

An Investigation of Technological Pedagogical Content Knowledge, Self-Confidence, and Perception of Pre-Service Middle School Mathematics Teachers towards Instructional Technologies

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ABSTRACT

Technology provides new methods and approaches for educational activities. Therefore, teachers should improve their ability and knowledge to integrate technology into instruction. The use of technology-based learning environment which is effectively used to improve the technological pedagogical content knowledge of pre-service teachers has a crucial importance for the training of pre-service teachers. In this regard, the purpose of this study is to investigate the technological pedagogical content knowledge (TPACK), TPACK related self-confidence, and perception of pre-service middle school mathematics teachers in terms of instructional technologies. In this study, TPACK Survey, TPACK Self-Confidence Survey, and TPACK Perception Survey were administered to 427 pre-service middle school mathematics teachers in elementary mathematics education program. The data were analyzed quantitatively. The data analysis revealed that there was a significant relationship between gender and perception towards technology. Moreover, it might be concluded that pre-service teachers improve their knowledge and self confidence to use technology in elementary mathematics education programs. Lastly, considering the finding that there was a relationship between the use of technology and self-confidence towards the use of technology, it might be inferred that self-confidence of pre-service teachers towards the use of educational technologies increases with the use instructional tools.

Keywords

Technological pedagogical content knowledge, Self-confidence, Perception, Pre-service teachers

Introduction

Teachers are individuals who provide appropriate methods, techniques, and materials in the process of education either as the source of the information or as a guide during the teaching process (Yalın, 2000; Şimşek, 2000). In today's world, technology has become an important part of teachers' knowledge base. Therefore, this makes the use of technology in education more frequent (Graham, Burgoyne, Cantrell, Smith, Clair, & Harris, 2009; Öztürk & Horzum, 2011).

Since the integration of technology has become crucial in education, the knowledge of teachers related to the use of technology has been centered at the heart of the research on educational technology. As it is defined previously, technological pedagogical content knowledge (TPACK) is the knowledge acquired by teachers in order to integrate technology in education while teaching content to the students (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). Although several studies have been conducted in the scope of TPACK, there is no obvious form of the technological knowledge that teachers should acquire and a strict method on how it should be acquired by teachers (Koehler & Mishra, 2005). Merely introducing the technology in educational process does not create a significant change on the integration of technology in education (Carr, Jonassen, Marra, & Litzinger, 1998). Therefore, how the technology can be integrated in education should be investigated in more detail since the knowledge of technology cannot be separated from the knowledge of teaching context in educational technology (Koehler & Mishra, 2005). In addition, it is recognized that the use of technology alone cannot create an effective improvement on the learning of students. Graham et al. (2009) emphasized that just the use of technology cannot get students to learn effectively. Rather, teachers should know how to use the instructional technology during the teaching process. Similarly, Clark (1985) highlighted the difference between "media" and "method of instruction." That is, mere the use of media cannot provide learning. It is a tool providing learning by the employment of appropriate methods and techniques while teaching mathematics. Therefore, the effective use of instructional technologies is more important than just acquisition of them for educational purposes.

Although technology has become available in the classrooms, the use of it has continued to be criticized because of some factors, such as teachers' use of technology infrequently and for knowledge transmission rather than the

construction of knowledge (Clark, 1985; Gao, Choy, Wong, & Wu, 2009; Harris, Mishra, & Koehler, 2009; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Sang, Valcke, van Braak, & Tondeur, 2010). Therefore, those observations get the correct integration of technology more emphasized in education (Chai, Koh, Tsai, & Tan, 2011).

In Turkey, FATİH Project (The Project of Improving Opportunities and Instructional Technologies) has been conducted since 2010 in order to integrate technology into education across the country (The Office of Innovation and Educational Technologies, 2016). One of the key actors of this project is teachers. Therefore, ideas and competences of teachers toward technology integrated education is an important factor for the effectiveness of the project. For this reason, it is important to investigate the integration of technology in education from the perspectives of teachers. As researchers stated, there is a need to develop teacher education strategies in terms of teachers' effective integration of technology into their teaching (Koehler & Mishra, 2005). Thus, an effective professional teacher education program can be prepared in order to get teachers be oriented with instructional technologies (Karataş, 2014a). In order to develop strategies to integrate technology in education, it is crucial to investigate the views of teachers based on the integration of technology into teaching (Öksüz, Ak, & Uça, 2009). For this reason, ideas and competences of pre-service teachers in relation with instructional technologies were investigated within the scope of the current study. In addition, the investigation of views of pre-service teachers makes a great contribution to the development of current teacher education program (Tınmaz, 2004). As Bitner and Bitner (2002) stated, there are several factors which are important to get teachers to integrate technology into teaching successfully. One of the factors is labeled as *fear of change* which includes self-confidence and perception. As Christensen (1997) stated, self-confidence levels of teachers in relation with technology use affect their teaching in learning environment. Also, teachers with favorable perception of technology are more eager to use technology in education (Tınmaz, 2004). Therefore, beliefs and ideas of teachers related to the use of technology might provide a valuable insight for researchers. As Tınmaz (2004) suggested gender is one of the major factors affecting the perception and competency of pre-service teachers in relation with technology use in education. Therefore, gender is one of the elements investigated within the current study. Moreover, TPACK, TPACK related self-confidence, and TPACK related perception of pre-service teachers were investigated based on grade level of pre-service middle school mathematics teachers in order to analyze whether there is a difference or not among grade levels. As Dong, Chai, Sang, Koh, and Tsai (2015) proposed for Chinese teachers, the efficiency of teacher education programs can be improved by a better understanding the TPACK and TPACK related beliefs of teachers. Moreover, Paraskeva, Bouta, and Papagianni (2008) stated that perception and self-confidence of teachers can be changed by the use of technological tools in teacher education. For this reason, the TPACK related content knowledge, perception, and self-confidence of pre-service teachers were investigated in the current study. This study is expected to contribute to the literature and close the gap in order to overcome the complexity of the integration of technology into teaching environments.

Technological pedagogical content knowledge

Technological pedagogical content knowledge (TPACK) is the knowledge acquired by teachers in order to integrate technology into education while teaching a particular content to students (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). Although several studies have been conducted on TPACK, there is no explicit form of the technological knowledge that teachers should acquire and a strict method on how it should be acquired by teachers (Koehler & Mishra, 2005). Therefore, further studies are required in order to examine the effects of TPACK on teachers' use of instructional technologies. In addition to the TPACK, perception of teachers toward instructional technologies is the other factor affecting teachers' use of instructional tools which will be described briefly.

Perceptions towards instructional technologies

According to Teo (2010), teacher educators should study beliefs and perceptions of teachers in order to grasp those characteristics of teachers and prepare courses for effective integration of technology. "Can pre-service teachers move beyond their own perceptions to create new visions of what teachers can be in the future?" or "Will developing a critical consciousness help teachers create these new visions of education?" are some questions directed by researchers related to perceptions of teachers (Carr-Chellman & Dyer, 2000, p. 4). Some researchers answered those questions by stating that teachers often teach the way they were taught in the past (Carr-Chellman & Dyer, 2000). Therefore, it might be relatively challenging to get teachers to use instructional technologies if they were not taught with those methods. According to Teo (2010), it is reasonable to create and

maintain a positive attitude toward learning technologies in the process of pre-service teacher education rather than after they begin the profession. Moreover, the researcher stated that attitude of teachers can be examined in order to predict the future use of technological tools by pre-service teachers. Therefore, the investigation of attitude of pre-service teachers towards learning technologies may give clues about their professional career. According to the research of Yıldırım (2000), the teachers who used computers more tend to develop positive attitudes which promote further use of learning technologies in teaching tasks such as online forums and ICT-based student-centered learning. Moreover, the perception of teachers towards learning technologies is a factor which has an influence on the successful integration of technological devices into teaching (Parr, 1999). There have been various studies in order to understand the perceptions of teachers on instructional technology (Savenye, 1992; Downes, 1993; Diegnueller, 1992). In the scope of those studies, whether teachers will use instructional technologies in their future career, their feelings about their competence, the notion of the relationship of technology and change in their minds, and how often technological tools are utilized in their methods courses were investigated.

The other concern is the perceptions of students since students' perceptions tend to be influenced by the perceptions of teachers and also by the use of technological devices within teaching and learning process as it is presented in Figure 1 (Cope & Ward, 2002). As the study of Cope and Ward (2002) illustrated, inadequate knowledge and improper perceptions of teachers towards instructional technologies may hinder the successful integration of those technologies and their respective learning outcomes. Therefore, it can be inferred that the attitude of teachers towards computers is a central concern to achieve successful use of computer in the teaching process (Teo, 2010). As a result, studies on teacher perception are important because of its effects on perceptions and learning of students in the long run.

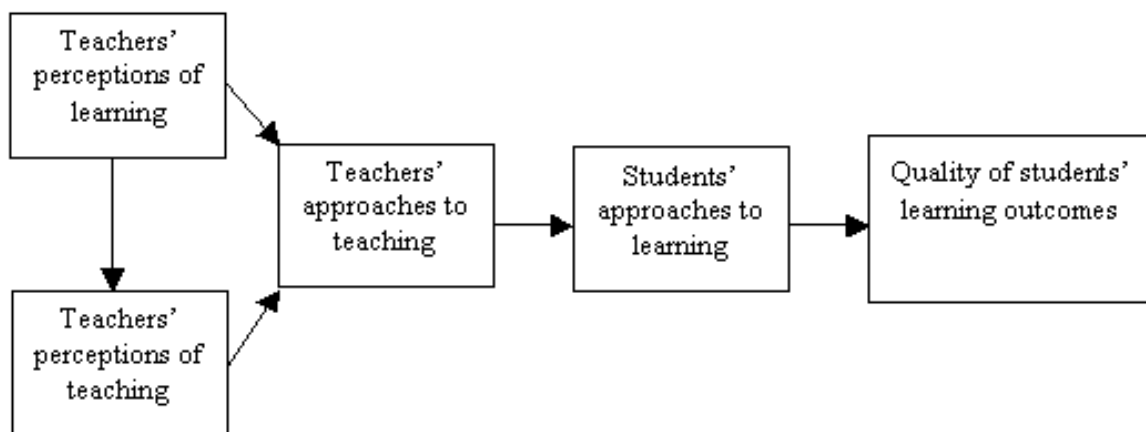


Figure 1. Teacher-student perceptions and quality of learning outcomes (Cope & Ward, 2002, p. 1)

While performing a task, self-efficacy is also a factor affecting one's preferences (Bandura, 1977). Therefore, self-efficacy beliefs of teachers might affect the preferences of teachers in relation with the use of instructional technologies in education. Therefore, self-confidence as a measure of self-efficacy will be briefly explained (Bandura, 1986).

Self-confidence towards instructional technologies

Literature shows that teachers tend to use more technology in their classroom if they have high levels of confidence in instructional technologies (Dawson, 2008; Zhao, Pugh, Sheldon & Byers, 2002; Littrell, Zagumny & Zagumny, 2005). According to the study of Graham et al. (2009), confidence in technological knowledge is a prerequisite for the confidence in TPACK. In other words, basic technical knowledge and skills related to instructional technologies are necessary in order to integrate them into instruction effectively (Finger, Jamieson-Proctor, & Albion, 2013). Confidence is accepted as a measure of self-efficacy (Bandura, 1986; Shell, Murphy, & Bruning, 1989). Therefore, the confidence level of pre-service teachers towards the use of instructional technologies is investigated as a measure of self-efficacy within the current study. Self-efficacy is one's belief related to his/her capacity to perform a particular task (Bandura, 1977). Therefore, computer self-efficacy can be defined as one's belief related to the use of computers for a specific purpose (Compeau & Higgins, 1995). Since inappropriate belief on computers results with less likely use of them, the self-efficacy level of teachers can be used to predict teachers' integration of technology within the teaching process (Delcourt & Kinzie, 1993; Oliver & Shapiro, 1993). According to Pamuk and Peker (2009), gender is the variable which is mostly studied in

relation with computer self-efficacy in comparison with other variables such as age, socio-economic status, and computer experience in the literature. According to the results, there has been no agreement in the literature on the relationship between computer self-efficacy and gender. In some studies males performed a higher computer self-efficacy (Durdell & Haag, 2002; Işıksal & Aşkar, 2003) whereas in some other studies there was no significant difference between male and female participants (Akkoyunlu & Orhan, 2003). Moreover, it is found that there is a correlation between computer self-efficacy and experience and training on the use of computers (Marakas, Yi & Johnson, 1998; Wilfong, 2006). Therefore, the training of teachers related to the use of learning technologies is significant in order to equip teachers with the required skills, attitudes, and knowledge toward learning technologies (Pamuk & Peker, 2009).

As researchers stated, there is a need to develop teacher education strategies in terms of effective integration of technology into teaching (Chai, Koh, Tsai, & Tan, 2011; Koehler & Mishra, 2005). In order to develop strategies to integrate technology into education, it is crucial to investigate the belief and ideas of teachers related to integration of technology into teaching (Öksüz, Ak, & Uça, 2009). Therefore, the knowledge and views of teachers related to TPACK might provide a valuable insight so as to get teachers involve the technology into their teaching effectively. For this reason, the TPACK related content knowledge, perception, and self-confidence of teachers were investigated within the current study.

The purpose of the study

The purpose of the study is to investigate the TPACK, TPACK related self-confidence, and perception of pre-service middle school mathematics teachers towards technology use.

Method

Study context

Faculties of education are the primary teacher education institutions in Turkey. Middle school mathematics teachers (5th through 8th) have a four-year undergraduate education in elementary mathematics education program while secondary level (9th through 12th) mathematics teachers are certified by 5-year long secondary mathematics education program. Both elementary and secondary mathematics education programs include content and pedagogical content courses specific to the needs of each grade level. Some of the content courses and all of the pedagogical content courses offered in both programs are similar in nature. However, because of the different content domains between elementary and secondary levels, secondary mathematics teacher education programs have advanced level content courses different from elementary mathematics teacher education programs.

The current teacher education program includes the courses comprising ICT (Instructional Computer Technologies) in an effort to train teachers to teach by the use of technology. There are two courses related to instructional technologies taught over two semesters in the first year of the program. Those courses include basic information technologies such as word processing, spreadsheets and presentation software to pre-service teachers. Those courses have been offered at almost each education faculty for four hours a week over two terms in Turkey. Teacher educators may prefer to use software such as PowerPoint in their undergraduate courses which can be considered as a starting point for the use of instructional technologies (Karataş, 2014b). However, the instructional experiences of pre-service teachers with technology do not go beyond the presentations given by the lecturers. Consequently, it is useful to examine the beliefs and knowledge of pre-service teachers concerning the use of technology for mathematics education. Since those courses cannot provide real teaching experiences with technology to pre-service teachers, some education faculties may also offer elective courses such as “Using Technology in Teaching and Learning Mathematics.” Those courses present theoretical bases for computer-based mathematics education and introduce some commonly used mathematical software, such as Dynamic Geometry Systems, Computer Algebra Systems and Win Logo. Within the scope of this course, pre-service teachers may also be assigned with mini-projects. The fourth grade pre-service middle school mathematics teachers also took the course “Using Technology in Teaching and Learning Mathematics” before the current study. Moreover, third and fourth grade pre-service elementary mathematics teachers take the course “Methods of Teaching Mathematics I-II.” In this course, pre-service mathematics teachers learn methods of teaching mathematics by the use of particular methods and techniques. Those courses might affect TPACK, TPACK related self-confidence, and TPACK related perception of students.

Participants

The participants of the study were pre-service middle school mathematics teachers who had adequate knowledge to use the technology in mathematics education. The data collection tools were administered to 427 pre-service middle school mathematics teachers, 104 freshman, 77 sophomore, 193 junior, and 53 senior students in elementary mathematics education program.

Data collection

In order to explore TPACK, TPACK related self-confidence, perception of pre-service teachers on the use of technology, and the relationship among them, three surveys were administered to pre-service teachers. In the following subtopics, the data collection tools are described briefly.

Technological Pedagogical Content Knowledge Survey (TPACK-S)

The survey was used in order to examine the TPACK of pre-service teachers. It was developed by Schmidt et al. (2009) and translated into Turkish by Öztürk and Horzum (2011). The survey was a 5-point Likert survey composed of 47 items across 7 dimensions, technological knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. The five points of Likert survey were “Totally agree,” “Agree,” “Neutral,” “Disagree,” and “Totally disagree.” In order to examine the construct validity of the scale, exploratory and confirmatory factor analyses were conducted by Öztürk and Horzum (2011). As a result, the scale was found similar to the original scale. The reliability of the survey was calculated as 0.94 by the use of Cronbach alpha coefficient.

Technological Pedagogical Content Knowledge Self-confidence Survey (TPACK-SCS)

The survey was used in order to examine TPACK related self-confidence of pre-service teachers. It was developed by Graham et al. (2009) and translated into Turkish by Timur and Taşar (2011). The survey was comprised of 31 items including technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge dimensions. The Cronbach alpha reliability coefficient was calculated as 0.92 by Timur and Taşar (2011). Since the Cronbach alpha coefficient of a scale should be above .7 (Pallant, 2005), the value might be considered reasonable for this study. The result of the factor analysis, which was conducted to determine the construct validity of the scale, showed that the scale was also valid in Turkish context and its structure was acceptable (Timur & Taşar, 2011).

The survey of perception towards technology

The survey was used in order to examine the perception of pre-service teachers regarding the use of technology in mathematics education. The survey developed by Öksüz, Ak, and Uça (2009) was comprised of 73 items. The internal consistency among the items was calculated as 0.95 by the use of Cronbach Alpha coefficient. As Pallant (2005) stated, Cronbach alpha coefficient of a scale should be greater than .7. Therefore, the value 0.95 was considered reasonable for the current study.

Data analysis

TPACK, TPACK related self-confidence, and perceptions of pre-service teachers regarding the use of technology in education were examined by the use of three different surveys. One-way between-groups multivariate analysis of variance (MANOVA) test was used in order to investigate whether there was a statistically significant difference between groups of male and female pre-service teachers. Then, another MANOVA test was conducted to observe whether there was a significant difference among the grade levels of pre-service teachers. Bonferroni adjustment was used to control for the Type 1 error. To do this, normal alpha value (.05) was divided by the number of tests that were used. Since there were three surveys, .05 was divided by 3 (which equal to .017 after rounding) and this new value was used to determine the significance (Pallant, 2005).

Results

The means and standard deviations were calculated by the use of points gathered from the surveys in order to examine the TPACK, TPACK related self-confidence, and perceptions of pre-service teachers regarding the use of technology in terms of gender (See Table 1). Table 1 shows that the mean of the male pre-service teachers on technological pedagogical content knowledge survey (TPACK-S) ($M = 3.44$, $SD = .43$) and technological pedagogical content knowledge related self-confidence survey (TPACK-SCS) ($M = 3.59$, $SD = .57$) was close to, but higher than the mean of the female pre-service teachers on TPACK-S ($M = 3.38$, $SD = .45$) and TPACK-SCS ($M = 3.46$, $SD = .56$). However, it was observed that female pre-service teachers ($M = 3.74$, $SD = .42$) performed better than male pre-service teachers ($M = 3.69$, $SD = .44$) on the Perception Survey related to use of technology.

Table 1. The means and standard deviations of points of pre-service teachers in terms of gender

Survey	Gender	<i>N</i>	<i>M</i>	<i>SD</i>
TPACK-S*	Female	330	3.38	0.45
	Male	97	3.44	0.43
TPACK-SCS**	Female	330	3.46	0.56
	Male	97	3.59	0.57
Perception	Female	330	3.74	0.42
	Male	97	3.69	0.44

Note. *M* = Mean; *SD* = Standard deviation. *TPACK-S = Technological Pedagogical Content Knowledge Survey; **TPACK-SCS = Technological Pedagogical Content Knowledge Self Confidence Survey.

One-way between-groups multivariate analysis of variance (MANOVA) was used to investigate gender differences between scores gathered from the surveys. Preliminary assumption testing was conducted to check the normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted.

Table 2. Differences between male and female pre-service teachers in terms of scores obtained from the surveys

Dependent variable	Type III sum of squares	df	Mean square	<i>F</i>	Sig.	Partial eta squared
TPACK-S*	.278	1	.278	1.400	.237	.003
TPACK-SCS**	1.402	1	1.402	4.451	.269	.003
Perception	.219	1	.219	1.225	.035	.010

Note. *TPACK-S = Technological Pedagogical Content Knowledge Survey; **TPACK-SCS = Technological Pedagogical Content Knowledge Self Confidence Survey.

Table 3. The means and standard deviations of pre-service teachers on surveys based on the grade level

Survey	Grade level	<i>N</i>	<i>M</i>	<i>SD</i>
TPACK-S*	Freshman	104	3.33	0.46
	Sophomore	77	3.40	0.51
	Junior	193	3.39	0.40
	Senior	53	3.54	0.46
TPACK-SCS**	Freshman	104	3.32	0.65
	Sophomore	77	3.55	0.53
	Junior	193	3.49	0.52
	Senior	53	3.73	0.48
Perception	Freshman	104	3.68	0.40
	Sophomore	77	3.81	0.48
	Junior	193	3.70	0.41
	Senior	53	3.83	0.42

Note. *M* = Mean; *SD* = Standard deviation. *TPACK-S = Technological Pedagogical Content Knowledge Survey; **TPACK-SCS = Technological Pedagogical Content Knowledge Self Confidence Survey.

There was a statistically significant difference between males and females on the combined dependent variables: $F(3,423) = 2.95$, $p = .032$; Wilks's Lambda = .98; partial eta squared (η^2) = .02. If the results for the dependent variables were considered separately, Table 2 revealed there was no statistical significance using a Bonferroni adjusted alpha level of .017 (0.05 divided by 3 based on the number of dependent variables), for any variable.

Partial eta squared (effect size) ranged from .010 to .003, each of these is a relatively small effect size, according to Cohen (1988).

The means and standard deviations were calculated by the use of points gathered from the surveys in order to examine the TPACK, TPACK related self-confidence, and perception of pre-service teachers regarding the use of technology based on grade levels of the pre-service teachers. Table 3 illustrates that freshman (1st grade) pre-service teachers had the lowest mean scores while the senior (4th grade) pre-service teachers had the highest mean scores on each of the surveys. Moreover, sophomore (2nd grade) pre-service teachers had close to but higher than the junior (3rd grade) pre-service teachers on the surveys. One-way between-groups multivariate analysis of variance (MANOVA) was used to investigate grade level differences in scores obtained from the surveys. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted.

Table 4. Difference between grade levels of pre-service teachers in terms of scores obtained from the surveys

Dependent variable	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
TPACK-S*	1.571	3	.524	2.668	.047	.019
TPACK-SCS**	6.379	3	2.126	6.980	.000	.047
perception	1.429	3	.476	2.697	.046	.019

Note. *TPACK-S = Technological Pedagogical Content Knowledge Survey; **TPACK-SCS = Technological Pedagogical Content Knowledge Self Confidence Survey.

As Table 4 shows, there was a statistically significant difference between grade levels on the combined dependent variables: $F(9,1269) = 2.81, p = .003$; Wilks's Lambda = .94; partial eta squared (η^2) = .02. If the results for the dependent variables were considered separately, the only difference to reach statistical significance using a Bonferroni adjusted alpha level of .017, was TPACK-SCS: $F(3,423) = 6.980, p = .000$, partial eta squared (η^2) = .047. Post-hoc comparisons using the Tukey's HSD test indicated that the mean score for Grade 1 ($M = 3.32, SD = .65$) was significantly different from Grade 2 ($M = 3.55, SD = .53$) and Grade 4 ($M = 3.73, SD = .48$). In addition, Grade 3 ($M = 3.49, SD = .52$) was significantly different from Grade 4 ($M = 3.73, SD = .48$).

Results show that male pre-service teachers have more self-confidence than female pre-service teachers in terms of using technology in mathematics education. However, it indicates that female students got higher scores than males in terms of the results of the perception survey towards technology. Besides, freshman students have lower self-confidence than the sophomore and senior students in terms of using technology, whereas junior students have less confidence than senior students.

Discussion and conclusion

The purpose of this study was to investigate TPACK, TPACK related self-confidence, and the perception of pre-service teachers based on the use of instructional technology in terms of gender and grade level. Results showed that male participants had higher scores on the surveys of TPACK and TPACK related self-confidence than female participants. In contrast, female participants had higher scores on the perception survey towards technology use than their male counterparts. This result coincides with the results of other studies stating that there is a significant relationship between gender and technology perception (Gilley, 2002; Siyambaş, 2015; Tinmaz, 2004). The study of Jamieson-Proctor, Finger, and Albion (2010) emphasized that self-perception of the pre-service teachers based on their competence with instructional technologies proposed that they did not have a high level overall. Within the current study, female participants had positive attitudes towards technology use in mathematics education. Although the comparison of the scores of pre-service teachers shows that there was no significant difference between the groups of male and female participants on each survey, the total scores were in favor of male participants. This result coincides with the results of the previous studies conducted on 49% female and 51% male participants (Durndell & Haag, 2002) and 79% female and 21% male participants (Jamieson-Proctor, Finger, & Albion, 2010). In those studies, it was found that male pre-service teachers had higher self confidence to use technology in education. Especially in the study of Jamieson-Proctor, Finger, and Albion (2010), it was found that male teachers were very confident to use instructional technologies while female teachers had no or little confidence. Therefore, male and female teachers differ in terms of their confidence to use the instructional technologies (Jamieson-Proctor, Finger, & Albion, 2010). The results may suggest that male pre-service teachers are more confident regarding the use of educational software for teaching of mathematics. This might be caused by the widespread use of technology by male pre-service teachers than

female counterparts. That is, this result might be related with the readiness of pre-service teachers to use instructional technologies rather than the teacher education program, and male pre-service teachers may feel more competent to use technological software than their female colleagues. In order to increase the self-confidence of both male and female pre-service mathematics teachers, different types of instructional activities might be presented to pre-service teachers by the use of instructional technological software in methods for teaching courses or other elective courses related to technology use in mathematics education. Moreover, pre-service teachers might be encouraged to create instructional activities including technological software on their own. Therefore, they may become more confident since they participate in the process of producing such activities. As a result, pre-service teachers might gain experience of the use of instructional technologies in real classroom environment.

The results for the analyses with respect to the grade levels were different from the study of Jamieson-Proctor, Finger, and Albion (2010). Although they found no difference based on the age of the participants, freshman pre-service teachers had significantly lower scores than the senior pre-service teachers within the current study. Therefore, it might be inferred that undergraduate courses such as Methods of Teaching Mathematics given at fifth and sixth semesters and Computer-based Mathematics Education given at seventh semester in teacher education program get pre-service teachers improve their self confidence to use technology in mathematics education. On the contrary, there was not a consistent change from freshman to senior pre-service teachers in the current study since there was a break on the results of junior pre-service teachers. By the participation of more pre-service teachers, the relationship among grade levels might be observed more precisely for the same variables. In addition, since already existing groups were used in the current study, the results might be biased. Therefore, further studies might be conducted by increasing the number of participants and by the use of randomization.

As Jamieson-Proctor, Finger, and Albion (2010) stated, teacher education programs should ensure that all pre-service teachers have the necessary knowledge bases such as technological knowledge and TPACK to integrate instructional technologies into education. In this respect, before the completion of teacher education program, the improvement of knowledge and self-confidence of pre-service teachers in order to use instructional technologies is a favorable outcome. Furthermore, the perception of pre-service teachers is a crucial element to integrate technology into instruction (Parr, 1999). Therefore, positive attitude of pre-service teachers towards instructional technologies was one of the positive outcomes of this study. In addition, a relationship was observed between the use of technology and self-confidence towards the use of technology as previous researchers found (Marakas, Yi, & Johnson, 1998; Wilfong, 2006). Therefore, the courses provided for pre-service teachers and in-service teachers might get them confident to use instructional technologies in mathematics education. As it is stated above, the TPACK, TPACK related self-confidence, and perception towards the use of instructional technologies of pre-service mathematics teachers might be improved by getting them participate in the creation and using procedure of learning activities which includes instructional technologies. If students engage in such activities adequately, they might appreciate the value of the use of instructional technologies in mathematics education. Therefore, their knowledge, self-confidence, and perception might be changed in this way.

Consequently, the study was limited to 427 pre-service middle school mathematics teachers from three different universities, who were predominantly female. Also, the results of the study were limited with the data obtained from the questions of three surveys. Hence, the generalizability of the conclusions of this study to larger student populations or other contexts might be limited. In addition, the results of the study were limited with quantitative analyses of data. Therefore, qualitative analyses might also be used in order to investigate the context more deeply. Lastly, empirical studies might be conducted related to the same research problem in order to control several factors and explain the results more effectively.

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