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Online training of TPACK skills of higher education scholars, a cross-institutional impact study

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Online training of TPACK skills of higher education scholars: a cross-institutional impact study

Abstract

Higher education institutions should provide adequate training for teachers in order to increase their awareness of the complex interplay between technology, pedagogy and the cognitive knowledge in their disciplines. However, research has shown that providing effective staff development by teacher educators to support these teachers' skills is not straightforward. An online teacher training program created and implemented by a team of 14 teacher educators in a cross-institutional program in the Netherlands was followed by 67 teachers. Data were gathered using a TPACK (Technological, Pedagogical, Content Knowledge) instrument in a pre-post test design. Furthermore, (perceived) learning satisfaction was measured in order to determine whether the design was appropriate. The results indicate that the teachers' TPACK skills increased substantially. Furthermore, most participants were positive about the design and implementation of the online professionalization program. Nonetheless, not all teachers were able to effectively learn in this context, requiring further fine-tuning and research.

Keywords: Technology, Teacher Education, Pre-post Test, TPACK, Cross-institutional design.

Introduction

The main obstacles impeding success in teaching/learning in virtual environments are essentially related to the exercise of the social and instructive functions in virtual environments (Alvarez, Guasch, & Espasa, 2009, p. 330).

An important development in higher education has been the increased learning possibilities brought by Information Communication Technology (ICT), that if used effectively can be a powerful learning experience for learners (Brouwer, Ekimova, Jasinska, Van Gastel, & Virgailaite-Meckauskaite, 2009; Löfström & Nevgi, 2008; Rienties, Tempelaar, Van den

Bossche, Gijselaers, & Segers, 2009). For example, ICT tools like discussion forums, Wikis, or web-videoconferencing can provide a rich and valuable learning experience for students and support the acquisition of knowledge and transferable skills (Giesbers, Rienties, Tempelaar, & Gijselaers, 2013; Resta & Laferrière, 2007).

A consequence may be that traditional methods of teaching become questioned as expectations change within the student population (Garrison & Vaughan, 2008). In addition, it requires academic staff and teacher educators to engage with potentially new learning environments and adds to the complexity faced. However, Smith (2003, p. 203) argues that "[t]eacher education has not been the leading force in introducing technology in education. The leading force has been the field itself." This may lead to a potential imbalance, as technology and the capabilities it offers, are not effectively fed through in training to support academic staff understand and anticipate how this may impact on learning.

Several researchers have suggested that higher education institutions (HEIs) should respond to this potential imbalance by providing adequate training and staff support for teachers in order to increase their awareness of the complex interplay between technology, pedagogy and content knowledge in their disciplines (Lawless & Pellegrino, 2007; Löfström & Nevgi, 2008; Rienties, Brouwer, Lygo-Baker, & Townsend, 2011; Rienties & Townsend, 2012). In particular, it is important that training provided by teacher educators is embedded into the teachers' daily practice (Lawless & Pellegrino, 2007; Löfström & Nevgi, 2008; Rienties et al., 2011; Stes, Min-Leliveld, Gijbels, & Van Petegem, 2010). However, research has shown that providing effective training opportunities for teachers so that they learn how to effectively redesign learning opportunities (McCarney, 2004; Stes et al., 2010; Struyven, Dochy, & Janssens, 2011), in particular through the incorporation of ICT (Lawless & Pellegrino, 2007; Ziegenfuss & Lawler,

2008), is not straightforward. Therefore, in this study we investigate the impacts of an innovative cross-institutional online professionalization program called MARCH^{ET} (Make Relevant Choices in Educational Technology), which was specifically designed to enhance teachers' skills to effectively integrate ICT into their teaching practice.

Although the practice of providing teacher training in face-to-face settings has been the dominant form of training in the last forty years, providing a training program completely online co-created by five HEIs by 14 teacher educators is, to our knowledge, innovative. As 67 teachers were interacting and learning with teachers from other institutes using a range of online tools for a period of eight to twelve weeks, teachers had the opportunity to obtain a first-hand, authentic and sustained experience of what it is like to learn in a distance education setting. Therefore, in this study the following questions will be asked: 1) what are the design principles of a cross-institutional online professionalization program MARCH^{ET}?; 2) To what extent were teachers satisfied with the innovative MARCH^{ET} professional training program?; 3) To what extent did teachers learn to effectively implement ICT in their education?

In order to answer these three questions, we will first explain the conceptual basis of this program, namely the technological pedagogical content knowledge model (TPACK) developed by Mishra and Koehler (2005; 2006). Afterwards, we will describe the five learning steps of the online professionalization program. Finally, we will discuss the learning satisfaction of participants and the impact of the program on participants' TPACK.

Technological pedagogical content knowledge (TPACK)

Many innovations in higher education have not delivered the fundamental changes that many teachers and researchers hoped for (Koehler & Mishra, 2005; Resta & Laferrière, 2007; Rienties et al., 2012). This has been attributed to a lack of organisational embedding of

innovation and ICT in particular (Resta & Laferrière, 2007; Rienties et al., 2012), a lack of understanding of the essential parameters for effective teaching with ICT (Alvarez et al., 2009; Koehler & Mishra, 2005; McCarney, 2004; Rienties et al., 2012; Valcke & Martens, 2006; Ziegenfuss & Lawler, 2008), and finally a lack of appropriate teacher training to effectively design and implement powerful learning and teaching experiences for students (Alvarez et al., 2009; Lawless & Pellegrino, 2007; Löfström & Nevgi, 2008). In other words, the application of ICT does not necessarily have added value in education unless the implementation of ICT in education is well-designed by teacher educators and implemented by teachers who appreciate both the technical and pedagogical implications (Lawless & Pellegrino, 2007; Rienties et al., 2012). Mishra and Koehler (2006) designed the technological pedagogical content knowledge (TPACK) model for successful learning using ICT to help consider how well aligned the different elements were. Mishra and Koehler (2006) argued that in order to successfully implement ICT in education, it is important to select the technology which is adjusted in line with the pedagogical approach and the content of the teaching module. In order to effectively address students' needs, teachers need to have sufficient content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). Mishra and Koehler showed that learning is most effective when teachers have appropriate awareness of the complex interplay between pedagogy, technology and discipline knowledge and integrate these when designing teaching.

Although there are many examples of successful implementations of technology-enhanced learning approaches in teaching practice (Brouwer et al., 2009; De Laat, Lally, Lipponen, & Simons, 2007; Garrison & Vaughan, 2008; Giesbers et al., 2013; Rienties et al., 2009; Rienties & Townsend, 2012; Ziegenfuss & Lawler, 2008), in practice there is often an imbalance between technological, pedagogical and content knowledge of a teacher and how

training addresses these three key areas. Technological knowledge is often seen as independent from content and pedagogical knowledge (Kinchin, 2012; McCarney, 2004; Mishra & Koehler, 2006; Rienties & Townsend, 2012; Ziegenfuss & Lawler, 2008).

Typically, when for example a Marketing teacher thinks about using new ICT tools in education, a teacher educator or a learning technologist from an e-learning centre is most probably consulted. If the Marketing teacher decides to use a wiki to discuss effective Marketing strategies in his marketing module without incorporating the wiki into the module design (e.g. having a task where students have to search for effective marketing strategies and report these findings in the wiki and afterwards critically reflect on peers' contributions), content (e.g. discussing marketing strategies in class based upon the discourse in the wikis) and pedagogy (e.g. using a collaborative learning approach rather than using a traditional lecture-based approach), it is likely that many of the students will not actively use the wiki. As a consequence, the teacher's motivation to use ICT may drop, which in turn may reflect back negatively on the teacher educator.

Research has suggested that content knowledge often determines the pedagogical approach taken and the adoption of particular technologies (Koehler & Mishra, 2005; Mishra & Koehler, 2006). In a review of 118 course designs for transitional, remedial education, Rienties et al. (2012) found that teachers from 22 countries consistently aligned their content with their pedagogical approach. However, the use of technology in these 118 courses was not found to be related to the teachers' content or pedagogical approach. This reflects the findings by Alvarez et al. (2009) who reviewed 16 blended and online teacher training programs and concluded that the focus on technology generally failed to relate this to pedagogy.

Recently, several instruments (Abbitt, 2011; Chai, Koh, & Tsai, 2010; Schmidt, Baran, Thompson, Koehler, & Mishra, 2009) have been developed to measure (perceived) TPACK knowledge and skills, primarily amongst pre-service teachers in primary and secondary education (for recent review, see Abbitt, 2011). For example, one of the first instruments for self assessment of the seven TPACK components was developed for pre-service teachers by Schmidt et al. (2009). It consisted of 75 items and explored the seven factor structure with 124 students in an instructional technology course in the US. In a study amongst 889 pre-service teachers in Singapore using a shortened version of Schmidt et al. (2009), Chai et al. (2010) using regression analysis, found that technological knowledge, pedagogical knowledge and content knowledge were all significant predictors of pre-service teachers' TPACK, with pedagogical knowledge having the largest impact.

Although these findings amongst pre-service teachers are important steps towards validating and refining the TPACK model, limited research is available in a higher education context, where the pressures on academic staff are substantially different from teachers in primary and secondary education (Alvarez et al., 2009; Kinchin, 2012; Kinchin, Lygo-Baker, & Hay, 2008; Postareff, Lindblom-Ylänne, & Nevgi, 2007; Rienties, Brouwer, & Lygo-Baker, 2013). Furthermore, most academic staff engaged in our study already had substantial teaching experience and some experience with technology-enhanced learning. Therefore, an instrument developed by Rienties et al. (2013) was used to measure the impact of the online professionalization program. As described by Rienties et al. (2013), three experts in technology-enhanced learning with substantial expertise in developing questionnaires designed a TPACK questionnaire consisting of 18 items, comprising six key elements: usage of technology-enhanced learning; expertise in teaching in collaborative learning settings; content and

pedagogical knowledge; technological pedagogical knowledge; technological content knowledge, and TPACK.

What is the instructional design philosophy of MARCH^{ET}?

The modules in this MARCH^{ET} were designed according to principles of the TPACK model (Koehler & Mishra, 2005; Mishra & Koehler, 2006; Rienties & Townsend, 2012), insights from Computer-Supported Collaborative Learning (De Laat et al., 2007; Garrison & Vaughan, 2008; Resta & Laferrière, 2007; Rienties et al., 2012), and literature from teacher training and academic development (Alvarez et al., 2009; Lawless & Pellegrino, 2007; Löfström & Nevgi, 2008; Stes et al., 2010; Ziegenfuss & Lawler, 2008). Furthermore, the ten years practical experience of delivering teacher education programs by the six core members of the MARCH^{ET} team was integrated in the instructional design of the modules.

First of all, the modules were designed based upon the notion that changing teaching practice takes time. In a meta-review of the effects of 21 training programs, Lawless and Pellegrino (2007) found that effective training programs provide teachers with training for a substantial period of time, in order to allow teachers to reflect on their practice and to use the inputs from the training in the actual learning environment. That is, a workshop and hands-on experience for a day, for example on how to use web-videoconferencing, in most cases does not lead to immediate substantial change in the way teachers integrate technology into the classroom (Lawless & Pellegrino, 2007). Staff need time to reflect on how they can effectively implement change and respond to the consequences that any change brings with it. Therefore, we designed our modules to last for eight to twelve weeks, with sufficient autonomy and freedom for teachers to learn and reflect at a time of their convenience.

Second, in line with Alvarez et al. (2009), we argue that learning is a social construct and training programs should be designed to reflect this. Therefore, we designed a program that allowed teachers to extend their socially situated competences in an active and meaningful learning environment. That is, teachers were distributed in small groups and discussed their teaching and learning challenges with peer-teachers from different institutes, as recommended by Smith (2003). Teachers were expected to attend four one hour online web-videoconferences, once every two-three weeks to meet each other. In between these online meetings, teachers were able to discuss their experiences in asynchronous discussion forums. In this way, teachers were able to work together with other teachers and learn from each others' experience, but to do so at a time and place that was chosen by them, allowing greater flexibility.

Third, the modules were designed to fit the teaching practice of teachers, rather than designing a training module on how to use technology X, Y or Z (Lawless & Pellegrino, 2007; McCarney, 2004). When teachers are provided with training opportunities that are detached from their daily practice, many teachers are unable to link their learning with their teaching practice (Stes et al., 2010). The goal of each teacher taking part in the MARCH^{ET} was to implement the redesign in their own teaching practice within six months after the training was completed. The tasks and assignments were aligned to this overall goal (Alvarez et al., 2009), whereby teachers worked both individually and in groups on critically re-evaluating their teaching practice, actually redesigning a module as part of the program's final learning outcome. After the program was finished, teachers were asked to implement the redesign into their daily teaching practice in order to evaluate the effect of the redesign and to further fine-tune it.

Sequence of Learning Steps of the training program

As part of the enrolment procedure for each module, participants were expected to fill in a questionnaire (pre-test) to measure their expertise with and attitudes towards ICT (see Instruments). Afterwards, an intake telephone interview was conducted by the module moderator in order to determine whether the selected online professional development program was appropriate for the needs of the respective participant in terms of practical relevance and experience, as recommended by Alvarez et al. (2009) and McCarney (2004).

Step 1. Orientation on the subject and tools

This step oriented participants towards the subject matter and tools to be used in the online settings. An initial kick-off meeting of one hour was arranged online using web-videoconferencing (Giesbers et al., 2013), whereby participants in groups of 3-7 were introduced to the concepts and organisation of the module by an online moderator and teacher educator (i.e. Janneke), as illustrated in Figure 1. It also provided the teachers with the necessary information about the intended learning outcomes, learning processes and assessment protocols of the module. The participants were invited to orient themselves on the range of usable tools which might be relevant for their own teaching practice.

➔ *Insert Figure 1 about here*

Step 2. Make a relevant choice for a tool

This step required participants to elaborate on the knowledge constructed in the previous step. Participants used asynchronous tools outside the web-videoconference in the module using Microsoft Sharepoint, such as a discussion board, sharing documents in their personal folder, working in a wiki or writing blogposts. By actively experimenting with the various ICT tools,

participants were able to experiment and discover how the tools fitted the desired pedagogical approach (and vice-versa). By actively experimenting with technology and aligning the functionality of technology to their pedagogical design, teachers evaluated the tool(s) with respect to the TP (technology and pedagogy) and TC (technology and content) interface. This selection was discussed by each group in a second web-videoconference as illustrated in Figure 1, whereby participant Frank explained how he intended to redesign his module to increase students' awareness of and interest in following the news. He was planning to use weblogs and discussion forums to allow students to share news with other students and other teachers shared their experiences and provided feedback on the initial design. After first exploring a new tool, Frank was encouraged in the module to also redesign his pedagogical approach.

Step 3. Redesigning your educational setting

The goal for each participant was to redesign and implement a module within his or her own teaching practice. This step required participants to apply their knowledge about TPACK in the context of their own teaching practice. Participants redesigned their module, changed their pedagogical approach and integrated this with a selected tool(s). In redesigning, they were required to actively discuss the alignment between content, pedagogy and technology of each others' design. Finally, the teachers designed an evaluation instrument to measure the effect of their redesign on students learning in their own teaching practice.

Step 4. Reflection on the module

Participants reflected on their own learning process and the experiences in the module and looked back to the situation when they started the module. After this step, the group process in the module was finished.

Step 5. Implementation, evaluation and presentation of the results on final conference

Participants implemented their redesigned lesson(s) in their teaching practice and evaluated the effects on learning by students using the evaluation instrument which they have designed in the module. Afterwards, participants were invited to share their experiences through a conference which was organized by the MARCH^{ET} as part of the professional development program. In round table discussions participants provided feedback on the results and experiences obtained in their teaching practice after implementing the (re)design.

Method

Setting

67 teachers from five higher educational institutes in the Netherlands participated in an online professional development program consisting of four separate and independent online modules (i.e. collaborative knowledge building; web 2.0 educational applications; measuring knowledge and understanding; and supervising students in distance learning). Each of the modules took eight to twelve weeks to complete with a total time investment of 20-25 hours and could be followed independently of the other modules. After completing a module, the participants (i.e. teachers) were expected to implement the redesign in their teaching. Most of the participants followed one module at a time. More specific details about the modules can be found at www.marchet.nl

Participants

The average age of the 67 participants was 41.04 (SD = 9.57).58% of the teachers were male. In total, 1 professor, 2 senior lecturers with a research task, 11 lecturers with a research task, 30 lecturers without a research task, 7 researchers without a teacher task, 5 PhD students, 1

managers and 10 other participants who did not fall uniquely in the previous categories participated. Teachers from a wide range of disciplines participated in MARCH^{ET}. Participants who successfully passed the module were given a certificate, which could be used as evidence material for their professional development program[i].

Instruments

Measurement 1 Learning satisfaction

The learning satisfaction of the participants was measured by an internally developed evaluation questionnaire. The questionnaire was adjusted in order to fit the program, leading to 19 questions using a Likert response scale of 1 (=totally disagree) to 5 (=totally agree) and one open question directly after the module was finished.

Measurement 2 Pre- and post-test TPACK

As described by Rienties, Brouwer et al. (2013), the TPACK questionnaire measured the participants' perceptions of how they designed and implemented technology-enhanced learning into their practice. The TPACK questionnaire consisted of 18 items, comprising six key elements: usage of technology-enhanced learning; expertise in teaching in collaborative learning settings; content and pedagogical knowledge; technological pedagogical knowledge; technological content knowledge, and TPACK. Given that participants were expected to fill in the TPACK questionnaire in the pre- and post-test, a conscious choice was made by the research team to limit the number of items per scale and only use scales relevant for this study. That is why content knowledge (CK) was left outside this study, was shortened to one item, pedagogical knowledge (PK) was narrowed by focussing on expertise in teaching in collaborative learning settings and technological knowledge (TK) was replaced by usage of technology-enhanced

learning. Finally, by aggregating the three TPACK categories and adding three additional items, an integrated TPACK score was derived. 65 (97%) participants filled in the pre-test. Of the 37 (55%) participants who successfully completed the module, 31 participants filled in the post-test questionnaire, while only five participants who dropped out completed the post-test questionnaire, despite two individualised reminders. In Table 1 example items, the number of items per scale, and Cronbach alphas for the pre- and post-test are illustrated. All scales in pre- and post-test met the threshold criteria commonly adopted in social science of Cronbach alpha ≥ .60, indicating reasonable reliability.

➔ Insert Table 1 about here

Results

To what extent were teachers satisfied with MARCH^{ET} professional training?

After 8-12 weeks of training, the participating teachers in general were moderately to positively satisfied with the overall training. As is illustrated in Table 2, respondents indicated that the design of the training module was appropriate, as most values were above the neutral value of 3.0. In general, the majority of participants were satisfied about the use of the online videoconferences (75%), the moderator (73%), the content (78%), the flexibility of the module setup (68%), and the user friendliness of the ICT system (57%). At the same time, the lowest scoring elements was the working together in the group (34% were positive), followed by their own contributions (54% were positive) and the feedback from the group (56% were positive). On average, participants spent 16.43 (SD = 7.56) hours on self-study in addition to the four hours of online consultation. 81% of the participants stated that they would recommend the MARCH^{ET} modules to others, indicating a significant overall satisfaction.

➔ Insert Table 2 about here

In order to test for difference between the learning experiences of participants who successfully completed the module and those who did not, a follow-up ANOVA analyses was used. This indicated no significant differences with the exception of one item, "I'm happy with my own contribution". The five participants who failed to complete the module were significantly less positive about their own engagements and contributions to the group discussions. The learning experiences across the four modules were similar, as ANOVA analyses indicated that no significant differences were found across the four modules with the exception of question "The assignments were motivating", whereby participants from the Module 3 (measuring and assessing knowledge) were significantly more positive than participants from the other three modules. In other words, participants across the four modules experienced a similar and positive learning satisfaction, irrespective of whether they completed or dropped-out of the module.

With respect to institutional differences, participants' learning satisfaction scores differed significantly with the assessments ($F(4, 31) = 3.162$, $p < 0.05$), feedback received from fellow-teachers ($F(4, 32) = 2.609$, $p < 0.05$), satisfaction with the module design ($F(4, 32) = 3.986$, $p < 0.05$), and the average score on all 19 items ($F(4, 32) = 3.437$, $p < 0.05$). In general, participants from the two science and technical research institutes A and C were more positive about the overall learning experience, in particular the quality of the assessments, design and feedback received in comparison to participants from the other institutes. Participants from the applied science university institute, D, were less satisfied about the program. Finally, dropout rates across institutes were significantly different ($F(4, 62) = 10.129$, $p < 0.01$), whereby all participants from Technical University (Institute C), 88% from Social Science University

(Institute E), 77% from Science University (Institute A), 31% from Medical University (Institute B), and only 19% from University of Applied Science (Institute D) passed the module.

What was the impact of MARCH^{ET} in terms of TPACK?

At the start of the training, taking a cut-off value of 3.0 for the TPACK instrument, 53% of the participants indicated that they did not actively use ICT in their current teaching practice. Furthermore, 37% of the participants indicated a limited expertise in designing and implementing collaborative learning environments. With respect to TPACK, participants were most positive about their cognitive pedagogical knowledge, where only 23% of the participants indicated not to balance cognition of their discipline with their pedagogical knowledge. 31% of the participants indicated limited technological pedagogical knowledge, while 36% of the participants indicated limited technological content knowledge.

In Figure 2, the technological pedagogical content knowledge (TPACK) of participants before and after the training is illustrated. Except for expertise in collaborative learning, all TPACK scores for the post-test were higher than the pre-test. Follow-up analyses of the six TPACK categories indicate that participants who completed the post-test were significantly more positive about their use of technology-enhanced learning in their classroom ($t = 2.357$, $p < 0.05$, Cohen d-value = 0.27). Furthermore, participants were marginally more positive about their content and pedagogical knowledge ($t = 1.785$, $p < 0.10$, $d = 0.29$) and technological pedagogical knowledge ($t = 1.861$, $p < 0.10$, $d = 0.38$). Finally, the integrated TPACK score, was significantly higher than the pre-test ($t = 2.723$, $p < 0.05$, $d = 0.46$), with a moderate effect size. In other words, these findings indicate that participants were more confident about their abilities to integrate technology within their pedagogical design and discipline, although from a

conservative statistical perspective the increase in the separate TPACK categories was not statistically significant.

➔ Insert Figure 2 about here

Discussion and conclusion

Given the possibilities that ICT offers to provide a rich learning experience to students, teachers need to be able to update their skills and expertise in a safe and cost-effective manner (Alvarez et al., 2009; Rienties & Townsend, 2012; Smith, 2003). At the same time, teacher educators are under increased pressure to provide support and training in technology that some teacher educators are less comfortable with. In terms of answering the first question of this study, a fundamental and key design principle of the five-step MARCH^{ET} is that training provided to teachers should be embedded within their daily practice. Providing a training program to teachers that did not address this specific need was unlikely to have a fundamental impact on their ICT skills (Lawless & Pellegrino, 2007). A particular merit of the MARCH^{ET} design is that teachers were interacting and learning with teachers from other institutes using a range of online tools for a sustained period of time, while also having sufficient flexibility for teachers to determine when and where to self-study. That is, teachers obtained a first-hand, authentic and sustained experience of what it is like to learn and teach in a distance education setting using a range of synchronous and asynchronous tools.

A second key design principle we used to provide an effective learning experience was to base our program on TPACK (Mishra & Koehler, 2006), which provides an increasingly internationally accepted conceptual model for teachers and teacher educators to balance and integrate technology, pedagogy, and discipline knowledge. A third key principle that links back

to the first principle is that teachers should have sufficient time within the training program to reflect on their own teaching practice and implement the learning into their own educational design. That is, by requiring teachers to redesign their module as a final learning outcome, teachers were actively encouraged by teacher educators to implement their insights and newly acquired skills into practice.

In terms of the second question, the results indicate that the learning experiences of the participants in general seemed to be positive, whereby most participants were positive about the overall design, moderation and tasks. However, not all participants were equally positive about the (lack of) contributions by and feedback from their peers and teachers. Similar to findings in CSCL with student interaction (De Laat et al., 2007; Giesbers et al., 2013; Jonassen & Kwon, 2001; Rienties, Giesbers, Tempelaar, & Lygo-Baker, 2013), whereby only a small number of participants actively contribute to social interactions, getting the balance right between guidance/structure and support/flexibility in order to facilitate both teachers in need of more support and those who are more self-directed, is a complex and delicate issue. Perhaps not all teachers were comfortable working together with other teachers who they only met online, reflecting the findings of McCarney (2004) who found that one of the least preferred methods of teacher training was distance education.

In terms of the impact of the professionalization program (i.e. our third question), teachers overall TPACK improved significantly after completing the program. Although the two subscales of the TPACK were higher after twelve weeks, the p-values were only marginally significant. However, while 53% of the participants indicated at the beginning of the program that they did not use ICT in the classroom, by the end this had reduced to 34%, indicating that more teachers had started to integrate technology-enhanced learning into their daily practice.

Albeit, not all participants were able to effectively balance TPACK after completing the MARCH^{ET} module. 18% of the participants indicated limited technological pedagogical knowledge, while 30% of the participants indicated having limited technological content knowledge. One possible explanation for the relatively poor p-values is that within the cohort a group of around 20 teachers was present, who already had substantial experience with ICT and how to integrate technology into education. As a result, their potential learning gap may have been relatively limited, or in statistical terms referred to as a ceiling effect. In contrast, some teachers who had limited experience with and/or confidence in ICT may have underestimated their expertise in TPACK. A second explanation may be that the actual effects of training take time to be experienced with confidence in practice. That is, both Lawless and Pellegrino (2007) and Stes et al. (2010) argue that the impacts of training need time.

A relatively surprising finding is that teachers in some institutes were more likely to complete the training modules and were more positive about the learning experiences offered, while in particular in Institute D pass-rates and satisfaction scores were substantially lower. One possible explanation is that teachers in applied universities of science in the Netherlands are more likely to already have substantial knowledge and expertise with pedagogical design and technology, as their roles are primarily focussed on teaching, providing pastoral care and administration. In contrast, most teachers at research-intensive universities are primarily employed as a result of their research profile and in general use more traditional teaching and learning approaches. Most teachers from Institute B were medical specialists, who in contrast to most other participants not only have to conduct research and teach, but primarily provide patient care and services. As a result, with an extremely busy schedule, dropping a voluntary teacher training program would be quite logical when patient care demands additional work.

Implication for teacher education and management

In the literature, several reasons are put forward to explain why some academic staff are reluctant to embrace technology, such as institutional culture (Hanson, 2009; Kinchin, 2012; Kinchin et al., 2008; Rienties & Townsend, 2012), anxiety over technology (Hanson, 2009; Jimoyiannis & Komis, 2007), and lack of training (Jimoyiannis & Komis, 2007; Lawless & Pellegrino, 2007). Given the difficult economic times at present and the increased opportunities offered by technology-enhanced learning, one wonders why more HEIs are not encouraging academic developers and teachers to work together beyond their institutional and national borders. As this study has highlighted, most participants were satisfied with the learning experience offered in an online training environment and there is some evidence that their (perceived) technological pedagogical content knowledge skills were enhanced; even if this was radically different from their previous training experiences.

Beyond obvious economies of scale when implementing a jointly developed cross-institutional training program, if institutional cultures are a possible limiting factor in technology-adoption, then allowing teachers to work with colleagues from different institutions in a (cross-national) online professionalization program may allow them to explore different technology-enhanced learning approaches in a safe (online) environment from different (international) perspectives. Finally, we would like to add a point for reflection related to teacher education. Although teacher education according to Smith (2003) has not been at the forefront of introducing technology in education, our experiences indicate that the possibilities offered by online teacher education are potentially substantial. If teacher educators and HEIs do not seize these opportunities to step into the market by offering similar cross-institutional professional development programs, we foresee a similar pressure on the business model of teacher education to that which is developing in the broader environment. As open educational resources like edX,

or distance education programmes like University of Phoenix, become available the potential for staff to use these, rather than the potentially more limited internal programs will probably increase.

Practical implications for teacher educators

The experiences of 16 teacher educators from five HEI working together to design a cross-institutional training program forced most teacher educators to step outside their own comfort zone. Sometimes the joint design-process caused some challenges, but overall we feel that by working together we were able to harness different perspectives, disciplines, institutional cultures and experience levels and this allowed us to create a more flexible and comprehensive training program. We found that by first designing an overall blue-print through extensive discussions (i.e. 5 step MARCH^{ET}), and afterwards designing the four modules based upon the expertise of each member of the team, this allowed us to create a consistent course design and learning experience for teachers.

All four modules are free to download and to be used freely, redesigned and reinvented for your own teacher training program or practice at http://www.onderwijsontwerpenmetict.nl/. We encourage teacher educators to critically reflect on our design and design choices, and adjust this to the requirements of the local context, institute, and culture. We would appreciate feedback on whether our design is appropriate in these different contexts.

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Table 1 Measures: Questionnaires, Item examples, Cronbach's alphas and descriptive statistics

Scale	N items	Exemplary item	M	SD	α-pre	α-post
Use of technology-enhanced learning	3	In the courses I teach, ICT tools are used to facilitate learning in a group	3.05	.82	.67	.72
Expertise in teaching in collaborative learning settings	2	I have experience in supporting students in collaborative learning.	3.48	.88	.67	.86
Content and pedagogical knowledge	1	When I design a teaching activity I always consider how the content and the pedagogy influence each other.	3.89	.84		
Technological pedagogical knowledge	4	When I design my teaching I always consider how pedagogy will influence the use of technology (ICT tool).	3.45	.74	.76	.65
Technological content knowledge	3	In my teaching I always consider how the technology (ICT tool) will influence the content of the teaching activity.	3.40	.77	.86	.60
TPACK	11	Designing teaching in which students use ICT requires changes in how we teach and what we teach	3.53	.50	.82	.73

Note: The Likert response scale of TPACK ranges between 1 (Totally disagree) to 5 (Totally Agree).

Table 2 Learning satisfaction of the teachers at the end of the module (ordered by score)

	M	SD
I would recommend this module to other people.	4.03	0.93
The online videoconferences were useful.	3.97	0.96
The moderator supported the learning process efficiently/good.	3.89	0.66
The learning material was of good quality.	3.86	0.71
The module's intention was clear to me.	3.81	0.88
The content of the module inspired me.	3.76	0.86
Average score six assignments	3.73	0.50
Working in the module was engaging and enjoyable.	3.73	0.80
I could spend my time working on the module flexible enough.	3.70	1.02
The assignments were motivating.	3.62	0.72
Working in the Virtual Learning Environment was evident and easy.	3.62	1.19
I've got useful feedback from the other participants.	3.54	1.04
The module was as I expected.	3.41	0.99
I'm satisfied with my course redesign.	3.38	0.72
I'm happy with my own contribution.	3.32	0.97
Working together as a group was very useful.	3.22	1.03
The online consultation hours were useful.	3.16	0.50
I would like to have more online videoconferences.	3.08	1.16
I would like to have more online consultation possibilities.	2.95	0.78

N=37 The Likert response scale ranges between 1 (Totally disagree) to 5 (Totally Agree).

Figure 1 Screenshot of web-videoconference

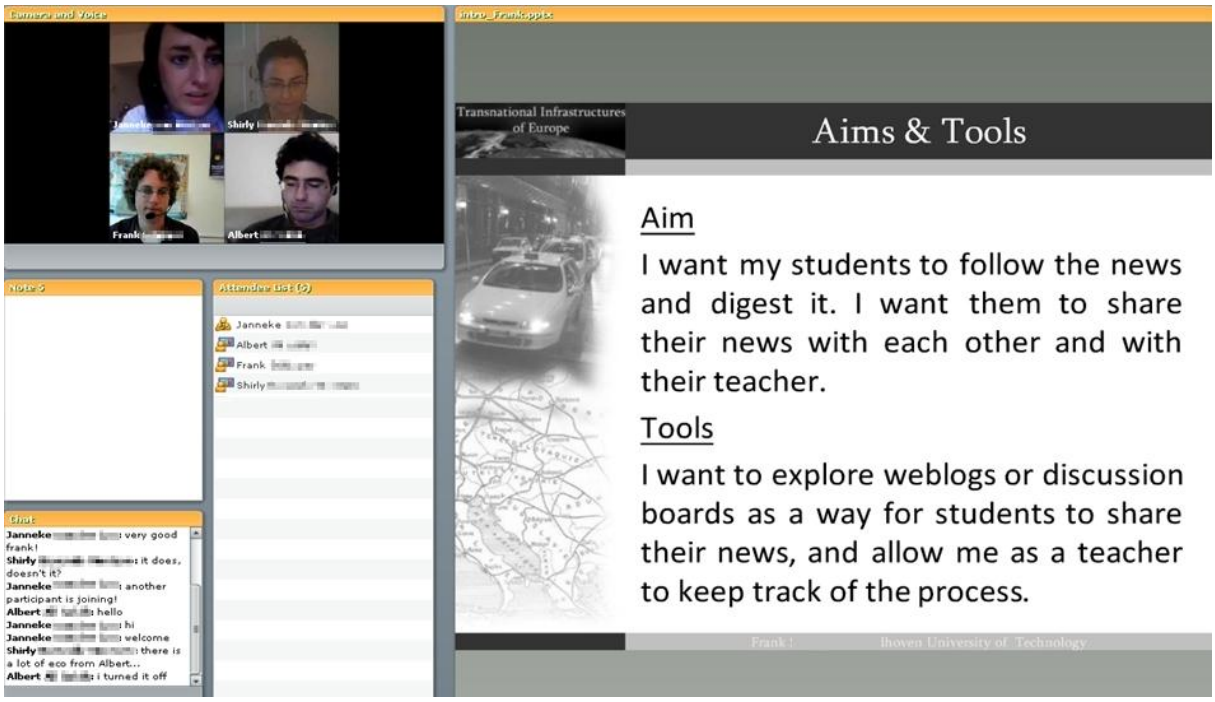
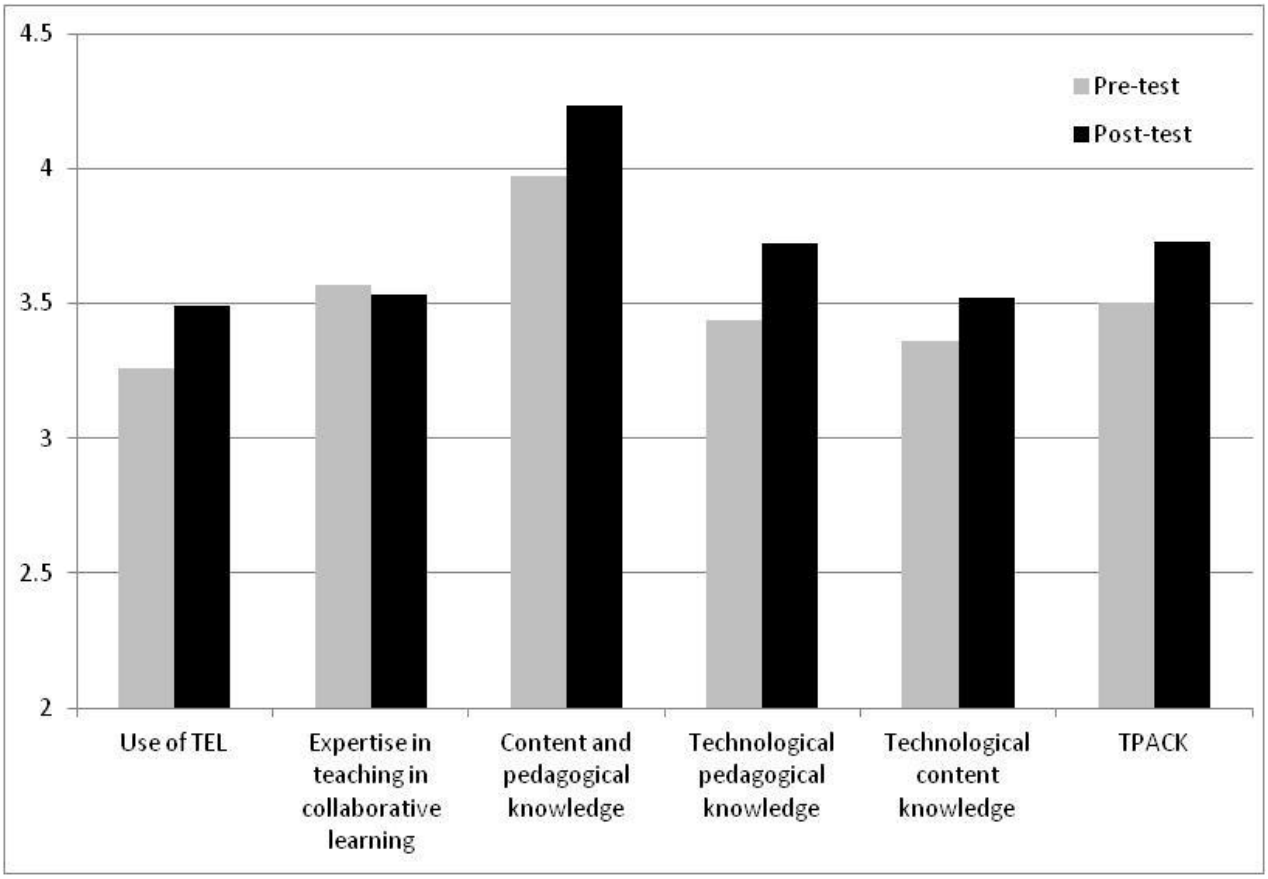


Figure 2 TPACK pre- and post-scores



[i] In contrast to countries such as the UK where most institutes offer lecturers in higher education as part of their probation a clear, detailed and intensive academic development program equivalent to a master degree, in the Netherlands teachers in higher education only have to follow a Basis Kwalificatie Onderwijs (BKO) program. This BKO is a basic program for learning and teaching equivalent to 200 hours of training if teachers have no teaching experience. However, teachers can provide evidence of their acquired skills and knowledge by following courses like the one described.