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Full Length Research Paper

Primary trainee teachers' attitudes to and use of computer and technology in mathematics: The case of Turkey

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This study explores Turkish primary mathematics trainee teachers' attitudes to computer and technology. A survey was conducted with a self constructed questionnaire. Piloting, factor and reliability (α = 0.94) analyses were performed. The final version of the questionnaire has three parts with a total of 48 questions including a Likert type attitude scale which contains 39 statements. The sample is a total of 361 students from the primary mathematics teacher training department in two different universities. The study found that the trainee teachers, in general, are positive towards computer use in mathematics with adequate level of attitudes, and usually express positive feelings about computer and information technology. These perceptions are not gender related as well. The study concludes that the need for training in computer and information technology competency in mathematics remains important, and that such programme needs to be specifically customized to account for the wide range of experiences and attitudes of trainee teachers.

Key words: Computer-based mathematics education, trainee teachers, attitude.

INTRODUCTION

Computer, technology and their uses in mathematics education started gaining more attention along with the new developments in education. Mathematics education authors both in teaching and learning mathematics, connects the issue with pedagogical considerations (Galbraith and Haines, 1998; Murphy and Greenwood, 1998; Garofalo et al., 2000; Kadijevich and Haapasalo, 2001; McAlister et al., 2005). These considerations usually focus on cognitive dimensions of mathematics education and effective computer (and educational software) use in action (Monaghan, 1993, 2004) and highlight their effects on students' learning, achievements and affective dimensions. For example, an acceptable level of computer use has positive effect on students' views, performance and confidence about the context. Similarly, the students who are more enthusiastic about computers and feel comfortable to use them in mathematics either as a student or a teacher are also able to do better tasks with computer. This confirms that the students with more experience have more positive feelings to teach mathematics with computer than the ones with less experience. Despite that, other factors (such as gender, knowledge, experience, accessibility, availability and sufficient resources etc.) may have also significant effects on the use of computer and technology.

Teacher training is one of the most critical components for the successful implementation of computer in schools since teacher training courses have vital influences on students for their future conceptions and uses of computer in the classrooms. Teachers' attitude is an important affective dimension which indicates their beliefs, perceptions, views, motivations, anxiety and avoidances about computer, technology and mathematics. In this context, the main question posed by Koehler and Mishra (2005, p. 131) is "What do teachers need to know about technology and how can they acquire this knowledge?". They noted that these questions have been at the centre of intense debate in the recent past and there is, however, little clarity about what form this technological knowledge should take, and how it should be acquired.

If trainee teachers have demonstrated proficiency with the integration of technology into their teaching, but do not believe that technology has a use in the classroom, they will probably avoid teaching with technology. In this respect, attitudes and beliefs about teaching with and about technology in mathematics could exclude well-planned teaching in teacher training. On the other hand, trainee teachers who believe in the potential and utility of technology in the classroom may persevere through the many challenges that face novice technology users and become models for students to follow.

Therefore, trainee teachers' understandings, explorations, views, attitudes, uses and reflections of the subjects on a new technology are important. These consequences may have important implications for mathematics education as well.

However, preparing teachers to use technology appropriately is a complex task for teacher educators. Garofalo et al. (2000) underline the fact that adoption of technology by teachers requires professional development that focuses on both conceptual and pedagogical issues, ongoing support in terms of intensive start-up assistance and regular follow-up activities.

Computer, technology and teacher training

Earlier considerations

Some of earlier literature on technology and pre-service teacher education indicates that teacher preparation programs were not adequately preparing their graduates to teach with technology (Strudler and Wetzel, 1999; Thurston et al., 1997) and they had not fully integrated technology into their programs for preparing teachers (Wang et al., 2003). Baslanti (2006) addressed the existing situation of technology and teacher education by summarising most part of the literature: Most pre-service teachers know very little about effective use of technology in education and leaders that believe there is a pressing need to increase substantially, the amount and quality of instruction teachers receive about technology.

It has been found that most teachers do not necessarily see technology as part of their teaching programs (Campell et al., 2000). Several studies usually concluded that many teachers, in particular primary school teachers, need assistance to clarify and reflect on their own perceptions about technology. However, the changing or broadening of teachers' views about the disciplines is proving to be a difficult task all over the world and there is a dearth of research regarding this issue in relation to technology (Wang et al., 2003).

All these findings portray a much more different picture than what is expected from colleges of education in terms of equipping tomorrow's teachers with the required technology skills.

Contemporary considerations

On the other hand, many recent literatures show that new developments and considerations are highly appreciated all over the world. The Technology Principle of the NCTM (Principles and Standards for School Mathematics) (2000) identified the "Technology Principle" as one of the six principles of high quality mathematics education and has guidelines and supports about the use of technology. In the 'Principles and Standards of School Mathematics', it is stated that "Technology is essential in the teaching and learning of mathematics; it influences the mathematics that is taught and enhances students' learning (p. 24)" and "Teachers should use technology to enhance their students learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently, well-graphing, visualizing, and computing (p. 25)". Furthermore, NCTM suggests that appropriate use of technology can facilitate such applications by providing ready access to real data and information, making the inclusion of mathematics topics useful for applications and to be more practical (e.g., regression and recursion), and making it easier for teachers and students to bring together multiple representations of mathematics topics (NCTM, 2000). It is pointed out that mathematics teachers, not technological tools, are the key change agents in bringing about reform in mathematics teaching with technology (Kaput, 1992; NCTM, 2000). Koehler and Mishra (2005) emphasized:

> "It is becoming increasingly clear that merely introducing technology to the educational process is not enough to ensure technology integration since technology alone does not lead to change. Rather, it is the way in which teachers use technology that has the potential to change education (p.132)".

NCATE (2008, p. 4) highlights and sets standards very clearly that teacher education programs should "… prepare candidates who can integrate technology into instruction, to enhance student learning and "… be able to integrate technology into instruction effectively."

Thus, the teachers present the content to students in challenging, clear, and compelling ways, using real-world contexts and integrating technology appropriately; and uses technology in their practices in order to plan, instruct and support students' learning. Therefore, the main purpose of using technology in teacher education is to promote an effective teaching and improved student learning. Thus, training of teachers with appropriate and sufficient proficiency is very important. Trainee teachers do not only need to learn how to use computers (or technology), but also how to incorporate computer when teaching. Thereby, pre-service teachers' attitudes and experiences would seem to be important in determining the willingness and preparedness of teachers with professional development opportunities and increasing the effective implementation of computer and IT in classrooms.

In this stage, computer attitudes are important because of the long-documented relationship between computer attitudes, motivation and performance. Gaining insights into students' attitudes and beliefs is also considered as a crucial step in understanding how the learning environment for mathematics is affected by the introduction of computers and other technology (Galbraith and Haines, 1998). In order to be reflective and recommend the use of computers, there should be an examination to determine trainee teachers' attitudes towards the use of computers.

Christensen (1998) stresses that the successful use of computers in the classroom depends on the teachers' attitudes towards computers, identifying teachers' attitudes as well as expertise in using computers, are the major factors in the adoption of computers into classrooms. Although teachers' attitudes have not typically been considered in the introduction of computers into the classroom, future successful implementation will need to address teachers' attitudes toward computers. According to a research study which examines the relationship between teacher attitudes and computer skills, it is critical that teachers possess both positive attitudes and adequate computer literacy skills in the successfully incorporate technology into the classroom (Christensen, 1998). Similarly, Mumtaz (2000) reports that teachers who successfully make use of IT, had a positive rather than negative attitude towards IT. Teachers who have positive attitudes towards IT itself will be positively disposed towards using it in the classroom.

Computer, technology and mathematics education

The above conclusions are paralleled in mathematics education as well. It is clear that students' understanding of the nature of mathematics can influence how they think and learn about mathematics and teachers' views of mathematics can influence the way they teach mathematics. It seem to be important for pre-service teachers to develop perceptions of mathematics that are in accordance with computer. This new perception has forced mathematics education authorities to switch the direction of teacher training towards the new changes. For example, the use of technology in mathematics teaching is not for the purpose of teaching about the computer, but for the purpose of enhancing mathematics teaching and learning with computer (Garofalo et al., 2000). They express that teachers who learn to use technology while exploring relevant mathematics topics are more likely to discover its potential benefits and use it in their subsequent teaching. Furthermore, they explained numerous ways of incorporating technology into teacher education for PSTs (preservice secondary mathematics, social studies, and science teachers). They categorized these approaches according to the primary user or controller of the technology—the teacher educator, the teacher, or the student. They stated that the three uses of technology in teacher education presented above are connected with different purposes and all can lead to an effective teaching, and improved student learning. Thus, all are important. However, they clearly stated:

> "The most direct and effective way to use technology to bring about enhanced student learning of mathematics is to prepare PSTs to incorporate into their teaching an array of activities that engage students in mathematical thinking facilitated by technological tools (p. 69)."

Considerations continue even for in-service teachers. According to the Department of Education (USA) study, nearly all teachers receive some professional development each year. One the most common topics of this teachers' professional development is educational technology (Wenglinsky, 2000).

The situation in Turkey

These reflections are also echoed in Turkey as well. More recently, Ministry of National Education (MEB, 2007) has changed primary mathematics curriculum. Introduction part of the new curriculum starts with the stress rapid developments in technology and its effects on teaching, learning and communicating mathematics. It highlights the consequence of the technology stressing the importance of estimation and problem solving (MEB, 2007, p.7). The following pages continue to highlight competency on using information technologies for searching, receiving, processing, analyzing, evaluating and presenting knowledge (p. 12). Particularly, it mandates effective use of technology and refers to new opportunities that technology serves for mathematics education nowadays; including materials, calculators and computers. It points out the importance of software, internet and other interactive programs and addresses some of them (MEB, 2007, p. 24 -25). Furthermore, it associates the use of calculator and computer with other abilities such as psychomotor skills (p. 22). All of these concerns address the necessary, formal and compulsory use of technology for the primary mathematics teachers.

Theoretical framework

In this context, Koehler and Mishra (2005) offer a perspective that considers the development of Technological Pedagogical Content Knowledge (TPACK, or formerly TPCK). They claim that their approach toward technology integration values rich knowledge about how technology, pedagogy, and content interact with one

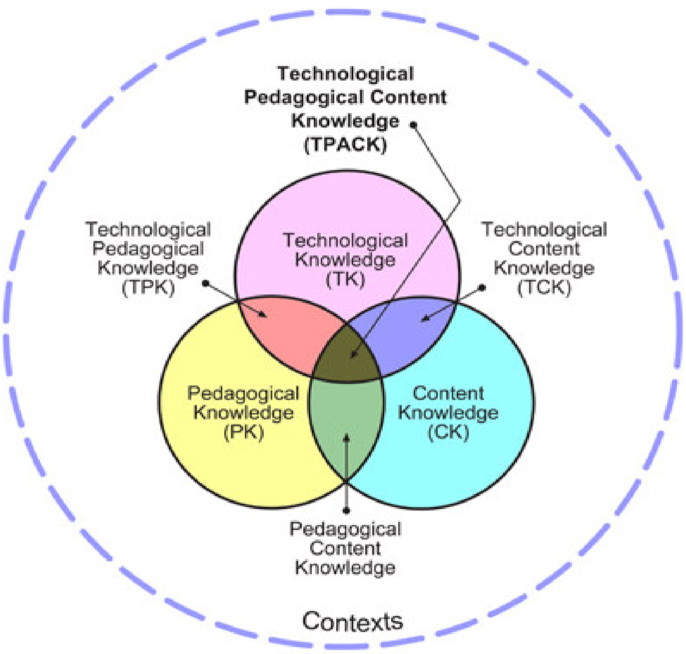

Figure1. The TPACK framework (Koehler and Mishra, 2008).

another. They stated that "for teachers to become fluent with educational technology, means going beyond mere competence with the latest tools, to developing an understanding of the complex web of relationships between users, technologies, practices, and tools (p.132)." Thus, they view technology as a knowledge system that comes with its own biases, and affordances that make some technologies more applicable in some situations than others. They view teachers' knowledge about technology as important, but not separate and unrelated from contexts of teaching, that is, it is not only about what technology can do, but also, and perhaps more importantly, what technology can do for them as teachers.

Consistent with this situated view of technology, they have proposed a framework describing teachers' under-standding of the complex interplay between technology, content, and pedagogy. They have built a framework describing Pedagogical Content Knowledge and to highlight the importance of 'Technological Pedagogical Content Knowledge' (TPACK) for understanding effective teaching with technology. At the core of their framework (Figure 1), there are three areas of knowledge: Content, Pedagogy and Technology.

"Content (C) is the subject matter that is to be learned/ taught, for example; … high school mathematics…. 'Technology' (T) encompasses modern technologies such as computers, the Internet, digital video, and more commonplace technologies including; overhead projec-tors, blackboards, and books… 'Pedagogy' (P) describes the collected practices, processes, strategies, proce-dures, and methods of teaching and learning. It also includes knowledge about the aims of instruction, assessment, and student learning (p. 133)."

However, they demand that their approach goes beyond seeing content, pedagogy, and technology as being useful constructs in and of themselves. They insist that their approach emphasizes the connections and interactions between these three elements.

"Good teaching is not simply adding technology to the existing teaching and content domain. Rather, the introduction of technology causes the representation of new concepts and requires the development of sensitivity to the dynamic and transactional relationship between all three components suggested by the TPACK framework" (p.134).

On the other hand, in contradiction to all the above inspirations, using technology to teach the same mathematical topics in fundamentally the same ways that could be taught without technology, does not strengthen students' learning of mathematics. Furthermore, it can be argued that using technology to perform tasks in mathematics that are just as easily or even better carried out without technology may actually be an obstacle to learning. Such uses of technology may convince teachers and administrators that preparing teachers to use technology does is not worth the considerable effort and expense necessary to do so. However, these ideas may not be commonly supported; they undermine the usefulness of technology. Appropriate and detailed research will prove the contradictions and may convince the opposed thought.

METHODS

Purpose of the study

This study deals with Turkish primary mathematics trainee teachers' attitudes to and use of the computer and technology in mathematics education. Thus, the study is quantitative, based on an exploratory research design and a survey research strategy.

The specific aim of this paper is to investigate the mathematics trainee teachers' attitudes towards the use of computer and technology in mathematics education that they acquire at the end of their four years of training. It also aims to draw implications for pre-service (and in-service) teacher education.

Survey

Surveys are virtually uncontested as the chief instruments for collecting student evaluations of educational process such as computer and technology. The inherent quantitative nature of survey data are more easily analyzed and compared than would be similar volumes of qualitative data. It has perpetuated the mindset of such measurements as the most effective means for assessing student views. However, a multi-method approach for gathering student evaluations of assessment methods is recommended.

The survey was conducted with a self constructed questionnaire. The questionnaire was developed specifically for this study. The instrument comprises of three parts. The first part consists of 8 multiple choice questions about students' experience with computer.

The second part is a Likert Type Attitude Scale. Likert Type Scale is one of effective ways of measuring attitudes. The first step in developing the survey was to collect items from different literature including mathematics (Dogan, 1999; Garofalo et al., 2000; Ocak, 2005), chemistry (Yavuz, 2005), technology (Campbell et al., 2000; Baslantı, 2006; Koehler and Mishra, 2005) and computer education (Christensen and Knezek, 2000). In this way, a large pool of sample items was obtained. The second step was the modifying and rewriting of unsuitable items in the pool and developing new special ones for the specific aim. Thus, 71 potentially suitable items were created and selected for piloting. The final step was designing and piloting the questionnaire. Total of 71 items were tested in a pilot study with 52 students. It was a 1 - 4 scale inventory (in which 1 stands for ''definitely agree'', and 4 for ''definitely disagree''). After piloting, a factor analyses have been conducted. The final version consisted of thirty nine items assessing the students' opinions regarding the extent to which the computer and information technology affect several aspects of the educational process, particularly learning and teaching of mathematics. The items measure how well each stated objective is being met based on students' perceptions of their current experience. It is believed that items are most appropriate for the undergraduate level where students have the experience and knowledge needed to accurately assess the importance of particular learning objectives. A total of 32 statements in the scale are positively phrased. The other 7 statements are negatively phrased, so disagreeing with them is considered as a positive attitude about the use of computers.

The third part of the questionnaire has a single open-ended question about the trainee teachers' views on the use of computer and technology in mathematics.

Validity of the survey

A Likert Type Attitude Scale was used to conduct this study. The scale was used to identify and determine the beliefs and conceptions of the primary mathematics trainee teachers. Construct validity refers to the degree to which a scale measures an intended hypothetical construct. This evidence of validity can be established by relating the scale or the instrument of interest to some other measures that are consistent with the hypothesis or the construct being assessed. Statistically, construct validity can be assessed through the use of a factor analysis procedure. The aim of this analysis is to identify the main components or categories that underline the scale. To check the construct validity, a maximum likelihood factor analysis with varimax rotation was conducted. The analysis yielded three factors with eigenvalues exceeding unity, and the factor solution accounted for 47.55% of the total variance. Factor 1 (Pedagogy); made up of 16 items, accounted for 36.27% of the total variance (eigenvalue = 14.14). Factor 2 (Technology); made up of 13 items, accounted for 6.85% of the total variance (eigenvalue = 2.67). Factor 3 (Content); made up of 10 items, accounted for 4.42% of the total variance (eigenvalue = 1.72).

Reliability of the survey

The set of 39 items was tested for reliability using an internal consistency method which yielded reliability coefficients of $\alpha = 0.94$. The value is higher than the 0.80 criterion which is regarded as internally reliable (Bryman and Cramer, 1997, p.63). Furthermore, the internal consistency and homogeneity for the three categories of the scale were assessed using Cronbach's alpha as well. Resultant indices for the two factors evidence satisfactory levels of internal consistency. The values of Cronbach's alpha of the three factors are relatively high ($\alpha = 0.91$, $\alpha = 0.88$ and $\alpha = .81$, respectively). The minimum advisable level is 0.70 (Nunnally and Bernstein, 1994). This implies that the measurement errors of these scales are relatively low and thereby the collected data on the three factors can be considered reliable. Based on these results, the three categories were judged to have adequate internal reliability.

Sample

The context is the Turkish higher education teacher training system. The analysis is based on an empirical study with students as the main informants. The authors starting point is an interest in understanding student learning from the perspective of students. The empirical material is from two different primary mathematics teacher training departments from two different universities. The primary mathematics department is an eight-semester (4 year) programme meant to serve as a teacher training course at the university. The focus on the department students, may therefore, well be sampling the views of the most students with respect to the use of computer and technology. It will be of particular interest to explore these students teachers' views, to identify the range of computer practices and to examine, encourages or constrains. The questionnaire was administered to the students at the end of academic year. The sample is made up of a total of 361 students (195 female and 166 male) at the end of their fourth year of training. All students were in face-to-face contexts. Therefore, the researcher explained how to complete the questionnaire to reduce any misunderstandings and to ensure high response rate.

One important limitation of this study lies in its phenomenological nature; the impacts described here are based primarily on students' responses.

Data analyzes

This paper reports quantitative analyses results of the second part (39 Likert Scale type questions) of the survey. Data was mainly analysed using quantitative descriptive statistical techniques. Descriptive analyses included percentages, means, standard deviations and frequency distributions. A factor analyses has also been conducted to see possible components of the scale.

RESULTS

The results section presents the main findings of the survey which reflects trainee teachers' views about and their attitudes to computer and technology at the primary mathematics teacher training department.

Factor analysis

Tables 1 and 2 present the factor analyses results of the primary mathematics trainee teachers' responses to the 39 Likert type items. Last columns in the tables give a clear result in the form of mean scores. Mean scores here are considered at intervals as:

$1.00 \leq \bar{x} \leq 1.74$; "definitely adequate",
$1.75 \leq \bar{x} \leq 2.49$; "adequate",
$2.50 \leq \bar{x} \leq 3.24$; "inadequate",
$3.25 \leq \bar{x} \leq 4.00$; "definitely inadequate".

Table 1. Explained total variance, KMO and Bartlett's test.

Factor	Initial eigenvalues			KMO measure of sampling adequacy		0.943
	Total	% of variance	Cumulative %			
1	14.148	36.278	36.278	Bartlett's test of sphericity	Approx. chi-square	5856.498
2	2.674	6.855	43.133		Df	741
3	1.724	4.420	47.553		Sig.	0.000

Table 2. Means, Standard deviations, and Cronbach's alpha coefficients of the three factors identified by deterministic rotated factor analyses[#] .

Items	Communalities	Factor Loadings	Item $\bar{x}$	S_x	Factor $\bar{x}$ (S_x)
Factor 1					
Doing maths with computer is enjoyable and stimulating	0.512	0.480	2.07	0.652	2.37 (0.190)
I think I will enjoy teaching maths with computer	0.462	0.409	2.10	0.732	
I am sure I am going to do better tasks with computer in maths	0.524	0.503	2.18	0.674	
I like doing maths with computer	0.534	0.574	2.19	0.763	
I enjoy learning maths with computer	0.476	0.464	2.23	0.684	
If it is possible I prefer computer to traditional ways in maths	0.233	0.367	2.23	0.760	
I try to do less work with computer about maths*	0.435	-0.516	2.29	0.732	
Doing maths with computer never threats me	0.410	0.610	2.35	0.780	
Doing maths with a computer makes me feel relaxed	0.527	0.673	2.39	0.668	
Using computer in maths education is a difficult job*	0.333	-0.550	2.43	0.722	
I think doing maths works with computers take more time*	0.164	-0.361	2.43	0.851	
I think it is easy to use computer in maths	0.444	0.635	2.45	0.781	
I like computer used maths lectures more	0.585	0.596	2.50	0.839	
I have a lot of self confidence with it comes to doing maths with computers	0.490	0.520	2.51	0.730	
I feel more comfortable using computer in maths	0.649	0.707	2.59	0.766	
Computer used maths lectures are my most favourite at school	0.463	0.543	2.61	0.801	
Reliability (α)		0.91			
Factor 2					
Knowing how to use computers will help me do well in my teaching career	0.403	0.477	1.86	0.696	2.21 (0.298)
If I could learn doing maths with computer better, I believe I am going to teach more successfully	0.514	0.536	1.91	0.781	
Computers would stimulate students to learn more maths	0.449	0.528	1.92	0.705	
It is possible to teach maths better with computer	0.500	0.586	2.00	0.658	
Maths teacher training should include computer based maths activities	0.471	0.483	2.01	0.691	
Computer would improve students' ability of doing maths	0.435	0.510	2.02	0.683	
Computer gives me more opportunity to learn new subjects in maths	0.348	0.440	2.19	0.748	
If there were a computer in my classroom, it would help me be a better maths teacher	0.343	0.489	2.19	0.793	
If I could, I would take more computer based maths subjects	0.525	0.512	2.29	0.904	
Computer help me to learn maths more easily	0.499	0.543	2.48	0.676	
I can learn more maths from computer than books	0.264	0.361	2.54	0.827	
I learn maths better, when I use computer	0.505	0.511	2.67	0.697	
I would learn more maths If I could use computers more often	0.352	0.525	2.71	0.803	
Reliability (α)		0.88			

Table 2. Contd.

Factor 3					
All students should have an opportunity to learn maths with computer at school	0.465	0.574	1.69	0.679	
Computer helps me to get better pictures of the facts and figures in maths	0.476	0.547	1.80	0.701	
Computer will improve mathematics education	0.488	0.546	1.83	0.659	1.98 (.218)
I would like to learn more about computer based mathematics education	0.459	0.521	1.85	0.723	
With computer, it is possible to do practical things in maths	0.304	0.461	1.89	0.644	
Computers can be used successfully with maths courses which demand creative activities	0.010	-0.101	2.32	0.801	
Learning maths with computer is a waste of time*	0.385	-0.518	2.94	0.718	
I never think to use computer in maths lessons*	0.536	-0.622	3.17	0.704	3.15 (0.144)
Using computer in maths education is a waste of time*	0.394	-0.570	3.24	0.709	
I think I will never use computer when I teach maths*	0.535	-0.676	3.25	0.689	
Reliability (α)		0.81			

[#] Extraction method: Maximum likelihood, Rotation method: Varimax with Kaiser Normalization; *denotes negatively phrased items.

The rating-scale data were analysed using deterministic (Maximum Likelihood Factor Analysis) methods. A factor analysis (SPSS Version 15.0 for Windows) of data from the instrument was conducted to ascertain whether there was a factorial or one-dimensional structure within the data sets. Therefore, a series of factor analyses was performed for the sample which identified non-directly observable factors based on teachers' responses. Exploratory factor analysis indicated that approximately 59.16% of variance coverage was provided by a seven-factor solution. In essence, the survey is acceptable as long as the results are reported as percentage agreement with each item. Because the instrument does not work as a measure of a single trait, the responses for each item within any one report should not be summed or aggregated, and no single item should be used as an indicator of overall results. This finding provides support to the construct validity of the questionnaire used to collect data on trainee teachers' concerns about the use of computer and technology. It has been observed that only three components' eigenvalues out of seven are greater than the others. For a clear interpretation of the extracted components, a factor analysis with Varimax rotation was applied to the data. The varimax rotation revealed a multidimensional solution, indicating that each item in the survey was evaluating a different aspect of the use of computer and technology. This suggested that all items in this version of the survey should be retained. The three factors were related to teachers' concerns and were identical to those mentioned in the specification table of the questionnaire.

First part of the Table 1 presents the results of explained variance. The three factors explain 47.55% of total variance with higher eigenvalues. Second part of Table 1 presents Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test and Bartlett's Test of Sphericity. The KMO value was 0.943, which indicated that the sample was suitable to run factor analysis (a minimum value of KMO = 0.60 is acceptable; Stevens, 1996). Similarly, high significance level of Bartlett's Test of Sphericity indicates that the factor model is appropriate for the scale.

The factor analyses with varimax rotation created three main factors. These factors together explained 47.55% of the total variance in all scale items. Thus, factor scores for each dimension were estimated, by calculating the average of the items that comprised each factor. No items (expect one item in the factor 3) with low loading values were identified. The mean scores, the relevant values of standard deviations and Cronbach's alpha values for each factor are presented in the Table 2. High levels of correlation coefficients are observed for every item within the factors. In social sciences, the common minimum cut-off loading value is 0.30 (Stevens, 1996; Tabachnick and Fidel, 2001). Consequently, all three factors are named according to the TPACK; that is, technology, pedagogy and content.

Factor 1: TPACK 1 (pedagogy)

First factor has 16 items. The items in this factor usually, are about pedagogical component. Therefore, the factor is named as "Pedagogy". The 'Pedagogy' (P) factor describes the collected practices, processes, strategies, procedures, and methods of teaching and learning. It also includes knowledge about the aims of instruction and student learning. In addition to the stated TPACK aspects above, what this study adds is an effective dimension to the aspects. Therefore, the items in the survey about this factor cover an effective dimension of the stated TPACK aspects as well. The effective dimension includes enjoyment, self-confidence, beliefs, motivation, anxiety, encouragement, preference, desire etc. Therefore, most of the items in this factor consist of related statements. Thus, a new perspective may be included in "Pedagogy" component of the TPACK.

Most of the positively phrased items mean scores in the "Pedagogy" factor are smaller than 2.50 (that is, agree). Correspondingly, the factor overall mean score ($\bar{x}$ =2.37) is "agree" as well. Therefore, the trainee teachers agree with the stated aspects of computer and its use in mathematics education.

On the other hand, three of the items in this factor are negatively phrased. Therefore, the trainee teachers' agreement with the items indicates a negative attitude. Moreover, students disagree with the four positively phrased items in this factor which indicates negative attitudes as well. Some of these items are about doing less works with computer and seeing computer use in mathematics education as difficult and time consuming activities. The others are about the affective dimensions (liking, feeling comfortable and self confidence about using computers).

As a whole, however, the students' overall attitude to computer about "Pedagogy" components seems to be sufficient, the situation is rather varied. In one hand, trainee teachers are positive and happy about the general statements. In the other hand, they are not very positive about the statements which directly relate themselves personally.

Factor 2: TPACK 2 (technology)

Second factor has 13 items. The items in this factor usually are about "Technology" component of the TPACK. Therefore, the factor is named as "Technology". The 'Technology' (T) encompasses modern technologies such as computers, the internet, digital video, and more commonplace technologies including overhead projectors, blackboards and books etc. The items in the survey about this factor cover different aspects of "Technology" component of the TPACK. The aspects include new opportunities and options with using computer, inspiration, using computer better, ability to use computer, inclusion of computer based activities, new mathematics subjects with computer, computer use and its effect on professional teaching, anxiety about computer use etc. Therefore, the items in this factor mostly consist of related statements.

Mean scores of almost all items (except three of them) in the "Technology" factor are lesser than 2.50 (that is, agree). Correspondingly, the factor overall mean score ($\bar{x}$ =2.21) is "agree" as well. Therefore, the trainee teachers agree about the stated aspects of computer and its use in mathematics education. This result clearly indicates that the students' attitude to computer about "Technology" component is sufficient.

Factor 3: TPACK 3 (content)

Third factor has 10 items. The items in this factor usually are about "Content" component of the TPACK. Therefore, the factor is named as "Content". 'Content' (C) is the subject matter that is to be learned/taught, that is, mathematics. The items in the survey about this factor cover different aspects of "Content (Mathematics)" component of the TPACK. They include two different aspects. First one is about learning different subjects of mathematics and their details, for example, facts, figures, practical works, creative activities etc. Second one is about effective computer use in mathematics education. Therefore, the items in this factor mostly consist of related statements.

Mean scores of the first group of all items (learning component) in the "Content" factor are lesser than 2.50 (that is, agree). Correspondingly, the components overall mean score ($\bar{x}$ =1.89) is "agree" as well. Therefore, the trainee teachers agree about the learning aspects of computer use in mathematics education.

Mean scores of the second group of all items (effective computer use component) in the "Content" factor are greater than 2.50 (that is, disagree). Correspondingly, the components overall mean score ($\bar{x}$ =3.15) is "disagree" as well. All of the items in this category are negatively phrased. Therefore, the trainee teachers' disagreement with the items indicates a positive attitude. These two results clearly indicate that the students' attitude to computer about "Content" factor is sufficient.

Descriptive statistic results of the Likert type statements

Table 3 presents the primary mathematics trainee teachers' overall responses to the 39 Likert type items about computer. Table 3 lists the items (translated from the original Turkish) in order of level of agreement, not in the order in which the items were presented in the questionnaire. Some statements are negatively phrased, so disagreeing with them is a positive statement about the use of computers. The results reveal that the Turkish pre-service mathematics teachers' views about computer and its use in mathematics are varied. Percentages show agreement level of the students with various aspects of computer and its use in mathematics education.

Positive attitudes

The only definitely agreed statement in the scale is "all students should have an opportunity to learn maths with

Table 3. Descriptive statistics results of the 39 statements in the scale (%).

	Definitely agree	Agree	Disagree	Definitely disagree
All students should have an opportunity to learn maths with computer at school	42.1	48.5	8.1	1.4
Computer helps me to get better pictures of the facts and figures in maths	35.7	50.1	13.1	1.1
Computer will improve mathematics education	31.0	56.1	12.0	.8
I would like to learn more about computer based mathematics education	31.9	53.9	11.4	2.8
Knowing how to use computers will help me do well in my teaching career	30.2	55.6	12.3	2.0
With computer, it is possible to do practical things in maths	25.0	62.5	10.8	1.7
If I could learn doing maths with computer better, I believe I am going to teach more successfully	31.9	48.3	16.4	3.3
Computers would stimulate students to learn more maths	25.3	60.7	10.3	3.6
It is possible to teach maths better with computer	20.7	59.4	19.0	.8
Maths teacher training should include computer based maths activities	20.6	60.0	16.9	2.5
Computer would improve students' ability of doing maths	20.1	60.2	17.5	2.2
Doing maths with computer is enjoyable and stimulating	16.1	63.1	18.9	1.9
I think I will enjoy teaching maths with computer	18.8	55.6	22.2	3.4
I am sure I am going to do better tasks with computer in maths	13.4	57.4	27.2	2.0
Computer gives me more opportunity to learn new subjects in maths	16.8	50.6	29.3	3.4
I like doing maths with computer	16.1	54.2	24.4	5.3
If there were a computer in my classroom, it would help me be a better maths teacher	19.2	47.1	29.2	4.5
I enjoy learning maths with computer	12.0	55.7	29.7	2.5
If it is possible I prefer computer to traditional ways in maths	15.5	50.8	29.1	4.5
If I could, I would take more computer based maths subjects	20.9	38.5	31.0	9.5
Computers can be used successfully with maths courses which demand creative activities	14.0	46.9	32.0	7.0
Doing maths with computer never threats me	12.6	46.6	34.4	6.4
Doing maths with a computer makes me feel relaxed	6.9	50.0	39.7	3.3
Using computer in maths education is a difficult job*	8.9	43.6	42.7	4.7
I think doing maths works with computers take more time*	14.3	37.5	**38.7**	9.5
I think it is easy to use computer in maths	10.0	43.3	38.6	8.1
Computer help me to learn maths more easily	6.1	44.3	45.4	4.2
I like computer used maths lectures more	12.5	35.1	42.3	10.0
I have a lot of self confidence with it comes to doing maths with computers	8.4	38.2	47.8	5.6
I can learn more maths from computer than books	10.8	34.7	43.6	10.8
I feel more comfortable using computer in maths	7.0	36.9	45.9	10.1
Computer used maths lectures are my most favourite at school	9.5	30.7	49.2	10.6
I learn maths better, when I use computer	4.2	34.0	52.9	8.9
I would learn more maths If I could use computers more often	8.1	26.1	52.0	13.8
I try to do less work with computer about maths*	3.4	35.2	48.3	13.1
Learning maths with computer is a waste of time*	3.9	17.3	59.9	18.9
I never think to use computer in maths lessons*	2.5	10.1	55.2	32.2
Using computer in maths education is a waste of time*	3.1	6.7	53.1	37.2
I think I will never use computer when I teach maths*	1.9	8.4	52.1	37.6

* denotes negatively phrased items.

computer at school" (42.1% strongly agree and 48.5% agree). Nearly all of the trainee teachers are very aware of this inevitable aspect of mathematics education that has to be provided for all students nowadays. But, still a smaller percent (9.5%) of the pre-service teachers disagree with the statement.

The trainee teachers agreed with most of the statement (total of twenty six) in the scale. They declare possible enhancements of individual mathematics learning with the opportunities of computer; “Computer helps me to get better pictures of the facts and figures in maths” (35.7% strongly agree, 50.1% agree), and “Computer gives me more opportunity to learn new subjects in maths” (16.8% strongly agree, 50.6% agree). Most of the trainee teachers are ambitious about receiving more mathematical experiences with computers during their training; “If I could learn doing maths with computer better, I believe I am going to teach more successfully” (31.9% strongly agree, 48.3% agree). They see this opportunity as an important indication of being a successful mathematics teacher. The trainee mathematics teachers believe that teaching and learning of mathematics is going to be improved with the help of computer; “Computer will improve mathematics education” (31% strongly agree, 56.1% agree). Correspondingly, trainee teachers admit that the computer’s contribution to the teaching of mathematics; “Knowing how to use computers will help me do well in my teaching career” (30.2% strongly agree, 55.6% agree). Likewise, trainee teachers seem to be very aware of the computer role in mathematics education; “With computer, it is possible to do practical things in maths” (25% strongly agree, 62.5% agree). Moreover, the trainee teachers are enthusiastic and ready to get more information about computer based mathematics education. They agree with the statements of “I would like to learn more about computer based mathematics education” (31.9% strongly agree, 53.9% agree), “Maths teacher training should include computer based maths activities” (20.6% strongly agree, 60% agree) and “If I could, I would offer more computer based maths subjects” (20.9% strongly agree, 38.5% agree).

Trainee teachers are also aware of computer’s capacity to inspire learning and studying mathematics; both for students and themselves. They confirm this fact with similar statements in the scale; “Computers would stimulate students to learn more maths” (25.3% strongly agree, 60.7% agree), “Computer would improve students’ ability of offering maths” (20.1% strongly agree, 60.2% agree) and “Computer helps me to learn maths more easily” (6.1% strongly agree, 44.3% agree). In the same way, trainee teachers agree that the computer helps not only in learning mathematics but also teaching mathematics better; “It is possible to teach maths better with computer” (20.7% strongly agree, 59.4% agree).

Moreover, they found out that offering mathematics with computer is much more enjoyable and they really like it. Trainee teachers are in agreement with some parallel statements; “Studying maths with computer is enjoyable and stimulating” (16.1% strongly agree, 63.1% agree), “Studying maths with a computer makes me feel relaxed” (6.9% strongly agree, 50% agree), “I like doing maths with computer” (16.1% strongly agree, 54.2% agree), “Studying maths with computer never threatens me” (12.6% strongly agree, 46.6% agree). In the same way, they also enjoy learning mathematics with computer; “I enjoy learning maths with computer” (12% strongly agree, 55.7% agree).

Trainee teachers thinks that not only offering and learning mathematics with computer is enjoyable but also teaching mathematics is enjoyable as well; “I think I will enjoy teaching maths with computer” (18.8% strongly agree, 55.6% agree). Furthermore, they have self confidence about doing better tasks with computer in mathematics; “I am sure I am going to do better tasks with computer in maths” (13.4% strongly agree, 57.4% agree), and find it easy “I think it is easy to use computer in maths” (10% strongly agree, 43.3% agree).

Trainee teachers wish to be in a learning environment during their training which has more opportunities about computer. This fact is highly accepted by the students; “If there were a computer in my classroom, it would help me to be a better maths teacher” (19.2% strongly agree, 47.1% agree). Moreover, they prefer computer to other methods in mathematics; “If it is possible, I prefer computer to traditional ways in maths” (15.5% strongly agree, 50.8% agree). Trainee teachers also believe computer contribution to creative activities in mathematics; “Computers can be used successfully with maths courses which demand creative activities” (14% strongly agree, 46.9% agree).

Trainee teachers largely disagree with negative statements (disagreement with the negative statements indicates positive attitudes) about usefulness of computer in mathematics; “Using computer in maths education is a waste of time” (53.1% disagree, 37.2% definitely disagree), “Learning maths with computer is a waste of time” (59.9% disagree, 18.9% definitely disagree). Thus, most of the sample considers using the computer to be a worthwhile activity. Similarly, they disagree with the negative statements about using computer in mathematics both for teaching and learning; “I think I will never use computer when I teach maths” (52.1% disagree, 37.6% definitely disagree), “I never taught of using computer in maths lessons” (55.2% disagree, 32.2% definitely disagree) and “I try to do less work with computer about maths” (48.3% disagree, 13.1% definitely disagree). On the other hand, quite a number of trainee teachers are in favour of either agree or strongly agree with the above statements (Table 3). Thus, these students are still having negative taught about computer and its uses in mathematics education.

Negative attitudes

Although most of the primary mathematics trainee teachers have positive feelings and their attitudes are in favour of computer based mathematics, some of them have confused feelings and are resistant to several aspects of the context. For example, half of the trainee teachers think that studying mathematics works with computer are time consuming; “I think studying maths works with computers take more time" (14.3% strongly agree, 37.5% agree). Besides, they assume that using computer is a difficult job; "Using computer in maths education is a difficult job" (8.9% strongly agree, 43.6% agree).

Most of the trainee teachers do not like computer used in mathematics lectures received during their training at the department; "I like computer to be used in maths lectures more" (42.3% disagree, 10% definitely disagree). Similarly, these lectures were not their favourites at the training; "Computer used maths lectures are my most favourite at school" (49.2% disagree, 10.6% definitely disagree). Most of them also do not believe computer contribution to their mathematics learning; "I learn maths better, when I use computer" (52.9% disagree, 8.9% definitely disagree) and "I would learn more maths If I could use computers more often" (52% disagree, 13.8% definitely disagree). In addition, more than half of the students do not see computer as a valuable and versatile source of information; "I can learn more maths from computer than books" (43.6% disagree, 10.8% strongly disagree). Moreover, most of the trainee teachers do not feel comfortable and do not have self confidence about using computer; "I feel more comfortable using computer in maths" (45.9% disagree, 10.1% definitely disagree) and "I have a lot of self confidence when it comes to offering maths with computers" (47.8% disagree, 5.6% strongly disagree).

A comparison (t-test) between all of the 39 statements about trainee teachers' attitudes to computers in mathematics education and the factor of gender are also been calculated. There is some level of statistically significant difference ($p \leq 0.05$) between male and female trainee teachers for only a few (a total of four) statements. These statements are about using computer in mathematics. Female students disagree with all of the four statements while male students agree with them. The female students think that using computer in mathematics is not easy ($\bar{x}$ = 2.54), they do not like computer used mathematics lectures ($\bar{x}$ = 2.61), they do not have self confidence about offering mathematics with computers ($\bar{x}$ = 2.58) and they do not feel more comfortable using computer in mathematics ($\bar{x}$ =2.70), while the male students agree with all of the four statements ($\bar{x}$ = 2,33, $\bar{x}$ = 2,37, $\bar{x}$ = 2.42, $\bar{x}$ = 2.46, respectively). There is no statistically significant difference ($p \geq 0.05$) between male and female trainee teachers for all of the other statements. Thus, it can be said that both male and female students have same level of attitudes, feelings, anxiety and self confidence about computers.

DISCUSSION AND CONCLUSION

The aforementioned results show different aspects of primary mathematics trainee teachers' attitudes to computers in mathematics education. First of all, they are very aware of the role of computer's in mathematics education. They recognized computer's inspiration to learning, studying and teaching mathematics both for students and teachers. They appreciate possible enhancements to individual mathematics learning with the opportunities provided by the computer and IT. Trainee teachers accept that computer helps not only in learning mathematics but also teaching mathematics better. They admit the computer's contribution to the teaching of mathematics. They also prefer the computer to other traditional methods both in teaching and learning mathematics, and believe computer can make a contribution in creative activities in mathematics. Thus, they reassure and clearly declare that teaching and learning mathematics is going to be improved by the help of computer. In addition, more than half of the students see computer as a valuable and versatile source of information.

Enjoyment, enthusiasm and self-confidence are very important affective factors in learning and teaching mathematics. These results show that Turkish trainee teachers are enthusiastic and ready to get more information about computer based mathematics education. Moreover, they found that studying mathematics with computer is much more enjoyable and they really like it. They also enjoy learning mathematics with computer too. In the same way, the trainee teachers think that both learning and teaching mathematics with computer are enjoyable. Besides, they have some level of self-confidence about doing better tasks. Thus, teachers with knowledge and experience with computers have a more positive attitude toward the potential of computers in education, and teacher attitudes and expertise are the major factors in the adoption and successful use of computer technologies. In addition, training is an important factor in fostering favourable attitudes towards computers.

Trainee teachers largely disagree with statements about the uselessness of computer in mathematics. Most of the samples consider using computers to be a worthwhile activity. Similarly, they disagree with the negative statements about using the computer in mathematics both for teaching and learning. Therefore, most of them suggest that they are going to use computer both for teaching and learning activities. It can be said that strategies to enhance teacher experience with computers could contribute to the formation of positive attitudes, thus, influencing teachers' use of computer and technology. These experiences can be in teacher training courses with content specific computer classes. These classes may be effective for reducing computer anxiety and helping students to gain competency in skills and confidence in using technology in the curriculum.

On the other hand, trainee teachers' views revealed highly important issues about the context (those have to be solved) during their professional training. One of the important issues is providing better training (learning) environments with more educational opportunities including computer and technology. The trainee teachers' aspiration about having more experience with computers during their training is an important indication of being a successful teacher. Another important point is students' anxiety about studying mathematics with computer. Trainee teachers consider studying mathematics works with computer to be time consuming. Furthermore, they also found that using the computer in mathematics is a difficult job.

Additionally, trainee teachers' responses also reveal some problematic feelings about computer in mathematics education. Most of the trainee teachers do not like computer based activities which they used in mathematics lectures very seldom. Similarly, computer based mathematics lectures are not their favourites. So even though the trainee teachers believe that computer would improve students' mathematics learning, they do not have the same feelings about themselves. They disagree that they could learn mathematics easily when they use computer. Moreover, most of the trainee teachers feel uncomfortable and have low level of self-confidence about using computers in mathematics. Trainee teachers revealed some factors which affect these considerations in the open ended part of the questionnaire (Dogan, 2008). They stated that they seldom came across the computer during the lectures and had inadequate computer based mathematics experiences. This may have been a basis on the views about computer contribution to their mathematical knowledge.

It is very important to change trainee teacher feelings towords a positive direction. Thus, all teachers have to be aware of this contemporary option which offers new opportunities in mathematics education. Teacher training courses have to provide all facilities and have the responsibility to provide this experience and make all trainees aware of this technology. These may show that, although, the pre-service teachers seem to appreciate teaching mathematics with computer, some of them are still resistant to context and may not fully recognize the situation.

The quantitative data presented in this study illuminate the views of trainee teachers, drawn from a teacher training department. Trainee teachers in the current study were positive about the use of computers in mathematics. They were generally comfortable and relaxed. However, some of them viewed the computer-based learning environment less favourable.

Despite the possible weaknesses in the study, the findings are consistent with some of the previous findings (Vale and Leder, 2004; McAlister, et al., 2005; Baki, 2000a, 2000b; Usun, 2004). The findings mainly indicate positive trainee teachers' attitudes towards the use of computer in mathematics education. Despite the fact that a smaller percent of the trainee mathematics teachers still seems to be resistant to the use of the computer for their future professional teaching, most of them have significantly stated that they are going to use it. Although the students' feelings about and familiarizations with computers seem to be a good point, responses also reflect that insufficient use of computer at their training with informal source of knowledge and practises, may result in redundant consequences for their later uses. Results show that some of the trainee teachers are still hesitant to include the use of computers in their future teaching. Although many teachers believe that computers are an important component of a student's education, their lack of knowledge and experience lead to a lack of confidence their attempt to introduce technology into teaching. This lack of confidence then leads to anxiety and reluctance to the use of technology. The open ended question of the survey revealed that the training acquired by the trainee teachers does not seem satisfactory. The formal curriculum of the primary mathematics department did not have sufficient level of computer lectures. The students approve that the activities for computer based mathematics education should be more than the usual computer and mathematics lectures. The lectures have to combine computer and mathematics including special tools, software, activities etc. Moreover, it is clear that teacher training need to have facilities and supportive environments with free access to computers and resources not only for common use and basic needs for lectures, but also for individual uses that are necessary for preparing teachers. Thus, providing purposeful activities with computer may increase trainee teachers' perceptions and support their future professional life. Supportive facilities have to be provided for in-service teachers as well.

It is apparent that ignoring teachers' beliefs when implementing instructional change leads to disappointment results. Neiderhauser and Stoddart (2001) stated that increasing the likelihood that computers will be used in ways that are consistent with instructional reforms, professional and pre-service development programs can focus on coupling changes in teachers' conceptions of the teaching and learning process with the availability of appropriate software and training, in how to use it with their students. As Rizza (2000) demands, teacher education programs must have the integration of computer technology and constructivist strategies, particularly with respect to the use of interactivity, real-world problems, context, and purposeful engagement, to be successful. Thus, an agreement may be proven that all of the pre-service primary mathematics teachers have to handle computer with confidence. These are parallel with the recommendations of NCTM (2000) and NCATE (2008) for being a good mathematics teacher. Effective school reform should integrate technology as a key component in the process (David, 1991 cited in Neiderhauser and Stoddart, 2001).

All these findings support the conclusions of Baki (2000a, 2000b) by indicating the need to change the syllabi of teacher training courses in Turkey in a way that it is better matched with the expectations and professional needs of the students and trainee teachers. Teachers need assistance in becoming more aware of how computers can be used to help their students meet a range of instructional objectives. These considerations can be supported by taking into account of Koehler and Mishra's (2008) TPACK theoretical framework to strengthen possible links and interactions between all main factors of pedagogy, technology and content knowledge. Vale and Leder (2004) suggest that the voices of students bring poignancy to the need of considering pedagogical approaches when using computers that will enhance the attitudes and learning of mathematics for these students. As Neiderhauser and Stoddart (2001) concluded, effective ways in using computers to meet a variety of instructional goals will need to become a carefully integrated part of teacher training and professional development efforts designed to change teachers' perspectives about teaching and learning.

REFERENCES

Baki A (2000a). Learning to Teach Mathematics within a Computer-Based Environment. Hacettepe J. Educ., 19: 186-193.

Baki A (2000b). Preparing Student Teachers to Use Computers in Mathematics Classrooms through a Long-Term Pre-Service Course in Turkey. Technol. Pedagogy Educ., 9(3): 343-362.

Baslanti U (2006). Challenges in Preparing Tomorrows Teachers to Use Technology: Lessons to Be Learned From Research. Turk. Online J. Edu. Technol., 5(1): 4.

Bryman A, Cramer D (1997). Quantitative Data Analysis. London: Routledge, p. 63.

Campbell J, Mcrobbie I, Ginns S, Stein J (2000). Pre-service Primary Teachers' Thinking About Technology and Technology Education. Int. J. Technol. Design Educ., 10: 81-101.

Christensen R (1998). Effect of Technology Integration Education on the Attitudes of Teachers and Their Students. Doctoral Dissertation, University of North Texas, http://www.tcet.unt.edu/research/dissert/rhondac/index.htm.

Christensen R, Knezek G (2000). Internal Consistency Reliabilities for 14 Computer Attitude Scales. J. Technol. Teacher Educ., 8(4): 327-336.

Dogan M (1999). Changes in Attitudes to Mathematics of Primary Trainee Teachers. Unpublished Doctoral Dissertation, Leeds University, School Of Education, UK.

Dogan M (2008). Mathematics Trainee Teachers' Attitudes to Computer. BSRLM Day Conference, Southampton, UK, 21 June 2008, http://www.bsrlm.org.uk/IPs/ip28-2/BSRLM-IP-28-2-Full.pdf

Galbraith P, Haines C (1998). Disentangling the Nexus: Attitudes to Mathematics And Technology in a Computer Learning Environment. Educ. Studies Mat., 36: 275-290.

Garofalo J, Drier H, Harper S, Timmerman MA, Shockey T (2000). Promoting Appropriate Uses of Technology in Mathematics Teacher Preparation. Contemporary Issues Technol. Teacher Educ., 1(1): 66-88.

Kadijevich DJ, Haapasalo L (2001). Linking Procedural and Conceptual Mathematical Knowledge Through CAL. J. Comput. Assisted Learn., 17(2): 156-165.

Kaput JJ (1992). Technology and Mathematics Education. In D.A. Grouws (Ed.), Handbook of Research on Mathematics Teaching and Learning. New York: Macmillan, pp. 515-556 .

Koehler MJ, Mishra P (2005). What Happens When Teachers Design Educational Technology? The Development of Technological Pedagogical Content Knowledge. J. Edu. Computing Res., 32(2): 131-152.

Koehler MJ, Mishra P (2008). Introducing Technological Pedagogical Knowledge. In The Handbook of Technological Pedagogical Content Knowledge for Educators, Edited by AACTE Committee on Innovation and technology. AACTE and Routledge, NY (provide page numbers).

McAlister M, Dunn J, Quinn L (2005). Student Teachers' Attitudes to and Use of Computers to Teach Mathematics in the Classroom. Technol. Pedagogy Educ., 14(1): 77-105.

MEB (Milli Eğitim Bakanlığı, Ministry of National Education), (2007). İlköğretim Matematik Dersi Öğretim Programı ve Kılavuzu (Primary Mathematics Curriculum), pp. 7-22.

Monaghan J (1993). IT in Mathematics Initial Teacher Training-Factors Influencing School Experience. J. Computer Assisted Learn., 9: 149-160.

Monaghan J (2004). Teachers' Activities in Technology-Based Mathematics Lessons. Int. J. Comput. Mat. Learn., 9: 327-357.

Mumtaz S (2000). Factors Affecting Teachers' Use of Information and Communications Technology: A Review of the Literature. Technol. Pedagogy Educ. 9(3): 319-342

Murphy C, Greenwood L (1998). Effective Integration of Information and Communications Technology in Teacher Education. Technol. Pedagogy Educ., 7(3): 413-429.

NCATE (National Association for Accreditation of Teacher Education), (2008). Professional standards Accreditation of Teacher Preparation Institutions: The Standard of Excellence in Teacher Preparation, p. 4.

NCTM (National Council of Teachers of Mathematics) (2000). Principles and Standards for School Mathematics. Reston, VA: Author, pp. 24-25.

Neiderhauser DS, Stoddart T (2001). Teachers' Instructional Perspectives and Use of Educational Software. Teach. Teacher Educ., 17: 15-31.

Ocak MA (2005). Mathematics Teachers' Attitudes toward the Computers. Turk. Online J. Educ. Technol., 4(3): 11.

Rizza MG (2000). Perspectives on Pre-service Teachers' Attitudes Toward Technology. The Teacher Educator, 36(2): 132-147.

Strudler NB, Wetzel K (1999). Lessons from Exemplary Colleges of Education: Factors Affecting Technology Integration in Pre-service Programs. Educ. Technol. Res. Dev., 47(4): 63-81.

Thurston CO, Secaras ED, Levin JA (1997). Teaching Teleapprenticeships: an Innovative Model for Integrating Technology into Teacher Education. J. Res. on Computing Educ., 29: 385-391.

Usun S (2004). Undergraduate Students Attitudes on the Use of Computers in Education. Turk. Online J. Educ. Technol., 3(2): 10

Vale CM, Leder GC (2004). Student Views Of Computer-Based Mathematics in the Middle Years: Does Gender Make a Difference? Educ. Studies Mat., 56: 287-312.

Wang A, Coleman A, Coley R, Phelps R (2003). Preparing Teachers around the World. Princeton: ETS, pp. 11-13, 30.

Wenglinsky H (2000). How Teaching Matters: Bringing the Classroom Back Into Discussions of Teacher Quality. Educational Testing Service (ETS). Princeton, NJ, USA, p. 30.

Yavuz S (2005). Developing a Technology Attitude Scale for Pre-Service Chemistry Teachers. Turk. Online J. Edu. Technol., 4(1): 2.