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Associations among Teachers' Attitudes towards Computer-Assisted Education and TPACK Competencies*

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Abstract. The current study investigates the attitudes of teachers towards Computer-Assisted Education (CAE) and their knowledge of technology, pedagogy and content via TPACK model that assesses the competencies for developing and implementing successful teaching. There were 280 participants in the study. The results of the study indicate that teachers' attitudes towards CAE scores are much higher than their TPACK scores. There is a low level positive correlation between their TPACK competencies and their attitudes towards CAE. Particularly, teachers' competencies of Technology Knowledge (TK) and Technological Pedagogical Knowledge (TPK) have much higher relationship with their attitude towards CAE when compared to other competencies. Attitude toward CAE is observed to differ by gender. As for TPACK competencies, TK and Technological Content Knowledge (TCK) differ by gender. The TPACK framework explains 20% of attitudes towards CAE. TK is the construct having the highest effect in explaining the attitude towards using CAE.

Keywords: TPACK competencies, computer-assisted education, CAE, attitude, technology, pedagogy.

1. Introduction

In the 2000s, there was a substantial increase in global Internet use (51% by 2000, and more than 97% by 2007) which led to a corresponding increase in the number of educa-

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tional research studies focused on the implementation of technology in education (Hilbert and Lopez, 2011). Computers started to be used as a tool to facilitate and improve instruction through the use of tutorials, drill and practice, simulation and problem-solving activities. CAE increased students' success (Camnalbur, 2008; Pilli and Aksu, 2013) and motivation (Papastergiou, 2009; Balanskat, Blamire, and Kefala, 2006). Parallel with innovations in technology, computer-assisted instructional approaches and teaching methods have been preferred more than teacher-centered traditional methods (Pilli and Aksu, 2013). The use of computers in education is referred by various terms, such as computer-assisted, -aided, -based and/or -enriched instruction or education. Hannafin and Peck (1988) defined CAE as the transfer of instructional content or activities to students via computer. Akkoyunlu (1998) described it as the use of computers as an aid to instructors to enrich educational activities and increase the quality of instruction.

In the past decade a great deal of energy have been spent and many research studies have focused on the integration of information and communication technologies (ICTs) into learning and teaching environments (Swain, 2006; Keengwe, Onchwari, and Wachira, 2008; Livingstone, 2012). Investment in ICT integration has correspondingly increased in recent years. In Turkey, for the project named FATIH – in English, the "Movement For Increasing Opportunities and Improving Technology" – has invested approximately US$200 million to purchase 675.000 tablet PCs (MNE, 2013a), and, for its 4-year duration, a total allocated budget of US$700 million. The project aimed to donate 42,000 schools with necessary hardware (10.6 million tablet PCs and 350.000 smart boards) and the software. Through the project, 120 thousand teachers received in-service training (MNE, 2013b). The project was expected to increase success of the students (Ocak, Gökçearslan, and Solmaz, 2014) and enable effective use of ICT tools in the educational process to ensure equality of opportunity in education (Kıranlı and Yıldırım, 2013).

The use of technologies in education has had a great impact on one country's development (Hemphill, 2013). However, investments in the field of ICT do not always result in effective use of these technologies (Vanderlinde, Van Braak, and Dexter, 2012). How these technologies should be used with ICT-integrated pedagogical models for what potential outcomes are heated debates in the field of educational technology (Livingstone, 2012; So and Kim, 2009).

Indeed, technology-based education does not mean solely the provision of a technology (whether hardware or software), but rather the whole process concerning the pedagogical methods and techniques for using technology within education. The International Society for Technology in Education (ISTE) has developed and described a number of standards for teachers. All teachers are expected to meet these standards and performance indicators as they design, implement, and assess any learning experience. These standards aim to improve students' learning, enrich professional practice, and provide positive models for students, colleagues and the community. When these ISTE standards are examined, 'technological, pedagogical and content knowledge' falls under the heading of the first standard, through which teachers are expected to facilitate and inspire student learning and creativity by using their knowledge of subject matter, teaching and learning, and technology (ISTE, 2014). However, although teachers are

generally motivated to use ICT in education, they seem to prefer learning these technologies for their individual use only (Jimoyiannis and Komis, 2007), and are less prone to transfer their knowledge to in-class teaching (Mama and Hennessy, 2013). As Ertmer *et al.* (2012) stated, teachers' negative beliefs and attitudes about the relevance of technology to students' learning, and their own limited knowledge are the strongest barriers for technology adoption. This suggests that teachers' attitudes and perceptions should also be measured alongside their competencies. Further, for effective ICT integration, instructors should be equipped with necessary content, technology and pedagogy knowledge and knowledge of how these intersect (Mishra and Koehler, 2006). Where ICT courses are available for teachers, then their effects should be measured by examining the attitudinal changes in those attending them (Yıldırım, 2000). In the current study, the Technological, Pedagogical, and Content, Knowledge (TPACK) competencies of teachers, specifically those working in FATIH project pilot area, and their attitudes towards Computer-Assisted Education (CAE) were investigated. It is believed that teachers TPACK competencies may have an association with their attitudes towards CAE. As Ertmer (1999) stated the 'internal barriers', teachers' confidence, beliefs about how students learn, as well as the perceived value of technology to the teaching/learning process, affect technology integration into teaching. Teachers with inadequate competence in TPACK knowledge domains may probably have a negative attitude toward CAE, or vice-versa; thus the association between two should be investigated. The level of attitude toward CAE may finally affect teachers' behavior of technology adoption in teaching. All these elements should be assessed while adopting technology use in education. As reported by Bai and Ertmer (2008), simply 'tossing technology at a student and hoping the technology sticks' is not the right strategy to be followed for a change but teachers' belief systems about learning and teaching will need to become an integral part of a systems change strategy.

1.1. *Theoretical Foundations*

In some of the studies TPACK was called as a framework; whereas in some others as a model. Bacharach (1989) stated that a theory or model should have several components: (a) constructs related via propositions (for theory building), (b) variables related via hypotheses (for theory testing), and (c) boundaries defined by assumptions about values, time, and space that limit causality and generalizability. The theoretical foundations for the technological, pedagogical, and content knowledge (TPACK) constructs are found in Shulman's PCK model (1986) since TPACK framework was essentially based on the Pedagogical Content Knowledge (PCK) model of Shulman (1986). The developers, Mishra and Koehler (2006) called TPACK a framework; while, Graham (2011) called it as a conceptual model in his paper; however, he additionally noted down that while hundreds of studies defined it as theoretical framing, there existed very little theoretical development of this model and its elements. While there were questions in minds about the concept of PCK that TPACK framework built on, this new framework added some more questions concerned with the technology knowledge domain.

1.1.1. *TPACK Framework*

The Technological Pedagogical Content Knowledge (TPACK) framework explains and describes how teachers can gain technological skills and knowledge. It claims that teachers must be knowledgeable about the relationship between technology and content, and shows how technology could be used to support the learning of specific content as well as how specific pedagogies best support the use of technology and facilitate learning (Polly, Mims, Shepherd, and İnan, 2010). Koehler and Mishra (2005) first introduced the term technological pedagogical content knowledge (TPCK), the acronym of which turned into later 'TPACK', as a conceptual framework to describe the knowledge and competencies for teachers to effectively teach with technology. Their framework was based on their observations and experience on collaborative design of online courses by the faculty teacher education and graduate students. They observed that the participants endeavored to understand the complex relationships among content, pedagogy and technology within their contexts. Graham (2011) stated that the framework was simple; it simply represented the interaction among three knowledge domains, and added that its high degree of parsimony was the underlying reason for its popularity.

Koehler, Mishra, and Yahya (2007) stated that developing and implementing successful teaching require an understanding of how technology is related to pedagogy and content. The TPACK framework focused on how technology should be integrated into the way one teaches using the necessary pedagogical approaches. Koehler and Mishra (2005) added technology to Shulman's model as a key component (Archambault and Barnett, 2010). TPACK was stated to be similar to the notion; it additionally focused on technological knowledge (TK) as an indispensable part of the teacher's profession (Voogt *et al.*, 2013). While PCK was concerned with teachers' understanding of educational technologies; the TPACK framework consisted of seven different competencies:

(a) Technological Knowledge (TK).
(b) Pedagogical Knowledge (PK).
(c) Content Knowledge (CK).
(d) Technological Pedagogical Knowledge (TPK).
(e) Pedagogical Content Knowledge (PCK).
(f) Technological Content Knowledge (TCK).
(g) Technological Pedagogical and Content Knowledge (TPCK).

Table 1 indicates each competence.

Koehler and Mishra (2008) claimed that besides content and pedagogical knowledge, there had to be technology knowledge domain (TK) in the framework since it was significant and that people had to know how to apply it productively in their lives and at work; and in teachers' case how to use it for an educational purpose.

However, the framework was helpful from an organizational standpoint but it faced the same problems as Shulman's PCK model did. Researchers stated that there was a perplexity in defining what constituted knowledge from each of the domains (knowledge competences) and they questioned how these competences existed in practice (Archambault and Barnett, 2010); how each competence was assessed in different contexts; (Rosenberg and Koehler, 2015) and how components of TPACK differed (e.g Technological Content Knowledge and Technological Pedagogical Knowledge) or related (integrative or trans-

Table 1
Definitions of TPACK Competencies

Competence	Definition
Technological Knowledge (TK)	The knowledge of operating systems and computer hardware, and the ability to use standard sets of software tools such as word processors, spreadsheets, browsers, and e-mail and how to use them briefly, in the case of digital technologies (Mishra and Koehler, 2006).
Content Knowledge (CK)	Knowledge of a subject but not considerations about the ways of teaching it (Chai, Koh and Tsai, 2013).
Pedagogical Knowledge (PK)	The processes, practices or methods about teaching and learning (Mishra and Koehler, 2006).
Pedagogical Content Knowledge (PCK)	The representation and formulation of concepts, pedagogical techniques, knowledge of students' prior knowledge, and theories of epistemology (Mishra and Koehler, 2006).
Technological Content Knowledge (TCK)	An understanding of appropriate technology use for teaching content (Cox, 2008).
Technological Pedagogical Knowledge (TPK)	Teaching and learning with technology including knowledge of existence, components and capabilities of various technologies and conversely, knowing how teaching might change as the result of using particular technologies (Mishra and Koehler, 2006).
Technological Pedagogical Content Knowledge (TPCK)	The knowledge and understanding of the interplay between CK, PK and TK when using technology for teaching and learning (Schmidt, Thompson, Koehler, Shin and Mishra, 2009). It includes an understanding of the complexity of relationships among students, teachers, content, practices and technologies (Archambault and Crippen, 2009).

formative) (Angeli and Valanides, 2009). Questioning all these challenges, researchers have begun to move beyond the "static" descriptive TPACK framework to falsifiable TPACK Models, which is important for the advancement of TPACK research.

1.1.2. *The TPACK Models*

Although there was a growing conceptual and empirical enthusiasm for the TPACK model, the literature was full of its critics (Holland and Piper, 2014). Archambault and Barnett (2010) pointed out that a conceptual model should be explanatory (explain and predict various phenomena), simple, accurate, reliable, valid, fruitful; have systematic power and a scope. They additionally underlined that TPACK itself as a model was weak for all these capabilities since it was weak in predicting or revealing new knowledge and did not suggest problems to be solved or hypotheses to be tested. As a consequence, the researchers uttered that all these challenges made it difficult for TPACK to be a fruitful model. Angeli and Valanides (2009) added that the lack of specificity was a problem of TPACK and exemplified the ambiguous definition of 'technological knowledge' as another problem. Graham (2011) emphasized that unless all the constructs of TPACK were understood deeply by researchers and practitioners, a model cannot be viable long term.

Offering their own Technology Integration Education (TIE) model, incorporating seven primary constructs and four moderator constructs, Holland and Piper (2014) not-

ed down that learners in TPACK model's seven different knowledge domains were not motivated the same universally. Learners in these knowledge domains appeared to be motivated contingently such that either intrinsic or extrinsic motivation worked better sometimes, but not all the time, for a specific knowledge domain. And that researchers not only need to know about either/or, but also about when both intrinsic and extrinsic motivation were required. Indeed, these two broad areas were reported in the literature before by Ertmer (1999); Ertmer *et al.*, (1999); and Ertmer *et al.*, (2012) in the name of external and internal barriers hampering teachers' efforts to integrate ICT. The 'external barriers' were: access, time, support, training, and availability of resources such as hardware and software and the 'internal barriers' were: teachers' confidence, beliefs about how students learn, as well as the perceived value of technology to the teaching/learning process. It was stated that particularly positive beliefs and attitudes toward ICT affected its integration into in-class teaching (Jimoyiannis and Komis, 2007; Anderson and Maninger, 2007; Kim, Kim, Lee, Spector, and DeMeester, 2013). Similarly, Holland and Piper (2014) stated that when thinking about technology integration and meaningful learning, one should keep the barriers suggested by Ertmer (1999); it was particularly suggested that the intrinsic, second-order change barriers were relatively more permanent and personal than first-order change barriers (Bai and Ertmer, 2008). The researchers added that simply 'tossing technology at a student and hoping the technology sticks' is not the right strategy to be followed for a change but teachers' belief systems about learning and teaching will need to become an integral part of a systems change strategy (Bai and Ertmer, 2008).

To support technology use in education, some models were developed by the researchers based on TPACK framework such as; the model based on three pedagogical techniques that social studies teachers often use: giving, prompting and making (Hammond and Manfra, 2009); the Technological Pedagogical Science Knowledge (TPSK) model for TPACK in science education (Jimoyiannis, 2010); the universally designed for learning Infused TPACK Practitioners' Model for Teacher Preparation (Benton-Borghi, 2013); the elaborated model of the TPACK framework to analyze and depict teacher knowledge (Cox and Graham, 2009). However, more model developments are required for different subject domains and contexts.

1.1.3. *How do Attitudes Differ from Beliefs? Teachers' Attitudes towards Computer-Assisted Education*

In their TPACK TIE Model, Holland and Piper (2014) identified beliefs and attitudes as important constructs besides others including the motivation construct in self-determination theory (Ryan and Deci, 2000; Deci and Ryan, 2008) for "barriers" to learning. Concerning the attitude construct, which has been a key psychological construct for years, Ajzen (1991; 2005) stated that:

(a) beliefs influence simultaneously attitudes, subjective norms, and perceived behavioral controls;
(b) attitudes, subjective norms, and perceived behavioral controls influence simultaneously intentions to behave, which ultimately influence behavior.

Kutluca (2010) stated that attitude is 'one of the determining factors in predicting people's behavior'; computer attitude, on the other hand, was defined as a person's gen-

eral evaluation or feeling of favour or antipathy toward computer technologies and specific computer related activities (Smith, Caputi, and Rawstorne, 2000; Kutluca, 2010). Emphasizing that teachers' attitudes toward computer is one of the most significant construct, Kutluca (2010) stated that if teachers had hesitation and/or unfavorable view, this may limit educational use of computers. This indicates how measuring attitudes of participants is significant particularly in TPACK studies.

Besides the studies measuring the influence of CAE on learning or teaching, the attitudes of individuals toward computers and CAE and especially with respect to gender have been studied in a few studies in the literature. Whitley's (1997) meta-analysis on studies of gender differences in computer-related attitudes and behavior indicated that males exhibited greater sex-role stereotyping of computers, higher computer self-efficacy and more positive affect about computers compared to females. The researcher reported in his study that males saw computers more appropriate to themselves and they were more competent on computer-related tasks. This study indicated that there was a gender difference in computer attitudes of individuals. There are some other studies indicating difference between gender and computer attitudes in favor of males, particularly in 1990s. (Liu, Reed, and Phillips, 1992; Hunt and Bohlin, 1993; Shashaani, 1994). However, in some studies no significant difference was found between computer attitudes and gender of individuals (Çelik and Bindak, 2005; Deniz, 1995; Deniz, 2007; Kutluca, 2010; Teo, 2008). On the other hand, gender difference regarding attitude toward CAE was studied limited in the literature. There are a few studies revealing that male students preferred using computer-assisted learning significantly more than females (Abouserie, Moss, and Barasi, 1992); there are some other studies reporting no significant relationship between gender and CAE (Cavas *et al.*, 2009; Gökçearslan, 2010; Şahin and Akçay, 2011).

On the other hand, in studies investigating TPACK competences with respect to gender, Koh and Chai (2014) found that gender appeared to affect teachers' pre-course TPACK perceptions in favor of males. Similarly, Erdogan and Sahin (2010) found that male pre-service mathematics teachers' TPACK competences were significantly higher than those of female teachers. In another study Lin, Tsai, Chai, and Lee (2013) found that female teachers were more confident in PK but less confident in TK compared to male teachers. Jang and Tsai (2012) found that teachers' TPACK scores did not change by gender in their earlier study; whereas, in a subsequent study they found that male teachers gave the TK questionnaire items significantly higher ratings than female teachers, which indicated males' superiority in TK (Jang and Tsai, 2013). It is obvious that, more research has to be done regarding gender affect in CAE and TPACK.

1.1.4. *The FATIH Project*

The aforementioned FATIH project was fundamentally targeted towards the use of communication technologies in education. By enhancing the use of technology in schools, this project aimed to transform schools into more productive places. The main objectives of the FATIH project were defined as:

(a) the provision of equal educational opportunities for students from different regions;
(b) the enhancement of the use of information technologies in schools;

(c) the integration of technology into teaching and learning activities to support students' learning.

The project consisted of five core elements:

(1) provision of hardware and software infrastructure;
(2) provision of instructional e-content;
(3) effective use of IT in instructional programs;
(4) in-service training of teachers;
(5) provision of effective, safe, administrable and measurable IT use.

The results of pilot implementation of FATIH project is valuable for effective actual implementation of this project and other ones. In contrast to previous TPACK studies, which were often carried out with prospective and in-service teachers at an educational setting, the current study was carried out with teachers who were taking part in the pilot implementation of an extensive ICT integration project, FATIH, in Turkey. As has been shown, attitudes, beliefs, practices and points of resistance are significant internal factors in successful ICT integration (Ertmer *et al.*, 1999). In the current study, teachers' attitudes towards CAE, their TPACK competencies, and the relationship among all these constructs were measured. Attitude and TPACK competences were named as constructs but not variables since as defined by Bacharach (1989) a construct is 'a broad mental configuration of a given phenomenon'; whereas, a variable is an 'operational configuration derived from a construct'. Indeed, a construct is not observed directly or indirectly (Kaplan, 1964); although a variable is. Some other researchers also named TPACK competencies as constructs in their studies (Archambault and Barnett, 2010; Graham, 2011).

1.2. *Research Questions and Research Propositions*

Thus, based on this review of literature, this study investigated these research questions:

1. What are teachers' attitudes towards CAE?
2. What are teachers' TPACK competencies?
3. Is there a significant relationship between teachers' attitudes towards CAE and their:
   (1) Technology Knowledge (TK)?
   (2) Pedagogy Knowledge (PK)?
   (3) Content Knowledge (CK)?
   (4) Technological Pedagogical Knowledge (TPK)?
   (5) Pedagogical Content Knowledge (PCK)?
   (6) Technological Content Knowledge (TCK)?
   (7) Technological Pedagogical and Content Knowledge (TPCK)?
8. Are there any differences between teachers' attitudes towards CAE and TPACK competencies by gender?
9. Can the TPACK competencies of teachers predict their attitude towards CAE?

2. Method

2.1. *Quantitative Research Design*

The data were collected through the survey method. Creswell (2012) defines survey research designs as procedures in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population. In the current study the participants' attitudes and competencies were collected.

2.2. *Purpose*

There are many research studies on TPACK in the literature for different purposes. Table 2 shows some of these TPACK studies' research types and findings.

The analysis in Table 2 indicates that TPACK framework has been frequently used for measuring technological-pedagogical competencies of individuals and for investigating it from different aspects and with different methodologies.

In the current study, descriptive statistics was employed for the analysis of the relationship between the first three research questions relating to the determination of CAE

Table 2
Varieties of Methods in TPACK Studies

Research Study	Finding
Experimental Design	There were significant differences in the TPACK of elementary teachers who used interactive whiteboards (IWBs) compared to teachers who did not use IWBs (Jang and Tsai, 2012). Integrating IWBs and peer coaching can develop the TPACK of science teachers (Jang, 2010).
TPACK model Adoption	The TPACK framework was expanded into a new framework, Technological Pedagogical Science Knowledge (TPASK), by incorporating a fourth dimension in order to address future policy frameworks concerning teachers preparing to integrate ICT in science education (Jimoyiannis, 2010).
Correlational Study	A significant connection between Stages of Concern and TPACK was found in another study by Chen and Jang (2014). The changing nature of the complex relationship between knowledge, beliefs about self-efficacy and potential areas of knowledge in TPACK domains influences pre-service teachers' beliefs about technology integration (Abbitt, 2011).
TPACK scale development, Validity Check	The validity check of the TPACK framework was implemented in some other studies (Archambault and Barnett, 2010; Kabakci Yurdakul, 2012; Mouza, Karchmer-Klein, Nandakumar, Yilmaz Ozden and Hu, 2014).
Perception Measurement towards TPACK	After designing an ICT lesson, the perceptions of teachers towards TPACK development differentiated (Koh and Chai, 2014).
Survey	Gender affects the TPACK perceptions of teachers (Horzum, 2013)
Trend Analysis	A trend analysis study showed that from 2002 to 2011 researchers and educators were increasingly interested in the TPACK framework (Wu, 2013).

attitudes of the teachers; their TPACK competencies; and for the correlation of TPACK domains and attitude towards CAE. An inferential statistics was employed to explain teachers' attitudes towards CAE and TPACK competencies by gender, besides the researchers investigated whether TPACK competencies predicted attitudes towards CAE was employed (Fraenkel and Wallen, 2003).

The current study was a correlational study in nature. It presented correlation and predictive results. As aforementioned, positive beliefs and attitudes toward ICT affected its integration into in-class teaching (Jimoyiannis and Komis, 2007; Anderson and Maninger, 2007; Kim *et al.*, 2013); thus, the current study aimed to measure teachers' attitudes towards CAE besides examining their TPACK competencies and their associations.

2.3. *Sample*

280 teachers from different subjects who are working in a FATIH project pilot area at different K12 schools in Karaman, Turkey participated in the study. Convenient Sampling technique was implemented for sampling procedure.

2.4. *Participants*

The teachers voluntarily participated in the study and they were teaching at 9, 10, 11 and 12 grades during time of the study. Details regarding these participants' genders and years of teaching experience are given in the Table 3.

2.5. *Survey Instruments*

Attitude Scale in Relation to Computer-Assisted Education
This scale was developed by Arslan (2006) to measure teacher candidates' attitudes toward CAE. There were 20 items in the scale, 10 of which implied a positive and the

Table 3
Demographics of the Participants

	Number	Percentage
Gender		
Male	80	28.57
Female	200	71.43
Teaching Experience in years		
1–10	83	29.64
11–20	156	55.71
21–30	35	12.50
31+	6	2.14

remaining 10 of which implied a negative meaning. The Cronbach alpha was measured as 0.93 by Arslan (2006). Each item was measured on a five-point Likert scale, ranging from ''disagree strongly'' (1) to ''agree strongly'' (5). In the current study, the Cronbach alpha was found to be 0.93. The more scores participants get from the scale, the more positive their attitudes towards CAE. CAE refers to the use of computers in the lessons, it does not involve use of mobile devices or the Internet. There are reversed items in the scale as "Computers cannot be used effectively in education", "Students cannot improve their creativeness in the computer-assisted lessons" and "Computers are effective tools in gaining attention of students."

2.6. *TPACK Survey*

In the study, the Technological Pedagogical and Content Knowledge model (TPACK) developed by Şahin (2011) was used. The survey consisted of the seven subscales forming the TPACK model: (1) Technology Knowledge (TK), (2) Pedagogy Knowledge (PK), (3) Content Knowledge (CK), (4) Technological Pedagogical Knowledge (TPK), (5) Technological Content Knowledge (TCK), (6) Pedagogical Content Knowledge (PCK), and (7) Technological Pedagogical and Content Knowledge (TPCK). The survey consisted of 47 items and each item had 5 choices: "1 = not at all", "2 = a little", "3 = moderately", "4 = quite a lot" and "5 = completely". The Cronbach alpha was found to be 0.70 by Şahin (2011). In the current study the Cronbach alpha was found to be 0.98. The survey was in Turkish so it was implemented without any translation. The higher scores the participants got from the subscales, the higher would be their competencies.

2.7. *Statistical Analysis*

To measure teachers' TPACK competencies and their attitudes towards CAE, basic statistical analyses were used. In order to investigate the relationship between TPACK competencies and attitudes towards CAE, a correlational analysis was conducted. In order to measure the differences between teachers' attitudes towards CAE and TPACK competencies by gender, a t-test was run. In addition, a hierarchical regression analysis by Tabachnick and Fidell (2013, p. 138) was carried out to see whether and by how much TPACK competencies predicted teachers' attitudes towards CAE.

3. Results

The results were presented in the same order as in the research questions.

Research Question 1: Teachers' Attitudes towards CAE

As indicated in Table 4, the mean attitude score of the participants towards CAE was found to be 79.3. The highest score that could be obtained from this scale was 100; thus, teachers' attitude towards CAE was highly positive.

Table 4
Teachers' Attitudes towards CAE

		N	Min	Max	Mean	Std. Deviation
Attitude towards CAE		280	23.00	100.00	79.3286	12.70393
	Total	280				

Research Question 2: Teachers' TPACK Competencies

When all other scores for different TPACK competencies in Table 5 were analyzed, all scores were found to be higher than the average. This indicated that all TPACK competencies of teachers were high.

When Table 5 is examined, it may be said that average values of TPACK components were not low.

Research Question 3: The Relationship between Teachers' Attitudes Towards CAE and Their TPACK Competencies

The relationship between teachers' attitudes towards CAE and their TPACK competencies was measured with a correlational analysis (Table 6). A positive relationship was found between all competencies and the attitude towards CAE.

Technology Knowledge (TK) and Technological Pedagogical Knowledge (TPK) were found to show the strongest degree of relationship with the variable attitude towards CAE compared to the ones with other competencies. Pedagogical Content Knowledge followed these competencies.

Research Question 4: Differences between Teachers' Attitudes towards Computer-Assisted Education and TPACK Competencies by Gender

The researchers also measured gender differences with respect to their attitudes and TPACK competencies. The results are presented in Table 7.

The results indicated that males have a better, more positive attitude towards CAE. Technology Knowledge (TK) competency of males is higher than females, while Technological Content Knowledge (TCK) competency of females is slightly higher than males.

Research Question 5: Can the TPACK Competencies of Teachers Predict Their Attitude towards Computer-Assisted Education?

The status of multicollinearity between the constructs within the study were detected by examining the VIF value. The VIF values were found to be lower than 5. In predicted regression model, there was no multicollinearity problem and assumption was enabled The TPACK model constructs and hierarchical regression analysis including gender are incorporated in Table 8.

With respect to the hierarchical regression coefficient, the order of the impact of predictors of attitude towards CAE was TK, CK, PK, TCK, TPK, PCK, TPCK. These constructs were incorporated in the hierarchical regression analysis in similar groups

Table 5
Teachers' TPACK Competencies

		N	Min	Max	Mean	Std. Deviation
TPACK	TK	280	17.00	75.00	49.1107	12.71856
	PK	280	6.00	30.00	21.0964	4.70735
	CK	280	6.00	30.00	22.9036	3.88933
	TPK	280	5.00	20.00	14.9536	2.76071
	PCK	280	7.00	35.00	25.4964	4.97449
	TCK	280	4.00	20.00	15.4643	2.84589
	TPCK	280	5.00	25.00	18.4750	3.55592
	Total	280				

Table 6
The Relationship between Teachers' Attitudes towards CAE and Their TPACK Competencies

Correlations

		Attitude towards CAE	TK	PK	CK	TPK	PCK	TCK	TPCK
Attitude towards CAE	Pearson Correlation	1	.408**	.249**	.127*	.318**	.300**	.244**	.283**
	Sig.(2-tailed)		.000	.000	.034	.000	.000	.000	.000
	N	280	280	280	280	280	280	280	280

**. Correlation is significant at the 0.01 level (2-tailed).
* . Correlation is significant at the 0.05 level (2-tailed).

Table 7
Attitudes towards Computer-Assisted Education and TPACK Competencies by Gender

	Gender	N	X	S	sd	t	p
Attitude towards CAE	Female	80	76.7250	13.17168	278	2.183	0.03
	Male	200	80.3700	12.39278			
TK	Female	80	46.6375	12.90103	278	2.07	0.03
	Male	200	50.1000	12.54099			
PK	Female	80	21.3000	4.59334	278	.457	0.64
	Male	200	21.0150	4.76110			
CK	Female	80	23.3500	3.39061	278	1.216	0.22
	Male	200	22.7250	4.06596			
TPK	Female	80	14.7250	2.47507	278	0.876	0.38
	Male	200	15.0450	2.86777			
PCK	Female	80	25.2625	4.75406	278	.497	0.62
	Male	200	25.5900	5.06857			
TCK	Female	80	16.0375	2.25828	278	2.145	0.03
	Male	200	15.2350	3.02415			
TPCK	Female	80	18.3125	3.36247	278	.483	0.63
	Male	200	18.5400	3.63655			

Table 8
Results of Hierarchical Regression Analysis for CAE

Step	B	Standart Error	β	t	p	R	R2
Step 1							
TK	.407	0.55	.408	7.443	.000	.408	16.6
Step 2							
TK	.413	.069	.413	5.988	.000	.413	17.1
CK	.144	.210	.053	.683	.495		
PK	-.281	.226	-.086	-1.241	.216		
Step 3							
TK	.354	.076	.354	4.683	.000	.447	20.0
CK	-.165	.234	-.061	-.702	.483		
PK	-.736	.268	-.225	-2.744	.006		
TCK	.665	.501	.144	1.328	.185		
TPK	.161	.298	.063	.539	.590		
PCK	.624	.383	.140	1.630	.104		

a. Dependent variable: Computer-Assisted Education
b. Predictors: (Constant), TK
c. Predictors: (Constant), TK, CK, PK
d. Predictors: (Constant), TK, CK, PK, TCK, TPK, PCK

(Koh, Woo and Lim, 2013), and all three steps were statistically significant. Only TK and PK were found to have a significant predictor of attitude towards CAE. Above, the constructs were incorporated into the regression analysis in groups, in three steps. TK incorporated in the regression analysis in the first step explained 16.6% of the variance in CAE attitude. In the second step, TK explained 17.1% of CAE attitude along with CK and PK constructs, and in the third step, TK explained 20% of CAE attitude along with CK, PK, TCK, TPK and PCK constructs. Besides, incorporation of TPCK construct into the third step did not change this ratio. TK was the only construct having the highest effect in all the steps; thus it explains the attitude towards CAE more than other constructs.

4. Discussion

4.1. *Teachers' Attitudes towards CAE*

The results indicated that teachers' attitude towards CAE was relatively positive. Similar results have been reached in other studies with teachers (Kutluca and Ekici, 2010; Küçük, İşleyen, Deniz, and Cansız, 2014) and with in-service teachers (Gökçearslan, 2010). In another study Albirini (2006) reported that predicted by computer attributes, cultural perceptions and computer competence, teachers found to have positive attitudes

toward ICT in education. Similarly, Cavas *et al.* (2009) in their study indicated that Turkish science teachers had positive attitudes toward ICT in education and although teachers' attitudes toward ICT did not differ by gender.

4.2. *Teachers' TPACK Competencies*

The teachers' TPACK scores were found to be slightly higher than the average. However, their degree of positive attitude towards CAE was much higher than their TPACK scores.

4.3. *The Relationship between Teachers' Attitudes towards CAE and Their TPACK Competencies*

There was a low level correlation found between their TPACK competencies and their degree of positive attitude towards CAE. In particular, the teachers' competencies in Technology Knowledge (TK) and Technology Pedagogical Knowledge (TPK) were found to have much stronger relationship to their attitude towards CAE when compared to other competencies. This result is predictable since CAE is related to the use of technology, that is, when teachers' technology competencies are already at a high level, their attitude is often positively affected by it. This result further indicates that, although these teachers have some technological competencies, they may still be in need of content and pedagogical knowledge. At this point, it is important to note that when the current study was implemented; the FATIH project's in-service training phase for teachers had not yet started. Thus, the participants in the study had not been exposed to any in-service training. If in-service training had already started, this could have increased these teachers TPACK competencies particularly the ones related to pedagogy, to a much higher level and made teachers' attitudes towards CAE much more positive. To exemplify this: a study of 869 Singapore pre-service teachers who had undergone a compulsory ICT course during their teacher training program indicated that these teachers' TPACK competencies were influenced by their experiences, and that the course had already helped them develop intermediary TPACK knowledge (Koh, Woo, and Lim, 2013).

4.4. *Differences between Teachers' Attitudes towards Computer-Assisted Education and TPACK Competencies by Gender*

In the study, teachers' attitudes towards CAE and TPACK competencies were additionally examined with reference to gender. As indicated in the literature, gender is found to have an effect on computer use in the classroom (Hermans, Tondeur, van Braak, and Valcke, 2008). It was found that males tended to have a more positive attitude toward CAE in the current study. As for TPACK competencies, males had a better Technology Knowledge (TK), while females had a better Technological Content Knowledge (TCK). The result regarding Technological Knowledge (TK) supports the findings of the study

of teachers by Koh, Chai, and Tsai (2010). However, in another study Lin *et al.* (2013) found that female teachers were more confident in PK but less confident in TK compared to male teachers. This supported the notion of males' having superior skills in using technology. In the current study, males were found to be superior in technology-based competences and to have a more positive attitude towards CAE. However, it was additionally found that females' level of competence increased when Content Knowledge was considered. This finding could be useful to practitioners who are working on ICT technology integration at schools.

Males have frequently been found to have superior competence to females with respect to use of technology in Turkey. Erdogan and Sahin (2010) found that male pre-service mathematics teachers' TPACK competencies were significantly higher than those of female teachers. It is reasonable to note down at this point that although in past decades the difference between male and female use of technology were clear cut, over time the competence of females has increased, especially for using Internet technologies. In recent years there has been almost no gender difference in use of technology and attitudes towards technology. For example, Şahin and Akçay (2011) and Gökçearslan (2010) reported that there was no significant relationship between gender and CAE. Similarly, Cavas *et al.* (2009) reported that teachers' attitudes toward ICT in education did not differ regarding gender. Although the current study found a difference according to gender in teachers' attitudes towards CAE and TPACK competencies, Jang and Tsai (2012) found that teachers' TPACK scores did not change by gender. However, in a subsequent study Jang and Tsai (2013) further examined each single TPACK component according to gender and found that male teachers gave the TK questionnaire items significantly higher ratings than female teachers. This finding supports the finding regarding males' superiority in TK in the current study.

4.5. *Can the TPACK Competencies of Teachers Predict Their Attitude towards Computer-Assisted Education?*

In accordance with the prediction of CAE variables by TPACK framework, TK explained 16% of variance in CAE attitude. This ratio increased up to 17% when CK and PK values were added to TK, and up to 20% when TCK, TPK and PCK values were added. The effect of TK merely was considerable as well. TK was the most effective construct in prediction of CAE attitude. In another study using TPACK framework in predicting self-competence for educative Internet use, technology, content, and TK were found to be significant predictors (Sahin *et al.*, 2013).

4.6. *Contributions, Limitations and Future Directions*

4.6.1. *Contributions*

It is obvious in the literature that more studies should be done on TPACK in different contexts; the definition of constructs; new models since TPACK framework is still seen complex (Archambault, and Barnett, 2010; Koh *et al.*, 2013). Being one of internal

barriers in technology integration, the variable CAE attitudes of teachers should be measured. The main contribution of this paper to the literature is to indicate how the TPACK model related with the attitude of doing Computer-Assisted Education (CAE). The study is believed to provide a useful critique or extension of the TPACK framework. The data were collected from the teachers within a pilot group in a technology integration project named FATIH performed in Turkey. It is believed that the results of the pilot study will contribute not only to the actual study but also other teachers and researchers.

4.6.2. *Limitations*

The participants of the current study are teachers from different branches working at K12. The study is limited with its type and number of participants and the context. The current study was limited within the pilot area; it could be repeated in the actual implementation all around the country. Besides the study may be repeated in other countries and in different contexts to reach more generalizable findings. All data were taken as self-reports in the study, which may cause bias as the provision of possibly favorable answers. A possible way to overcome this limitation would be also adding qualitative data in further studies.

4.6.3. *Future Directions: Research and Practice*

Researchers may further investigate TPACK competencies and attitudinal changes of teachers during and after the project with repeated measure research design or as a longitudinal study. Besides there is a need for a further research investigating the associations between TPACK knowledge, teacher beliefs and attitudes at different contexts.

4.6.4. *TPACK Framework*

Graham (2011) claimed TPACK to be still a very complex concept causing scholarly debates. In their study As Voogt *et al.*, (2013) stated that there are three different understandings of the concept emerged from the review. There is a need of more studies to strengthen the weak parts of the TPACK framework and to explain its constructs more obviously by clarifying their differences and relationships. Besides the clarification of construct definitions, their necessity in the framework should be implied. More studies should be done what TPACK means for specific subject domains and more instruments should be developed to measure specific competencies in TPACK framework and particularly to measure it in different contexts. These are required for long-term survival of the TPACK framework.

4.6.5. *TPACK Models*

Besides required studies on the framework, TPACK research now needs to move beyond from 2-construct models to multiple-construct models that investigate the relationships of other constructs such as attitudes and motivation that may cause variation among the acquisition of TPACK competencies. As Archambault and Barnett (2010) stated researchers should focus on what type of model might more accurately de-

scribe teachers' in three knowledge domains, and how this model might be used to prepare prospective educators at colleges of education and teacher education programs to overcome challenges of teaching. There is a need of falsifable TPACK models in different contexts.

4.6.6. *Practitioners: Teachers and Students*

It is suggested that teachers should use technology for teaching. However simply putting technology in front of teachers or students is not effective for healthy technology adoption and use. Teachers' technology competencies, their beliefs and/or attitudes towards CAE should be evaluated prior to the beginning of any ICT integration project. Particularly female teachers should be encouraged to use technology in their teaching. Technology pedagogical competencies of teachers should additionally be enhanced for effective implementation of technology in education. Increasing awareness about it and in-service training is significant.

5. Conclusion

Today technology is extensively used for education around the world from K12 to post-graduate students, to life-long learners. In comparison to previous years, many educational settings are now well furnished with computers and satisfactory Internet access. However, bringing the necessary technology into educational environments does not guarantee effective learning. As well as the provision of technology, the implementation of corresponding pedagogical approaches effectively is important. This necessitates the teacher training involving use of right pedagogical methods and techniques for teaching with technology besides technological knowledge as well as the use of effective educational materials. The current study has investigated the attitudes of teachers towards computer-assisted education and their knowledge of technology, pedagogy and content using the TPACK model, which assesses the competencies required for developing and implementing successful technology-integrated teaching. Teachers' competencies and attitudes regarding use of technology in education may vary based on the environment, atmosphere, culture and the times of use which may be investigated in further studies.

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