S-TECHNO: An instructional design model for redesigning instructional technology courses

Saadet Korucu-Kis
Necmettin Erbakan University, Turkey

Kemal Sinan Ozmen
Gazi University, Turkey

ABSTRACT

This study describes the development and implementation of an instructional design (ID) model to increase the efficiency of instructional technology (IT) courses, by adopting a constructivist perspective envisaging the simultaneous treatment of multiple barriers (technological beliefs, knowledge, skills) to engage student teachers as whole persons in the learning-to-teach process. To this end, the paper first presents the theoretical framework underpinning the study. This is followed by the introduction of the Set-up, Think, Explore, Create, Hone, Negotiate and Opine (S-TECHNO) model. The model was implemented in a 14-week program with 80 student teachers. A quasi-experimental research design was employed to evaluate the effectiveness of the model. Data included survey responses, semi-structured interviews, written metaphors, reflection journals, observations and lesson plans. The results revealed that the S-TECHNO model can significantly improve student teachers' beliefs, knowledge and skills about the instructional use of technology. Implications for teacher education programs are highlighted and some future research possibilities are discussed.

Keywords: *instructional design; student teachers; teacher education; technology integration*

INTRODUCTION

The 21st century skills require students to go beyond the mastery of basic technology knowledge and skills and to use these technologies for accomplishing high-level tasks in relevant contexts. However, such sophisticated uses of technology to obtain positive learning outcomes in K-12 settings first necessitate teachers to be competent in the use of technology (Aslan & Zhu, 2017). Yet, research shows that teachers most often use technology for low-level tasks such as searching the Internet, word processing, and giving assigments among other tasks (Wozney, Venkatesh & Abrami, 2006).

A proposed reason for teachers' incompetency in incorporating technology into classrooms has been limited exposure to technology integration experiences in teacher education programs (Baydas & Goktas, 2017; Funkhouser & Mouza, 2013). Although the quality and quantity of experiences student teachers undergo in these programs can have a major impact on their future use of technology (Ottenbreit-Leftwich, Glazewski, Newby & Ertmer, 2010; Tondeur et al., 2012), student teachers report that they do not leave these programs well prepared to teach with technology (Adu Gyamfi, 2016; Sang et al. 2012). One study (Banas & York, 2014) ascribes this situation, to a large extent, to the content and implementation of IT courses. Against this backdrop, this study attempts to extend and enhance the existing research on the design of IT courses by proposing an integrated ID model.

Traditionally, IT courses focus on the development of technical knowledge and skills in relation to technology (Polly et al., 2010). Research indicates that although acquiring technology literacy is an essential part of technology education such traditional instructional approaches do not allow student teachers to see the connections between technology training they receive during teacher education and the digital demands they are expected to meet in real classrooms (Ottenbreit-Leftwich et al, 2010). To address this challenge, researchers have engaged in systematic research efforts and proposed some useful concepts that can guide the design of IT courses. For example, going beyond a techno-centric view of technology courses, Mishra and Koehler (2006) drew attention to subject-specific and pedagogy-related issues in technology education and proposed the framework of technological pedagogical content knowledge (TPACK). This framework is referred to as the knowledge base student teachers must have and indicates that teacher preparation programs must provide student teachers with experiences through which they can integrate knowledge of technology, pedagogy, and content to achieve technology integration. Other researchers (Buabeng-Andoh, 2012; Chen, 2010) have suggested that possession of technology skills increases the likelihood of technology integration since lack of such skills causes frustration and lowers student teachers' competence to incorporate technology into instructional practices (Lee & Lee, 2014). Researchers, like Ertmer (2005) and Ottenbreit–Leftwich, Glazewski, Newby, and Ertmer (2010) have contended that neither mere mastery of technology knowledge nor technology skills by itself assure the integration of technology, and beliefs constitute the final frontier in the successful implementation of technology given that what student teachers experience in teacher education programs is "mediated or filtered by teachers' perception" (Zhao & Frank, 2003, p. 817). Considering technology was not a part of most of student teachers' previous learning experiences, (Funkhouser & Mouza, 2013; Polly et al., 2010), then challenging student teachers' technological beliefs becomes crucial during preservice education.

In view of these observations, Sang et al. (2010) stated that much research has thus far focused on isolated teacher-related factors, however, a broader perspective must be adopted to gain a comprehensive understanding of teacher-related barriers and to overcome them. In response to this call, Korucu-Kis and Ozmen (2018) proposed the framework of Instructional Technological Competence (ITC). Building upon previous literature indicating that there is a continuous interplay between these separate but interrelated constructs during instructional practices (Ertmer, 1999; Hew and Brush, 2007; Zhao & Frank, 2003), the ITC framework suggests that IT courses must be designed in such an integrated manner that student teachers' technological beliefs, knowledge, and skills are addressed simultaneously given that treating them in isolation disrupts the synergy between them and causes student teachers to feel not completely prepared to teach with technology. The authors also incorporate the construct of technological awareness into their framework since it is a unifying superordinate which integrates the constituents of knowledge, skills, and beliefs (Freeman, 1989).

Taken together, these discussions not only demonstrate what teacher-related variables are influential on technology-integrated instructional practices, but also indicate the need for simultaneous treatment of these variables to keep the synergy between them to have better results in terms of technology integration. Yet, the question remains on how to design educational technology courses to address this need.

A useful approach for restructuring technology courses can be utilizing from Instructional Design (ID) theory. According to Gustafson and Branch (1997), ID models can be used to develop training programs and create high-quality instruction. Specifically, classroom-oriented ID models establish guidelines for instructional planning and provide a roadmap for instructors to follow. Above all, the systematic procedures embraced by these models not only acknowledge the interaction between different components but also require the coordination of all activities to ensure the integrity between these constituents.

In the literature, a few ID models−developed to increase student teachers' competency in technology integration can be found. For example, Jang and Chen's (2010) TPACK-COPR model and Lee and Kim's (2014) TPACK-IDDIRR model aim to engage student teachers in activities through which they can align technology knowledge with pedagogy and content knowledge in order to achieve technology integration. Chang, Chien, Chang and Lin's (2012) MAGDAIRE model emphasizes the importance of mastery of technological knowledge and skills to implement technology-integrated teaching. However, given the lack of a holistic approach among the existing models that embrace the constructs of awareness, beliefs, knowledge and skills which together form the basis upon which teachers make instructional decisions (Ertmer, 1999; Freeman, 1989; Hew & Brush, 2007; Zhao & Frank, 2003), the present study aimed to develop and implement an instructional design model. Through a constant process of awareness-raising, the S-TECHNO model intends to challenge student teachers' technological beliefs, knowledge, and skills and seeks to find answers to the following research question: "Does a course intervention based on the S-TECHNO model impact student teachers' technological beliefs, knowledge and skills in relation to instructional technologies?"

THEORETICAL FOUNDATION

The philosophical orientation and theoretical perspective adopted in an ID study lays out the concepts upon which a model is built. Therefore, the congruency between theoretical underpinnings and the intent of the model is of utmost importance to the success of the proposed model (Gustafson & Branch, 1997). With an overarching purpose to address student teachers' emotions, thoughts and actions in the teaching of technology integration, the S-TECHNO model was grounded in the constructivist philosophy because a technology-driven classroom in essence predicts a student-centered environment where learners are affectively, cognitively and behaviorally active in the process of knowledge construction (Harasim, 2012).
Constructivism, a theory of learning and knowledge construction, suggests that learning takes place as a result of one's active involvement in and construction of new experiences, rather than passively receiving what is transmitted (Applefield, Huber & Moallem, 2001). According to Lee and Hannafin (2016) constructivism is not a single and unified theory; rather there are a variety of perspectives within the constructivist theory (Ernest, 1995) and the S-TECHNO model primarily draws on two major trends in constructivist philosophy: cognitive and social constructivism.

The cognitive constructivist perspective is based on Piaget's (1971) theory of cognitive development and learning. The theory suggests that individuals construct new knowledge through interactions between their previous knowledge and current understandings (Richardson, 2005). Learning occurs as a result of internal cognitive conflicts individuals go through when they encounter a new phenomenon incompatible with their existing schemas (Applefield, Huber & Moallem, 2001). This state of disequilibrium leads to the process of assimilation or accommodation when individuals try to make sense of the data to reach a state of equilibrium (Eggen & Kauchak, 2013). While the notion of assimilation refers to the incorporation of new experiences into existing cognitive structures, the notion of accommodation refers to a change in the existing schemata. Therefore, creating classroom situations through which student teachers can accommodate their traditional views of technology as an add-on with technology as a smooth partner, is an important step for establishing technology-integrated environments.

Unlike cognitive constructivism taking on an individualistic orientation in the knowledge construction process, sociocultural theory (Vygotsky, 1978) highlights the role of social interactions and stresses the significance of the context in human learning. A key idea of this theory is the concept of Zone of Proximal Development (ZPD) which implies that learners can perform beyond their current ability level if they are provided with mediated learning environments. According to Johnson and Golombek (2003), mediational means include three levels which are, object-regulation, other-regulation, and self-regulation. In object-mediated regulation, learners seek help from artifacts in their environments such as technological devices to accomplish certain tasks. In other-regulated mediation, learners seek help from other more knowledgeable persons like teachers scaffolding them for new learning experiences. Lastly, in self-regulated mediation, learners gain control over both their cognition and activity. In the context of pre-service technology education, student teachers' zone of proximal development can be defined as a space between their traditional view of technology as a supplementary tool and a maturing understanding of technology as an integral part of the learning process. Therefore, the quality of mediation provided by more knowledgeable others (such as teacher educators, mentors, peers) or cultural artifacts/tools (such as technological devices, reflective journals, theoretical readings) is of considerable significance for fostering student teachers' competence for a seamless technology integration process.

In addition to these two major constructivist paradigms, more specific constructivist theories were also utilized because of their relevance to the key idea of "whole person" upon which S-TECHNO is constructed. One of them was the theory of Andragogy. The theory points out that adult learners set foot in higher education programs with a wealth of experiences and special traits that are likely to influence how and what learners learn in those institutions. Likewise, student teachers enter teacher education programs with cumulative schooling experiences serving as a frame of reference that shapes their conceptions about the role of technology for learning and teaching. Therefore, Knowles, Holton and Swanson (1998) suggest that adult learners must be provided with: (a) the purpose behind learning new content, (b) learning environments which allow learners to assume ownership of their learning, (c) opportunities through which they can discover where they are and they want to be, (d) problem-solving-centered and meaningful activities which will enable them to cope with real-life situations, and; (e) knowledge they will see a value in learning in order to make them go through transformative learning experiences.

Another contributory theory to the development of the S-TECHNO model was the conceptual change model (Posner, Strike, Hewson & Gertzog, 1982) which suggests that learners' naïve understandings must be challenged by alternative conceptions to make them aware about the discrepancies and anomalies in their pre-existing knowledge, skills, and beliefs in order to create cognitive dissonance in them. According to Posner et al. (1982), creating cognitive conflicts is preliminary to changing the status quo in learners' incomplete preconceptions and there are four conditions to be met for conceptual change to take place: (a) learners must be dissatisfied with their current understandings by seeing the inadequacy of their existing conceptions to solve the problems they confront, (b) learners must understand the intelligibility of the new concept seeing the possibilities inherent in the new concept to solve the problems encountered, (c) learners must experience the potential inherent in the new concept and understand its plausibility, and; d) learners must see the new concept as a fruitful tool which can do more than it does with the current problems.

Teacher cognition research also provided important insights for the model. Influenced by various factors such as schooling experiences, pre-service preparation, contextual factors and classroom practices. This research field refers to the unobservable dimension of teaching and moves the emphasis from exemplary teacher behaviors and student achievement to what teachers know, believe and think (Borg, 2003; Pajares, 1992). These researchers state that it is this invisible aspect of teaching that directly affects teachers' behaviors. The field of teacher cognition implies the interconnectedness between the observable and unobservable dimensions of teaching and suggests the importance of quality education before in-service teaching begins.

Employed in different ways (personal or collaborative) at different phases of the model, the concept of reflection (Schön, 1983) was another feeder field that has contributed to the design of the model. Reflection suggests that learning occurs when experience is integrated with reflection and theory with practice (Humphreys & Susak, 2000). In the context of pre-service teacher education, Wallace

(1991) indicates that student teachers do not come to teacher education programs with blank minds; rather they have pre-existing cognitions about the practice of teaching, the role of teachers and learners, types of activities and materials used, because they spend almost 12 years in educational settings before they start receiving their professional education. Reflection pertains to making student teachers aware of those unconsciously stored cognitions and bringing them to the surface. The reflective model suggests that the effectiveness of professional courses is contingent upon quality reflecting on what is practiced. In other words, teacher education programs should ensure that the relationship between the received knowledge and experiential knowledge is reciprocal. Student teachers should be provided with experiences through which they can apply what they learned in teacher education programs so that such experiences can feed back into their received knowledge through reflection (Wallace, 1991).

The S-TECHNO model also paid particular attention to the standards of the International Society for Technology in Education (ISTE) which is a globally-recognized professional education organization that provides teachers and students with guidelines for the knowledge and skills they need to have for the effective use of technology in teaching and learning. The five standards presented by ISTE (2008) for teachers to attain can be used as a road-map by teacher education programs as follows: (a) providing student teachers with experiences through which they can integrate knowledge of subject matter, pedagogy and technology, (b) creating technology-enriched and student-centered environments and employing both summative and formative assessment methods to inform the teaching and learning processes, (c) equipping student teachers with the knowledge and skills necessary to exchange information and collaborate with students, peers and parents, (d) modeling and teaching the appropriate and ethical use of digital technologies, and; (e) infusing student teachers the idea of being life-long learners who can make effective use of technologies for the renewal of the teaching profession.

Synthesizing the theories reviewed, the following 11 principles have been extracted to base the S-TECHNO model upon: (a) mentoring, (b) providing the rationale behind learning new content, (c) creating cognitive conflict, (d) making use of prior learning experiences, (e) inquiry, (f) promoting active engagement, (g) providing authentic learning experiences, (h) developing autonomy, (i) increasing collaboration, (j) reflecting, and; (k) promoting formative assessment.

Finally, it is also important to define the constructs addressed in this study before elucidating the model.

Technological Awareness: This refers to the capacity to recognize what beliefs, knowledge and skills teachers have (Freeman, 1989) in relation to digital technologies.

Technological Beliefs: Within the context of this study, technological beliefs are defined as the perceived value beliefs about technology–either exherent or inherent (Korucu-Kis & Ozmen, 2019). Exherent value beliefs refer to viewing technology just as a supplementary tool which serves for accomplishing low-level tasks such as word processing, searching information or making presentations. Inherent value beliefs, on the other hand, refer to viewing technology as an integral part of classrooms through which high-level tasks are fulfilled such as exploring, problem-solving, designing and reflecting. Korucu-Kis and Ozmen (2019) suggest that student teachers who hold inherent value beliefs are more likely to engage with classroom integration of technology because the potential and rationale of using technology in their subject-matter discipline is internalized by them in such a way that they see technology as a smooth partner of their instructional practices.

Technological Knowledge: Since the ultimate aim of the IT courses is to help student teachers integrate technology knowledge with pedagogy and content knowledge, this study focuses on the intersection of these three domains as a unique body of knowledge (TPACK) and adopt the definition of knowing which appropriate technologies and pedagogy are needed to best enhance the learning of a specific content (Mishra & Koehler, 2006).

Technological Skills: For this study, technological skill refers to teachers' appropriate, accurate and fluent uses of instructional technologies in classrooms.

THE S-TECHNO MODEL

The S-TECHNO model aims to cultivate the idea of technology as a smooth partner for teaching and learning processes in accordance with the concept of seamless connection of technology to instructional purposes as suggested by ISTE (2008). To do so, the model aims to explicitly and simultaneously address student teachers' awareness, beliefs, knowledge, and skills since each construct influences the others and plays a decisive role in whether the technology will be integrated or not. Built on the aforementioned design guidelines, the model has a two-stage training process. The phase of set-up in stage one is led by the teacher educator and aims to put student teachers in readiness for operation. The remaining six phases of stage two−think, explore, create, hone, negotiate, opine− are mainly carried out by student teachers. Each stage has a specific function and is described below in more detail:

(S)et-up: This phase moves from student teachers' reflection on their prior learning experiences to theoretical readings, to observation of modeled lessons, to hands-on experiences, and to the development of understanding about the rationale of using technology in teaching. To these ends, the teacher educator first investigates student teachers' beliefs, knowledge and skills through appropriate methods (such as questionnaires, mind mapping, discussions, metaphors, drawings, essays). In this way, the teacher educator not only gains familiarity with the trends about the current status of instructional technologies among student teachers and designs his/her lessons accordingly but also helps student teachers develop technological awareness giving them opportunities to articulate their conceptions about technology use in teaching and learning. Then, the teacher educator provides student teachers with key readings about the nature and potential of technology for the subject matter to be taught. In this way, the teacher educator intends to set the scene for the conceptual change process by activating student teachers' existing conceptions and helping student teachers compare them with new learning experiences.

Next, the teacher educator directly initiates the conceptual change process. Here, student teachers are provided with a learning problem and asked to brainstorm over solutions. In order to create cognitive dissonance, they are asked questions such as: "Did you encounter such problems when you were students?", "How did your former teachers deal with those problems?", "Were you satisfied with the solutions?", "How would you solve the problem if you were in your teacher's shoes?" Having a general view of student teachers' conceptions, the teacher educator models a lesson, making meaningful uses of technology for maintaining cognitive conflict in student teachers. To further the dissonance in student teachers, the teacher educator encourages them to exchange their ideas about the intelligibility, plausibility, and fruitfulness of the technological tools employed during the lesson. After that, the teacher educator starts introducing different types of technologies to student teachers and presents them with learning problems in the subject matter to be taught. Student teachers try to apply what they have learned to solve authentic problems with the guidance of the teacher educator. This step lasts for several weeks and it is intended to provide student teachers with familiarity about various types of technologies and practicing opportunities.To further the conceptual change process, the set-up phase paves the way to the stage of TECHNO.

(T)hink: This phase is based on thinking over learning problems in the subject matter. The teacher educator can use either cases articulated by student teachers based upon their early learning experiences or videos, podcasts or images to present the problematic events. Student teachers

are encouraged to discuss solutions in response to questions of: “How can you solve this problem?, “What can be the role of technology while addressing this problem?” and “In what ways do you find (not find) the suggested solutions effective?” and their answers are recorded through a mind mapping software to be displayed and extended upon in the following phases.

(E)xplore: At the end of the think phase, student teachers are encouraged toward self-directed inquiry. For this purpose, they are divided into groups and assigned to explore different ways of dealing with the related problem incorporating digital technologies. Next class, they come together to share the alternative solutions they have come up with. They also find opportunities to revise their initial suggestions and compare them with the alternative ones discussing on the pros and cons of each solution. Through the phases of think and explore, it is intended to create puzzlement and build awareness in student teachers about their existing beliefs, knowledge and skills since such endeavors would urge them to question their existing conceptions in terms of adequacy and efficiency while proposing solutions to problems.

(C)reate: The create phase involves getting student teachers to put into practice what they have come up with in the previous stage. For this purpose, each group creates lesson plans to solve the problem in question.

(H)one: Student teachers have the chance to perform what they have interrogated and created so far at this stage. One of the groups is assigned to implement their lesson plan in the classroom. Other student teachers act as the target audience and the instructor observes the lesson without any interruption.

(N)egotiate: Following the implementation of the lesson plan, student teachers participate in discussions on the methods, techniques, materials and technologies used and they exchange ideas about good applications and areas that need further improvement. Based upon peer and instructor feedback, student teachers find opportunities to refine their understanding about the role of technology in the teaching and learning processes.

(O)pine: This phase is meant to help student teachers develop an awareness of their beliefs, knowledge and skills concerning the integration of technology into instructional practices as well as providing the teacher educator with formative evaluation opportunities. Student teachers are required to individually reflect on to what extent they have made sense of the new learning experiences incorporating technology. They write down their opinions in their learning journals and share their entries with the teacher educator so that he/she can see whether the cycle has helped student teachers deepen their understanding about the role of technology. Based on student teachers’ views and needs, the teacher educator may provide more support in the design and implementation of lesson plans.

The phases of explore, create, hone, negotiate and opine together aim to develop an understanding about the intelligibility, plausibility and fruitfulness of using digital technologies in student teachers.

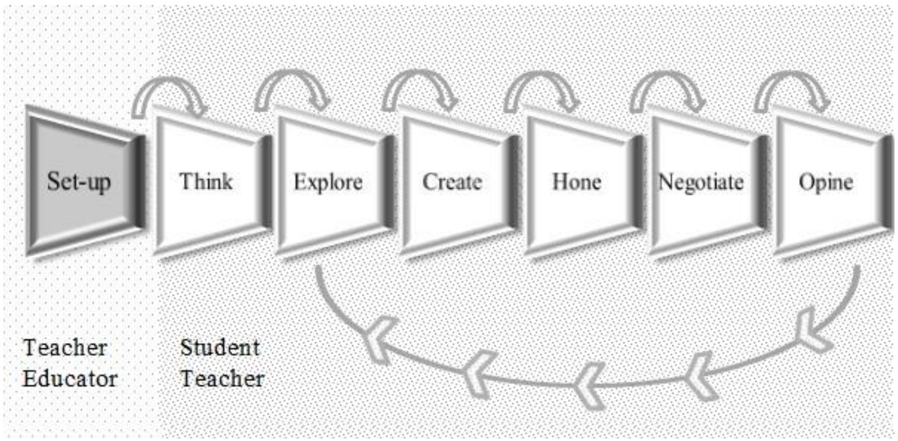

Figure 1. *The S-TECHNO Model*

Figure 1 presents the S-TECHNO model. Although the S-TECHNO model features a linear structure, the continual arrows indicate that it may sometimes be essential to turn back to the previous phases before going forward. For example, after the negotiate or opine phases, student teachers may need to go back to the "explore" phase and repeat the "create and hone" phases if they and their peers are not satisfied with the activities done in the "hone" phase.

METHODS

The study employed a mixed-method quasi-experimental design (Cohen, Manion & Morrison, 2001). Treatment (traditional course or S-TECHNO-based course) was the independent variable of this research study. The dependent variables were student teachers' technological beliefs, knowledge and skills. Student teachers' progress was measured by administering pre-tests and post-tests before and after the intervention respectively.

Context and Participants of the Study

This study was carried out in the context of a four-year undergraduate teacher education program during the 2015-2016 school year in Turkey. There is a standardized curriculum designed by the Council of Higher Education (CoHE) for teacher education programs. The program curriculum includes three technology-related courses. While the courses of Computer I and Computer II aim to help student teachers gain basic knowledge and skills in using different hardware and software applications, the Instructional Technology and Material Development (ITMD) courses focus more on the integration of teaching, learning and technology. In accordance with the objectives of the ITMD courses, the S-TECHNO model has been designed to be implemented in these courses.

Participants of the study were a convenience sample of 80 student teachers enrolled in the English Language Teaching (ELT) Program of a state university. Of the 80 student teachers taking part in the study, 41 of them were assigned to the experimental group (EG). 33 of the participants were female and 8 of them male. The control group (CG) consisted of 39 student teachers and 30 of them were female and 9 of them were male. Although the class size was equal in both groups, two student teachers in the control group did not want to take part in the study since participation in the study was on a voluntary basis.

Data Collection

The quantitative data for this study were obtained from surveys, structured observations and lesson plans. The survey consisted of two parts. The first part included use of the questionnaire for English as a foreign language teachers' Technology Pedagogy and Content Knowledge (EFL-TPACK) which was found to be a valid and reliable tool (Bostancıoğlu & Handley, 2018). The second part was developed by the researchers for descriptive purposes. A variety of technological tools ranging from hardware (such as computers, smart phones, clickers) to software (social media, office programs, video-sharing sites) were listed. Student teachers were asked to rate the listed technologies on a 5-point likert scale in terms of: (a) how applicable they find the listed technologies to their field, and (b) how prepared they feel using them for instructional purposes. It was pretested with 100 student teachers and examined by three experts to ensure the clarity and completeness of the items. Structured observations provided another set of quantitative data for the study. The Technology Integration Observation Instrument (Hofer et al., 2011) was used to assess the quality of technology integration in student teachers' lesson plans and presentations.

The qualitative data for the study were collected through metaphors, semi-structured interviews, and reflection journals. Considering the potential of metaphors in making the tacit explicit (Leavy, 2007), student teachers were asked to construct metaphors about the role of technology in ELT. Similar to the technique employed by Saban (2010), student teachers were handed out a paper with the prompt "Technology in language teaching is like … because…". The researcher conducted studies on metaphor construction both with the experimental and control group at the begining and end of the intervention. These served as pre- and post-tests to investigate and compare each group's prior and posterior beliefs, knowledge and skills in relation to instructional technologies. To acquire further understanding about the possible effects of the intervention process on the experimental group, they were asked to keep reflection journals throughout the intervention process and semi-structured interviews were held with six student teachers at the end of the intervention.

Intervention

The intervention process lasted for 14 weeks and the classes met for four hours once a week. While the courses in the experimental group were taught by the researcher through the S-TECHNO model, the control group was involved in their regular coursework. In accordance with the aims of the model, the first five weeks aimed to help student teachers understand the rationale of using technology. Each class embedded English language learning-related problems, discussions on required readings, hands on experiences, and contextualization of the technologies to language teaching and assignments. For the subsequent nine weeks, the experimental group was divided into eight groups. They were presented with some language learning problems to solve through the integration of technology into their lesson plans in the first round. They started implementing what they learnt and created in the classrooms. In the second round, more specific problems were posed. Referring to the national curricula, problems were created drawing on the themes from the English Language course books of primary/secondary school students. Student teachers were expected to create unit-based lesson plans and teach them in the classrooms. During student teachers' demonstrations, the researcher with a second observer kept observation checklists to evaluate the performance of student teachers.

Data Analysis

The data collected through surveys were analyzed through independent sample t-test and paired sample t-test. To identify the impact of independent variable on the dependent variable, effect size was calculated. Cohen (1988) classifies effect sizes as small ($d = 0.2$), medium ($d = 0.5$), and large ($d \geq 0.8$). In order to analyze the qualitative data obtained through metaphors, interviews and reflection journals, the typological analysis (Hatch, 2002) was used. Metaphors were analyzed using a priori codes of “exherent value beliefs” and “inherent value beliefs” about technology. The typologies that framed the analysis of interviews and reflection journals were technological beliefs, knowledge and skills. In order to increase the credibility of the findings, qualitative data were analyzed by a second coder. In order to reach agreement on different codings, the coders were involved in a negotiated agreement process. When necessary, data were member checked through asking student teachers to clarify their statements. Finally, the observational data and lesson plans were analyzed using the Technology Integration Observation Instrument. Each of the six categories in the instrument was scored using a scale of 1 to 4. The first four rows were used to evaluate student teachers’ lesson plans and the last two rows were used to assess the implementation of these lesson plans as suggested by Hofer, Grandgenett, Harris & Swan (2011). In case of any discrepancy in scoring the instrument, the researcher and the second observer discussed the scores until an agreement was reached.

FINDINGS

Survey Results

The initial independent sample t-test conducted to investigate whether there was any difference between the two groups in terms of the subscales of the survey revealed no significant difference between the EG and CG ($p>.05$). A close examination on the descriptive statistics for the subscales of relating different technologies to ELT ($M=2.96$, $SD=.68$ for EG; $M=2.73$, $SD=.49$ for CG) and preparedness level for using different types of technologies in ELT ($M=2.74$, $SD=.69$ for EG; $M=2.52$, $SD=.51$ for CG) has revealed that most of the student teachers in both groups were not able to relate and instructionally use most of the technologies listed. In addition, results of the TPACK survey have shown that the majority of the student teachers rated themselves slightly above average ($M>3.0$) with regard to the construct of TPACK ($M=3.06$, $SD= 0.65$ for EG; $M=3.24$, $SD=0.79$ for CG).

In order to investigate whether the experimental group outperformed the control group after the intervention, another independent sample t-test was run. Results revealed statistically significant differences between the groups ($p<.05$). While the control group did not show significantly better results in the post-test: (a) relating different technologies to ELT ($M=2.77$, $SD=.40$), (b) preparedness level for using different types of technologies in ELT ($M=2.54$, $SD=.60$) and (c) TPACK ($M=3.26$, $SD=.82$); the experimental group obtained higher post-test scores: (a) relating different technologies to ELT ($M=3.78$, $SD=.61$), (b) preparedness level for using different types of technologies in ELT ($M=3.61$, $SD=.67$) and (c) TPACK ($M=3.91$, $SD=.58$). In the same way, the results of the paired samples t-test indicated that the experimental group had significantly higher results in the post-test in comparison with the pre-test ($p<.005$) and the effect size was large for each individual scale ($d>0.8$).

Results of the Metaphor Analysis

The analysis of the metaphors yielded important insights about what value beliefs student teachers hold about technology. The theme of “Types of technology users” was developed from the four categories generated: Indifferent Users, Middle-of-the-roaders, Embracers and Resisters. While the first three categories were common in both the EG and CG, the last category was developed from the metaphors constructed by the CG. Below is the definition for each category:

Resisters: Although these student teachers are aware of the advantages of technology, they oppose the unconscious use of it since they view technology as an obstacle in the path of teachers’ and students’ creativity and productivity.

Indifferent Users: Student teachers in this category view technology as an extra tool. Using or not using it doesn't matter for them.

Middle-of the-roaders: These student teachers are typical users of technology who view technology as a supplementary tool. Technology tools have a subservient role for them and it serves to promote some end in the teaching and learning process.

Embracers: This category refers to student teachers who believe that technology is an essential part of classrooms and there is an interaction between people and technology.

Table 1:*Pre- and post-test metaphors of EG and CG*

	Types of Technology Users	Pre-test n	Update on Metaphors	No Update on Metaphors	Category Change				Post-test n
Typologies					Exherent Value Beliefs			Inherent Value Beliefs	
					Resisters	Indifferent Users	Middle-of-the-Roaders	Embracers	
Control Group	Resisters	3	1	2	---	---	---	---	3
	Indifferent Users	10	---	10	---	---	---	---	10
	Middle-of-the-roaders	15	5	10	---	---	---	---	15
	Embracers	11	---	11	---	---	---	---	11
Experimental Group	Indifferent Users	4	3	1	---	---	1	2	1
	Middle-of-the-roaders	32	28	4	---	---	---	18	15
	Embracers	5	3	2	---	---	---	---	25

As shown in Table 1, the results of pre-intervention metaphor analysis reveal that the majority of the student teachers in both groups construct metaphors that fit in the typology of exherent value beliefs about technology. However, while the metaphors constructed after the intervention show no typology change in CG, considerable updates can be seen in the metaphors of the EG. For example, three of the indifferent users wrote different metaphors at the end of the intervention process. While two of these metaphors showed that there was a change towards inherent value beliefs, one of them still pointed to exherent value beliefs. 28 of the middle-of-the-roaders also provided an update on their metaphors. 18 of them showed changes in their typologies. The findings also display that three of the embracers in EG updated their metaphors. In addition, it can be seen that five of the embracers keep their ideas about the essential role of technology for language teaching. Overall examination of both the pre-test and post-test displays an increase in the number of embracers in EG. However, despite the regular use of technology in their classrooms, the CG showed no change in their beliefs about the role of technology in language teaching.

Results of the Interview and Journal Analysis

The results obtained from the exit interview and reflection journals provided further clarification and support for the survey and metaphor results. The three main categories generated from the data are: a) Increase in technological knowledge, b) Increase in technological skills and c) Development of inherent value beliefs about technology. For example, when student teachers were asked whether the intervention process developed their technology knowledge, most of them indicated an increase in their knowledge. For example, one of the student teachers wrote in his reflection journal:

> *I have already known some technological tools but I have learnt much more than I knew beforehand. I learnt about the relationship between technology and language teaching and the rationale of using technology in ELT. We have also learnt lots of programs like plotagon, penzu, hotpotatoes, wikis, podcasts, autorap etc.*

Referring to the improvement in his technological skills, one interviewee stated that:

> *Your classes also showed us how to use what we already use in our daily lives like Facebook, twitter or Instagram. For example, I was confused when I saw the program of hotpotatoes. I couldn't figure it out. But you showed us, we tried it at home for our assignment. Although I had difficulty at first, it was worth to see my product at the end. Audacity is another program that I can use now although it seemed complex at first.*

With regard to the changes in their beliefs about the role of technology for ELT, one student teacher wrote in her reflection journal:

> *I am wondering why our teachers did not use technology since it has many advantages and again I am wondering while we are always using technology in our lives, why do not we use technology in education? It is really confusing. After discussing on the articles we read, I saw technology and ELT can make a happy marriage. But why do not we allow? This is because teachers do not know its potential for language teaching, It is because teachers do not have adequate knowledge and skills. If we had not taken this course, technology would still stand outside my classrooms. But now, it won't since I will take it into my classrooms.*

Turning now to the findings gained through observations and lesson plans; further information will be provided about the experiences student teachers went through throughout the implementation process

Results of the Observations

Student teachers' performances and lesson plans were assessed by two observers separately scoring the rows of Technology Integration Observation Instrument. The overall performances delivered by student teachers were plotted on a bar chart to show the changes between their first and second performance. While the highest score student teachers would get from the instrument was 24, the lowest score was 6. Compared to their initial performances, the results show an obvious improvement for most of the participants.

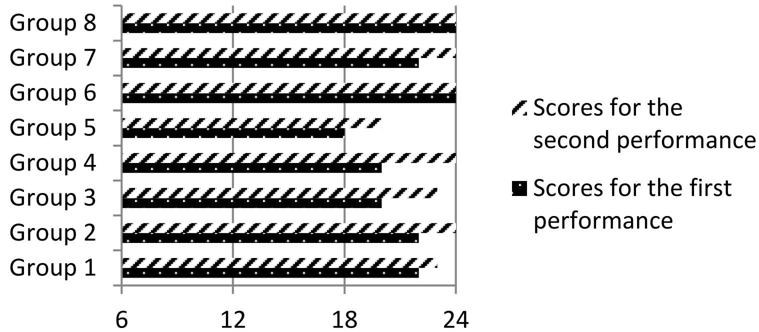

Figure 2: *Results of the Observations*

Overall, the qualitative and quantitative findings regarding the impact of a S-TECHNO-based course on student teachers' technological beliefs, knowledge and skills revealed that participants went through positive experiences and there were changes in most of the student teachers' beliefs, knowledge and skills in relation to technology.

DISCUSSION

In the quest to understand barriers impeding the integration of technology into classrooms, factors related to student teachers have become a subject of investigation for many researchers. While some drew attention to the development of technological skills of student teachers (Chen, 2010), others highlighted the integration of technology knowledge with pedagogy and content knowledge (Mishra & Koehler, 2006). Accordingly, a number of strategies including designing instructional models have been suggested to contribute to the development of student teachers' technological knowledge and skills. Despite the important work these models have done to guide teacher education programs to increase the aforementioned constructs, what is missing in these models is the explicit treatment of beliefs which, according to Verloop, Drier and Meijer (2001) is the reason for the failure of most of the educational innovations. In order to bridge this gap, we proposed the integrated ID model of S-TECHNO. To our knowledge, this study is the first one simultaneously addressing these three interrelated constructs through the amalgamation of the constructivist propositions of awareness-raising, mentoring, creating cognitive conflict, hands-on experiences, inquiring, authentic experiences and collaboration, reflection, formative evaluation, and texts and class discussions (Murphy & Mason, 2006) for understanding the rationale behind learning new content. We subsequently probed whether the proposed model helped student teachers develop inherent value beliefs, knowledge and skills with respect to instructional technologies.

Before the intervention process, the independent sample t-test results displayed that there was no significant difference between the EG and CG in terms of all the subscales of the survey. A close examination of the descriptive statistics for the subscales of relating different technologies to ELT and preparedness level for using different types of technologies in ELT has revealed that most of the student teachers in both groups were not able to relate and instructionally use most of the technologies listed. These results are in alignment with previous studies (Adu Gyamfi, 2016; Sang et al. 2012) which indicated that student teachers do not feel adequately prepared to teach with technology. Results of the TPACK survey have shown that the majority of the student teachers rated themselves slightly above average in each construct of the TPACK. While these results corroborate the ideas of Horzum (2013) who stated that student teachers generally rate themselves above average in TPACK constructs, they show differences with the results obtained from the factors of relating technology tools to ELT and preparedness level to use technology for language teaching given that student teachers had lower mean scores in these subscales. A possible explanation for this might be that student teachers evaluate themselves about TPACK based on the technologies they know without being aware of the numerous technologies available that can be used in language teaching. This finding provides further support for the ideas of Wu and Wang (2015) highlighting the importance of using more than one tool in measuring student teachers' technology knowledge to have reliable findings. Results of the typological analysis have revealed that the majority of the student teachers have exherent value beliefs about technology. The categories of resisters, indifferent users and middle-of-the-roaders have shown that most of the student teachers view technology as an additional tool in language teaching. On the other hand, it was found out that a small number of participants see technology as an integral part of classrooms. In alignment with this, only one category–embracers– was developed to refer to the student teachers who view technology as an integral part of classrooms. These results are in agreement with Chen's (2011) findings which showed that most of the student teachers subscribe to instrumental views about technology and view it as an add-on acting separately from their mental processes.

After the intervention process, the Independent sample t-test results showed that the EG had higher mean scores in the subscales of the survey compared to the student teachers in the control group. While the paired sample t-test results illustrated no significant difference in the post-test mean scores of the CG, the results showed that there was a significant increase in the post-test scores of the EG with a large effect size in the subscales of relating different technologies to ELT and preparedness level for using different types of technologies in ELT as well as the constructs of TK, TCK, TPK and TPCK. Observation results confirmed these findings showing that the more experience student teachers have with technology, the better performance they deliver. Content analysis of the metaphors revealed that there was a considerable increase in the number of the embracers in the EG. Grasping the inherent value of technology for language teaching, almost half of the student teachers in the treatment group stated inherent value beliefs about technology at the end of the intervention. Insights obtained through exit interviews and reflection journals further supported these findings based on student teachers' insinuations for the cognitive dissonance they experienced during the implementation process. However, some of the student teachers in the EG kept stating exherent value beliefs about technology. A possible explanation for this might be the limited time allocated for the implementation process and lack of opportunities for more practice. This result supports previous research highlighting the important role of constant experience in belief change (Ertmer, 2005). In addition, although there were some updates in the metaphors of the control group, these updates referred to no change in student teachers' views about the role of technology in language teaching. It was seen that most of them still kept holding exherent value beliefs about technology.

In general, the findings showed that participation in a S-TECHNO-based course positively influenced student teachers' technological beliefs, knowledge and skills. These results seem to be consistent with other research which found that teacher training endeavors specifically made for the classroom integration of technology hold promise to develop student teachers' competence for the successful implementation of technology in their teaching practices (Gibson et al., 2014). The findings may also confirm the natural fit between constructivist propositions and the effective classroom use of technology (Harasim, 2012). Therefore, these findings can serve to remind teacher educators to employ more constructivist methods in IT courses because of the complementary link between the successful implementation of technology and constructivist propositions. Considering some student teachers' persistency on exherent value beliefs about technology after the intervention process which could be explained by insufficient practicing opportunities due to only one-semester-long IT courses, another important implication of this study for teacher education programs is, therefore, the integration of technology across teacher education curriculum because much longer meaningful experiences in teacher education programs increase the likelihood of belief change in student teachers (Lee, 2015). Leading from the same finding, future research possibilities entail a detailed qualitative analysis of reasons underlying student teachers' lasting exherent value beliefs in relation to the use of technology in ELT. Given that the intervention process was limited to 14 weeks, it was not possible to investigate whether the student teachers indicating positive improvements in their beliefs, knowledge and skills would integrate technology into their future teaching practices. Hence, investigating the influence of the model on student teachers' technology integration in K-12 settings can be another beneficial avenue of research to test its long-term efficiency. Finally, the implementation of the study through micro experiences of teaching in simulated classroom conditions limited our ability to monitor and evaluate the impact of the model on student teachers in real classroom settings. In order to further establish the effectiveness of the model, a similar study could be conducted synchronously with the practicum process when student teachers could get authentic feedback from real students.

CONCLUSION

Compiling the prior research on individual-level barriers and effective strategies to overcome these obstacles, the S-TECHNO model was proposed to redesign IT courses based on the empirical evidence that student teachers do not feel adequately prepared to teach with technology. Results obtained in this study indicate that the S-TECHNO model had positive effects on the EG's technological beliefs, knowledge and skills in that they reported and displayed meaningful technology knowledge and skills along with increased awareness about the inherent value it has for their subject matter and intention to incorporate technology into their instruction. The plausible reason for this development has been suggested as the establishment of the model on constructivist propositions that envisage the participation of student teachers as whole persons in the learning-to-teach process. Although the implementation of the model requires serious commitment and it may not guarantee the future classroom integration of technology, we presume that it would affect the likelihood of doing so since student teachers are likely to teach the way they are taught (Ertmer 2005; Hew and Brush 2007). We also believe that the findings of the study may contribute to debates among researchers and practitioners on how to effectively design IT courses. Thus, future work should undoubtedly continue to explore the potential effects of the S-TECHNO model in different contexts and subject-matter disciplines.

Acknowledgements:

This work was supported by the Scientific and Technological Research Council of Turkey (TUBITAK).

Author Note:

This study is an abridged version of the product phase of the first author's PhD dissertation completed under the supervision of the second author.

REFERENCES

Adu Gyamfi, S. (2016). Identifying Ghanaian pre-service teachers' readiness for computer use: A technology acceptance model approach. *International Journal of Education and Development using Information and Communication Technology,* vol. 12, no. 2, p.105.

Applefield, J. M., Huber, R., & Moallem, M. (2001). Constructivism in theory and practice: Toward a better understanding. *The High School Journal,* vol. 84, no. 2, pp. 35-53.

Aslan, A., & Zhu, C. (2017). Investigating variables predicting Turkish pre–service teachers' integration of ICT into teaching practices. *British Journal of Educational Technology,* vol. 48, no. 2, pp. 552–570.

Banas, J. R. & York, C. S. (2014). Authentic learning exercises as a means to influence preservice teachers' technology integration self–efficacy and intentions to integrate technology. *Australasian Journal of Educational Technology,* vol. 30, no. 6, pp. 728–746.

Baydas, O. & Goktas, Y. (2017). A model for preservice teachers' intentions to use ICT in future lessons. *Interactive Learning Environments*, vol. 25, no. 7, pp 930–945.

Borg, S. (2006). *Teacher cognition and language education: Research and practice.* London: Continuum.

Bostancioglu, A., & Handley, Z. L. (2018). Developing and validating a questionnaire for evaluating the EFL 'Total PACKage': Technological Pedagogical Content Knowledge (TPACK) for English as a Foreign Language (EFL). *Computer Assisted Language Learning*, pp. 1-27.

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development Using Information and Communication Technology, vol.* 8, no. 1, pp. 136–155.

Chang, C. Y., Chien, Y. T., Chang, Y. H., & Lin, C. Y. (2012). MAGDAIRE: A model to foster pre-service teachers' ability in integrating ICT and teaching in Taiwan. *Australasian Journal of Educational Technology,* vol. 28, no. 6, pp. 983–999.

Chen, R. J. (2010). Investigating models for preservice teachers' use of technology to support student–centered learning. *Computers & Education,* vol. 55, no. 1, pp. 32–42.

Chen, R. (2011). Preservice mathematics teachers' ambiguous views of technology*. School Science and Mathematics,* vol. 111, no. 2, pp. 56-67.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Newbury Park, CA: Sage.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education.* London: Routledge.

Ernest, P. (1995). The one and the many. In L. Steffe & J. Gale (Eds.), *Constructivism in Education* (pp. 459-486), New Jersey: Lawrence Erlbaum.

Ertmer, P.A. (1999). Addressing first– and second–order barriers to change: Strategies for technology integration. *Educational Technology Research and Development,* vol. 47, no. 4, pp. 47–61.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, vol. 53, no. 4, pp. 25–39.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education,* vol. 42, no. 3, pp. 255–284.

Freeman, D. (1989) Teacher training, development, and decision making: A model of teaching and related strategies for language teacher education. *TESOL Quarterly,* vol. 23, no. 1, pp. 27–46.

Funkhouser, B., & Mouza, C. (2013). Drawing on technology: An investment of preservice teacher beliefs in the context of an introductory educational technology course. *Computers & Education*, vol. 6, no. 2, pp. 271–285.

Gibson, P. A., Stringer, K., Cotten, S. R., Simoni, Z., O'Neal, L. J., & Howell-Moroney, M. (2014). Changing teachers, changing students? The impact of a teacherfocused intervention on students' computer usage, attitudes, and anxiety. *Computers & Education,* vol. 71, pp. 165-174.

Gustafson, K.L., & Branch, R.M. (1997). *Survey of instructional development models*. Syracuse, NY: ERIC Clearinghouse on Information & Technology.

Harasim, L. (2012). *Learning Theory and Online Technologies*. New York: Routledge Taylor & Francis Group.

Hatch, J. A. (2002). *Doing Qualitative Research in Education Settings*. Albany: SUNY Press

Hew, K. F., & Brush, T. (2007). Integrating technology into K–12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development,* vol. 55, no. 3, pp. 223–252.

Hofer, M., Grandgenett, N., Harris, J., & Swan, K. (2011). Testing a TPACK-based technology integration observation instrument. In C. D. Maddux (Ed.), *Research highlights in technology and teacher education*. Chesapeake, VA: Society for Information Technology & Teacher Education (SITE), pp. 39-46

Horzum, M. B. (2013). The investigation of technological pedagogical content knowledge of student teachers. Technology, Pedagogy and Education, vol. 22, no. 3, pp. 303-317.

International Society for Technology in Education (2008). *National Educational Technology Standards for Teachers.* Available from http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf (Accessed 22nd June 2018).

Jang, S. J., & Chen, K. C. (2010). From PCK to TPACK: Developing a transformative model for preservice science teachers. *Journal of Science Education and Technology,* vol. 19, no. 6, pp. 553–564.

Knowles, M. S. (1984). *Andragogy in action.* San Francisco: Jossey-Bass.

Korucu-Kis, S., and Ozmen, K. S. (2018). Toward an Integrated Technology Integration Framework for Teacher Preparation: Instructional Technological Competence. *i-manager's Journal on School Educational Technology,* vol. 14, no. 2, pp. 31-50.

Korucu-Kis, S., & Ozmen, K. S. (2019). Exherent and Inherent Value Beliefs about Technology: Missing Pieces in the Puzzle of Technology Integration? *International Journal of Educational Technology,* vol. 6, no. 1, pp.1-11.

Leavy, A. M., McSorley, F. A. & Boté, L. A. (2007). An Examination of What Metaphor Construction Reveals about the Evolution of Student teachers' Beliefs about Teaching and Learning. *Teaching and Teacher Education,* vol.23, no. 7, pp.1217-1233.

Lee, E., & Hannafin, M. (2016). A design framework for enhancing engagement in student-centered learning: Own it, learn it, and share it. *Educational Technology Research and Development,* vol. 64, no. 4, pp. 707–734.

Lee, C. J., & Kim, C. (2014). An implementation study of a TPACK-based instructional design model in a technology integration course. *Educational Technology Research and Development,* vol. 62, no. 4, pp. 437-460.

Lee, Y., & Lee, J. (2014). Enhancing student teachers' self–efficacy beliefs for technology integration through lesson planning practice. *Computers & Education,* vol. 73, pp.121–128.

Lee, I. (2015). Student Teachers' Changing Beliefs on a Pre-service Teacher Education Course in Hong Kong. In T. Wright & M. Beaumont (Eds), *Experiences of Second Language Teacher Education*. UK: Palgrave Macmillan, pp. 15-41.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record,* vol. 108, no. 6, pp. 1017–1054.

Murphy, P. K., & Mason, L. (2006). Changing knowledge and changing beliefs. In P. A. Alexander & P. Winne (Eds.), *Handbook of educational psychology*. Mahwah, NJ: Erlbaum, pp. 305-326

Ottenbreit–Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education,* vol. 55, no. 3, pp. 1321–1335.

Piaget, J. (1971). *Biology and knowledge*. UK: Edinburgh Press.

Polly, D., Mims, C., Shepherd, C. E., & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (PT3) grants. *Teaching and Teacher Education: An International Journal of Research and Studies*, vol. 26, no. 4, pp. 863-870.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education,* vol. 66, no. 2, pp. 211-227.

Saban, A. (2010). Prospective teachers' metaphorical conceptualizations of learner. *Teaching and Teacher Education,* vol. 26, no. 2, pp. 290-305.

Sang, G., Valcke, M., van Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology*. Computers & Education,* vol. 54, pp. 103–112.

Schön, D. (1983). *The reflective practitioner: How professionals think in action.* London: Temple Smith.

Tondeur, J., van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: a synthesis of qualitative evidence. *Computers & Education,* vol. 59, no. 1, pp. 134–144.

Verloop, N. J., Driel, V., & Meijer, P. C. (2001). Teacher knowledge and the knowledge base of teaching. *International Journal of Educational Research,* vol. 35, no. 5, pp. 441-461.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological process.* Cambridge, MA: Harvard University Press.

Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education,* vol. 14, no. 1, pp. 120–173.

Wu, Y. T., & Wang, A. Y. (2015). Technological pedagogical and content knowledge in English language: Representation of primary teachers of English in Taiwan. *The Asia-Pacific Education Researcher,* vol. 24, no. 3, pp. 525-533.

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal,* vol. 40, no. 4, pp. 807–840.