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Pre-service Teachers' Perceptions on Development of Their IMD Competencies through TPACK-based Activities

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ABSTRACT

The current study investigated perceived development of pre-service teachers in their Instructional Material Design (IMD) competencies through the course *Instructional Technology and Material Design,* which is based on a technological, pedagogical, and content knowledge (TPACK) framework. A total of 22 Elementary Education pre-service teachers participated in the study. Five activities based on TPACK were designed by the instructors to provide students with specific teaching experience. Action research methodology was followed during the study, and each activity was part of the cycle of design. Data were collected through a questionnaire on pre-service teachers' IMD competencies, their journals, assignments, open-ended questionnaires, teaching practice forms, observations, and software evaluation forms. The study revealed that pre-service teachers gained essential competencies in instructional material design. Moreover, the results showed that they experienced incorporating TPACK into their future teaching practices.

Keywords

TPACK, Instructional material design competencies, Action research, Pre-service teachers

Introduction

One framework used to explain and describe teachers' knowledge and skills related to technology integration is Technological, Pedagogical, Content Knowledge, collectively referred to as TPACK (Mishra & Koehler, 2006; Niess, et al., 2009). Technological tools are often used as educational aids in primary and secondary education (Polly, Mims, Shepherd, & Inan, 2009); the technology means "the systematic application of scientific and other organized knowledge to practical tasks" (Galbraith, 1967, p. 12 as cited in Earle, 2002). Mishra and Kohler (2006) list some of technologies used in traditional classrooms as textbooks, overhead projectors, typewriters, and charts of the periodic table. According to Yanpar-Yelken (2011), every tool that can be used for educational purposes can be defined as technology, including 3D materials, board markers, and textbooks. Digital technology refers to multiple formats, including information that can be evaluated and integrated using computers (Pool, 1997).

Teachers must have the ability to use these tools effectively in order to facilitate learning processes (Clements, 2002). Polly et al. (2010) emphasize that teachers need to understand (a) the relationship between technology and content, including how technology can be used for the learning of specific content; (b) the relationship between technology and pedagogy, including how specific pedagogies best support the use of technology; and (c) the relationship between content and pedagogy, including how specific pedagogies facilitate the learning of specific content. In other words, teachers need to be knowledgeable about the intersection of technology, pedagogy, and content (Özgün-Koca, Meager, & Edwards, 2010). Nelson, Chistopher, and Mims (2009) state that TPACK-competent teachers exhibit best practices in pedagogy, content, and technology, and organize meaningful, collaborative, and technology-rich learning opportunities for their students. The Ministry of National Education, General Directorate of Teacher Training and Education (2006) has identified a set of Teaching Profession General Competencies, one of which is related to Material Preparation and Development. Specifically, teachers need to be able to develop educational materials that demonstrate content knowledge, utilize pedagogical knowledge, and incorporate technology. To meet the competency levels determined by the Ministry of National Education, teachers need TPACK knowledge. Therefore, pre-service teacher education programs are expected to provide TPACK necessary to apply the model effectively. Finger, Jamieson-Proctor and Albion (2010) advocate this with the words: "Preservice teacher education programs have the responsibility for preparing future teachers who are likely to be teaching their students in a world characterized by ongoing technological changes" (p. 114).

According to Angeli and Valanides (2008), "TPCK development efforts need to invest on socio-cognitive constructivist ideas" (p. 16), since the effort transforming a content domain through technology must firstly target learners' conceptual ecology consisting of their knowledge base. Moreover, Nelson et al. (2009) state that some technologies, such as Web 2.0 tools, are based on construction of knowledge together; teachers with well developed TPACK used these tools to provide learners with experiences in which they were active. This study helped pre-service teachers to gain experience in designing instructional materials and integrating them through the course Instructional Technology and Material Design, which was designed based on TPACK.

Theoretical background of the study

The TPACK framework is designed as an extension of Shulman's Pedagogical Content Knowledge (PCK), which requires an understanding of both pedagogy and content (Shulman, 1986). Mishra and Koehler (2006) and Angeli and Valanides (2008) explain that Shulman's framework has transformed into TPACK, connecting technology to curriculum content and pedagogical approaches. TPACK is defined as "a conceptual framework designed to illustrate the characteristics of teacher knowledge and technology integration in education." (Nelson, Christopher, & Mims, 2009, p. 82).

The TPACK model features interdependent components of teachers' knowledge: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). Shin et al. (2009) define CK as learned or taught knowledge about a subject matter; PK as knowledge about practices and methods of teaching, including classroom management skills, teaching strategies, and evaluation techniques; and TK as knowledge about both standard and more advanced technologies.

The interactions among these bodies of knowledge are represented as pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). Shin et al. (2009) define PCK as the awareness of best teaching approaches and content arrangement for effective teaching. TCK refers to an understanding of appropriate technology use (Cox, 2008). TPK indicates the application of technology in education without referring to specific content (Cox, 2008). With regard to TPK, Shin et al. (2009) add that teachers equipped with knowledge about technologies use them as pedagogical strategies in their classrooms. TPACK is not defined as a simple combination of three independent domains; instead, content, pedagogy, and technology are interdependent, each one affecting the others (Harris, Mishra, & Koehler, 2007). That is to say, choice of content influences pedagogical methods and technology, while technology affects how content is taught (Mishra, Koehler, & Zhao, 2007). Holmes (2009) emphasizes that teachers need to be able to integrate technology with specific content in meaningful ways in order to teach effectively. Hu and Fyfe (2010) add that the development of TPACK occurs when teachers know how to use computers and are aware of strategies that incorporate ICT tools and enhance student understanding of content.

Research questions of the study

What is the elementary education pre-service teachers' perception about development of their IMD competencies in a TPACK-based course consisting of collaborative projects?

a. How does this perception pertain to technology use?
b. How does it relate in terms of pedagogical knowledge while designing and using Instructional Material?
c. What is their perception in terms of content knowledge on the IMD?
d. What is their perception in terms of technology, pedagogy, content knowledge (TPACK) on the IMD?

Methodology

We practiced action research methodology in the current study. Altrichter, Posch, and Somekh (2005) state that, "Action research starts from practical questions arising from everyday educational work" (p. 5). We, as the instructor and teaching assistants of the Instructional Technology and Material Design course, began by assessing the students' awareness of being a teacher and knowledge of how to integrate technology into their teaching. Gall, Gall, and Borg (2003) emphasize that teachers are also researchers who reflectively investigate their practice through action research.

We changed our course plan as a result of the continuous evaluation of our teaching. According to Avison, Lau, Myers, and Nielsen (1999), in action research studies, practice and research inform each other synergistically and iteratively. We applied the steps outlined by Glanz, who points out that the nature of action research is cyclical, and each cycle consists of several phases: Select a focus, collect data, analyze and interpret data, take action, reflect, continue/modify (as cited in Gall, Gall, & Borg, 2003). In the current study, we planned five activities around these phases of action research design in order to address the research questions. After classroom practice, we improved the design of some activities to enhance our teaching. To do this we followed "Steps of the action research process" offered by Altrichter, Posch, and Somekh (2005): Finding a starting point, clarifying the situation, developing action strategies and putting them into practice, and making teachers' knowledge public.

Sampling

Out of 25 elementary education pre-service teachers who enrolled in the Instructional Technology and Material Design course, 22 participated in the study. Three pre-service teachers did not want to take part in the questionnaires, although they did write and submit journals during the course. We applied two forms of convenience sampling, captive and volunteer, drawing samples from an accessible and willing population (Teddlie & Yu, 2007).

All pre-service teachers were second-year college students enrolled in the night program for elementary education. Half the participants were male, and half were female. Ages ranged from 19 to 25 with an average age of 21. The average GPA was 2.79 out of 4.0. According to the questionnaire results, all participants had taken some of the same educational courses, including: Introduction to Education Sciences, Psychology of Education, and Teaching Techniques and Methods. Except for one female pre-service teacher, all students reported using a computer regularly for between two and 12 years, with an average of six years of use. Moreover, they had also used computers to create Word documents, Excel spreadsheets, and PowerPoint presentations for class work.

Instruments

Instruments were applied as the following:

1. The demographic questionnaire: consisted of ten questions, asking about age, gender, department, program types, class level, GPA, education lessons, computer use, coursework that demanded computer use, and activities conducted using the computer.
2. The Teacher Skills Related with Material Development and Evaluation questionnaire: was developed by the Ministry of National Education (2006) to identify pre-service teachers' perceptions of relevant competencies. It also has ten items. In this questionnaire, the pre-service teachers were asked to rate their perceived current levels of competency for ten items on a five-point Likert-type scale (1 = Not Competent, 2 = Slightly Competent, 3 = Competent, 4 = Very Competent, 5 = Extremely Competent).
3. The IT questionnaire: consisted of six diagrams that showed competencies about IT. The meaning of figures in the questionnaire represented individuals' perceptions of their competencies in technology and their ability to integrate them into teaching. It was applied at the beginning and at the end of the course.
4. An open-ended message design activity questionnaire: had four questions to learn students' opinions about the Message Design activity. The questions were about: what the pre-service teacher took into account while communicating both synchronously and asynchronously; whether there was a change in terms of procedure while communicating on the internet and face-to face; what difficulties they met during communicating on the internet and face-to face; and what they gained from this activity.
5. Open-ended journal entry questionnaires: after each activity asked pre-service teachers to describe four components as skills acquired, difficulties faced, strategies used to tackle those difficulties, and group members' labors.
6. A Teaching Practice Evaluation Form: was applied after the 3D and PowerPoint design activities. The form consisted of four parts: personal, classroom management, content presentation, and teaching methods applied and goals. It was developed by the facilitators of the course.
7. The Software Evaluation Checklist. This checklist was developed by Heinich, Molenda, Russell, and Smaldino (2002) and has three main parts: software description, rating, and open-ended questions. Software description includes title, serial title, keywords, format, source, date, cost, length, subject area, intended audience, brief

description, objectives, and entry capabilities required. The rating section has 12 points for evaluation. The third part included open-ended questions about strong points, weak points and recommended actions for the course.

8. Four-part, open-ended questionnaire was conducted to learn about pre-service teachers perceptions on skills acquired, difficulties faced, strategies used to tackle those difficulties, and group members' labors.

All the instruments were applied to define whether a change occurred in pre-service teachers' perception about their IMD competencies. The IT questionnaire was applied at the beginning and end of the course to see whether the pre-service teachers thought that their relationship with IT changed during the course. Moreover, journals applied after each activity aimed to learn which competencies they gained. Table 1 shows a timeline of the instruments conducted as related to planned activities.

Table 1. Activities planned and instruments correlated to research questions

Date	Instruments and Activities
22nd February 2011	Introduction to Course Demographic Questionnaire The Teacher Skills Related to Material Development and Evaluation Questionnaire
Beginning of the Course (1st March 2011)	Questionnaire about IT
During the Course (1st March-31st May 2011)	Activity 1: Instructional Message Design Open-Ended Activity Design Questionnaire Open-Ended Journal Entry Questionnaire Activity 2: 3D Material Design and Teaching Practice Open-Ended Journal Entry Questionnaire Teaching Practice Evaluation Form Activity 3: PPT Design and Teaching Practice Open-Ended Journal Entry Questionnaire Teaching Practice Evaluation Form Activity 4: Software Evaluation Open-Ended Journal Entry Questionnaire Software Evaluation Checklist Activity 5: Instructional Web Site Development Open-Ended Journal Entry Questionnaire
End of the Course (9th of June 2011)	Open-Ended Questionnaire Questionnaire about IT

Procedure

The procedure of the study was drawn from the stages of the action research process described by Altrichter, Posch, and Somekh (2005). As seen in Figure 1, the first step of the procedure was finding a starting point. To that end, the Teacher Skills Related to Material Development and Evaluation questionnaire was applied at the beginning of the course. The results showed that the students lacked technology integration knowledge. In the second step of the procedure, clarifying the situation, we met with pre-service teachers to discuss the results of the questionnaire and their impressions about the class. As the instructors and teaching assistants, we defined activities under the scope of the third step, developing action strategies and putting them into practice, and then applied these activities during the course. However, since the aim was to develop their IMD competencies with regard to technological, pedagogical, and content knowledge, each activity was revised according to students' comments after completion. At this step, pre-service teachers were divided into groups of five since we also wanted them to learn about each other with respect to social constructivism (Yanpar-Yelken, 2011). For the fourth step, making teachers' knowledge public, we wrote the current article for publication. The procedure of the study continued during the Instructional Technology and Material Design comprising of 12 four-hour sessions.

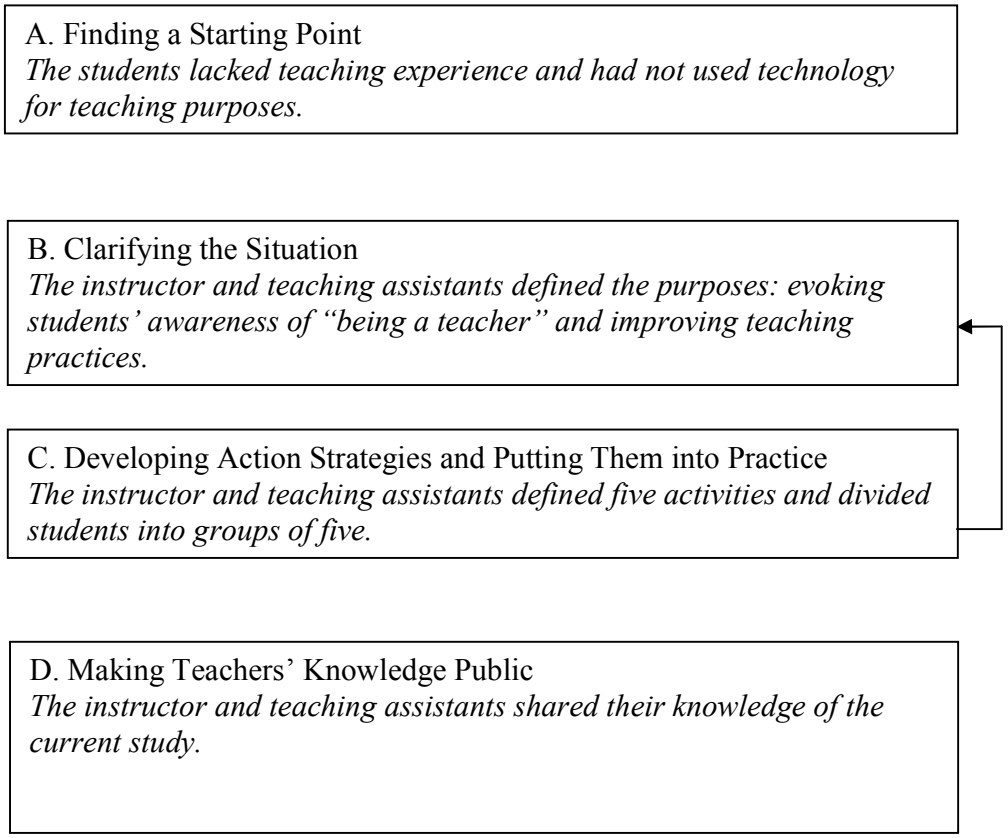

Figure 1. Steps of the action research process (Altrichter, Posch, and Somekh, 2005)

Activities designed based on TPACK

Using the TPACK framework, five activities were designed in a course entitled Instructional Technology and Material Design to develop the Elementary Education pre-service teachers' IMD and integration competencies. Five activities related with TPACK knowledge as follows:

PCK+TK: The first activity was an in-class activity about message design. Five event examples, one for each group, were prepared to show importance of message design in teacher-student interaction. These event examples were assigned to each group and the groups was asked to write a scenario and perform it based on these scenarios. Within the groups, one of the pre-service teachers performed as teacher while others performed as students (PCK). Moreover, the pre-service teachers discussed the scenario that was created by each group at the end of the lesson. Then, all the pre-service teachers continued discussing the components of message design (source, message, channel, and receiver) both synchronously (e.g., MSN, Skype, Gtalk) and asynchronously (e.g., Gmail, Hotmail, Yahoo) on the internet (TK).

TPACK: The second activity included 3D material design and in-class teaching with the material designed. The groups were asked to choose a subject matter from the national curriculum of primary schools. They prepared 3D materials to teach the selected subject matters by thinking how to teach it. Then, they taught the chosen subject matters by integrating 3D materials in class (TPACK).

TPACK: The third activity was PPT design and in-class teaching with designed material. The groups selected a subject matter from national curriculum of primary schools and prepared PPT to teach the chosen subject matters. Then, they taught the selected subjects by integrating PPT in class (TPACK).

TCK: For the fourth activity, the groups were instructed to evaluate educational software designed for primary school students using Heinich et al. (2002) Software Evaluation Checklist. Then, they were instructed to search educational software for teaching subject matters, evaluate and present them in class. During the presentation, the group members were asked to mention their scores as a result of Heinich et al. (2002)'s Software Evaluation Checklist by explaining why they gave these scores. Moreover, they were directed to mention their suggestions for improvement of the designs of software.

TPACK: The fifth, last, activity was web site construction on subject matters they selected from the primary school curriculum. In class, web-design principles were discussed, and a web tool was introduced to the pre-service teachers, who had very little experience with web site development. Then, the groups prepared the Web sites and published them to teach a subject online. The groups presented their web sites and other groups made suggestions for improvement. The groups also continued discussing each others' products.

All the above activities were designed in order to provide pre-service teachers with experiences and knowledge on material design by focusing what they would teach and how they would teach. The pre-service teachers designed 3D materials, PPTs and web sites in addition to selecting and evaluating educational software by focusing on design principles. All these activities related to material design competencies and directly addressed the research question.

Data analysis

The analysis of the data gathered through the demographic questionnaire, the Software Evaluation checklist (Heinich et al., 2002), the Teaching Practice Evaluation Form, and the open-ended questionnaire about change were descriptive in nature. Thus, we analyzed these data using descriptive statistics. Two researchers coded the journals and observation notes by organizing categories of significant statements through themes, as described by Ayres, Kavanaugh, and Knafl (2003). Then, we gathered a list of themes found in the data and correlated them under the constructs social constructivist course design. According to Miles and Huberman's (1994) formula, interview intercoder reliability on the merged themes was 92 percent.

Validity issues

The data collected in the current study were also qualitative in nature. We used the following strategies suggested by Creswell (1998) to validate the study results:

- Peer debriefing: We discussed the process of the study with colleagues before, during, and after data collection.
- Triangulation: We triangulated methods by collecting data through journals, assignments, open-ended questionnaires, teaching practice forms, observations, and software evaluation forms.
- External audits: We asked for experts' comments on the techniques used in the research study. Moreover, all the developed instruments were verified by an expert before application
- Members check: All data were analyzed by two researchers and verified by an expert.

Results

Action research step 1: Finding a starting point

This step began with the results of the Teacher Competencies Related to Material Development and Evaluation questionnaire prepared by the Ministry of National Education (2006). The competencies described in the questionnaire aligned with TPACK. Items 1, 5, 6, 7, and 8 were about pre-service teachers' content knowledge (CK); items 2, 4, and 10 were about pedagogical knowledge (PK); and items 3 and 9 were about technological knowledge (TK). Most pre-service teachers defined their skill levels as "Slightly Competent," as seen in Table 2.

Table 2. Results of the teacher skills with frequencies of students' answers

Item No and TPACK	Perceptions about Competencies Related to Material Development and Evaluation	(1) Not Competent	(2)Slightly Competent	(3)Competent	(4)Very Competent	(5)Extremely Competent
1.(CK)*	To prepare worksheets	4	14	2	0	0
2.(PK)	To take into account individual differences while designing or selecting instructional materials	3	10	8	1	0
3.(TK)	To use the computer or other technologies while designing instructional materials	3	18	1	0	0
4.(PK)	To take into account students' opinions while designing materials during instruction	3	15	4	0	0
5.(CK)	To take into account usability and cost effectiveness while designing instructional materials	6	11	4	1	0
6.(CK)	To design instructional material appropriate to content	6	11	4	1	0
7.(CK)	To benefit from environmental resources	4	14	3	1	0
8.(CK)	To take into account how the design of instructional material allows content presentation	4	14	4	0	0
9.(TK)	To access concepts related to teaching-learning by using technology and evaluate them in terms of accuracy and appropriateness	4	16	2	0	0
10.(PK)	To contribute to the improvement of students' creativity and aesthetical understanding by giving them the opportunity to design materials	3	15	3	1	0

Note. * Two students did not answer the first question.

The instructor also asked pre-service teachers about Instructional Technology (IT), technology integration in instruction, and their expectations about the course. Two teaching assistants observed these conversations, recording their observations. Three codes emerged as a result of analysis of these notes: misconceptions about IT, lack of knowledge about technology integration, and more practice. Similar, the pre-service teachers thought IT just meant technology, not a tool that can be used in teaching. They stated they did not know how to integrate technology, and they needed practice to learn.

Action research step 2: Clarifying the situation and IT questionnaire results

While discussing the results, the instructor and teaching assistants identified their main purpose as improving pre-service teachers' IMD competencies by planning TPACK-based activities. Moreover, since the pre-service teachers did not know how to integrate technology in instruction, they were placed in groups of five in order to learn from each other. The instructor and teaching assistants incorporated a social constructivist approach to make pre-service teachers experience instructional material design via group learning. Also, they decided to have pre-service teachers present their products or teach using their products both in class and on the internet to provide across group learning.

A questionnaire focusing on Instructional Technology and student relationships about Instructional Technology and Material Design was conducted at the beginning of the course (Appendix A). The students stated that the figures in the questionnaire accurately showed the person's competencies in combining technology, pedagogy, and content.

In the questionnaire at the beginning of the course, 11 pre-service teachers selected Figure 1, which showed no relationship between IT and the person, while seven selected Figure 2, which indicated a slight relationship between IT and the person. Two pre-service teachers claimed a relationship with IT in the middle by selecting Figure 3, while one selected Figure 4 (a bit above the middle) and one selected Figure 5, which showed the relationship between the person and IT as very close.

Action research step 3: Developing action strategies and putting them into practice

Message design activity (all sub-research questions)

The open-ended journals of the groups showed that these pre-service teachers understood key components of designing messages to dialog with students. Moreover, the groups emphasized that they learned to take into account students' individual differences, ages, and genders during message design. During the activity, students stated that they also learned specific teaching and classroom management strategies with regard to the events. All groups claimed that watching and criticizing other groups' dramatizations made them think about different situations that a teacher may face. Because of this activity, they saw deficiencies in their strategies and identified alternatives as suggested by other groups (RQ1d).

The groups completed an open-ended activity design questionnaire that included questions about their communication experience via e-mail and chat programs. The themes that emerged as a result of the students' answers were (a) being a model for students in an online environment, (b) message design according to students' ages and skill levels, (RQ1b) (c) presenting important points with highlights, (RQ1c) (d) considering the quality of technological infrastructure, (RQ1a) and (e) understanding the benefits of communication with students outside class. The pre-service teachers stated that they tried to be a positive model while utilizing both asynchronous and synchronous communication tools. According to them, good grammar and avoiding jargon or abbreviations was important while communicating with students. Moreover, they stated that based on students' age and class level, appropriate font size could highlight important points. The groups acknowledged that a teacher should assess technical infrastructure quality and the channel of the message. According to them, if a teacher communicates with students synchronously, they must be aware of video and sound quality and bandwidth availability.

Lastly, pre-service teachers stated that the activity demonstrated the benefits of communicating with students outside the classroom. They indicated that they intend to use both asynchronous and synchronous communication tools to contact students.

3D material design and teaching practice activity (all sub-research questions)

The groups' journals and teaching plans, the Teaching Practice Evaluation form, and created materials were analyzed to measure pre-service teachers' teaching competencies. The open-ended journal entries presented several themes: material design principles appropriate to student level (RQ1b); appropriateness of content, color, and font (RQ1c); cost effectiveness; enhancing students' participation and improving creativity (RQ1b); difficulty using 3D materials during practice (RQ1d); classroom management problems (RQ1d); and the importance of having alternatives and sharing knowledge via technology (RQ1a). The open-ended journals also showed that the pre-service teachers took into account the relationship between content and student level during material development. They explained that they tried to use appropriate colors, font size, and pictures, and they started to think about the cost of materials. The pre-service teachers emphasized that they tried to include games, puzzles, and matching to make students more active. Except for one group, the pre-service teachers did not find themselves successful during practice. The Teaching Practice Evaluation Form showed that three groups gave themselves a C (69-74 out of 100), while one group gave themselves a B (75-89) and the other an A (90-100). During the teaching practice, they had difficulty using the materials effectively because of classroom management problems and students' unexpected questions or

behaviors. They became aware that they lacked alternative methods for handling unexpected situations. The Teaching Practice Evaluation Forms also indicated low self-determined grades for classroom management.

Additionally, the instructor wanted pre-service teachers to share their instructional materials via blogs and YouTube. The groups indicated that as people saw and commented on their materials on the internet, they realized that sharing knowledge through technology helped other teachers enhance their practices, as well (RQ1a). Analysis showed that colors, font types, and picture use were very similar in two groups' materials. The lesson plans showed that groups tried to design materials to keep students active (RQ1d); however, the journals and Teaching Practice Evaluation Form showed that they could not apply their plans effectively. Figure 2 shows one of the groups' 3D material, which was designed to teach the phases of the moon through experiments.

Figure 2. 3D material designed by one of the groups to teach the phases of the Moon

PPT design and teaching practice (all sub-research questions)

The results of the demographics questionnaire that was applied at the beginning of the course showed that the pre-service teachers had mostly used PPT for presentation purposes rather than teaching purposes. For that reason, the instructor and teaching assistants wanted the groups to teach a subject from the national curriculum. For this activity, groups' journals, teaching practice evaluation form, lesson plans, group PPTs, and observation notes were analyzed. According to the analysis, the following themes emerged: ways to provide for student participation (RQ1b); difficulty in teaching with PPT (RQ1d); problems related to classroom management; PPT design that used contrast colors, appropriate font size, and animations and pictures but eliminated excessive use of elements (RQ1c); and content that highlighted strategies and presented concise information. The groups' journal analysis showed that they struggled to make their students active during the lesson (RQ1d): three groups used worksheets, the fourth used gaming, and the last used a puzzle (RQ1a). According to the groups' journals, although they saw improvement with respect to their classroom management, they did not find themselves successful at making students active. According to them, it was very difficult to teach using PPT presentations in a constructivist curriculum. All the groups first presented the content, and then tried to make students active through gaming, puzzles, and worksheets. On the Self Evaluation Forms, the groups rated themselves highly on classroom management but lower on teaching strategies such as providing for students' participation, asking questions, assessing learning during instruction, and material use. One group gave themselves an A; the others gave themselves Bs. Another issue the groups mentioned in the journals was PPT design issues. While they attempted to give concise information without excessive elements, they also wanted to include pictures and animations in their presentation to attract students' attention. In addition, during the PPT preparation, they paid attention to the contrast between background and text colors.

Software evaluation and presentation (sub-research questions 1.a and 1.d)

The groups' journals, the Software Evaluation Checklist developed by Heinich et al. (2002), and instructional software were analyzed to determine the following themes: learning about instructional software concepts (RQ1a),

being aware of the importance of selecting software (RQ1a); being aware of the criteria to select software (RQ1a), and thinking about how to integrate software in teaching practices (RQ1d).

According to the groups' journals, this activity taught them about instructional software concepts. Before this activity, they had the misconception that all computer materials were software or, for example, videos on the internet. During this activity, pre-service teachers became aware of options from CDs, the internet, and bookstores. They also emphasized that while selecting the instructional software, they also had to consider its integration capabilities. According to the groups' journals, they did not experience any difficulties during the software selection process because they worked together. Except for one group, which selected software that taught chess, the groups selected software for mathematics education. The Software Evaluation Checklists showed that the groups generally tended to grade each criterion as high. Observations supported this result, as groups were very pleased with the software they selected. However, the groups' journals showed that after the presentations, the pre-service teachers had learned several main points about educational software selection.

Web-based Instruction(all sub-research questions)

The groups' journals and websites were analyzed to learn their opinions about web-based instruction activity and its contribution to their profession. The following themes emerged: the new experience teaching on the web (RQ1d), lack of knowledge with regard to designing a website (RQ1a), not knowing how to broadcast on the internet (RQ1a), not knowing how to make students active (RQ1b), tackling problems posed by group members, and the need to add communication tools (RQ1a).

The group journals showed that preparing web-based instruction was a new experience for them. They had difficulty designing websites, although the instructor showed them how and prepared a small sample website during class. They also had difficulty publishing their websites, despite course instruction. The pre-service teachers struggled to make students active during web-based instruction, partly due to the lack of communication tools for teacher-student interaction. The pre-service teachers stated that they learned many things from their group members during this activity. They emphasized that if they had not been working as a group, they would not have been able to design the web-based instruction successfully. The analysis of the websites showed that the groups focused on activities such as puzzles, game site links, and tongue twisters. In their journals, the groups complained about their lack of competency developing games and simulations. The websites were designed according to principles that indicated construct colors for background and texts (RQ1c).The categorization of the content and simplicity of the language used were appropriate for elementary school students (RQ1b). The only aspect that the groups omitted from the material design principles involved usability. Four groups' websites did not initially provide a menu that allowed students to navigate freely. Based on instructor direction, they later added menu structures to their sites.

Open-ended and IT questionnaires results (research question 1 in general)

At the end of the course, the groups were wanted to share their opinions about their experiences through their journals. After analysis, five themes emerged: learning through experiences, gaining a different point of view about teaching, learning instructional material design, benefits of technology integration in instruction, and enjoyment of 3D material design.

The pre-service teachers expressed satisfaction from learning course content through the activities, which expanded their perspectives about teaching and technology integration. They gained awareness of the importance of knowing content well, capturing students' attention, and making instruction entertaining by encouraging students' participation and using technology. Moreover, they stated that awareness of technology was not enough; teachers need to know how to use it during instruction for maximum effectiveness. The groups listed the benefits of technology integration to instruction as making knowledge concrete for students and making instruction entertaining and motivating. All groups stated that they liked designing and teaching with the 3D materials the most.

The IT questionnaire applied at the end of the course indicated that pre-service teachers saw their relationships with IT grow closer during the course. Twelve students selected Figure 4, with an IT relationship a bit above the middle,

while seven described their relationship with IT as very close (Figure 5). Three of them chose Figure 6 at the end of the course, representing that the person was fully integrated with IT.

Discussion and conclusion

Under the scope of the course, we designed activities based on TPACK to develop elementary education pre-service teachers' IMD competencies. The aims were to make them use TPACK during instruction consistent with teacher competencies described by the Ministry of National Education (2006).

With regard to the research question, the IT questionnaire was given to the pre-service teachers in order to understand their perceptions on the relationship between them and IT. The results showed that most pre-service teachers selected Figure 1 (n = 11) and Figure 2 (n = 7). Also, according to the IT questionnaire, the pre-service teachers perceived they had a closer relationship with IT at the end of the semester. Twelve of them selected Figure 4, while 7 selected Figure 5 and Figure 6 (n = 3). The results of the journals that pre-service teachers wrote after the each activity supported to this finding. The groups' analysis journal results after the message design activity showed that pre-service teachers learned how to design messages to dialog with students by taking into consideration the students' individual differences including age and gender. The open-ended activity design questionnaire that the groups completed after their communication experience, via e-mail and chat programs, showed that the pre-service teachers realized the importance of discussing the subject matter outside the classroom, thanks to the technology. For the 3D and PPT design activity, pre-service teachers learned to create materials by considering the design principles such as appropriateness to level, content, font use, cost effectiveness, usability, student participation, and student creativity. As regards the fourth activity, they learned how to select educational software according to relevant criteria and integrate educational software in instruction. With regard to the fifth activity, they perceived that they learned how to design web-based instruction, although they experienced some difficulties since they had not done it before. Parallel to the results, Doering, Veletsianos, Scharber, and Miller (2009) found that the in-service teacher gained a considerable movement within TPACK domains through TPACK-based course experiences.

One of the results of the current study was that the pre-service teachers started to think as teachers and also, talked about the benefits of their learning into their future teaching. Similarly, Özgün-Koca et al. (2010) found in their study that the mathematics pre- service teachers' TPACK development was closely related to a shift in identity from *learners of mathematics* to *teachers of mathematics*." (p. 10). Moreover, they were confident about incorporating technology into their future teaching (Özgün-Koca et al., 2010).

The journals and observation notes showed that pre-service teachers learned from their group members. The comments made by peers during presentations and teaching practice activities made them aware of many concepts of teaching, one of the promises of social constructivism mentioned by Airasian and Walsh (1997). Jang found in the study, that peer coaching enhanced both the teachers' TPACK and technology integration skills (as cited in Jang, 2008). Jang (2008) stated that teachers can tackle the difficulties of applying a new technology more easily if they work together instead of alone. In the current study, pre-service teachers stated that they had difficulties while designing Web based instruction but could tackle these difficulties thanks to working with a group.

Moreover, the results showed that the pre-service teachers' perception of IT was changed. At the beginning of the course, IT, to them, meant technology; they did not think about its instructional implications or know how to integrate it into teaching. The journals showed that pre-service teachers thought that their competencies using technology, pedagogy, and content for teaching purposes were enhanced through experiences. These results were consistent with the study of Bos (2011) who found that using TPACK framework helped teachers become aware of the value in teachers integration of meaningful technology in instructional units. Chai, Koh and Tsai (2010) also found pre-service teachers' TPACK perceptions before and after attending TPACK-based ICT course design significantly different with moderately large effect sizes.

In sum, according to the study results, TPACK offers many benefits for preparing teachers to incorporate technology in the classroom. However, to apply it successfully, researchers should continue to investigate and present TPACK-based course design examples, especially those applied in K-12 schools.

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APPENDIX A
Pre- and Post Questionnaire

The graphics below are representing the relationship between you and Instructional Technology. Using a symbol, please note where you believe you would currently align yourself.

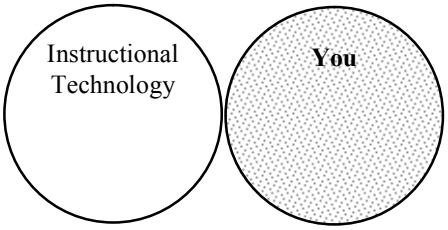

Figure 1

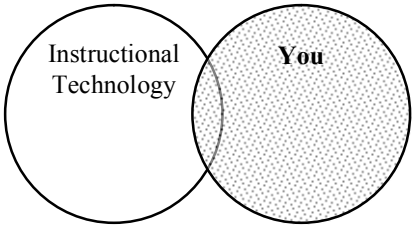

Figure 2

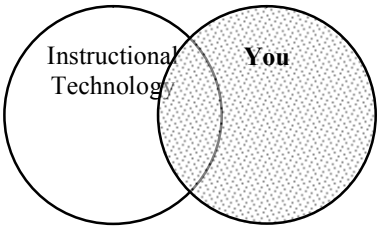

Figure 3

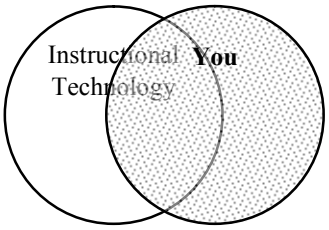

Figure 4

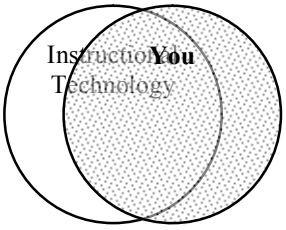

Figure 5

Figure 6