International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:4, No:7, 2010

Integrating Technology into Mathematics Education: A Case Study from Primary Mathematics Students Teachers

Berna Cantürk-Günhan, Esra Bukova-Güzel

***Abstract*—**The purpose of the study is to determine the primary mathematics student teachers' views related to use instructional technology tools in course of the learning process and to reveal how the sample presentations towards different mathematical concepts affect their views. This is a qualitative study involving twelve mathematics students from a public university. The data gathered from two semi-structural interviews. The first one was realized in the beginning of the study. After that the representations prepared by the researchers were showed to the participants. These representations contain animations, Geometer's Sketchpad activities, video-clips, spreadsheets, and power-point presentations. The last interview was realized at the end of these representations. The data from the interviews and content analyses were transcribed and read and reread to explore the major themes. Findings revealed that the views of the students changed in this process and they believed that the instructional technology tools should be used in their classroom.

***Keywords*—**Integrating Technology, Mathematics Education, Primary Education, Teacher Education.

I. Introduction

TODAY, teachers guide for students to learn mathematical concepts in mathematics education at all levels. In this process, technology is used as a mind tool that ''can be used to support the deep reflective thinking that is necessary for meaningful learning.'' [1] The National Council of Teachers of Mathematics stated that technology is an essential tool for teaching and learning math, technology be used wisely by well-informed teachers to support mathematical understanding [2].

Some research studies have shown that the use of instructional technologies can help improve students' skills. The use of technology in mathematics lessons has provide students to have positive attitudes, build confidence in their ability to do mathematics, construct mathematical knowledge, and visualize abstract mathematical concepts [3]. Kerrigan has found the benefits of using mathematics software and websites to include promoting students' higher-order thinking skills, developing and maintaining their computational skills, introducing them to collection and analysis of data, facilitating their algebraic and geometric thinking, and showing them the role of mathematics in an interdisciplinary setting [4]. Wenglinsky revealed that computers may serve to improve student mathematics achievement as well as enhance the overall learning environment of the school [5]. The utilization of technology in the mathematics classroom can range from simple information delivery and drill-and practice exercises to an environment of authentic practices and problem solving [6]. As a result of such researches and because of integrating technology positive affects to the learning, teachers must be able to integrate technology in their mathematics lessons and use technology as a teaching or learning tool.

The Committee for the Association of Mathematics Teacher Educators, the teacher preparation programs need to focus on strengthening the pre-service teachers' knowledge of how to incorporate technology to facilitate student learning of mathematics through experiences that:

- *allow teacher candidates to explore and learn mathematics using technology in ways that build confidence and understanding of the technology and mathematics;*
- *model appropriate uses of a variety of established and new applications of technology as tools to develop a deep understanding of mathematics in varied contexts;*
- *help teacher candidates make informed decisions about appropriate and effective uses of technology in the teaching and learning of mathematics; and*
- *provide opportunities for teacher candidates to develop and practice teaching lessons that take advantage of the ability of technology to enrich and enhance the learning of mathematics [7].*

Therefore the purpose of this study is to investigate how pre-service teachers comprehend learning and teaching through the use of instructional technologies such as animations, Geometer's Sketchpad software, video-clips, spreadsheets, and power-point presentations and what they think about the instructional technologies. It is thought that this study will change the pre-service teachers' perspectives about the use of instructional technology.

Berna Cantürk-Günhan is with Dokuz Eylul University, Facuty of Education, Department of Primary Education, , Izmir, Turkey. (corresponding author to provide phone: +90 232 420 48 82; e-mail: berna.gunhan@deu.edu.tr). ,

Esra Bukova-Güzel is with Dokuz Eylul University, Facuty of Education, Department of Science and Mathematics Education, Izmir, Turkey. (corresponding author to provide phone: +90 232 420 48 82; e-mail: esra.bukova@deu.edu.tr).

II. Method

The investigation was a qualitative case study. This research was conducted during the spring term of 2006–2007 academic years at a state university in Izmir, Turkey in seven weeks. The data collected from two semi-structural interviews. These were pre-interview before the representations about integrated technology into mathematics education and post-interview after the representations. Firstly, pre-interview was realized with twelve primary mathematics student teachers at the beginning of the study. Secondly, the learning tools integrated technologies prepared by the researchers were represented to the students in five weeks. These representations about integrated technologies mathematical concepts contain flash animations, Geometer's Sketchpad activities, video-clips, spreadsheets, and power-point presentations. After these representations, the post-interview was carried out with the students. The interview data transcribed at the end of the study.

A. Participants

The study group was formed of twelve primary mathematics student teachers (6 females and 6 males) from the Faculty of Education. The students were determined by using the purposeful sampling method. The students were classified as to receive the courses about mathematics content knowledge, general pedagogical knowledge, pedagogical content knowledge, integration technology into mathematics education, and school experience and to use the computer programs.

Six students who were receiving the courses about mathematics content knowledge and general pedagogical knowledge were in third class. These students knew office programs (word, excel, and power-point) and software program (sketchpad) in different levels. These levels included same quantity of the students were named as the low, medium, and high level. The low level's students knew the office programs in very limited usage. The medium level's students knew the office programs. The high level's students use functionally the office and software programs.

Six students who completed the courses about mathematics content knowledge, general pedagogical knowledge, pedagogical content knowledge, integration technology into mathematics education, and school experience were in fourth class. Besides, these students knew office programs (word, excel, and power-point) and software programs (sketchpad and derive) in different levels. The low level's students knew the office programs. The medium level's students knew the office and software programs. The high level's students use functionally the office and some software programs.

The characteristics of the students were given in Table I. In this table, the letters were formed by using the first letter of the participants' names.

TABLE I
THE CHARACTERISTICS OF THE STUDENTS

Classes	Levels	Microsoft Office	Sketchpad	Derive
The Third Class	Low Level	G, Z	-	-
	Medium Level	H, C	-	-
	High Level	A, S	A, S	-
The Fourth Class	Low Level	T, O	-	-
	Medium Level	Y, E	Y, E	-
	High Level	D, S	D, S	D, S

B. Instruments

In this study, the data collected from two semi-structural interviews containing the pre-interview and the post-interview. Three open-ended questions were asked to the students in these interviews. "How the instructional technology tools affect constructing mathematical concepts" and "Could you prepare the instructional technology tools? If you want to prepare instructional technology tools, what will you take into account?" were asked to the students during the pre-interview. In additional to these questions, "which representation did you most like?" was asked to them in the post-interview for determining the students' views about the representations.

C. Materials

In this study, the representations were used as materials. It was developed about integrated technologies mathematical concepts including flash animations, Geometer's Sketchpad activities, video-clips, spreadsheets, and power-point presentations. When these materials were prepared it was noticed that they were suitable for constructivist learning environment. In this part, it was introduced these materials.

1-Flash Animations

In this study, the Flash Animations were provided to construct mathematical knowledge, procedures, and concepts by using mathematical models. It was intended that these materials should be interesting, emphasize the critical points of the concepts, and allow meaningful learning. Nine representations were presented about the flash animations such as limit concept, function concept, induction, and factorization. One of the examples was given in Figure 1. In this animation, it was aimed to construct the factorization concept by using geometrical shapes.

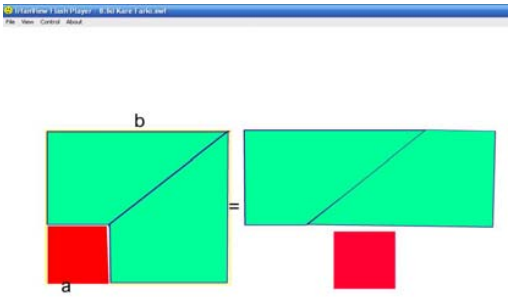

Fig. 1 The one example of flash animations about the factorization

2-Geometer's Sketchpad Activities

The Geometer's Sketchpad activities were mainly used to show dynamic representations of the properties of the triangles' area. These representations were important to estimate the static of the area when the height and its side conditions were not altered. It was intended that these materials should provide making mathematical conjectures and using the dynamic capabilities to visualize an idea under a wide variety of situations. One of the examples was given in Figure 2. In this Geometer's Sketchpad activities, it was aimed to discuss how the area of the triangle was static.

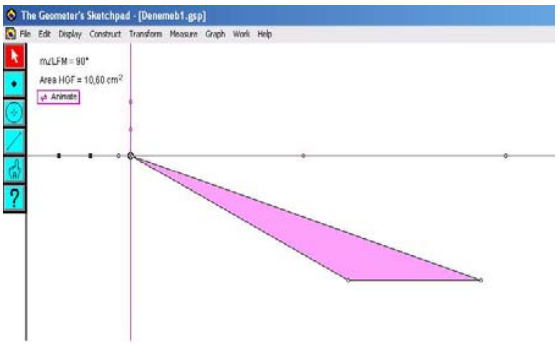

Fig. 2 The one example of the Geometer's Sketchpad activities about the area of the triangle

3-Video Clips

In this study, the video-clips were mainly used to show the constituting of the three dimensional figures such as cylinder and rectangular parallelepiped. These representations were important to promote the mathematical thinking and higher-order thinking, to enrich students' understanding, to generate the mathematical concepts by providing visualization, to assist students as a scaffolding, to reveal 3-D figures' qualities by students. One of the examples was given in Figure 3. In this video-clip, it was aimed to reveal rectangular parallelepiped by using the papers whose shapes had the same areas. It was intended that students recognized the characteristics of the rectangular parallelepiped when it was generate in the video-clip.

Fig. 3 The one example of the video-clips activities about rectangular parallelepiped

4-Spreadsheets

The spreadsheets activities were mainly used to construct the mathematical modeling about given situations. These representations were important to explore mathematical formulas, to generalize the mathematical connections, to develop problem solving skills, to discover mathematical concepts properties. One of the examples was given in Figure 4. In this spreadsheets activity, it was aimed to arrange in order the given fractions.

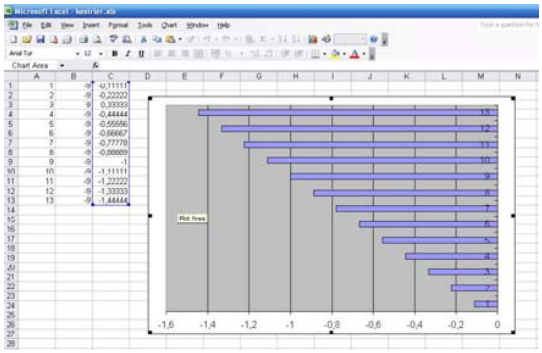

Fig. 4 The one example of the spreadsheets activities about fractions

5-Power-Point Representations

The PPT presentations were mainly used to give knowledge, to assess students' understanding, to present the history of mathematical concepts, to provide mathematical games. These representations were important to show mathematical and general knowledge, to render interesting to lesson. One of the examples was given in Figure 5. In this PPT presentation, it was aimed to understand the absolute value concept and to assess understanding.

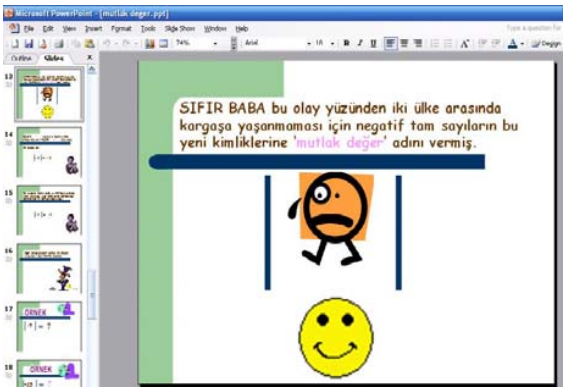

Fig. 5 The one example of the power-point representations about the absolute value concept

D. Procedure

The researchers investigated the learning tools in literature. Then the representations about integrating technologies in mathematics concepts were organized by the researchers. These are flash animations, Geometer's Sketchpad activities, video-clips, spreadsheets, and power-point representations.

The application was carried out within seven weeks. All of the students who took part in the study were interviewed at the beginning of the study. The interviews, which form the

majority of the material, are characterized by reflective conversations. The length of the interviews varied between 20 and 25 minutes. Before each interview took place, the students were informed of the purpose of the interview. All of the interviews were tape-recorded with the permission of the students. The pre-interviews kept going in the first week.

The flash animations representation was put forward to the students in the second weeks. Geometer's Sketchpad activities, video-clips, spreadsheets, and power-point representations were offered respectively during four weeks. Every representation lasted about 90 minutes. After every representation was introduced, it was asked for the students to discuss related the representations.

At the end of the study, all of students were interviewed in the seven week. The data transcribed at the end of the study.

E. Data Analysis

The interviews were recorded with the audio-taped. The data were transcribed verbatim and then they were coded. Evaluation was guided by the ideas of qualitative content analysis [8]. The coded data were presented and described under these main themes, and then the interpretation and discussion of the results was offered. The main theme named "The Students Views about the Using Technology", "The Students' Approaches for Preparing Instructional Tools", and "The Students' Views about The Instructional Tools". The students' responses were grouped in the main themes. It could try to evaluate the differences between the pre-interview and the post-interview.

III. Results

The findings obtained from the pre and post interviews were discussed in this part. During the interviews, the questions like "How the instructional technology tools affect constructing mathematical concepts", "Could you prepare the instructional technological tools? If you want to prepare technological learning tools, what will you take into account?", and "which representation did you most like? Or which representations did you like?" were answered by the students. The analysis of the pre-interviews and post-interviews produced certain themes in relation to the use of instructional technological tools. The results of this study are presented under these themes, along with the necessity of the technology in primary mathematics education, using technology in constructing mathematical concepts, preparing this kind of tools, and the views about presented tools. In the pre-interviews, the excess of half of the students (n=7) mentioned that the instructional technological tools should be use in constructing mathematical concepts but two students in third class explained that the instructional technological tools were unnecessary in mathematics education and three students in fourth class declared that the using instructional integrated technological tools would depend on the mathematical subjects. On the other hand, in the post-interviews, all the primary mathematics student teachers stated that the instructional technological tools should be use in mathematics education. The views of primary mathematics student teachers in the third class concerning the effects of using instructional technological tools in constructing mathematical concepts were shown in Table II as follows. In Table II, it was seen that the students' views changed in pre and post interviews.

TABLE II
THE VIEWS OF THE PRIMARY MATHEMATICS STUDENT TEACHERS IN THE THIRD CLASS ABOUT THE USING TECHNOLOGY

Student Teachers' Views *	**3L1**	**3L2**	**3M 1**	**3M 2**	**3H1**	**3H2**
Technology is helps our understanding.	G, Z	G, Z	-	H, C	-	-
It provides retention of learning.	-	Z	-	-	A	A
It can supply visualization the mathematical concepts.	Z,	G, Z	H, C	H, C	A, S	A, S
It can gain the higher-order thinking to the students.	Z,	Z	-	-	-	-
It can motive.	-	G	H, C	H, C	A	A, S
It can improve the research skills of the students.	-	-	H	H	-	-
It can become better their critical thinking skills.	-	-	H	H	-	S
It can increase in quality of their mathematical thinking skills.	-	-	H	H	-	S
It can enhance their intuitive thinking skills	-	-	-	-	-	A
It can supply for the students to thinking creatively.	-	Z	-	H, C	-	-
It can connect the mathematical concepts with the real world.	Z	Z	C	C	-	-
It can accomplish active learning	-	G, Z	-	C	A	A, S
It can provide that what the students learned integrate another subject.	-	Z	-	-	-	-

* 3L1 means that the students in third class having the low level were pre-views, 3L2 means the students in third class having the low level were post-views. (L: low level, M: medium level, H: high level)

TABLE III
THE VIEWS OF THE PRIMARY MATHEMATICS STUDENT TEACHERS IN THE FOURTH CLASS ABOUT THE USING TECHNOLOGY

Student Teachers' Views *	**4L1**	**4L2**	**4M 1**	**4M 2**	**4H1**	**4H2**
Technology is helps our understanding.	-	O	E	E	S	S
It provides retention of learning.	-	-	Y	Y	D	D
It can enable the mathematical concepts to visualize.	T	T, O	-	-	S	D, S
It can gain the higher-order thinking to the students.	-	-	-	-	-	S
It can motive.	-	T	E	E, Y	D, S	D, S
It can sophisticate the problem solving skills of the students.	-	-	Y, E	Y, E	-	-
It can become better their critical thinking skills.	-	-	Y	Y	-	S
It can supply for the students to thinking creatively.	T	T	-	-	S	S
It can advance their psychomotor skills.	T, O	T, O	-	-	D, S	D, S
It can give an opportunity for exploring and discovering results.	O	O	-	E	-	-
It can connect the mathematical concepts with the real world.	-	-	Y	Y, E	D	D
It can carry out active learning.	T, O	T, O	Y, E	Y, E	D	D

* 4L1 means that the students in fourth class having the low level were pre-views, 4L2 means the students in fourth class having the low level were post-views. (L: low level, M: medium level, H: high level)

It can be seen in Table II, it was expressed by the students that the instructional technology tools help understanding of the mathematical concepts, provide visualization of the mathematical concepts and retention of learning, supply for the students to thinking creatively, can be motive, and accomplish active learning. They are very important results in terms of the using of these materials. Furthermore, it is seen that their first views changed positively.

The views of primary mathematics student teachers in the fourth class in relation to the same questions were shown in Table III. In Table III, it was seen that these students' views also changed in the pre and post interviews. These students' views were consistent with the third class students' views. They also expressed the different views than the ones of the third class such as many students said that it sophisticate the problem solving skills and the psychomotor skills, give an opportunity for exploring and discovering results.

When examined Table III, in addition to the third class students' views, it was put into words by most of the fourth class students that the instructional technological tools could connect the mathematical concepts with the real world. The students also mentioned that using instructional technologies in constructing mathematical concept developed students' learning outcomes such as motivation, higher-order thinking, researching skills, and communication among the peers. These results were shown that the views of the students changed in this process and they believed that the instructional technologies were positively affected on the construction of mathematical concepts.

The students' responds regarding the question what you will notice while you prepare the instructional tools were given Table IV.

TABLE IV
THE APPROACHES OF THE PRIMARY MATHEMATICS STUDENT TEACHERS IN THE THIRD CLASS FOR PREPARING INSTRUCTIONAL TOOLS

Student Teachers' Views	3L 1	3L 2	3M 1	3M 2	3H 1	3H 2
It should be appropriate lesson' objectives.	-	-	C	C, H	A, S	A, S
It should be suitable for students' pre-knowledge and experiences.	G, Z	G, Z	-	H	A, S	A, S
It should be interesting.	G, Z	G, Z	-	H	-	A
It should relate among the mathematical concept.	-	Z	-	-	-	-
It should emphasize the critical points of the concept.	-	Z	-	C, H	-	S
It should connect the real world with mathematical concepts.	-	Z	-	-	-	-
It should be dynamic.	-	G	-	-	-	-

It can be seen in Table IV, it was declared by the students in the third class that the tools should be suitable for students' pre-knowledge and experiences, be appropriate lesson' objectives, be interesting, and emphasize the critical points of the concept.

The approaches of the primary mathematics student teachers in the fourth class were given in Table V.

TABLE V
THE APPROACHES OF THE PRIMARY MATHEMATICS STUDENT TEACHERS IN THE FOURTH CLASS FOR PREPARING INSTRUCTIONAL TOOLS

Student Teachers' Views	4L 1	4L 2	4M 1	4M 2	4H 1	4H 2
It should be appropriate lesson' objectives.	-	-	E	E, Y	D, S	D, S
It should be suitable for students' pre-knowledge and experiences.	T	T	Y	E, Y	S	S
It should be interesting.	-	T	E	E	-	D
It should be prepared to prevent misconceptions about the concept.	O	O, T	-	Y	D	D
It should provide higher-order thinking.	T	T	-	-	-	-
It should relate among the mathematical concept.	T	T	Y	Y	-	-
It should emphasize the critical points of the concept.	-	O	E	E	-	D
It should connect the real world with mathematical concepts.	-	-	-	E	D	D

The views of the fourth class's students were similar the third class students' views. They also expressed the different views than the ones of the third class such as many students said that it should relate among the mathematical concept and connect the real world with mathematical concepts.

In addition to the third class students' views, it was made clear by most of the fourth class students that the instructional technological tools should be prepared to prevent misconceptions about the concept and provide higher-order thinking.

These results were shown that the views of the students changed in this process and they believed that the instructional technological tools should be many properties of the constructivist learning environment.

In the post-interview, the question "which representations did you most like?" was answered by the students. 50% of the students said that they liked Geometer's Sketchpad activities, 83% of the students liked flash activities, and 58% of the students liked excel activities.

IV. DISCUSSIONS AND CONCLUSION

This study addressed the primary mathematics student teachers' views about using instructional technological tools in math class. The main findings from the data revealed four major themes: necessity of technology in mathematics education, the positive sides of the instructional technological tools, preparing instructional technological tools and the thoughts about instructional technological tools.

The first theme was the necessity of the technology in mathematics education. After the presentations, all of the participants maintain the necessity of the technology.

The second theme was the positive sides of the instructional technological tools. It was shown that the views of the students changed and the third and fourth mathematics teachers believed that the instructional technology tools were positively affected the learning process. They declared that the instructional technology tools can gain higher-order thinking skills and constructivist learning environment. For this reason, the using of technological tools must be used in

mathematics lessons. The research literature has provided evidence that the using technological tools in mathematics lessons can help students' understanding of mathematics concepts and improve their achievement [9, 10, 11, 12].

The third theme was the preparing instructional technological tools. Both of the students in the third and fourth class expressed that the tools should be suitable for students' pre-knowledge and experiences, be appropriate lesson' objectives, be interesting, prevent misconceptions, connect real world, and emphasize the critical points of the concept. The instructional technological tools should be carefully prepared and effective teachers maximize the potential of technology to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics. When technology is used strategically, it can provide access to mathematics for all students [13].

The fourth theme was the pre-service teachers' thoughts about the prepared instructional technological tools. They said that they liked them.

The using of instructional technological tools plays an important role in education. Integrating technologies in mathematics education developed students' motivation, higher-order thinking, researching skills, and communication among the peers. Besides, Rizza argues that teachers should be use technology in order to be successful in their future careers [14]. That's why, teacher training programs should be include how the pre-service teachers use instructional technological tools in mathematics courses, how they prepare them, and how they present them.

REFERENCES

[1] D. H. Jonanssen, and C. S. Carr, "Mind tools: affording multiple knowledge representations for learning," in *Computers as cognitive tools. No more walls* S. P. Lajoie (Ed.), Hillsdale, NJ: Lawlence Erlbaum Associates, Inc. 2000, pp. 165–196.

[2] National Council of Teachers of Mathematics (NCTM), *Principles and Standards for School Mathematics*, VA Reston. 2000.

[3] G. Kersaint, "Toward technology integration in mathematics education: A technology-integration course planning assignment,"*Contemporary Issues in Technology and Teacher Education*, vol. 7, no. 4, pp 256-278, 2007.

[4] J. Kerrigan, "Powerful software to enhance the elementary school mathematics program," *Teaching Children Mathematics*, vol. 8, no. 6, pp 364–377, 2002.

[5] H. Wenglinsky, "*How teaching matters: Bringing the classroom back into discussions of teacher quality*," Princeton, NJ: Educational Testing Service, 2000.

[6] S. Papert, "*The children's machine: Rethinking school in the age of the computer,"* New York: Basic Books. 1992.

[7] Association of Mathematics Teacher Educators' Technology Committee. *Draft position statement titled Preparing Teacher to Use Technology to Enhance the Learning of Mathematics*. 2005.

[8] P. Mayring, (2000). Qualitative content analysis [28 paragraphs], *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [Online Journal]* Available: *http://www.qualitative-research.net/index.php/fqs/article/view/1089/2385*

[9] D. H. Clements and M. T. Battista. "Computer environments for learning geometry," *Journal of Educational Research*, vol.10, no. 2, pp. 173-197, 1994.

[10] J. I. Heller, D. A. Curtis, R. Jaffe and C. J. Verboncoeur, "The impact of handheld graphing calculator use on student achievement in Algebra 1," ERIC Document Reproduction Services No. ED493688, 2005.

[11] J.C. Hollar and K. Norwood, "The effects of a graphing-approach intermediate algebra curriculum on students' understanding of function," *Journal of Research in Mathematics Education*, vol. *30, no.* 2, pp. 220-226, 1999.

[12] B.B. Schwarz and R. Hershkowitz, "Prototypes: Brakes or levers in learning the function concepts? The role of computer tools," *Journal for Research in Mathematics Education, vol. 30, no.* 4, pp. 362-389, 1999.

[13] National Council of Teachers of Mathematics (NCTM), (2008, March 24,). The Role of Technology in the Teaching and Learning of Mathematics. Available: http://www.nctm.org/about/content.aspx?id=14233

[14] M. G. Rizza, "Perspectives on preservice teachers' attitudes toward technology," *The Teacher Educator*, vol. 36, no. 2, pp.132-147, 2000.

Berna Cantürk Günhan is a lecturer Dr of the Department of Primary Education in Dokuz Eylul University, Faculty of Education. She received her Master's Degree in 2001 from Dokuz Eylul University. She received her PhD in 2006 from Dokuz Eylul University. She has published many papers on mathematics education in several journals. Her research interests are in the areas of primary and secondary mathematics education, teacher education, teaching geometry, technology in mathematics education, and drama in mathematics education.

Esra Bukova Güzel is a lecturer Dr of the Department of Science and Mathematics Education in Dokuz Eylul University, Faculty of Education. She received her Master's Degree in 2002 from Dokuz Eylul University. She received her PhD in 2006 from Dokuz Eylul University. She has published several papers on mathematics education in many journals. Her research interests are in the areas of pedagogical content knowledge of mathematics teachers, constructivist learning approach in mathematics teacher education, and mathematical modelling