Eurasia Journal of Mathematics, Science & Technology Education, 2016, **12**(3), 583-592

How Special are Teachers of Specialized Schools? Assessing Self-Confidence Levels in the Technology Domain

Zehra Çatma
Gaziantep College Foundation Private Schools, TURKEY
Mehmet Sencer Corlu
Bilkent University, TURKEY

•*Received 29 Dec 2014• Accepted 27 Oct 2015•Published online 23 Jan 2016*

This study investigates whether specialized high school mathematics teachers, chosen to educate selected students, are mentally ready to integrate Fatih project technologies into their teaching. Forty mathematics teachers from randomly selected specialized and general high schools in Ankara responded to a survey comprising 31 items grouped under four measures of self-confidence in the technology domain. An independent t-test revealed no statistically significant difference between specialized and general high school teachers' self-confidence levels. We conclude that technological pedagogical content knowledge should be an essential criterion for selecting specialized school teachers, who educate the country's future innovators

Keywords: Fatih project, self-confidence, technological pedagogical content knowledge, mathematics teachers, teacher selection

INTRODUCTION

Technology continues to have a major impact on our societies through its role in the education of young generations. Vision 2023, a foresight exercise prepared by the Scientific and Technologic Research Council of Turkey (2005), indicates that the improvement of the technological infrastructure in Turkey—possibly empowered by the intense public interest shown towards technology—has brought with it an expansion of technology in daily and professional life. In keeping with this increasing role of technology, Vision 2023 suggests that a positive change in the overall quality of education is warranted in order to make schooling more student centered, lifelong, and independent from its physical limitations. Such a positive change in schooling can happen through the help of technologically literate teachers. As the main facilitators of learning in the classroom, teachers need to implement the change by incorporating technology into their teaching. In addition to their role as subject-area experts, teachers have the potential to lead the process of change in society as well. Through

Correspondence: Mehmet Sencer Corlu,
Graduate School of Education, Bilkent University, Main Campus-G Building, 06800, Bilkent, Ankara, Turkey.
E-mail: sencercorlu@gmail.com
doi: 10.12973/eurasia.2016.1245a

ISSN: 1305-8223

such a change, constraints that limit the innovation capacity of Turkish society may end (Kaput, 1992; Turkish Academy of Sciences, 2009).

Technology is considered an essential tool, particularly for improving the teaching and learning of mathematics. Technology enhances students' learning in mathematics by enabling students to interact with mathematical structures and to formulate their own rules and conjectures (Ministry of National Education [MoNE], 2013; National Council of Teachers of Mathematics, 2000). Through technology, teachers extend the mathematics they teach by bringing realistic settings into their classrooms (Kaput & Thompson, 1994; Karakırık & Durmuş, 2005; Özgün-Koca, 2012). Technology has been instrumental for both the students and teachers in the way they do mathematics.

Mathematics teachers need to be well equipped to integrate technology into their teaching. Shulman's (1986) fundamental theory on teaching knowledge claims that "mere content knowledge is likely to be as useless pedagogically as content-free skill" (p.8); similarly, mathematics teachers' ability to effectively utilize technology in their teaching is dependent on a variety of factors. Koehler and Mishra (2005) explain these factors under the technological pedagogical content knowledge (TPCK) construct. TPCK refers to technology, pedagogy, and content knowledge and is referred to as the "*Total PACKage"* (Thompson & Mishra, 2007, p. 38): a body of knowledge that helps teachers to represent the concepts with technology, to choose the best pedagogical and instructional techniques, and to identify the strengths, weaknesses, and misconceptions of students. This relatively new subject-specific construct emerges at the nexus of Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK), which are needed to effectively use technology in teaching. Therefore, TPCK sets the foundation for an effective use of technology in mathematics, fostering innovation in Turkish classrooms and society.

From an idealistic point of view, Kaput (1992) states that the major limitation of effectively using technology in classroom settings is the lack of human imagination. This, along with the rigidity of old habits, is among teachers' greatest challenges. However, when examined from a more pragmatic point of view, inadequate knowledge of the curriculum and instructional methods emerge as more immediate difficulties for teachers (Niess, et al., 2009). Supporting this pragmatic view, Ferrini-Mundy and Breaux (2008) noted that "[in] the absence of professional development on instructional technology and curriculum materials that integrate technology use into the lesson content, teachers are not particularly likely to embed technology-based or technology-rich activities into their courses" (p. 437). Both the idealistic and the pragmatic approaches emphasize the need to improve the readiness levels of teachers for technology integration, especially those teachers at selective specialized schools who prepare Turkey's future innovators. In order to address this need, Ministry of National Education (MoNE, 2012) started to develop nation-wide projects.

State of the literature

- Both the idealistic and the pragmatic approaches to using technology in classroom settings emphasize the need to improve the readiness levels of teachers for technology integration.
- Research indicates that Turkish teachers are not ready to adopt advanced technologies.
- The Turkish educational system provides a limited number of selected students (~%6 of the entire student population) with the best available mathematics education in specialized secondary schools.

Contribution of this paper to the literature

- The current study contributes to the Fatih project by investigating the mental readiness of mathematics teachers in integrating technology into their teaching.
- There are relatively few measures available for in-service teachers in the technology domain.
- Because educating the future innovators of the country requires teachers with skills beyond mere content knowledge, the current form of the teacher selection examination may not be successful in selecting Turkey's most technologically or innovatively literate teachers.

The Fatih Project

The Fatih project, a Turkish acronym literally meaning *movement of enhancing opportunities and improving technology*, is a large-scale government initiative that aims to increase the use of technology in over 42,000 schools and 570,000 classrooms (MoNE, 2010). The project's first phase is in progress and encompasses equipping Turkish classrooms with technological tools, including smart boards, projection machines, Internet connections, and electronic and enriched books, and each student and teacher in the country will soon be provided with a tablet PC (MoNE, 2012). Based on claims that Turkish teachers are inclined to misinterpret technology as a presentation or activity tool, rather than as an integral part of their teaching (Altan, 1998), the program's planned second phase concerns the professional development of teachers. The Fatih project aims to help Turkish teachers integrate high-end educational technologies into their teaching.

Turkish mathematics teachers may not be any different from their colleagues in their difficulties using technologies that come with the Fatih project. Previous research indicates that Turkish teachers are not ready to adopt such advanced technologies (Timur, 2011). In addition to the knowledge dimension of readiness, teachers' mental readiness within the context of technology is equally important (Kayaduman, Sırakaya, & Seferoğlu, 2011). Given the substantial resources allocated to the Fatih project, investigating the readiness of teachers at all dimensions is warranted.

Specialized high schools

The Turkish educational system provides a limited number of selected students (%6 of the entire student population) with the best available mathematics education in specialized secondary schools (9th through 12th grade). These elite schools offer more advanced mathematics courses with a greater number of instructional hours when compared to the programs of general high schools (Özel, Yetkiner, Capraro, & Küpçü, 2009). In fact, results of an international comparison study show that there is up to two standard deviation difference in mathematics and science performance of specialized high schools and general high schools (Berberoğlu, 2007). The teachers at specialized schools are selected and hired based on their scores on a test that measures their mathematics content knowledge (Gür & Çelik, 2009; Özoğlu, 2010). It is therefore worthwhile to investigate whether these selected teachers, who are chosen to educate a highly selective group of students, are mentally ready to lead their students as the future innovators of the country.

Research question

The main purpose of this study is to investigate Turkish mathematics teachers' mental readiness to facilitate effective teaching within the Fatih Project. Mental readiness in this study is defined as teachers' self-confidence levels within the technology domain. Specifically, it is hypothesized that the mean scores of general high school mathematics teachers are not statistically significantly different from the mean scores of specialized high school teachers.

METHODOLOGY

Participants

The study's sample consisted of 40 mathematics teachers (21 female; $n_{\text{general school}} = 14$; $n_{\text{specialized school}} = 26$) working at ten high schools in the Çankaya district of the capital city of Ankara. The district was populated with socio-economically advantaged students, and the district had the highest number of specialized schools in the city.

Researchers randomly selected an equal number of specialized and general schools from a list of all high schools in the district. All mathematics teachers at these schools were invited to complete the survey, and the overall response rate was 51%.

The participants were mostly middle-career professionals (median age group was 40-49 for both school types, and no participant had less than ten years of teaching experience), whereas only a few of them had advanced degrees (six teachers in specialized schools and only one teacher in general schools had a master's degree or beyond). Thus, the background of the participating teachers was not similar to the rest of the Turkish mathematics teacher population in terms of age and experience (Corlu, Erdoğan, & Şahin, 2011).

In both specialized and general high schools, approximately 85% of the participants had personal computers, whereas 35% of the specialized and 14% of the general high school teachers had personal tablets. The percentage of the teachers who knew about the Fatih project was about 60% in both specialized and general schools. However, some teachers used technologies that come with Fatih project without knowing much about the project.

Instrument & data collection

The data collection instrument consisted of 31 items, which were grouped theoretically under four measures: Technological Pedagogical Content Knowledge (TPCK 8 items), Technological Pedagogy Knowledge (TPK 7 items), Technological Content Knowledge (TCK 5 items), Technological Knowledge (TK 11 items). The instrument was an adaptation of a technology confidence survey (Graham, Burgoyne, Cantrell, Smith, & Harris, 2009), which was translated into Turkish by Timur (2011). A confirmatory factor analysis examining a similar context to that of the present study showed that a four-factor model fit the data well (Timur & Taşar, 2011). The modifications for the current study were limited to rewording the items in order to specifically address the self-confidence levels of mathematics teachers in using technologies within the Fatih Project. Participants responded to statements using a five-point Likert-type scale (strongly confident = 4, confident = 3, neutral = 2, unconfident = 1, and strongly unconfident = 0). Thus, the score range for each dependent variable was 0 to 4, which was calculated by averaging the responses for each measure. The independent variable was school type (specialized or general high school), coded as a dummy variable. The instrument was administered face-to-face in 2013 Spring.

Data were first explored with respect to normality and outliers. Any violations were checked by means of graphical and statistical measures, such as histograms, standardized scores, skewness, and kurtosis (Tabachnick & Fiedell, 2007). Data were assumed normal and no outliers were detected. Reliability of the scores in the current study was estimated with one of the most widely used measures in quantitative research: Cronbach's *alpha* coefficients were .91 (*TPCK*), .88 (*TPK*), .89 (*TCK*), and .90 (*TK*), which indicated good measure of internal consistency of the scores across the four measures. In addition to the validity evidence based on a pilot study and expert views of two professors in mathematics education and educational technology, the upper limits of validity were estimated by the square root of the Cronbach's alpha coefficients as .95 (*TPCK*), .94 (*TPK*), .94 (*TCK*), and .95 (*TK*) (Angoff, 1988). Based on effect sizes estimated through a pilot study, G*Power3 power analysis software showed that a sample size of 58 would be sufficient to show (α = 0.05) a statistically significant difference between two independent groups (Faul, Erdfelder, Lang, & Buchner, 2007).

Data analysis

The study employed descriptive statistical methods to draw an outline of participants' self-confidence levels in the technology domain. Bivariate correlations were estimated between each pair of factors with Pearson's product-moment correlation coefficient *r*. Data were analyzed at the item level using the Mann-Whitney non-parametric test. Effect sizes at the item level were first estimated with the help of the formula $r = z/\sqrt{n}$, which was later converted to Cohen's d for an easier interpretation of practical significance. An independent *t*-test was conducted to answer the research question. Effect sizes at the factor level were estimated in score-world statistics with Cohen's *d*. Effect sizes and their confidence intervals were reported, regardless of whether or not a statistically significance was observed, in order to allow fellow researchers to make informed decisions on the practical significance of their results. A post-hoc power analysis was conducted only when statistical significance was not observed (Thompson, 2008).

RESULTS

When data were analyzed at the item level for location statistics, the overwhelming majority of items centered about a median of 2. This indicated that on average, mathematics teachers in the sample were not strongly confident in their knowledge of Fatih project technologies. However, the range values, which were used as measures of data dispersion, were quite large. Two items exhibited a statistically significant difference between self-confidence scores of general and specialized school teachers. The results of the non-parametric two-sample Mann-Whitney *U* test showed that specialized school teachers' mean ranks were statistically significantly higher than general school teachers' mean ranks for both items, and both items were in the TK domain: *saving pictures and applications in tablet PCs from an internet page* (z = -2.02, p = .04) and *constructing a document that includes text and graphs in tablet PCs* (z = -2.43, p = .02). The effect sizes (Cohen's d = 0.68; and Cohen's d = 0.82, respectively) were taken to indicate a medium effect when they were compared to Timur's (2011) smallest effect size in an intervention study (Cohen's d = .77). Table 1 shows the means and standard deviations of scores in each factor for both groups.

The highest mean score for specialized teachers was in the TCK domain, indicating they were most confident in their mathematics content knowledge when they had to use Fatih project technologies. This was expected as teachers at specialized schools were selected according to their scores in a test that measures their mathematics content knowledge. General school teachers were most confident in their TPCK and they were least confident in their TK. Standard deviations were between 0.49 and 0.75. Table 2 shows the bivariate correlations between each pair of continuous variables.

All correlations were statistically significant at p < .05 and were evaluated as moderately strong, indicating that all factors were measuring related but not identical constructs. The strongest correlation was observed between the TPCK and TCK

Table 1. Descriptive statistics for continuous variables

School Type	TPCK		TPK		TCK		TK	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Specialized School	2.46	0.72	2.48	0.72	2.61	0.81	2.48	0.64
General School	2.54	0.68	2.43	0.49	2.48	0.57	2.22	0.75

Note 1. $\bar{x}$ indicates the mean, SD indicates the standard deviation statistics.
Note 2. TPCK (Technological pedagogical content knowledge); TPK (Technological pedagogical); TCK (Technological content knowledge); TK (Technological knowledge).

scores, indicating that teachers were associating their content knowledge with their pedagogical content knowledge when technology was considered. In the technology domain, pedagogy knowledge was not as strongly correlated with pedagogical content knowledge as content knowledge was.

In order to answer the research question of the present study, an independent *t*-test was used. Based on the results of the independent *t*-test, the differences between general and specialized school teachers' scores were not statistically significant for TPCK ($t[38] = -0.37$, $p > .05$), TPK ($t[37] = 0.22$, $p > .05$), TCK ($t[36] = 0.48$, $p > .05$), TK ($t[36] = 1.11$, $p > .05$). These findings showed that researchers failed to reject that the sample was from the population described by the null hypothesis. 95% confidence intervals were reported in Figure 1.

All effect sizes were negligible with respect to effect sizes estimated in Timur (2011) or effect sizes estimated from the item-level differences in this study. See 95% confidence intervals for the effect sizes in Table 3 (see Navruz & Delen, 2014).

A post-hoc power analysis estimated that the achieved powers were 10% in TPCK, 8% in TPK, 13% in TCK, and 31% in TK measures, indicating that a much larger sample size would be needed for statistical significance.

Table 2. Bivariate correlation statistics for continuous variables

	TPCK	TPK	TCK	TK
TPCK	1	.47**	.77**	.44**
TPK		1	.58**	.34*
TCK			1	.50**
TK				1

*Note. *Correlation is statistically significant at the .05 level (2-tailed). **Correlation is statistically significant at the .01 level (2-tailed).*

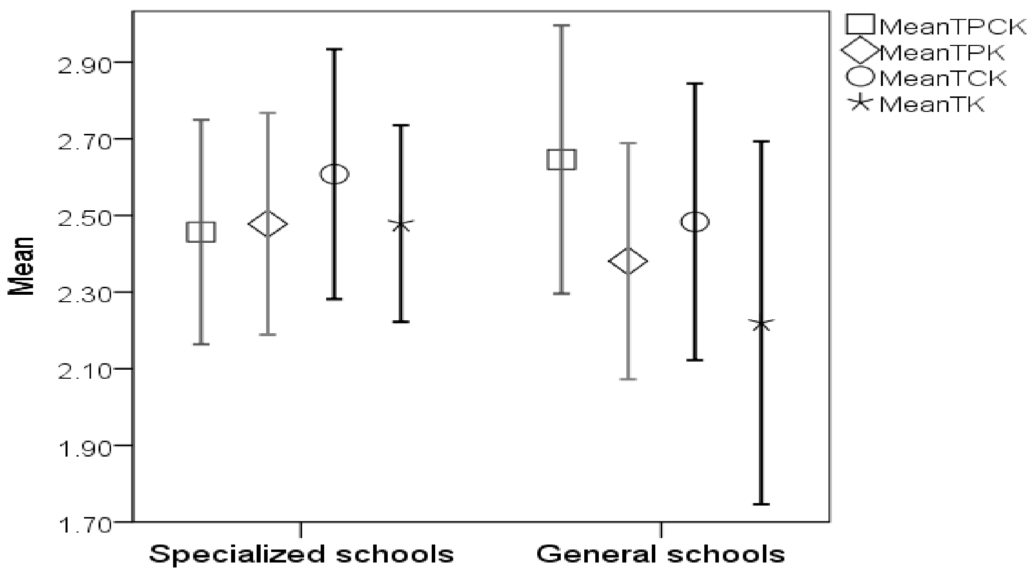

Figure 1. 95% confidence intervals around the point estimates of the means

Table 3. 95% Confidence intervals for Cohen's *d* effect sizes

	Mean difference	Cohen's *d*	*d* lower limit	*d* upper limit
TPCK	-0.08	-0.12	-0.39	0.24
TPK	0.05	0.08	-0.20	0.34
TCK	0.13	0.18	-0.13	0.50
TK	0.26	0.40	0.15	0.82

DISCUSSION

The current study contributes to the Fatih project by investigating the mental readiness of mathematics teachers in integrating technology into their teaching. The instrument yielded data with high reliability estimates in TPCK, TPK, TCK, and TK measures with moderately strong and close correlations between measures, indicating the usefulness of our four-scale model. This is noteworthy in the Turkish context for two reasons: First, there are relatively few measures available for in-service teachers in the technology domain (Öztürk, & Horzum, 2011), compared to TPCK measures developed for pre-service teachers (e.g., Erdemir, Bakırcı, & Eyduran, 2009; Timur, 2011). Second, the overwhelming majority of the existing instruments, which are grounded in social cognitive theory, are developed for pre-service teachers (e.g., Çakıroğlu, Çakıroğlu, & Boone, 2005).

It is evident from the study that mathematics teachers of specialized schools are not more mentally prepared to implement Fatih project technologies than their colleagues working at general schools. The scope of the specialized school teacher selection examination, which tests content knowledge of teachers for employment at specialized schools, could be one speculative explanation for this finding (Staiger & Rockoff, 2010). Educating the future innovators of the country requires teachers with skills beyond mere content knowledge (National Research Council, 2011; Organisation for Economic Co-operation and Development [OECD], 2010). Hence, the current form of the selection examination may not be successful in selecting Turkey's most technologically or innovatively literate (Erdogan, Corlu, & Capraro, 2013) and self-confident teachers. The authors suggest that MoNE reconsider the scope of this examination by testing potential candidates' TPCK levels as well.

In consideration of the high overall self-efficacy levels of Turkish teachers (OECD, 2009), particularly of Turkish mathematics teachers (Corlu, Erdogan, & Şahin, 2011), participants' lower confidence in integrating technology into their teaching is critical. In particular, the low mean scores from the TK measure may indicate poor technology knowledge among Turkish mathematics teachers, regardless of their pedagogy or pedagogical content knowledge (Sadi et al., 2008). Alternatively, this finding can be explained through the negative effects of the initial teacher employment system on pre- and in-service teachers' self-efficacy beliefs. Research shows that teacher education programs lose their credibility because of the extreme importance given to this test at the teacher education level (Özoğlu, 2010). Another explanation may come from the lack of professional development opportunities that foster integrated teaching knowledge (Corlu, Capraro, & Capraro, 2014), pedagogical content knowledge, or technological pedagogical content knowledge (Palmero & Rodriguez, 2012; Schleigh, Bossé & Lee, 2011). Poor professional development opportunities and overemphasis on pedagogy or content alone can be harming in-service mathematics teachers' self-confidence in integrating new technologies into their teaching (Öztürk, 2005). In addition, the budgetary constraints of both faculties of education and schools (Çiftçi, Taşkaya, & Alemdar, 2013; Gürol, Donmuş, & Arslan, 2012) may not allow teacher candidates and teachers to practice enough to develop confidence with these technological tools.

It is evident from the strong correlation between TPCK and TCK scores that teachers are associating their content knowledge with their pedagogical content knowledge. Previous research findings have found considerably high correlations between these two constructs in other fields (Phelps & Schilling, 2004), and it is apparent that the connections may be valid in the technology domain, as well.

Despite all other limitations, including the low achieved power, there is a need to examine how the instrument performs for other subject area teachers and in other districts of Ankara or in other cities across Turkey; thus, a replication study is strongly recommended (Makel & Plucker, 2014). A confirmatory factor analysis with larger sample sizes is also recommended as a future research topic.

ACKNOWLEDGEMENTS

The authors appreciate the comments of faculty members Dr Margaret K. Sands, Dr Jennie F. Lane at the Graduate School of Education, Bilkent University and Dr Emin Aydın of Marmara University. This study is conducted as part of first author's master thesis.

REFERENCES

Altan, M. Z. (1998). Eğitim fakülteleri, teknoloji ve değişim [Faculties of education, technology, and change]. *Kuram ve Uygulamada Eğitim Yönetimi Dergisi, 15*, 295-304.

Angoff, W. H. (1988). Validity: An evolving concept. In H. Wainer, & H. I. Braun (Eds.), *Test validity* (pp. 19-33). Hillsdale, NJ: Lawrence Erlbaum Associates.

Berberoğlu, G. (2007). *Türk bakış açısından PISA araştırma sonuçları* [The results of PISA survey from Turkish perspective]. Retrieved from http://www.konrad.org.tr/Egitimturk/07girayberberoglu.pdf

Çiftçi, S., Taşkaya, S. M., & Alemdar, M. (2013). The opinions of classroom teachers about Fatih project. *Elementary Education Online, 12*(1), 227-240.

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: Implications for educating our teachers in the age of innovation. *Education and Science, 39*(171), 74-85.

Corlu, M. S., Erdoğan, N., & Şahin, A. (2011). A comparative study of South Korea and Turkey: Attitudes, beliefs, and creative student-oriented teaching practices of middle school mathematics teachers. *Journal of the Korean Society of Mathematical Education Series D: Research in Mathematics Education*, *15*(3), 295-310.

Çakıroğlu, J., Çakıroğlu, E., & Boone, W. J. (2005). Pre-service teacher self-efficacy beliefs regarding science teaching: A comparison of pre-service teachers in Turkey and the USA. *Science Educator, 14*(1), 31-40

Erdemir, N., Bakırcı, H., & Eyduran, E. (2009). Determining of student teachers' self-confidence using technology in instruction. *Journal of Turkish Science Education, 6*(3), 99-108.

Erdogan, N., Corlu, M. S., & Capraro, R. M. (2013). Defining innovation literacy: Do robotics programs help students develop innovation literacy skills? *International Online Journal of Educational Sciences, 5*(1), 1-9.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191.

Ferrini-Mundy, J., & Breaux, G. A. (2008). Perspectives on research, policy, and the use of technology in mathematics teaching and learning in the United States. In G. W. Blume & M. K. Heid (Eds*.), Research on technology and the teaching and learning of mathematics: Cases and perspectives* (pp. 427-448). Charlotte, NC: Information Age Publishing.

Graham, R. C., Burgoyne, N., Cantrell, P., Smith, L., St Clair, L., & Harris, R. (2009). Measuring the TPACK confidence of in-service science teachers. *TechTrends*, *53*(5), 70-79.

Gür, B. S., & Çelik, Z. (2009). *Türkiye'de millî eğitim sistemi: Yapısal sorunlar ve öneriler* [National education in Turkey: Structural problems and recommendations]. Ankara, Turkey: Siyaset, Ekonomi ve Toplum Araştırmaları Vakfı.

Gürol, M., Donmuş, V., & Arslan, M. (2012). İlköğretim kademesinde görev yapan sınıf öğretmenlerinin Fatih projesi ile ilgili görüşleri [The views of primary school classroom teachers about the Fatih Project]. *Eğitim Teknolojileri Araştırmaları Dergisi, 3*(3), #3.

Kaput, J. (1992). Technology and mathematics education. In. D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 515-556). New York: MacMillan Publishing.

Kaput, J. J., & Thompson, P. W. (1994). Technology in mathematics education research: The first 25 years in the JRME. *Journal for Research in Mathematics Education*, *25*(6), 676-684.

Karakırık, E., & Durmuş, S. (2005). A new graphical logo design: Logoturk. *Eurasia Journal of Mathematics, Science, and Technology, 1*(1), 61-75.

Kayaduman, H., Sırakaya, M., & Seferoğlu, S. S. (2011, February). *Eğitimde Fatih projesinin öğretmenlerin yeterlik durumları açısından incelenmesi* [Investigation of Fatih project in terms of teacher competencies]. Paper presented at the 13th Akademik Bilişim Conference, İnönü University, Malatya, Turkey. Retrieved from http://ab.org.tr

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, *32*(2), 131-152.

Mackel, M. C., & Plucker, J. A. (2014). Facts are more important than novelty: Replication in the educational sciences. *Educational Researcher. doi:* 10.3102/0013189X14545513

Ministry of National Education. (2010). *Projects* [Online Newsletter]. Retrieved from http://projeler.meb.gov.tr/pkmtr/images/stories/dergi/dergi_2010_4.pdf

Ministry of National Education. (2012). *Fatih: Towards the education of information age* [PowerPoint slides]. Retrieved from http://fatihprojesi.meb.gov.tr/tr/icerikincele.php?id=12

Ministry of National Education. (2013). *Ortaöğretim matematik dersi öğretim programı* [Secondary schools mathematics curriculum]. Ankara, Turkey: Author.

National Council of the Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

National Research Council. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. Washington, DC: National Academy Press.

Navruz B., & Delen E. (2014). Understanding confidence intervals with visual representations. *Abant Izzet Baysal Üniversitesi Egitim Fakültesi Dergisi, 14*(1), 346-360

Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper, S. R., Johnston, C., Browning, C., Ozgun-Koca, S. A., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education, 9*(1), 4-24.

Organisation for Economic Co-operation and Development. (2009). *Creating effective teaching and learning environments: First results from TALIS*. Retrieved from www.oecd.org/dataoecd/17/51/43023606.pdf

Organisation for Economic Co-operation and Development. (2010). *Measuring innovation: A new perspective - online version*. Retrieved from http://www.oecd.org/document/22/0,3746,en_41462537_41454856_44979734_1_1_1_1,00.html

Özoğlu, M. (2010). *Türkiye'de öğretmen yetiştirme sisteminin sorunları* [The problems of teacher education system in Turkey]. Retrieved from http://www.setav.org/ups/dosya/20275.pdf.

Öztürk, C. (2005). *Türkiye'de dünden bugüne öğretmen yetiştiren kurumlar* [From the past to the present: Institutions that educate teachers in Turkey]. Istanbul, Turkey: Marmara Üniversitesi Atatürk Eğitim Fakültesi Yayınları.

Öztürk, E., & Horzum, M. B. (2011). Adaptation of technological pedagogical content knowledge scale to Turkish. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi, 12*(3), 255-278.

Özel, S., Yetkiner, E. Z., Capraro, R. M., & Küpçü, A. R. (2009). Young adolescent education in Turkey. In S. B. Mertens, V. A. Anfara, & K. Roney (Eds.), An international look at educating young adolescents (pp. 1-23). Charlotte, NC: Information Age.

Özgun-Koca, S. A. (2012). An analysis of prospective mathematics teachers' views on the use of computer algebra systems in algebra instruction in Turkey and in the United States. *Turkish Journal of Computer and Mathematics Education, 3*(1), 1-20.

Palmero, J. R., & Rodriguez, J. S. (2012). Impact of education policies to incorporate ICT as innovative agents in the classroom: Advantages and drawbacks. *The New Educational Review, 27*(1), 134-147.

Phelps, G., & Schilling, S. G. (2004). Developing measures of content knowledge for teaching reading. *Elementary School Journal, 105*, 31–48.

Sadi, S., Şekerci, A. R., Kurban, B., Topu, F. B., Demirel, T., Tosun, C., Demirci T., & Göktaş, Y. (2008). Öğretmen eğitiminde teknolojinin etkin kullanımı: Öğretim elemanları ve öğretmen adaylarının görüşleri [Effective technology use in teacher education: The views of faculty members and preservice teachers]. *Gazi Üniversitesi Bilişim Teknolojileri Dergisi, 1*(3), 43-49.

Schleigh, P. S., Bosse, M., & Lee, T. (2011). Redefining curriculum integration and professional development: In-service teachers as agents of change. *Current Issues in Education*, *14*(3), 1-14.

Scientific and Technological Research Council of Turkey. (2005). *Vizyon 2023 teknoloji öngörü projesi* [Vision 2023: Turkey's national technology foresight program]. Ankara, Turkey: Author.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *American Educational Research Association, 15*(2), 4-14.

Staiger, D. O., & Rockoff, J. E. (2010). Searching for effective teachers with imperfect information. *Journal of Economic Perspectives, 24*(3), 97-118.

Tabachnick, B.G., & Fiedell, L.S. (2007). *Using Multivariate Statistics* (5th ed.) Boston, MA: Allyn and Bacon.

Thompson, A. D., & Mishra, P. (2007). Breaking news: TPCK becomes TPACK. *Journal of Computing in Teacher Education, 24*(2), 38-39.

Thompson, B. (2008). *Foundations of behavioral statistics: An insight-based approach.* New York: Guilford

Timur, B. (2011). The development of pre-service science teachers' technological pedagogical content knowledge in force and movement subjects (Unpublished doctoral dissertation), Gazi University, Ankara.

Timur, B., & Taşar, M. F. (2011). The adaptation of the technological pedagogical content knowledge confidence survey into Turkish. *Gaziantep University Journal of Social Sciences*, *10*(2), 839-856.

Turkish Academy of Sciences. (2009). *Türkiye Bilimler Akademisi bilim raporu* [Turkish Academy of Sciences science report]. Ankara, Turkey.

◈◇◈