be a great improvement at the trainee schools. It is often policy to deny trainee's access. Personally, I find it incomprehensible. Fortunately, I find my own way in this, but for those for whom it is difficult, it becomes difficult.”

Using teacher educators as role models (ROL). The strategy using teacher educators as role models (ROL) is more often than not recognized in the curriculum (*M* = 3,85). The participants indicate that they consider their digital literacy teacher educator to be a role model about applying TPACK knowledge. However, they express a need for more time to practice executing the inspiring examples. Furthermore, some examples required digital equipment not available at the internship school, defeating the applicability. The majority of the remaining teacher educators are not seen as role models for applying TPACK knowledge. One respondent explained the differences between teacher educators as role models for ICT integration as follows:

> “The ICT teacher paid a lot of attention to it, but much less in other subjects and by other teacher educators. It would be better if those teachers also came up with suggestions, so that you can get inspired for each subject.”

One respondent indicated that examples of ICT integration by students are overshadowed by examples given by the teacher trainer: “In the lessons, mainly examples were given by the teacher, no examples of student use were discussed.” One respondent expressed the need for more practice:

> “In my opinion, the importance of ICT in education is sufficiently covered. The practical application of it in the lessons and becoming proficient in it is less so. I would have liked to have seen more about which programs are recommended and how you can use them properly (and become proficient in them).”

One respondent indicated a lack of coherence between teacher-training institute and internships: “These examples were the lessons in ICT at the teacher training institute. this was certainly not the case at the internships.”

Collaboration with peers (COL). The strategy collaboration with peers (COL), is more not than often recognized (*M* = 3,03). Pre-service teachers have more time working together in designing ICT-rich lessons outside of class than during class. The Covid-19 Pandemic made collaboration more difficult. Some respondents indicated that collaboration was impaired by the Covid-19 pandemic: “Corona has

thrown a spanner in the works, I think". Another respondent answered: "Because of Corona, the group fell apart a bit and cooperating was difficult." Due to the online classes, other choices were made, as this answer shows: "It was Corona time: mostly online class. Contact with other students, but not so much about this."

Reflecting on the role of technology in education and instructional design (DES). The strategy reflecting on the role of technology in education and instructional design (DES) is more not than often recognized (*M* = 3,47). One respondent indicated the need for more guidance on lesson design: "There is too little integration of ICT in the subjects and too little guidance in the design of lessons themselves. This is not looked at together." Reflection was recognized to the extent that the digital literacy teacher trainer did substantiate his/her vision in class. Internship did not give rise to reflection because (a) often, limited ICT-competence of the teachers was observed there and (b) there was hardly any time left for reflection. Some collaborative designing of ICT-rich lessons was recognized but there was insufficient supervised practice time. Independence is expected to develop soon regarding the designing of ICT-rich lessons.

Feedback (FEE). Feedback (FEE) is the least recognized strategy (*M* = 2,93). Feedback was recognized in the curriculum, but mostly used to grade, thus summative in nature. The feedback moments were generally linked to assignments (e.g., a portfolio assignment or an assignment concerning integration of Multimedia principles and Maths). A respondent explained how feedback was summative instead of formative: "This is reflected in the portfolio, but I didn't really get any clear feedback on it, except for a grade. Not how I could improve or what the next step would be."

Table 3

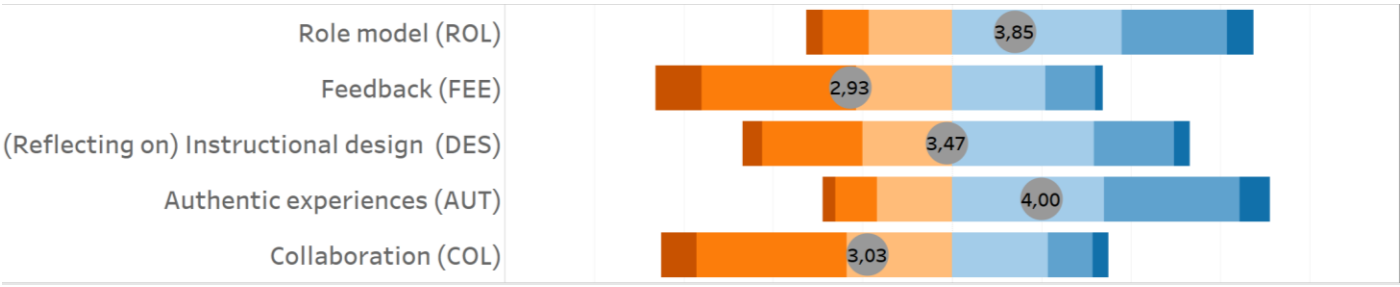
Recognition of the SQD strategies (Tondeur et al., 2015) in the current curriculum was measured by the SQD questionnaire. 1=totally disagree (weak), 6=totally agree (strong). (N = 70)

SQD strategies	*M*	*SD*
Role model (ROL)	3,85	1,18
Feedback (FEE)	2,93	1,25
(Reflecting on) Instructional design (DES)	3,47	1,24
Authentic technology experiences (AUT)	4,00	1,17
Collaboration (COL)	3,03	1,26

Figure 3 shows "slightly agree" or "slightly disagree" to be the most common in the distribution of answers, except for feedback (FEE) where "disagree" is the most common answer.

Figure 3

Recognition of the SQD strategies (Tondeur et al., 2015) in the current curriculum was measured by the SQD questionnaire. 1=totally disagree (weak), 6=totally agree (strong). (N = 70)



Note. Answer totally disagree, disagree, slightly disagree, slightly agree, agree, totally agree.

4.2 SQD questionnaire with a division of two-year study and a four-year study

For this analysis, the respondents' answers were divided into two groups by study duration (Table 4 and Figure 4). Collaboration (COL) is shown to have a statistically significantly lower means. This means that in the two-year study program, Collaboration (COL) is significantly less recognized.

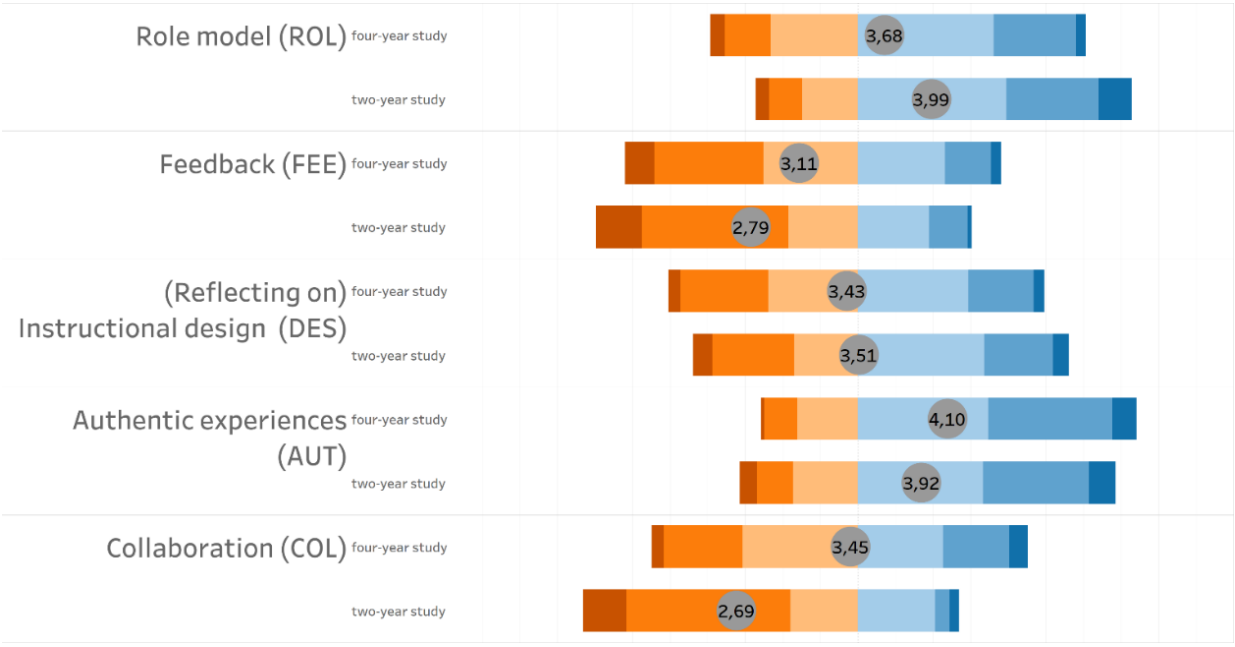
Table 4

Recognition of the SQD strategies in the current curriculum measured by the SQD questionnaire (4-year study length N=40, 2-year study length N=30)

SQD strategies	*Study length*	*N*	*M*	*SD*
Role models (ROL)	4	30	3,68	1,14
	2	40	3,99	1,19
Feedback (FEE)	4	30	3,11	1,25
	2	40	2,79	1,23
(Reflecting on) Instructional design (DES)	4	30	3.43	1,19
	2	40	3,51	1,27
Authentic technology experiences (AUT)	4	30	4,10	1,09
	2	40	3,92	1,17
Collaboration (COL)	4	30	3,45	1,24
	2	40	2,69	1,88

Figure 4

Recognition of the SQD strategies (Tondeur et al., 2015) in the current curriculum measured by the SQD questionnaire. 1=totally disagree (weak), 6=totally agree (strong) (4-year study length N=40, 2-year study length N=30)



Note. Answer totally disagree, disagree, slightly disagree, slightly agree, agree, totally agree.

Open-ended questions

The open-ended questions topics correspond to the micro strategies of the (SQD) 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.

The summary of the results of six open-ended questions are presented next, grouped according to the SQD strategies (Table 5). The question was: “If you can elaborate on what you recognized or missed during teacher training in respect of the statements, then please do so below”.

Table 5

Summary of emergent themes from open-ended questions corresponding to the six strategies of the SQD model (Tondeur et al., 2012).

	SQD strategy	Emergent themes	Summary
1	Using teacher educators as role models	Teacher trainers recognized as role models	Digital literacy teacher trainers are recognized as role models, while the majority of others are not. More time is needed to practice executing the inspiring examples. Some examples required digital equipment not available at the internship school, defeating the applicability.
2	Reflecting on the role of technology in education	Time spent on reflecting and circumstances on the internship	Reflection to the extent that the Digital literacy teacher trainer did substantiate his/her vision in class. Internship did not give rise to reflection because (a) often, limited ICT-competence of the teachers was observed there and (b) there was hardly any time left for reflection.
3	Learning how to use technology by design	Independence required when designing ICT-rich lessons	Some collaborative designing of ICT-rich lessons was recognized but there was insufficient supervised practice time. Independence is expected to develop soon regarding the designing of ICT-rich lessons.
4	Collaboration with peers	Self-organized collaboration Covid-19 pandemic	Pre-service teachers have more time working together in designing ICT-rich lessons outside of class than during class. The Covid-19 Pandemic made collaboration more difficult.
5	Scaffolding authentic technology experiences	Internship not providing accounts for interns	Some pre-service teachers discussed examples of student ICT use outside of class on their own initiative. Encouragement by the Digital literacy teacher-trainers was recognized. There were possibilities for authentic technology experiences in practice. However, some internship schools withheld login accounts necessary for interns to practice teaching with the authentic tools.
6	Providing continuous feedback	Quantity and nature of feedback	Feedback was recognized in the curriculum, but mostly used to grade, thus summative. The feedback moments were generally linked to assignments (e.g., a Portfolio assignment or an assignment concerning integration of Multimedia principles and Maths).

5. Conclusions and discussion

The objective of this study was to establish to which extent final-year preservice teachers perceive the occurrences of effective strategies, employed by the teacher-educators to support their students to gain adequate pedagogical ICT competence.

The research question was:

How do pre-service teachers of five Teacher Training Institutes perceive the occurrences of the strategies used by teacher educators to support the development of their pedagogical ICT-competences?

The quantitative data show that occurrences of “scaffolding authentic technology experiences” and “using teacher educators as role models” are recognized in the curriculum by most students. The qualitative data, however, reveals a nuance. The internships provide a space for authentic practice of ICT integration, but coherence with the teacher training institute is not guaranteed. In-service teachers vary in their ICT integration practice. The literature shows service teachers need to interact with in-service teachers who understand and model ICT integration in their classrooms. When in-service teachers do not, they potentially discourage preservice teachers from using technology in learning and teaching (Graham et al., 2009). Coherence may suffer as some internship schools lack the digital equipment used at the teacher training institutes. Some internships withhold login accounts necessary for interns to practice teaching with authentic tools. Coherence also suffers as teacher training institutes have no live access to online pupil tracking systems and online teaching environments used at the internships. The literature shows that practising with the authentic tools is important to develop a sense of achievement by applying knowledge (Barton & Haydn, 2006).
The digital literacy teacher-trainers are recognized as role models concerning ICT Integration, but the majority of other teacher-educators are not. The literature indicates that pre-service teachers need many subject-specific examples of ICT integration from all of their teacher educators. This is necessary because pre-service teachers still have limited knowledge of teaching content and of pedagogy (Becuwe et al., 2017).
The quantitative results indicate that the strategy “collaboration with peers” is underutilized. This can cause feelings of insecurity when designing technology-rich lessons (Koh & Chai, 2016). The qualitative data show that the Covid-19 Pandemic made collaboration with peers more difficult. Collaborating with peers is recognized significantly less in the two-year study program.
The quantitative results show that in our dataset, the SQD strategy “reflecting on the role of technology in education” merges with the strategy of collaborative design. The resulting concept is perceived to be underutilized, which may result in the value of ICT integration not being understood. According to the literature, its value grows with pre-service teachers’ development of TPACK. This concerns using a particular technology for a specific teaching strategy in a content area and with a specific pedagogical approach (Baran et al., 2018).
Providing continuous feedback is the least recognized strategy. The qualitative data explain this. Feedback is perceived as summative. The feedback moments were generally linked to assignments (e.g. a Portfolio assignment or an assignment concerning integration of Multimedia principles and Maths). According to literature traditional assessment lacks the relationship between the tests and what is needed to make progress in using ICT in the classroom (Tondeur et al., 2012).

Earlier research suggests the feedback strategy and items related to the design of ICT-rich lessons seem to be the most challenging for Teacher Training Institutes (Tondeur et al., 2015). Our findings reflect this, but collaboration with peers during the Covid-19 pandemic has shown to be equally challenging.

5.0 Restrictions

This research has its limitations, in particular, because this is carried out in one academic year. Data was gathered using self-reporting. Self-reported data can provide important findings on the topic, in using self-report data there is always the potential for error in recall (Egbert et al., 2002).
The qualitative data were analyzed using an interpretive process of coding and the subjective nature of this approach leaves room for bias on behalf of the researcher.
The original SQD questionnaire (Appendix 1) was translated from English to Dutch (Appendix 2: Translated item wordings of the SQD-scale) to suit the language proficiency of the Dutch respondents. Translation of instruments may have created differences in meaning. To check for its validity, exploratory factor analysis was used.
This research employed mixed-methods (one-phased) data collection to augment/provide an additional source of information. After the interpretation of the data, it could have been extra informative to organise focus groups to let the preservice-teachers react to the findings. This would have provided an additional interpretation opportunity of the quantitative data.

5.1 Recommendations

Based on the results, recommendations to improve the potential of pre-service training to enhance future teachers' pedagogical ICT-competences s would be to:

-expand the modelling of ICT use in courses and classrooms situations by all teacher educators and throughout the entire teacher preparation program;
-collaborate (e.g. in a teacher-trainer design team) to further develop the curriculum together with pre-service teachers and in-service teachers;
-to monitor (with fixed intervals) the Pedagogical ICT Competencies (supported by reflection and formative feedback) in the digital literacy classes and internships and allocate more time for pre-service teachers construct their vision of ICT in education;
-address the different experiences between the two-year program and the four-year program regarding collaboration with peers while (re)designing lessons together to include ICT integration;
-move from summative feedback to continuous formative feedback. E.g. to select and incorporate a self-reporting self-assessment instrument used by pre-service teachers and discuss their progress. This will provide them with ongoing evaluation and a reference to discuss their learning outcomes;
-form partnerships with internship schools to collaboratively work toward identifying the best strategies to support pre-service teachers in their lesson design and practice related to technology integration;
-partner with internship schools to provide continuous feedback to pre-service teachers regarding their ICT integration practice.

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Appendix 1: Item wordings of the SQD-scale

Item wordings of the SQD-scale (Tondeur et al., 2015)

During my pre-service training, …
Role model (ROL)
(ROL1) I saw many examples of ICT use in an educational setting
(ROL2) I observed sufficient ICT use in an educational setting in order to integrate applications myself in the future
(ROL3) I saw good examples of ICT practice that inspired me to use ICT applications in the classroom myself
(ROL4) The potential of ICT use in education was demonstrated concretely
Reflection (REF)
(REF1) I was given the chance to reflect on the role of ICT in education
(REF2) We discussed the challenges of integrating ICT in education
(REF3) We were given the opportunity to discuss our experiences with ICT in the classroom (i.e., during internships)
(REF4) There were specific occasions for us to discuss our general attitude towards ICT in education.
Instructional design (DES)
(DES1) I received sufficient help in designing lessons that integrated ICT
(DES2) We learned how to thoroughly integrate ICT into lessons
(DES3) We received help to use ICT when developing educational materials
(DES4) I received a great deal of help developing ICT-rich lessons and projects to use for my internship
Collaboration (COL)
(COL1) There were enough occasions for me to work together with other students on ICT use in education (i.e., we developed ICT-based lessons together)
(COL2) I was convinced of the importance of co-operation with respect to ICT use in education
(COL3) During my pre-service training, student teachers helped each other to use ICT in an educational context
(COL4) Experiences using ICT in education were shared
Authentic experiences (AUT)
(AUT1) There were enough occasions for me to test different ways of using ICT in the classroom
(AUT2) I was able to learn to use ICT in the classroom through the internships
(AUT3) I was encouraged to gain experience in using ICT in a classroom setting
(AUT4) Students were encouraged when they attempted to use ICT in an educational setting
Feedback (FEE)
(FEE1) I received sufficient feedback about the use of ICT in my lessons
(FEE2) My competences s with ICT were thoroughly evaluated
(FEE3) I received sufficient feedback on how I can further develop my ICT competences s
(FEE4) My competences s in using ICT in the classroom were regularly evaluated

Note. Response categories: totally disagree - disagree - slightly disagree - slightly agree - agree -totally agree.

Appendix 2: Translated item wordings of the SQD-scale

Translated (Dutch) item wordings, based in the original SQD scale item wordings (Jo Tondeur et al., 2015)

Tijdens mijn opleiding, …
Rolmodel (ROL)
(ROL1) Zag ik veel voorbeelden van ICT gebruik in een educatieve context
(ROL2) Zag ik voldoende ICT gebruik in een educatieve context om in de toekomst ook zelf toepassingen te integreren
(ROL3) Zag ik goede voorbeelden van ICT gebruik die me inspireerden om ICT toepassingen ook zelf in de klas te gebruiken
(ROL4) Is de potentie van ICT gebruik in het onderwijs concreet gedemonstreerd
Reflectie (REF)
(REF1) Kreeg ik genoeg kansen om op de rol van ICT in het onderwijs te reflecteren
(REF2) Hebben we de uitdagingen bij het integreren van ICT in het onderwijs besproken
(REF3) Kregen we de mogelijkheid om onze eigen ervaringen met ICT in de les te bespreken (met andere woorden tijdens stages)
(REF4) Waren er specifieke momenten waarop we onze eigen visie op ICT in het onderwijs bespraken
Educatief ontwerp (ONT)
(ONT1) Kreeg ik voldoende hulp bij het ontwerpen van lessen waarin ICT werd geïntegreerd
(ONT2) Leerden we hoe we ICT grondig in onze lessen konden integreren
(ONT3) Kregen we hulp bij het gebruik van ICT bij het ontwerpen van educatieve materialen
(ONT4) Kreeg ik veel hulp bij het ontwikkelen van ICT-rijke lessen en projecten voor het gebruik tijdens mijn stages
Samenwerking (SAM)
(SAM1) Waren er genoeg mogelijkheden voor mij om samen te werken met andere studenten aan het gebruik van ICT in het onderwijs (m.a.w. we hebben samen ICT-rijke lessen ontworpen)
(SAM2) Was ik overtuigd van het belang van samenwerking bij het gebruik van ICT in het onderwijs
(SAM3) Hielpen aankomend leraren elkaar om ICT in een educatieve context te gebruiken
(SAM4) Werden ervaringen met het gebruik van ICT in het onderwijs gedeeld
Authentieke ervaringen (AUT)
(AUT1) Waren er genoeg momenten voor mij om verschillende manieren om ICT toe te passen in het onderwijs te proberen
(AUT2) Was ik in staat om te leren hoe ik ICT in mijn onderwijs kon toepassen tijdens mijn stages
(AUT3) Werd ik aangemoedigd om ervaring op te doen in het inzetten van ICT in de context van mijn klas
(AUT4) Werden studenten aangemoedigd op het moment dat ze probeerden om ICT in hun onderwijs toe te passen
Feedback (FEE)
(FEE1) Kreeg ik voldoende feedback op het gebruik van ICT in mijn lessen
(FEE2) Zijn mijn competenties ten aanzien van ICT grondig geëvalueerd
(FEE3) Kreeg ik voldoende feedback op hoe ik mijn ICT competenties verder kon ontwikkelen
(FEE4) Zijn mijn competenties in het gebruik van ICT in de klas regelmatig geëvalueerd

Notitie. Antwoord categorieën : Geheel mee oneens - oneens – enigszins oneens – enigszins mee eens – mee eens -geheel mee eens.