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Measuring and Supporting Pre-Service Teachers' Self-Efficacy Towards Computers, Teaching, and Technology Integration

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Abstract

This paper reports on two studies designed to examine pre-service teachers' self-efficacy beliefs. Study I investigated the measurement properties of a self-efficacy beliefs questionnaire comprising scales for computer self-efficacy, teacher self-efficacy, and self-efficacy towards technology integration. In Study I, 200 pre-service teachers completed the self-efficacy questionnaire. Confirmatory factor analyses resulted in a modified measurement model consisting of the three hypothesized self-efficacy scales. Study II reports on an intervention to clarify the effects of digital video composition experiences on these same three self-efficacy variables. Participants were 22 pre-service teachers and 16 adult education students enrolled in a Finnish university education course. Data comprised pre- and post-measures of self-efficacy with the instrument validated in Study I. The results showed, in particular, a significant increase in pre-service teachers' beliefs in all three aspects of self-efficacy. Provision of hands-on engagement with technologies appears to be an effective way to enhance pre-service teachers' confidence in using technology in their teaching.

Keywords: teacher self-efficacy, computer self-efficacy, self-efficacy towards technology integration, digital video composing, teacher education

Introduction

Today's youth increasingly use digital devices in their daily lives (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013) and schools are expected to support students' development of the various digital literacies required in the labor market (Davies, Fidler, & Gorbis, 2011; Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). Younger people need to be competent creators and producers of digital information, and they should be able to communicate that information in multiple modes (e.g., CCSS, 2010) in both out-of-school and academic contexts (see Bennett & Maton, 2010). Likewise, teachers are expected to be skilled in embedding new technologies into their instructional practices in pedagogically purposeful ways (International Society for Technology in Education [ISTE], 2008). Further, teachers should be able to demonstrate both an understanding of and confidence in how to engage and support students in their development of digital practices associated with knowledge construction and communication (International Reading Association [IRA], 2009; National Council of Teachers of English [NCTE], 2010).

Unfortunately, teachers' use of technology may be limited to supporting traditional ways of teaching and learning rather than incorporating innovative uses of technology into their practices (Bang & Luft, 2013). A review by Bingimlas (2009) indicates that teacher-level barriers to technology integration in education are often related to a lack of confidence, limited technological competencies, negative attitudes, and resistance to change. These findings pose a number of challenges to teacher education programs seeking to develop pre-service teachers' abilities and confidence in utilizing technology in the classroom. The purpose of Study I was to build a better understanding of the nature of self-efficacy in relation to pre-service teachers' confidence in using technology in teaching.

For Study II, we designed a course that offered pre-service teachers a theoretical understanding of technology integration along with hands-on experience of using technology. Course development drew on work by Tondeur et al. (2012), who identified seven key themes

that would best prepare pre-service teachers to integrate technology into their lessons; these included practices such as aligning theory with practice, scaffolding authentic technology experiences, using teacher educators as role models, and collaborating with peers. Given that one of the teacher-level barriers to integrating technology into education is lack of confidence related to technology use in classrooms, Study II explored the potential of digital video composition as a tool for enhancing pre-service teachers' self-efficacy.

Self-efficacy

Self-efficacy (Bandura, 1997) refers to people's judgments of their capabilities to perform successfully in a specific task. Self-efficacy beliefs have a pivotal role in one's choices of activities, effort invested in given endeavours, and persistence when facing obstacles or failures. Indeed, self-efficacy beliefs have been associated with successful performance in a wide range of domains, such as academic achievement (Multon, Brown, & Lent, 1991), writing (Pajares, 2003), mathematical problem solving (Pajares & Miller, 1994), and work-related performance (Stajkovic & Luthans, 1998).

According to Bandura (1997), self-efficacy beliefs are constructed by interpreting information from four principle sources. The first and most important source informing one's self-efficacy is having mastery experiences; such experiences provide the most reliable evidence for one's judgments. Experiencing success should raise one's confidence that one will be able to accomplish similar tasks whereas repeated failures may diminish one's confidence in success. For example, pre-service teachers who have mastery experiences with technology are likely to be more confident in using it in their classrooms compared to pre-service teachers with negative experiences with technology. Further, if one believes that she or he is capable of succeeding in a task but acknowledges that the current approach is ineffective, failure in this task will not necessarily lower self-efficacy (Bandura, 1997). Also, occasional failure after many mastery experiences should not affect one's self-efficacy beliefs (Shunk & Usher, 2011).

It is important however, that in interventions planned to enable mastery experiences the tasks to be accomplished are designed so as to emphasize the connection between effort and success (Ames, 1992). Success with simple tasks that require little effort may do little to motivate pre-service teachers' internal desires to learn about new pedagogies or increase their computer skills. In contrast, challenging tasks that a) emphasize understanding new content and improving skills for personally relevant reasons, and b) offer students control over either the process or the product are much more likely to create intrinsic purposes for learning which, in turn, lead to mastery goal orientations (Lepper & Hodell, 1989; Malone & Lepper, 1987).

Vicarious experiences, a second source of self-efficacy, provide information through observing the performance of others (Bandura, 1997). In particular, observing similar others' successful performance can raise observers' self-efficacy. If others can perform new or challenging tasks successfully, people are inclined to believe they too are more likely to succeed in the task (Schunk & Usher, 2011). In addition, vicarious experiences offer pre-service teachers an opportunity to learn effective strategies for managing the task demands (Tschannen-Moran & McMaster, 2009).

A third source of self-efficacy is that of verbal and social persuasion from others (Bandura, 1997). Encouragement from teachers and other students along with evaluative, positive feedback about performance may raise students' confidence in accomplishing a task in a related domain (Usher & Pajares, 2008), particularly when this feedback focuses on student effort towards mastery goals and the opportunity for intrinsic reflection and self-improvement (Ames, 1992; Graham & Golan, 1991). However, as Bandura cautions, it is often easier to erode a student's self-efficacy with negative comments than to enhance it with positive messages, an observation that should be considered when offering feedback. Notably, in order to be effective, social persuasions should be genuine (Britner & Pajares, 2006) and should emphasize independent thinking, content mastery, and self-referenced standards

(Ames, 1992). Psychological and affective states serve as a fourth and final source of self-efficacy (Bandura, 1997). Negative emotional reactions, such as anxiety or stress, may lower self-efficacy beliefs whereas positive reactions, such as being in a good mood, may raise self-efficacy beliefs.

Computer Self-Efficacy, Teacher Self-Efficacy, and Self-Efficacy towards Technology Integration

The challenges posed to teacher education and professional development programs seeking to enhance teachers' confidence in utilizing technology in the classroom have been approached from different perspectives. One common way to examine teachers' confidence levels is to evaluate computer self-efficacy (e.g. Albion, 1999; Paraskeva, Bouta, & Papagianni, 2008; Teo, 2009). *Computer self-efficacy* refers to a person's perceived ability to use a computer (Compeau & Higgins, 1995). Research suggests that computer self-efficacy is associated with pre-service teachers' intention to use technology in their future teaching (Gialamas & Nikolopoulou, 2010; Teo, 2009).

Teacher self-efficacy refers to teachers' beliefs about their ability to influence student learning and their achievement (Bandura, 1997). Teacher self-efficacy is associated with discovering and applying new teaching methods, setting higher goals, and exhibiting persistence in the face of failure (Ross, 1994). Teachers' sense of their instructional efficacy affects how they orchestrate learning activities in their classrooms (Bandura, 1997). In addition, teacher self-efficacy is related to the academic progress of their students (Berman, McLaughlin, Bass, Paul, & Zellman, 1977; Tschannen-Moran, Hoy, & Hoy, 1998).

Bandura (1997) stressed that because of the rapid development of technological tools, the pedagogical use of technology may require special types of teacher self-efficacy. He argued that if teachers have high self-efficacy regarding their ability to use technology, they will be more willing to adopt new technologies in their classroom practices. For this reason, some researchers (e.g, Wang, Ertmer, & Newby, 2004) have introduced the construct of *self-*

efficacy towards technology integration, defined as teachers' confidence to use technology effectively for purposes of instruction (see also Anderson & Maninger, 2007)

However, unlike previous studies on pre-service teachers that have focused on one or two of these three aspects of self-efficacy, this study investigated the relations between all three aspects to determine whether they are truly separate constructs or whether they are somehow interconnected. This knowledge, in turn, can help teacher educators design modes of instruction that integrate these ideas in ways that best support educators' self-efficacy when they come to make decisions on the use of technology in the classroom.

Enhancing Pre-Service Teachers' Self-Efficacy

There is evidence to show that pre-service teachers' self-efficacy towards technology integration can be enhanced through courses that provide either mastery experiences or vicarious experiences of technology use. Heo (2009) found that digital story-telling experiences improved pre-service teachers' self-efficacy towards technology integration. Wang et al. (2004) reported that pre-service teachers who were exposed to vicarious experiences related to successful technology integration experienced greater positive changes in their self-efficacy towards technology integration than those who were not exposed to vicarious experiences at all.

Koh (2011) found that instruction designed around independent problem solving increased pre-service teachers' computer self-efficacy. He stressed that instruction should also include opportunities to observe teaching-related examples of the pedagogical use of technology. In addition, Abbit and Klett (2007) found that coursework for pre-service teachers that offer opportunities to consider and discuss technology integration practices in the context of effective pedagogies are likely to raise pre-service teachers' self-efficacy beliefs more than courses focused primarily on developing proficiency with a specific technology.

Unfortunately, pre-service teachers continue to report that they do not feel prepared to use technology in the classroom (Drent & Meelissen, 2008; Kay, 2006). Researchers suggest this

lack of preparation stems from having a single introductory educational technology course that focuses on how to actually use the technology in question rather than courses that focus on how a given technology can be used for teaching and learning (see Agyei & Voogt, 2011; Kleiner, Thomas, & Lewis, 2007).

Digital Video Composition

One way to help pre-service teachers feel more prepared to use technology in their instruction is to actively engage them with the same tools and practices that students are expected to use when constructing and sharing knowledge with others. One emerging practice involving new technologies is digital video composition, which refers to a process of representing meaning through texts that combine images, sounds, gestures, and textual elements in complex ways (Miller, 2013). Multimodal text production demands both the use of various technological tools and resources and the flexibility to move across different modes, genres, and discourses (Kress, 2003).

According to Bruce & Chiu (2015), digital video composition provides students with opportunities to learn through authentic experiences, new modes of writing, and social engagement. A recent review found that digital video composition has not only been used to develop students 21st century skills across a wide range of subject areas (Miller, 2013) but also to foster motivation and engagement in learning (Bruce & Chiu, 2015; Norton & Hathaway, 2010). A focus on digital video composition also reflects national standards for teaching and learning in a digital information society (Australian Curriculum, Assessment and Reporting Authority, n.d.; CCSS, 2010; The Finnish National Board of Education, 2014) and the shift from emphasizing learner recall and information transmission to personal understanding and co-construction of new knowledge (Binkley et al., 2012). Thus, for this study, our course design included explicit opportunities for pre-service teachers and future educational professionals to engage in digital video composition in the hopes that these

experiences would help them develop confidence in using technology and sharing ideas through multimedia formats.

The Present Research

The present research consists of two studies examining self-efficacy beliefs that are thought to be central to the way in which technologies are integrated into instruction. The aim of Study I – a *Validation Study* – was to test and verify the measurement model for a self-efficacy questionnaire comprised of items pertaining to computer self-efficacy, teacher self-efficacy, and self-efficacy towards technology integration. Study II was an *Intervention Study* that examined whether experiences of digital video composition would enhance pre-service teachers' and adult educators' self-efficacy in the three aforementioned areas. The self-efficacy questionnaire validated in Study I was utilized to evaluate the effects of the intervention. Our research aims grew out of a desire to explore the potential of digital video composition while also seeking to understand what would happen if we aligned our pedagogical decisions with Bandura's theory of self-efficacy. A connection between these ideas could help design a theoretically-informed set of practices aimed at simultaneously facilitating pre-service teachers' technology skills, their knowledge about sound teaching practices, and their confidence to use technology when they venture out into their first teaching experiences.

Study I: Validation Study

Participants and data

After excluding two participants with incomplete questionnaires, the total number of participants was 200. Participants' average age was 23.9 years ($SD = 3.9$) and 82 % were female. Most were pre-service teachers ($n = 197$) and three were from either special or early education teacher programs. Data were participants' responses to a 14-item questionnaire measuring their self-efficacy beliefs.

At the time data were collected, all the pre-service teachers had completed at least one of the four teaching practicums required for their studies; these accounted for approximately 175 of the 702 total hours reserved for teaching practice, planning, observations, and other independent work. Of the participants, 47% had completed one teaching practicum and 30% two practicums. Many pre-service teachers (81%) had at least some experience as a substitute teacher.

Self-efficacy questionnaire

We designed a self-efficacy questionnaire aligned with constructs of teacher self-efficacy (Bandura, 1997), computer-self-efficacy (Compeau & Higgins, 1995), and self-efficacy towards technology integration (Wang et al., 2004). These aspects of self-efficacy were chosen to test whether they would prove to be separate constructs of potential value for understanding the role of self-efficacy when working in a range of increasingly digitalized educational environments. Computer self-efficacy was measured with five items, teacher self-efficacy with four items, and self-efficacy towards technology integration with five items. The items are described in Table 1. The items were designed to take into account situations that teachers and adult educators may face in educational contexts. Items were measured using a ten-point Likert scale.

Table 1. Self-efficacy questionnaire items

Aspect of self-efficacy	Item No.	Statement
Computer self-efficacy	1	I feel confident that I can use ICT efficiently
	2	I feel confident that I can learn to use new ICT tools independently
	3	I feel confident that when I use ICT I can solve technical problems if I face them
	4	I feel confident that I am able to find a useful ICT application on the Internet if I need to find one
	5	I feel confident that I am able to download programs on the Internet
Teacher self-efficacy	1	I feel confident that I can apply different kinds of teaching methods to enhance my students' learning
	2	I feel confident that I can create meaningful learning experiences for my students
	3	I feel confident that I can motivate my students to be actively involved in their learning
	4	I feel confident that I can develop my teaching
Self-efficacy towards technology integration	1	I feel confident that I can integrate ICT as a meaningful part of my teaching
	2	I feel confident that I can find new ways to apply ICT in my teaching
	3	I feel confident that I can motivate students to use ICT in their learning
	4	I feel confident that I can create meaningful learning experiences for my students with ICT
	5	I feel confident that I can apply ICT to enhance my students' learning

Data analysis

Confirmatory Factor Analysis (CFA) was used to evaluate how well the expected initial measurement model of the self-efficacy questionnaire worked. CFA was conducted by using Mplus 7.3 and the rest of the statistical analyses was conducted using IBM SPSS Statistics 22. Initial inspection of the questionnaire items indicated that, for five items, the scores were not normally distributed (Skewness or kurtosis values above 1.0 or below -1.0). Thus, to take into account the non-normality of the data, CFA with Maximum Likelihood with Robust Standard Errors (MLR) was performed.

This study used the following fit indices and cutoff values for acceptable fit: χ^2 -test (ns, $p > .05$), Root Mean Square Error of Approximation (RMSEA) values close to .06, and Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) values close to .95 (Hu & Bentler, 1999). Additionally, the RMSEA was estimated with a 90 percent confidence interval.

In the CFA analysis, the initial measurement model of the self-efficacy questionnaire was tested first. If the initial model showed lack of fit, the CFA was continued, by following a model generation approach, to establish a model that was satisfactory both statistically and theoretically (Kline, 2011). Iterative procedures were followed: in each phase the model was changed, one parameter at time, based both on the modification indices and on the theoretical justification, until a satisfactory model was achieved.

Results

First, the initial measurement model of the self-efficacy scales was tested. Figure 1 shows the standardized parameter estimates of the model, including factor loadings, residual variances and correlations between factors. All parameter estimates were statistically significant ($p < .001$). Assessment of the fit indices indicated that the model did not fit to the data well: $\chi^2(74) = 168.982, p < 0.01$; RMSEA = .08, (90 % C.I. = .066, .099); CFI = .94; TLI = .92. The chi-square test was significant and the RMSEA value was not close to the value .06, whereas the CFI but not TLI was close to .95. In order to address the sources of the lack of fit, a model generating approach was implemented.

Inspection of the modification indices showed that three items, one in each scale, caused the considerable lack of fit. First, the modification indices indicated that residual correlations should be estimated between Items 4 (“I am able to find a useful ICT application on the Internet if I need to find one”) and 2 (“I can learn to use new ICT tools independently”) and 5 (“I feel confident that I am able to download programs on the Internet.”) of the Computer Self-efficacy scale. Closer inspection of these three items showed that Item 4 may measure skills similar to those measured by Items 2 and 5 on the Computer Self-efficacy scale. That is, the ability to find useful ICT applications requires that one knows how to use that tool, which effectively demonstrates that Items 4 and 2 measure rather similar competencies. Similarly, in order to find a useful ICT application from the Internet, one has to also know how to download it. Hence the similarity between Item 4 and 5 seems evidence as

well. As both statistical and theoretical reasons indicated that item four seemed to be problematic, it was removed from the Computer Self-efficacy scale.

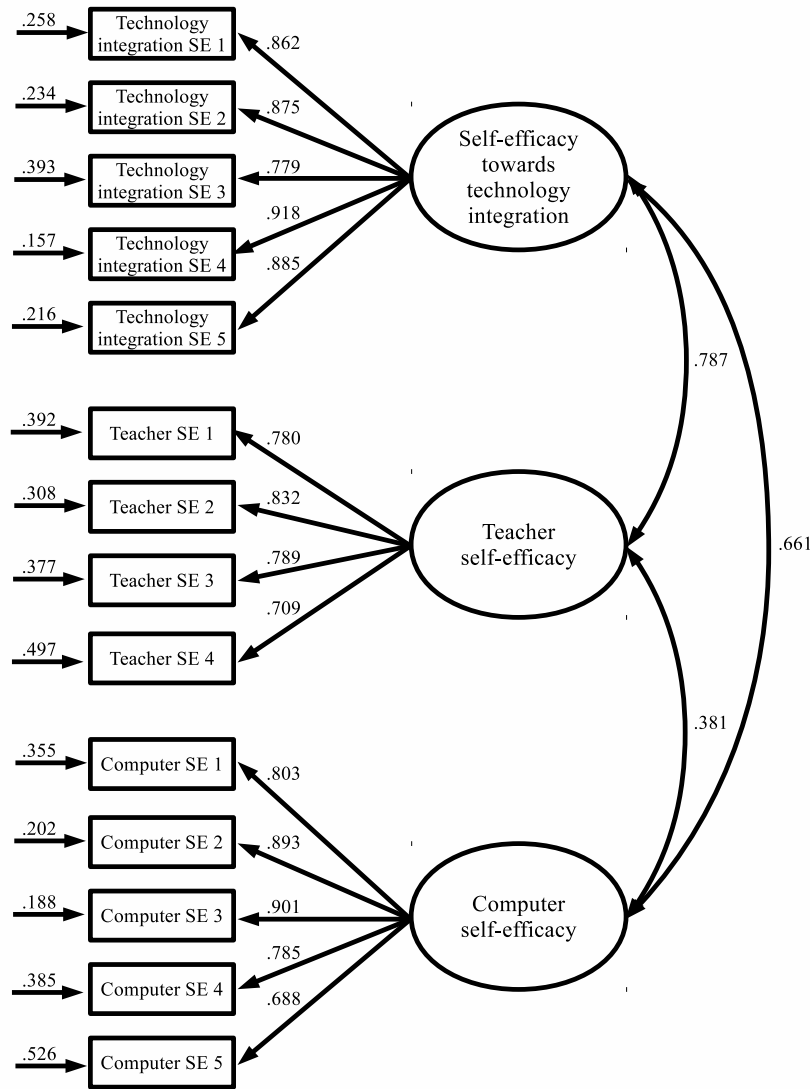


Figure 1. Initial measurement model of self-efficacy scales including standardized parameter estimates.

Second, the modification indices suggested that the first item on the Teacher Self-efficacy scale (“I feel confident that I can apply different kinds of teaching methods to enhance my students’ learning”) should also be allowed to load on both the Computer Self-efficacy and Self-efficacy towards Technology Integration scales. The modification indices showed further that the residual correlation should be estimated between the first item on the

Teacher Self-efficacy scale and first item on the Self-efficacy towards Technology Integration scale (“I feel confident that I can integrate ICT as a meaningful part of my teaching”). Review of the item wording for Item 1 on the Teacher Self-efficacy scale suggests that it measures participants’ pedagogical self-efficacy rather broadly. Therefore, the other forms of self-efficacy (Teacher Self-efficacy and Technology Integration Self-efficacy) are reflected in this item. This is further indicated by the suggested residual correlation between the first item on the Self-efficacy towards Technology Integration scale. Theoretical considerations also supported removal of the first item on the Teacher Self-efficacy scale, and hence it was removed.

A final adjustment was made to the Self-efficacy towards Technology Integration scale. The modification indices indicated that the residual correlation between its third item (“I feel confident that I can motivate students to use ICT in their learning”) and the third item on the Teacher Self-efficacy scale (“I feel confident that I can motivate my students to be actively involved in their learning”) should be estimated. There appeared to be overlap between these two items, the former measuring more specific confidence in the ability to motivate students to use ICT, and the latter broader confidence in the ability to motivate students. As removal of Item 3 from the Teacher Self-efficacy scale would have reduced it to only two items, it was decided instead to remove the third item from the Self-efficacy towards Technology Integration scale.

After the removal of one item on each scale, the final measurement model of self-efficacy questionnaire was tested. All parameter estimates were statistically significant ($p < .001$). The fit indices for the model were as follows: $\chi^2(41) = 66.038, p = 0.01$; RMSEA = .06, (90 % C.I. = .030, .082); CFI = .98; TLI = .97. Again, the chi-square test was rejected but the RMSEA was .06 and both the CFI and TLI clearly above the cut-off value of .95. The model was, therefore, judged to be acceptable. The final measurement model, as described in Figure 2, includes the standardized factor loadings, residual variances and correlations between the

factors. The factor loadings of the modified measurement model were similar to those of the initial measurement model. Similarly, the correlations between the self-efficacy factors were similar in the initial measurement model and in the final measurement model of the self-efficacy questionnaire. The Self-efficacy towards Technology Integration factor was positively correlated with the factors for both Teacher Self-efficacy and Computer Self-efficacy. The Teacher Self-efficacy factor showed a moderate, but positive correlation with the Computer Self-efficacy factor. Finally, the reliabilities for the self-efficacy scales were as follows: Self-efficacy towards Technology Integration $\alpha = .93$; Teacher Self-efficacy $\alpha = .84$; Computer Self-efficacy $\alpha = .89$.

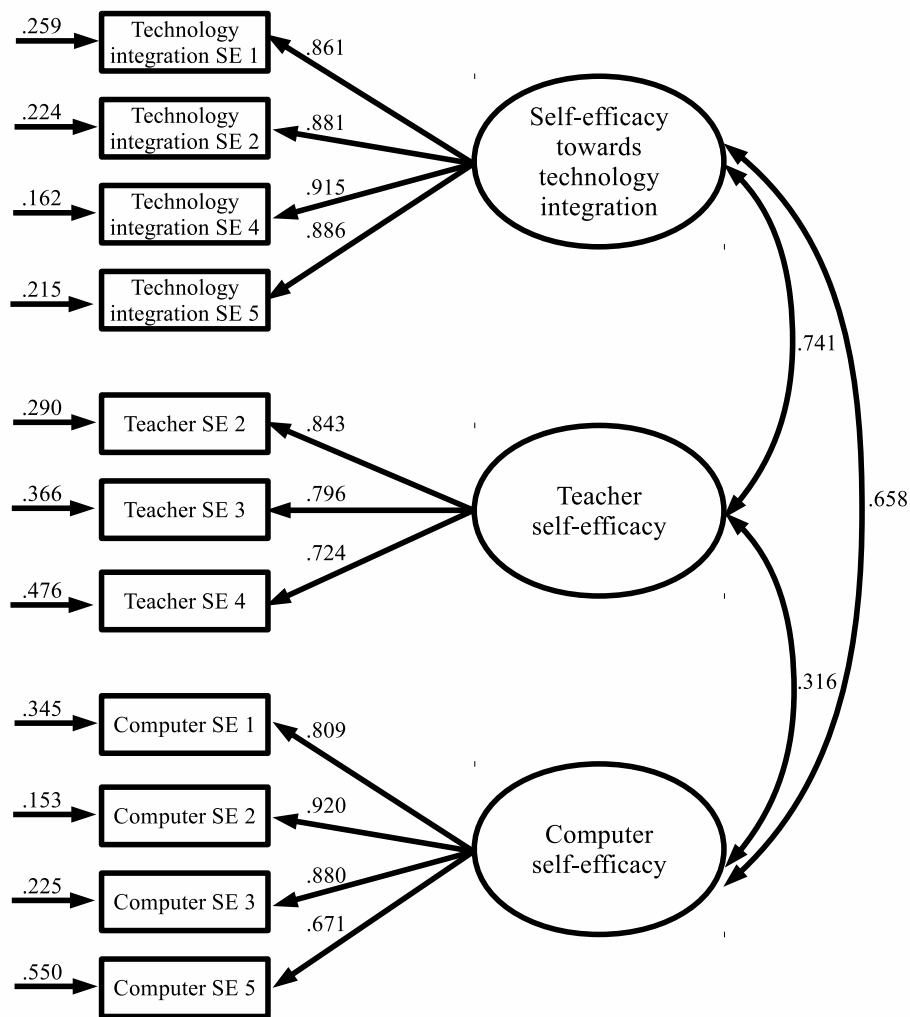


Figure 2. Final measurement model of self-efficacy scales including standardized parameter estimates.

Study II: Intervention Study

Participants

The course on digital literacies and learning in digital environments was taught in a Finnish university. Students ($n = 38$; 26 females and 12 males), ranging in age from 22 to 51, participated in the course. Some students ($n = 22$) were enrolled in a teacher education program and others ($n = 16$) were enrolled in an administrative program for education and adult education. The latter program prepares students for educational planning, training, administration, and adult education, but they are not certified to teach in the classroom. Students in this administrative program might, for example, be responsible for planning teacher professional development programs or they might be in a position to inform educational policy. Therefore, participation in the course offered these students a teacher's perspective on technology integration that would likely prove useful later in their career. Written consent was sought from all students.

At the beginning of the course, background information was collected. Participants were close to the end of their master's program. Most of the pre-service teachers ($n = 22$; 91%) had completed at least two of the four mandatory teaching practicums; these accounted for approximately 350 of the 702 total hours reserved for practice teaching, planning, observations, and other independent work. Coursework in the adult education program did not include any in-school practicum experiences. Many pre-service teachers (77%) had at least some substitute teaching experience, and more than half of the students in the education and adult education administrative program (56%) also had at least some teaching experience.

Of the participants, 63% (22 of the 35 students who answered this item) felt their education program did not include enough courses focusing on different types of Information and Communication Technologies (ICT) or courses that would help them integrate ICT into their teaching. This suggested a need for more courses on integrating digital tools and practices into teaching. Prior to taking our course, we also asked participants to describe their

ability to compose digital videos. As shown in Table 2, 29% indicated they could not compose videos at all; 42% reported being minimally skilled at composing digital videos; and 29% reported being moderately skilled (21%) or very skilled (8%) at composing digital videos. Among those who reported minimal or no skill in digital video composition, 13 were pre-service teachers and 14 adult education students. Among those who reported being moderately or very skilled, 9 were pre-service teachers and 2 were adult education students. Given the importance of individuals being able to use digital tools to create, remix, and share information with others in today's participatory culture (Jenkins et al., 2006), we decided to incorporate collaborative video production experiences into the course design.

Table 2. Pre-service teachers' and adult education teachers' self-evaluation of their digital video composing skills at the beginning of the course

Self-evaluation of skills	Pre-service teachers		Adult education students		All participants	
	n	%	n	%	n	%
Not at all skilled	3	13.6	8	50.0	11	28.9
Minimally skilled	10	45.5	6	37.5	16	42.1
Moderately skilled	6	27.3	2	12.5	8	21.1
Very skilled	3	13.6	0	0	3	7.9
Total	22	100	16	100.0	38	100

Course Learning Objectives

Explicit course learning objectives included being able to 1) build theoretical knowledge and methods for teaching in new digital learning environments, and 2) compose a digital video and interpret the meanings created through different modalities. An additional implicit aim of the course was to increase students' confidence in using technology in their teaching.

Main Learning Task

The main learning task in the course reflected these learning objectives. The task was to compose a three-minute digital video in one of eleven small groups of two to four students. Students utilized either Movie Maker or iMovie to compose their videos. Each group was

asked to choose a teaching method or a reform on the topic of digital literacies and name a pedagogical target group for their video. The purpose of the video was to convince the target group of the usefulness of the teaching method or need for the reform. Further, to ensure groups possessed the necessary theoretical knowledge before embarking on their video productions, students were asked to compose a traditional written essay outlining theories that informed their work. Later, they were expected to apply their theoretical knowledge while learning how to communicate their educational expertise through multimodal compositions.

Course Design

The course (six class sessions) was taught by two Finnish teachers who also acted as researchers. The first four sessions each comprised a 90-minute interactive lecture. Lecture topics included learning and literacy in a digital age, collaborative learning in digital learning environments, online inquiry, and multimodal meaning making. In the fifth session (90 minutes), the groups began to develop their videos and conferenced briefly with instructors for initial feedback. An additional 50 hours of coursework was then allocated for independent work in small groups outside of the classroom.

Each small group prepared their videos in three phases. In Phase 1, each group produced a written idea paper containing information about their topic, the target group of their video, and their main arguments for the teaching method or reform selected. In Phase 2, the groups composed a short essay that included both the theoretical background for their video and the initial script for their video. Phase 3 began in the fifth class session, when students began to develop their videos in small groups. During this session, the instructors/researchers arranged a fifteen-minute individualized feedback session with each group. After the meeting, students had five weeks in which to produce their video.

In the sixth and final class meeting, all the students watched, analyzed, and discussed each group's video. Thus, instead of just having teachers as an audience, the students had a wider audience from which they also got feedback on their final products. After the course,

each student wrote a reflective (and individual) self-evaluation report about his or her learning and group work.

We supported the students' work by sequencing the task into manageable parts and by giving them feedback during each phase of the task. In one of the sessions, students were also instructed in multimodality and how different modes and the interplay between them can be utilized in meaning making. We did not, however, give any explicit instruction on how to use the technologies needed in multimodal composition. We wanted students to learn independently how to use these new technologies, as they would face similar challenges in learning how to use new and constantly evolving technologies in their professional lives.

Measure and data analyses

To evaluate the effects of the course design (i.e. digital video compositions) on students' self-efficacy, students' perceived self-efficacy over time was measured with the 11 questionnaire items validated in Study I. Data consisted of students' answers ($n = 38$) to the self-efficacy questionnaire administered at the beginning and the end of the course. A Wilcoxon signed-rank test was used to compare participants' self-efficacy beliefs before and after the course. The test was run separately for the pre-service teachers and adult education students. Owing to the small sample size and negatively skewed distributions of most of the sum variables among participating pre-service teachers, a non-parametric test was chosen. Effect sizes were computed to assess the magnitude of change in both groups.

Results

Table 3 shows the mean values of the aggregated scales of the three aspects of students' self-efficacy at the beginning and end of the course. These results suggest that the pre-service teachers' perceived self-efficacy significantly increased ($p < 0.001$) during the course in all three aspects of self-efficacy. The effect sizes of these increases ranged between 0.52 and 0.57 (computer self-efficacy $r = 0.57$; teacher self-efficacy $r = 0.56$; self-efficacy towards technology integration $r = 0.52$) and point to the significant effect of the experience

of digital video composition on these students' self-efficacy beliefs in all three aspects of self-efficacy measured in this study. However, among the adult education students, computer self-efficacy was the only aspect to show a statistically significant change ($z = -2.39$; $p < 0.05$; $r = 0.42$) during the course.

Notably, the standard deviation of scores before and after the course for aspects of computer self-efficacy and self-efficacy towards technology integration decreased. This decrease suggests that students with low self-efficacy, in particular, grew more confident in using technology and integrating technology during the course. For example, the computer self-efficacy score for the ten students (26%) who scored less than 6 at the beginning of the study rose, on average, from 4.53 to 6.58. Five of these students were pre-service teachers and five were adult educators.

Table 3. Mean values of aggregated scales of the three aspects of students' self-efficacy at the beginning and end of the course and the results of the Wilcoxon test.

Aspect of self-efficacy	Pre-service teachers (n = 22)				Students in education/adult education (n = 16)			
	<i>M</i>	<i>SD</i>	<i>Z</i>	<i>p</i>	<i>M</i>	<i>SD</i>	<i>Z</i>	<i>p</i>
<i>Computer self-efficacy</i>								
At beginning of course	6.97	1.80			6.73	2.00		
At end of course	8.22	1.01	-3.82	<0.001	7.48	1.58	-2.39	<0.05
<i>Teacher self-efficacy</i>								
At beginning of course	7.28	1.00			7.23	1.50		
At end of course	8.02	0.94	-3.71	<0.001	7.02	1.82	-0.95	ns.
<i>Self-efficacy towards technology integration</i>								
At beginning of course	6.37	1.74			5.97	1.89		
At end of course	7.42	1.29	-3.43	<0.01	6.56	1.46	-1.22	ns.

Note: Possible maximum value in each aspect of self-efficacy is 10.

Discussion

Validation Study

Unlike many previous studies of pre-service teachers, where the focus has often been a single aspect of self-efficacy (see Anderson & Maninger, 2007; Gialamas & Nikolopoulou, 2010; Teo, 2009), this study investigated three aspects of self-efficacy: computer self-efficacy, teacher self-efficacy, and self-efficacy towards technology integration, and how

these three constructs combine to measure teachers' self-efficacy. We then measured the impact of digital video experiences on the self-efficacy of teachers during their pre-service education.

Results of the validation study showed that self-efficacy can be measured reasonably well with the three constructs. The constructs of Teacher Self-efficacy and Computer Self-efficacy seemed to be quite separate, as the correlation between the two factors was moderate. In contrast, computer self-efficacy was found to be positively associated with self-efficacy towards technology integration. Interestingly, our analyses suggested that self-efficacy towards technology integration had an even stronger relationship with teacher self-efficacy than with computer self-efficacy, suggesting that they are related and partially overlapping constructs. It would make sense then, as also reported by others (e.g., Evers, Brouwers, & Tomic, 2002; Swan, Wolf, & Cano, 2011), that the participants in our study who scored higher on aspects of teacher self-efficacy (e.g., confidence in creating meaningful learning experiences) may be more inclined than those with lower scores to explore innovative technology use as part of their efforts to incorporate student-directed learning opportunities into their curriculum.

Moreover, the reliability coefficients for the three scales were all excellent, which further supports the validity of these constructs. Even after removing one item from each of the scales, the factor loadings and other parameters were not greatly affected, indicating that the modified measurement model of the self-efficacy questionnaire seems to be reasonably valid and reliable. However, a limitation of this study is the lack of an independent sample with which to test the modified measurement model of the self-efficacy scale. Therefore, any interpretation on the validity of the scales must be made with caution. The results may reflect the capitalization of chance and therefore further studies would need to use the self-efficacy questionnaire with independent samples to verify its measurement model. Lastly, it would be beneficial to test this questionnaire with in-service teachers, in order to further clarify how

well the questionnaire measures the three aspects of self-efficacy. To provide further information about the validity, the sample could include in-service teachers from various disciplines. Furthermore, collecting samples from both pre-service teachers and in-service teachers would enable measurement in variance testing between the different contexts. These findings could inform future research on designing supports that best meet the unique needs of each population.

Many many current national curricula and standards emphasize integration of educational technologies in teaching (Australian Curriculum, Assessment and Reporting Authority, n.d.; CCSS, 2010; The Finnish National Board of Education, 2014) but many in-service teachers report a lack of related skills or confidence (Alenezi, 2016; Bingimlas, 2009), there is an urgent need to advance professional development programs supporting teachers in their pedagogical use of technology. The present study suggests that all three aspects of self-efficacy -- computer self-efficacy, teacher self-efficacy and efficacy towards technology -- need to be supported during the course of teacher education programs to ensure that future teachers are properly prepared for using technology in their pedagogies. The instrument validated in Study I could be used to explore in which of these three aspects in-service teachers may need the most support. This would help professional development programs to target those aspects with the greatest needs. In addition, the instrument could enable teacher educators to follow the development of pre-service teachers' self-efficacy in all three dimensions. This would allow teacher educators to make adjustments during the program if one or multiple aspects of self-efficacy seem to be or remain low.

Intervention Study

The intervention component of the present study found that providing hands-on experience with digital video composition in pedagogical contexts seemed to be an effective way to enhance pre-service teachers' self-efficacy towards technology use in teaching. Informed by Bandura's (1997) four sources of self-efficacy, the digital composition

experiences in the course were intentionally designed to a) allow students opportunities to *master* their creation of a digital product, b) *vicariously experience* and reflect on the success of other groups' digital compositions, c) *verbally and socially persuade* other students of the importance of pedagogically sound digital practices, and d) collaboratively support others in ways that elicit *positive emotional reactions* to the innovative tools and practices associated with technology integration in education. The finding that this carefully designed digital video composition task positively affected all three studied aspects of pre-service teachers' self-efficacy offers a model for other teacher educators to explore a similar set of tangible and pedagogically sound methods in their own education courses. In addition, Study II showed how the instrument can be used to measure the efficacy of interventions targeted to support pre-service teachers' confidence to use technology in their class. As indicated, the intervention effects may vary from one group to another. The developed instrument would allow comparisons of how intervention effects may vary in different aspects of self-efficacy among various participant groups and thus, inform how teaching might need to be adjusted to different groups.

However, this study was limited to measuring short-term changes in self-efficacy beliefs (from the beginning to end of one course) without clarifying whether the changes observed would last over time. In future studies, self-efficacy beliefs should be measured not only at multiple points during teacher education but also later, for example after new teachers have completed their first year of teaching. Measuring self-efficacy in the induction phase would be particularly important, because it is a critical phase for enhancing pedagogical professionalism and may direct a teacher's career as a whole (Jokinen, Heikkinen, & Morberg, 2012).

The results of this study showed only moderate effect sizes (a range between 0.52-0.57) for increases in three areas of self-efficacy. Nevertheless, in education, effect sizes of this magnitude (e.g., larger than .25) are considered meaningful and important for practice

(Thompson, 2008). Of course, these effect sizes may partially be explained by the fact that many of the pre-service teachers scored high in self-efficacy at the beginning of the course – which suggests these pre-service teachers would be inclined to actively use technology in their teaching even without the intervention. However, particular attention should be paid to the pre-service teachers in our sample who reported low self-efficacy before the intervention. Theoretically, low self-efficacy may foster avoidance behaviours; that is, in the present context, such teachers may, contrary to expectations, avoid efforts to integrate technology into their instruction.

Notably, there were significant increases in scores on computer self-efficacy and self-efficacy towards technology integration, especially among the pre-service teachers with the lowest self-efficacy scores at the beginning of the course. Thus, the larger effect for the students in this category has important implications for practice. One reason for this increase might have been the engaging nature of the digital video composition task (cf. Bruce & Chiu, 2015) required to complete the course. Second, the digital video composition process occurred in small groups, rather than individually, which is in line with previous research findings that group work is a key factor in facilitating positive experiences when learning how to use technology (see Friesem, 2015). Opportunities to face new technologies together with peers may provide a low-threat learning environment for pre-service teachers with low self-efficacy and thus, decrease their possible anxiety towards educational technology and avoidance of failure (cf. Tondeur et al., 2012). Positive collaborative experiences while learning new technologies during teacher education may be particularly important when moving towards a more collaborative culture in schools where new technologies will be implemented as a joint effort of the school community.

In the present study, in contrast to the pre-service teachers, experience of digital video composition did not have a significant effect on teacher self-efficacy or self-efficacy towards technology integration in the adult education students. Notably, experience of digital video

composition had a significant effect only on the adult education students' computer self-efficacy. Because the adult education program is more theory- than practice-oriented, the intervention appeared to provide them with important, but new, opportunities to reflect on their pedagogical understanding in ways that are more typical of pre-service teacher programs. However, it could be that these relatively new experiences were not familiar enough to the students in the adult education program to exert the same effect as they did for the pre-service teachers enrolled in the course. This might explain the lack of significant growth in the adult educators' self-efficacy with respect to skillful pedagogy. Nevertheless, the fact that the self-efficacy of the adult education students benefitted to some degree suggests that more opportunities to think about how the use of technology applies to schools and classroom instruction may help inform the decisions they make as school administrators.

This study has several limitations. First, because of the small sample size and two unique populations in the sample, the results must be interpreted with caution. Second, the course was voluntary and thus might have attracted specific types of the students. For example, male students were over-represented compared to other literacy-related courses in the teacher education program. Third, the study did not include a control group that would have studied the same content with more traditional study methods.

Given that many students participating in the intervention felt that teacher education programs do not provide enough courses related to technology integration, innovative ways of embedding technologies as a part of regular content learning are highly needed. The current study provided one example of how the experience of well-planned hands-on digital video composition helps pre-service teachers to develop confidence in using technology and sharing ideas through multimedia formats –the very same digital literacy practice with which many students had limited previous experience. In the future, it would be interesting to investigate how connecting this type of course with a practicum, where pre-service teachers could apply

their learning experiences in authentic ways with real students, could further strengthen students' confidence.

Concluding remarks

This paper reported two studies. The validation study (Study I) expanded our understanding of the aspects of self-efficacy that may be particularly important for effectively using technology in classrooms. The instrument developed to measure self-efficacy towards computers, teaching, and technology integration can be used to further inform the design of curricula in programs of teacher education as well as teachers' professional development. We found that the instrument would be particularly useful in identifying those pre-service teachers with low self-efficacy so that they could be supported in becoming more confident in pedagogical use of technology during their studies. All teachers should have sufficient confidence in using technology in their classrooms, as should all students in primary and secondary schools be guaranteed equal opportunities to learn with technology in meaningful ways.

The intervention study (Study II) illuminated particular support mechanisms that can be embedded into content area classes to foster pre-service teachers self-efficacy towards computers, teaching, and technology integration. In this study, the combination of a challenging digital video composition task, sequencing the task into manageable parts, collaborative work, providing feedback during the process, and sharing the end product with others (cf. Kiili, Mäkinen, & Coiro, 2013) was shown to be a useful way to enhance pre-service teachers' confidence in all measured aspects. Thus, this type of digital video composition task, involves a multilayered process that offers multiple points of using technologies and digital resources that appears to promote self-efficacy in ways that lead to new digital opportunities for pre-service teachers to experience success.

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