PRINT: ISSN 0972-0073 ONLINE: ISSN 2456-6802
Anthropologist, 16(1-2): 167-176 (2013)
DOI: 10.31901/24566802.2013/16.1-2.16

Teacher Candidates' Opinions on Real Life Problems Designed in GeoGebra Software

Muharrem Aktumen[1] and Mehmet Bulut[2]

[1]Ahi Evran University, Terme Street, 40100, Faculty of Education, Kirsehir, Turkey
E-mail: aktumen@gmail.com
[2]Gazi University, Gazi Faculty of Education, Teknikokullar, Ankara, Turkey
E-mail: mbulut@gazi.edu.tr

KEYWORDS Dynamic Mathematics Software. GeoGebra. Opinions. Teacher Candidates. Real Life Problems

ABSTRACT This study reviewed students' perspectives on the use of GeoGebra, a program that aids in the transfer of real life problems into the realm of teaching. This case study was realized by 24 first-year students in the department of mathematics education of Ahi Evran University. GeoGebra was used as the presentation medium for a semester in order to depict various mathematical concepts. At the end of the term, real life problems were presented to the students and the students worked on these real life problems on GeoGebra. The data of the study was obtained with a four-question questionnaire. When the results of the study were examined, it is seen that students believe that the transfer of the real life problems to the classroom and active computer use is required in the process of the transfer of the real life problems to the classroom.

INTRODUCTION

Computer software for the purpose of education, in which visual components are a significant feature, is actively used in mathematics instruction, with its structure that enables students to test their predictions and to produce a generalization by using the data. There are two important software media used in mathematics instruction, namely computer algebra systems (CAS) and dynamic geometry software (DGS). Briefly, CAS manages operations on symbols that are used in the demonstration of mathematical objects. These symbols can be a number of demonstrators, such as whole numbers, rational numbers, real numbers, or complex numbers, and also can be symbols that represent more abstract algebraic objects, such as polynomials, rational functions, and systems of equations. Software such as Maple, Derive, Mathematica, and Reduce are examples for computer algebra software (Davenport et al. 1993). There are many studies that justify the advantages of computer algebra software use during instruction (Kabaca 2006; Aktumen 2007, 2008; Aksoy 2007; Tuluk 2007).

Dynamic geometry software focuses on the relationships between point, line, circle, and geometrical shapes. Cabri and Sketchpad dynamic geometry software are the most well-known DGSs. Dynamic learning mediums present new opportunities to students to learn mathematics. In this context, dynamic is defined as support during the process of discovering and learning through experience. Research (Hazzan and Goldenberg 1997; Hölzl 1996; Choi-Koh 1999) shows that geometry software that has dynamic features provides an opportunity to students to focus on abstract structures more frequently than the commonly used paper-pen studies (Güven and Karatas 2003).

GeoGebra, which is open source dynamic mathematics software, combines the visualization and symbolic calculation features of CAS with DGS's changeability and ease of use. Thus, GeoGebra assumes the role of a bridge between geometry, algebra and even analytical mathematic disciplines. For this reason, GeoGebra is labeled as dynamic mathematical software (Preiner 2008; Hohenwarter and Preiner 2007).

The user interface of GeoGebra was translated into Turkish by Dr. Erol Karakirik, Dr. Mustafa Dogan, and Süleyman Cengiz, and the help menu was translated by Dr. Mustafa Dogan and Dr. Erol Karakirik. It is emerging as an important value to combine the relationships between geometry and algebra in education items, with its dynamic features and potential in mathematics instruction (Hohenwarter and Jones 2007; Aktumen et al. 2009). The program has been translated into 48 languages since the date the study was written and it is free and open source software. Arranz et al. (2009) stressed that GeoGebra helps to examine the changes in each shape's (mathematical objects) features in such an easy way that the observation of changeable and unchangeable features is allowed. GeoGebra is a tool that university students may use to discover functions, graphs, and various mathematical terms, though it was designed for high school education. (Sangwin 2007). GeoGebra is used from the primary school level to the university level for mathematics instruction (Hohenwarter et al. 2008).

Gainsburg (2008) stated that the applications in which real life combinations are handled may include:

- Simple analogies (for example, relating negative numbers to sub zero temperatures)
- Classic "word problems" (for example, "Two trains leave the same station…")
- The analysis of real data (for example, finding the mean and median heights of classmates)
- Discussions of mathematics in society (for example, media misuses of statistics to sway public opinion)
- "Hands-on" representations of mathematics concepts (for example, models of regular solids, dice)
- Mathematically modeling real phenomena (for example, writing a formula to express temperature as an approximate function of the day of the year).

GeoGebra is an effective tool to transfer each real life situation to an educational platform (Aktumen et al. 2011; Aktumen and Kabaca 2012; Aktumen et al. 2012). Wurning (2007) stated that to the ability insert photos with curves or scanned materials in GeoGebra provides a new opportunity for students. Heck (2008) stated that GeoGebra, which through its use of digital imaging dynamic geometry software, establishes a real-world connection with the geometry and algebra, can be used as a modeling tool. Pierce et al. (2005) reported that they believed for years that it is necessary to apply the three algebraic representations (symbolic, numeric, and graphic) in order to teach secondary mathematics well, and the other visual fourth representation is added, which is close to a physical state, with its use of digital images. Pierce et al. (2005) believe that digital photographs and films help to create a perfect model of real life situations in the classroom.

Gainsburg (2008) stated that mathematics teachers stress the importance of the relationship between education and the real life problems. Pierce and Stacey (2009) discussed that there are many difficulties in teaching mathematics to 14- and 15-year-old students. They also argued that dynamic geometry provides opportunities to transfer real life into the classroom, through the possibility of visualizations, coloring, and animations that are impossible in a traditional classroom atmosphere, which in turn deepens mathematical thinking that is handled under different topics.

The advantages of providing an elaborate atmosphere for students containing real life problems are summarized by Blum and Niss (1989) as:

- To incite general adequacy and attitudes (the belief that mathematics is useful)
- To educate citizens who have critical competencies (the ability to analyze a data carefully)
- To equip students with mathematic problem solving skills
- To give students an elaborate and comprehensive image of mathematics (containing applications) and,
- At times, to encourage a traditional mathematics learning model (Pierce and Stacey 2009).

When the mathematics curriculum that has been implemented in 6th through 8th grades since 2005 is examined, one can state that: I) With the help of dynamic geometry software, students can form geometric drawings or can perform interactive research on geometrical shapes, and II) Teaching and learning process should begin with concrete experiences, as young learners can learn better in the environment in which the knowledge is described with concrete models (MEB 2009). The use of concrete items is important in mathematics instruction, and the case in which knowledge is represented in different dimensions should be used. Teacher candidates who are included in this study should possess the relevant qualifications as teachers of 6th-8th grade students in primary school. GeoGebra has emerged as an important education tool with its features that enable the two cases above. Thus, the opinions of teacher candidates, who are educated in the primary mathematics education departments, about the transfer of real life problems into the classroom setting are becoming more important. The ideas and the opinions of teachers about the use of technology in the education process is situated at the center of this integration process (Mümtaz 2000). The presentation of a new technological device to be used by teachers is insufficient on its own to change the learning-teaching areas. For the sake of education and instruction, the practicality of an innovation depends on the teachers' belief in the benefits that this innovation will provide, and their level of education that enables them to transfer this innovation to the classroom. In this way alone can teachers attempt to understand and implement what is new to them (Simmt 1997; Baki et al. 2002; Baki and Çelik 2005).

The research problem statement:

"What are the opinions of teacher candidates who are educated in the department of primary mathematics education, regarding the transfer of real life problems to the classroom environment with the aid of a computer?"

The sub-problems are proposed as:

I) To what extent was a computer used in the mathematics lessons of the teacher candidates, who are educated in the department of primary mathematics education, during their education prior to their university education?

II) What are the opinions of teacher candidates, who are educated in the department of primary mathematics education, regarding the necessity of using real life problems to construct mathematical terms in the minds of the students?

III) Do teacher candidates, who are educated in the department of primary mathematics education, believe that they will be able to use and develop the computer applications that can transfer real life problems to the classroom in their professional life?

METHODOLOGY

This qualitative research was designed as a case study, and carried out by 24 first-year-students, consisting of 13 women and 11 men receiving education at Ahi Evran University. GeoGebra was used as presentation tool for fall semester in 2010-2011 academic year in order to depict various mathematical terms that are studied in the pre-calculus course that is taught to first-year students in the mathematics education department, with the purpose of transferring real life problems to the classroom environment. At the end of the term, the real life problems, which were designed in GeoGebra and developed by the concept of functions and placed in the GeoGebra's Real Life Problems and Applications Section, and presented to the students. The students worked on these real life problems in GeoGebra. All GeoGebra applications can be found at www.ankarageogebra.org/bje. The problems were discussed with the students and the problems were solved in the dynamic medium provided by GeoGebra. During the course of this process, four open-ended questions were posed.

Measurement Tool

After the real life problems designed in GeoGebra were introduced to the students, four open-ended questions were posed to the students, who responded in writing. The four questions posed to the students were:

I) Prior to your university education, did your teachers use computers during your mathematics lessons? If so, at which level (elementary/middle school), by using which software, and how was it executed?

II) Do you believe that real life problems should be used to form various mathematical concepts in the minds of the students? Why?

III) Is the computer an effective tool to apply real life problems in education? If so, why?

IV) Do you believe that you will be able to use and develop computer programs in which real life problems are transferred into the classroom in your professional life?

Real Life Problems and GeoGebra Applications

Kinetic Math Problems and Concept of Functions

A kinetic math problem is suggested in this part for the sake of drawing an image of concept of functions in the minds of the students. This problem prepared by the researcher was posed to students after the GeoGebra file was opened. In this activity, the problem is presented as follows (Fig. 1);

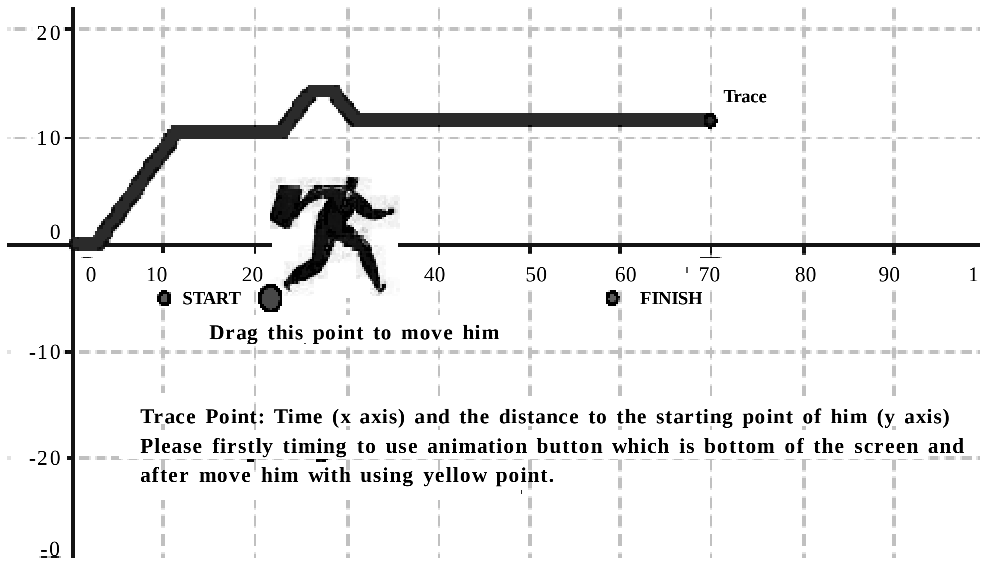

Fig. 1. The screenshot of GeoGebra applet about Kinetic Math Problem

Motion Problem

A person with constant velocity moves from the starting point and waits for 5 minutes at each A, B and C points, and reaches the arrival point. Can you draw the motion of this person on a graph with the x-axis representing the time and the y-axis representing the distance to the starting point?

Timing begins when the activity commences. The user can change the position of the person in the application by using the cursor. In the graph, the x-axis represents time and the y-axis represents the distance of the person to the starting point. In this problem, the concept of functions can be argued. There are two criteria for the explanation of the concept of functions. The former is that there should not be an element in the domain that does not match with an element in the range, namely, there should be no element left unmatched. The counterpart of this expression in the application is that there must be a distance from the person to the starting point in each time t. The latter criteria outlines that it is necessary for an element in the domain to match only one element, which means that there must not be two different distances of a person at a time t, which is a representation of time in the application. Obviously, a person cannot be in different places at the same time.

Motorcycle, Jumping Water and Quadratic Functions

To construct quadratic functions terms in the minds of the students', motorcycle (Fig. 2) and circumventing water (Fig. 3) problems are used by Galileo's trajectory by using the geometrical parabola as the root. After examining the trajectory of the path of the thrown object, it was stated that the path should be a parabola (Topdemir and Yinilmez 2009). These problems prepared by the researcher were posed the students after the GeoGebra application file was opened. Problems were designed as follows:

Motorcycle Problem

Can you form the quadratic functions that represent the paths (ascent and decent) the motorcycle followed?

Jumping Water Problem

Can you form the quadratic functions that represent the path of the water?

The aim of these problems is to force students to question quadratic functions and to enable them to construct the graph in their minds. Quadratic functions are the ones as $a, b, c \in R$

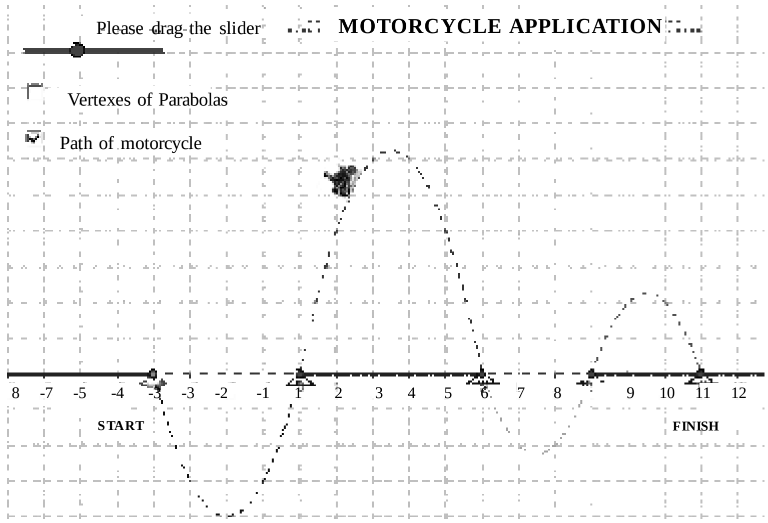

Fig. 2. The screenshot of GeoGebra applet about motorcycle problem

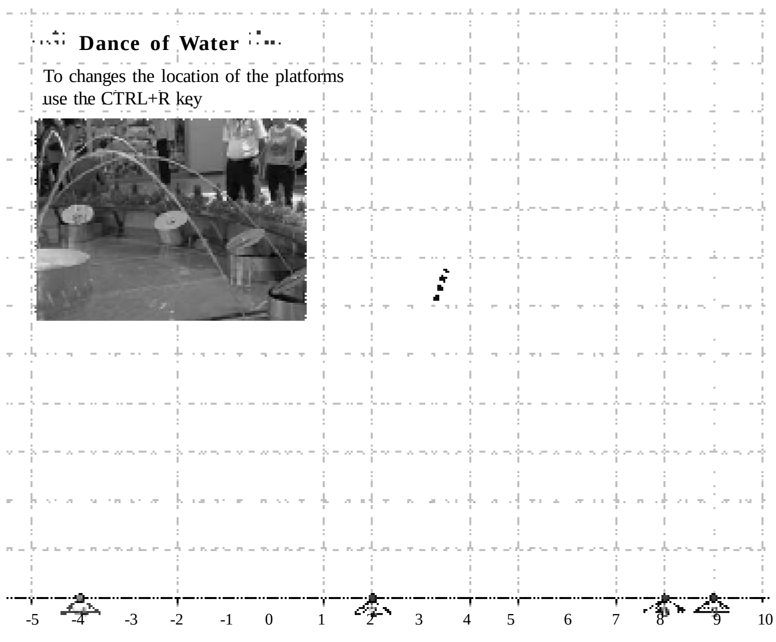

Fig. 3. The screenshot of GeoGebra applet about jumping water

and $a \# 0$ must be $f: R \rightarrow R$, $f(x) = ax^2 + bx+c$. After discussing this problem in GeoGebra, the opportunity will be given to the students to be able to rapidly solve the path of the motorcycle for the coefficients of a, b and c. What makes the motorcycle problem different from the jumping water problem is that in the motorcycle problem, the function the coefficient of x^2 can be either negative or positive, but in the jumping water problem it must be negative. The students are expected to recognize this relationship.

Population Density in Turkey Problems and Cube Root Functions

It is suggested to use the population density of Turkey according to year as the subject of the problem in order to allow the students to form the cube root function (Fig. 4). The data in the problem highlights the population density in Turkey between the years 1927-2000. This data is provided by TÜÝK (Turkish Statistical Institute) and the data for the population is formed by rounding to the value of the closest million. This problem was prepared by the researcher and posed to the students after the GeoGebra file was opened as follows:

The population density of Turkey problem: The x-axis indicates the years and the y-axis indicates the population, and the populations by year are depicted in blue. Can you determine a function that passes through or which passes by the nearest point?

I) Can you make a prediction about the population of Turkey in the year 2035 after determining the most suitable function?

II) There appears a decrease in population increase in Turkey after 2035. Can you find an appropriate function to represent this situation?

The goal in presenting these problems is to force students to consider quadratic functions and cube root functions and allow them to develop the graph in their minds. The first item of the problem resembles the previous activity, in that it is used to determine a quadratic function. However, in second item of the problem, the cube root function, which is described as the function that brings each real number to its cube root, is expected to be formed by the students.

Cargo Problem and the Greatest Integer Function

A cargo problem is suggested to construct the greatest integer function in the minds of the students.

Cargo Problem

A cargo company calculated the price of freight as 10 lira for 1 kilogram for the first 100 kilometers from the center, and 5 lira for each 100 kilometers after that point. Apply the prices of this company to a coordinate system and draw a graph of object-price. One should be able to understand the price for one kilogram of cargo for any distance. Create an equation of the greatest integer function based on the information provided.

The goal of this problem is to make the students consider greatest integer functions and allow them to be able to construct the graph in their minds (Fig. 5).

Data Analysis

The responses the students provided to the four open-ended questions in the written discussion, which are used as measurement tools, are resolved using the content analysis method. First, the written data received from the students are transferred into the computer for content analysis. The data transferred to the computer were examined by two researchers, and one of

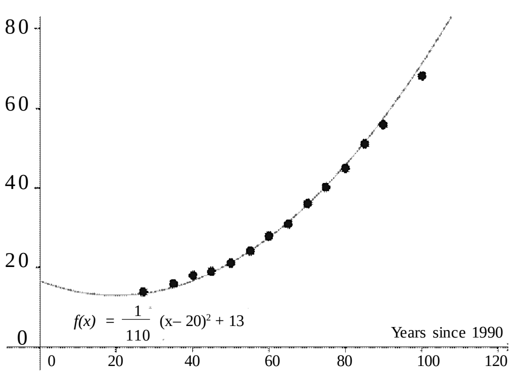

Fig. 4. The screenshot of GeoGebra applet about the population table of Turkey

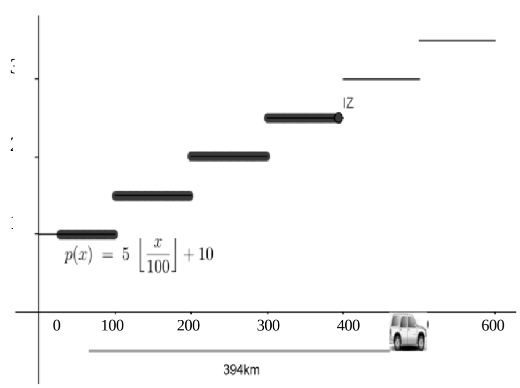

Fig. 5. The screenshot of GeoGebra applet about cargo problem

the researchers encoded the data independently. Later, the two codes were combined. The categories related to the codes were written under each question, taking the four open-ended questions as main themes. The sum of the percentages can exceed 100, as each person can enter more than one category for each question.

RESULTS

This section includes the findings of the research. The students use their selected usernames. One by one, the sub categories of the four are formed. Additionally, in the studies the ideas of the students for each question are included without any change.

The students' responses to the question, "Was the computer used by your teachers during your mathematics lessons prior to your university education? If so, at which level, by using which software, and how was it executed?" are stated in Table 1.

Table 1: The level of computer use prior to university education

Categories	*f*	*%*
Computers were never used during my education prior to university.	22	92
Computers were rarely used during my education prior to university.	1	4
Computers were used during my education prior to university.	1	4

While 22 of the students who completed the discussion form stated that they did not use a computer during their mathematics lessons prior to their university education, the student with the username *Sabah* stated that a computer was used during his mathematics lessons prior to his university education in order to make presentations, which was impressive and provided an opportunity to see various questions, in addition to saving time.

The students' responses to the question, "Do you believe that real life problems should be used to form various mathematical terms in the minds of the students? Why?" is shown in Table 2 with percentage and frequency values.

The student with the username *MTGS* stated his idea as: "*The subjects are better understood when they are associated with the real life, and thus they become more permanent. When they are not associated with real life, they remain as imaginary items*". It is clear that this student believes that knowledge is better retained when associated with real life.

Table 2: The necessity of the use of real life problems

Categories	*f*	*%*
The abstract mathematical terms are made concrete.	11	46
It makes the subject more interesting The student enjoys the lesson more.	6	25.
It increases the permanence of knowledge by providing conceptual learning.	6	25
It counters the perception that mathematics is unnecessary.	4	17
It makes the subject more clear and easy to perceive.	8	33

The student with the username *Kral* stated that students believe that mathematics only consists of calculations detached from real life, because in real life, there is a transfer of the abstract objects in the mind into the concrete objects of real life. These ideas will change when real life problems are implemented. The student with the username *Asude* stated that some student who success or not in mathematics, believe that mathematics course is unnecessary. These idea will change when real life problems are implemented. These ideas expressed by both Asude and Kral are supported by literature. The students stated that when real life problems are used in the classroom, the belief that mathematics is unnecessary and has no relevance to real life, will lose its importance

The students' responses to the question, "Is the computer an effective tool to apply real life problems in education? If so, why?" are depicted in Table 3 according to the percentage and frequency values.

The student with the username *Sabah* stated that, "*The computer is an effective tool because it is a visual method to aid learning. It provides concrete results by stimulating all our senses, except smell. If real problems were used we could understand mathematics better because to see the images on the computer that we normally see on the board would double our interest in mathematics. The subjects taken from real life make students learn effectively when animated.*" The student with the username *Tatar* stated that, "*The computer helps us to find different solutions, and in this way prob-*

lems are seen clearly and the solutions are reached by different and easier ways." The student with the username *11* stated that, "*It gives us more time.*" The student with the username *Number 10* stressed that "*I absolutely believe it. Anyway, education without technology cannot be useful, as the next generation will work very closely with technology*."

Table 3: The real life problems on the computer

Categories	*f*	*%*
It saves time with its ability to solve problems quickly.	2	8
It has a powerful visualization capacity (Picture animation, video).	14	58
It uses to different senses.	1	4
Abstract mathematical terms are transferred into concrete concepts.	5	21
It increases the permanence of knowledge through conceptual learning.	5	21
It immediately displays the values that variations take according to different values. It provides opportunities for experiments.	1	4
It brings situations into the classroom that otherwise would be impossible	2	8
It allows for the creation of different solutions.	1	4
It increases the students' motivation in the lesson.	3	12
It makes real life problems easy to understand.	3	12
To a certain extent, using real life problems on the computer is possible, but a better outcome is obtained by learning through experience.	1	4

The student with the username *Isimsiz* had a negative response, stating that, "*Computer can be useful but things can change according to the environment and lifestyles of the students*." The student with the username *Mai* as also responded negatively, stating that, "*It is true to some extent, but learning by experience is more acceptable. Only the visual aspects are important for a computer*."

The students' responses to the question, "Do you believe that you will be able to use and develop computer programs in which real life problems are transferred to the classroom in your professional life? Why?" are given in Table 4 according to the percentage and frequency values.

The student with the username *Kral* stated that, "*I believe I will encounter problems when I use the computer because my technical knowledge is low. However, I believe that I can do good things if I educate myself. However, considering that I do not use computer much, my level of command is low. My ability to use the computer is not very high, but I believe I can, and have a desire to improve it*." The student with the username *Hamus* stated that, "*The implementation of this type of education is good. I believe that I will improve my computer knowledge and will be able to use it in lessons. I want to be able to be useful and be innovative. I do not want to be a useless teacher and do not want to make the mistakes our teachers made. I do not want to write questions and ask them later in the exams. I do not want to be a teacher with easy solutions. I want to provide useful things to the students. I want to prove to students that mathematics is an exciting lesson, contrary to the ideas they have. I want to provide many opportunities to my students that I failed to have. I believe I will improve myself during university regarding computer use*."

Table 4: Do you believe that you will be able to develop and use this type of program in your professional life?

Categories	*f*	*%*
I believe that I can use if I receive the necessary technical information during my university education.	13	54
I will develop this type of computer application for my students.	5	21
I will develop this type of application in order to be different.	2	8
I must develop this type of application in order to adapt to modern technology.	2	8
I believe that I can use and develop these applications.	3	12
I can use it but I have doubts as to whether my students are ready for this medium.	1	4
I am afraid of computers.	1	4
This type of application requires imagination and creativity. I do not have enough imagination.	3	12
I have doubts as to whether the school in which I will work will have the necessary environment and the money needed.	1	4

The student with the username *Yagmur*, stated that, "*The computer is used in every aspect of life, as we are in the computer age. It is not acceptable that a teacher can distance himself or herself from computers in an age such as this, in which children are growing up with* *computers. I will use every opportunity to use the computer by improving my skills*." The student with the username *Fatma* stated that, "*I like the lessons in which the computer is frequently used. I am very interested in the computer. We can see different points of view. It increases our creativity. You must support studies on this. I think these are good applications. We can concentrate on lessons better, and we should continue to learn these.*"

The student with the username *Asude* stated that, "*Your applications were really well thought out and thoroughly studied. I want to improve on these types of projects, even if I do not have a deep imagination. I think these applications are good. We have had high-quality and effective lessons. The things you explain and demonstrate in the classroom really stayed with me.*" She additionally stated that, "*I want to use computer applications and I believe I will improve on them. But I hope the necessary technological media for this can be provided during my professional life. The lessons containing these applications should be increased and developed.*"

DISCUSSION

When the results of this study examined, it is seen that students did not receive the necessary computer-supported lessons in their mathematics education prior to their university education, and their experience on this subject is incredibly insufficient. It is seen that students stated ideas that necessitate the use of real life problems and they believe that the computer is an important tool to transfer real life problems to the classroom environment. This point of view is parallel to the studies of Güzel and Gülhan (2010), who examined flash software applications and the opinions of teacher candidates on this subject. The opinions about transferring real life problems into the classroom with the aid of the computer can be found in the literature (Pierce and Stacey 2009; Gainsburg 2008; Wurning 2007; Pierce et al. 2005; Pierce and Stacey 2009). Yet it was revealed that students believe that they will not be able to form applications in their profession similar to those that were presented to them. Most of the students stated that they are doubtful about they will receive the necessary technical information during their university education. It is seen that the primary mathematics education department of the education faculties in Turkey provide Computer I and Computer II lessons to increase computer literacy. Yet one can claim that these lessons are insufficient for a teacher to provide the ability to transfer real life problems into the classroom, to use the software on this subject, and to improve on it. The teachers should be educated at the level at which they will teach with the same educational capacities, due to the fact that it is believe that teachers will teach in the same manner in which they are taught (Baki 2002).

CONCLUSION

This study indicated the importance of integration technology into mathematics learning with real life applications which designed in GeoGebra. When the results of the study were examined, the pre-service mathematics teachers believe that real life applications are important for mathematics learning and that students believe that the transfer of the real life problems to the classroom and active computer use is required in the process of the transfer of the real life problems to the classroom.

This study has shown many benefits of using GeoGebra applets. These applets help understand mathematics meaningfully, visualization of the some abstract mathematical concepts, relate real world and mathematics and comprehend the importance of mathematics.

As a result, it is found that developments of mathematical tasks and dynamic mathematics software usage in mathematics lessons are necessary for future teachers. Also, for motivation of teachers, it is crucial to show good examples of activities designed by software such as GeoGebra.

RECOMMENDATIONS

In the past, there were computer-supported lessons for the students prior to 2006 in the primary mathematics education department of the education faculties in Turkey, after which it was removed from the curriculum. The removal of such lessons from the curriculum can be perceived as a negative step. In this case, in order to integrate the use of computers into the elective courses of the third and fourth year elective courses of the primary mathematics education department, computer-aided courses can be offered. For these lessons offered, GeoGebra can be considered as an important choice. GeoGebra provides important opportunities in the classroom, with its interface that has been translated into 48 languages, its help menu, its algebra, graph and table representations, its constantly updated structure, and free software. It is a dynamic educational medium. With these features, it is recommended to use GeoGebra as a basis to shape the content of the elective courses.

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