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PRE-SERVICE MATHEMATICS TEACHERS' VIEWS ABOUT GEOGEBRA AND ITS USE

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Abstract: The purpose of this study was to determine the views of pre-service Mathematics teachers' (PMTs) about GeoGebra and its use after being exposed to GeoGebra activities designing processes. This is a case study which was conducted with 36 PMTs. Three open-ended questions were used, after the completion of the 14-week process of GeoGebra training and designing of GeoGebra activities. The content analysis of the open-ended questions indicated that all of the PMTs think that GeoGebra has positive effects on their professional development. They also stressed that GeoGebra can contribute to students' academic achievement. In addition all the PMTs stated that they would like to use GeoGebra in their professional career. However, while more than half of the teachers stated that their use of GeoGebra in their professional lives depends on some conditions and the rest of them stated that they would use GeoGebra and expressed their reasons for using it.

Key words: pre-service mathematics teachers, Computer assisted teaching, Geogebra, Mathematics education

1. Introduction

As mathematics is a universal language which consists of figure, number and symbols that enable us to understand the world and to improve the environment we live in (Baykul, 2009), it is an important discipline that affects human life. In changing world, if it is taken into consideration that people who understand the mathematics and who are good at mathematics will be more successful in the future (National Council of Teachers of Mathematics [NCTM], 2000), the importance of mathematics education is understood better. Although it is an important field, it has been reported that students are not successful at mathematics sufficiently (PISA, 2015; TIMSS, 2016). On the other hand there are studies that indicate usage of technology in mathematics lessons improves success of mathematics by making positive contribution for learning of students (Dikovic, 2009; Seloraji & Kwan-Eu, 2017). In consideration of the opportunities that technology presented for learning, the use of technology is a necessity and beyond preference anymore (López, 2011; NCTM, 2000) and technology should be used as a learning instrument for improving learning opportunities of the students by including them in mathematics lessons (Van De Walle, Karp & Bay-Williams, 2012/2010). In the light of this information, it is stated that information and communication technologies should be used for learning and teaching mathematics effectively in current elementary school mathematics curriculum in Turkey (Ministry of National Education, [MoNE], 2013) as well and the use of technology is encouraged, especially in geometry lessons. In fact, technology enriches mathematical learning and presentation of content with giving permission to be increased explorations and it enables students to solve problem, make reasoning and focus on mathematical ideas and examine them (Van De Walle et al., 2012/2010). However, the integration of technology into class environment depends on teacher (NCTM, 2000), moreover, it is hard to achieve this integration for teacher (Cuban, Kilpatrick, & Peck, 2001). By the reason of obstacles in educational environment and classroom management as the availability of computers and software, the restriction of curriculum and time, the lack of support of colleagues and school management, it is known that the integration of technology into mathematics lessons gets difficult (Hohenwarter, Hohenwarter, & Lavicza, 2008). These causes that obstruct the integration of

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technology have been classified in literature in two steps: First order (external) and second order (internal) factors (Ertmer, Addison, Lane, Ross, & Woods, 1999). As the deficiencies of software and hardware apart from proficiency of teacher, the inadequateness of trainings that are provided for pre-service teachers-teachers-academicians, the deficiencies of managers about the support for using technology, the inadequateness of physical conditions of classes and school, crowded classes, the lack of experts who should provide technical support, the lack of economic resources, the lack of time that is necessary for making arrangements to integrate technology into class are classified as first order factors; the factors that stem from teachers as lack of knowledge about use of technology, low level of self-efficacy, negative attitudes, lack of motivation, the problem that they are not technology literate are the second order factors. Despite these difficulties about integration of technology into class environment, technology is considered as a means of improving quality and accessibility of education by researchers and many teachers (Van De Walle et al., 2012/2010).

With the use of technology and computers in the classroom environment, the concept of computer-assisted teaching emerged. In recent years, for computer-assisted mathematics teaching, computer algebra systems and dynamic geometry software (DGS) programs have been developed (Davenport, 1994; Sträßer, 2001, 2002). One of the DGS programs is GeoGebra showing the multiple representations of objects (Aktümen, Yıldız, Horzum & Ceylan, 2011). Developed by Markus Hohenwarter, this software program includes both the features of computer algebra systems and DGS programs (Hohenwarter & Jones, 2007); thus offers many opportunities for its users (Dikovic, 2009; Hohenwarter & Preiner, 2007).

GeoGebra can be used as a tool in the training of PMTs. Because it is strongly believed that the use of this program in the classroom environment by PMTs will contribute them to teach mathematics. In fact, research has revealed that mathematics teachers should possess a profound grasp of mathematics, should understand how students learn mathematics by considering their individual differences and should select instructional tasks and strategies that can promote learning in order to increase the quality of mathematics education (Shulman, 1986; Van De Walle et al. 2012/2010). In addition, research also indicates that teachers did not use the technology in their class because of not having enough knowledge about the technology integration (Karagiorgi & Charalambous, 2004; Niess, 2005). Thus, teachers need to acquire knowledge, skills, attitudes and habits in order to adapt to technology, to understand technology, and to take advantage of opportunities offered by technology (Mishra & Koehler, 2006). It is thought that it is important to change attitudes, skills and habits at the desired level (Ertmer & Ottenbreit-Leftwich, 2010) and to acquire the necessary knowledge for mathematics teachers before starting their professional career. Thus, the content of undergraduate teacher training programs can be organized to achieve these objectives. As a matter of fact, as what can be done by students through DGSs particularly while learning the subjects related to geometrical figures is considerably different from what can be done without computer, the mathematics education to be conducted by using DGS programs will be both changeable and improvable (Van De Walle et al., 2012/2010, p.117). Hence, PMTs should be able to use GeoGebra activities in their lessons, and be able to design and to have the skills to use GeoGebra activities. On the other hand, research states that teachers' beliefs and views influence the learning environments they create in their classrooms (Ball, 1998). Therefore, it is believed to be of great importance to investigate the views of PMTs about GeoGebra after they have learned how to design GeoGebra activities to be used in their classrooms. When the literature was reviewed, studies investigating PMTs' (Agyei & Benning, 2015; Baltacı, Yıldız, & Kösa, 2015; Kutluca & Zengin, 2011; Zengin, Kağızmanlı, Tatar, & İşleyen, 2013) and mathematics teachers' (Aktümen, et al., 2011; Kaleli-Yılmaz, 2015; Zakaria & Lee, 2012) views about the use of GeoGebra in math classes were found. In their study, Zengin et al. (2013) indicated that the PMTs think that the use of GeoGebra can lead to positive outcomes such as facilitating understanding, increasing retention and concretization. Baltacı et al. (2015) reported that elementary mathematics teachers are of the opinion that GeoGebra facilitates thinking by encouraging reasoning and interpretation. In addition, there are some studies exploring the learning processes regarding subjects such as calculus (Dikovic, 2009; Majerek, 2014), probability (Radakovic & Aizikovitsh-Udi, 2012), translation and rotation transformations (Baltacı & Baki, 2016), analytic geometry (Baltacı & Yıldız, 2015), geometrical reflection (Seloraji & Kwan-Eu, 2017). These researches found that GeoGebra is effective in teaching of such subjects. In the current study; on the other hand, the purpose is to

investigate the views of the PMTs about GeoGebra and its use after being exposed to GeoGebra activities designing processes. To this end, the answers to the following questions will be investigated:

1. What are PMTs' views about the effect of GeoGebra activities designing processes on their professional development (PD)?

2. What are the PMTs' views about the effect of the mathematics education using GeoGebra on students' academic development?

3. What are the PMTs' views about their using GeoGebra in their classes when they become teachers?

2. Method

2.1. Research model

This qualitative research is a case study to investigate the PMTs' views about the GeoGebra and its use. In the case study, environments, individuals or processes are evaluated as a whole and the focus is on the roles and relationships in the process and it allows an in-depth investigation of a particular group and the analysis of the data obtained through the data collection tools without having any concern about the generalization of the data (Yıldırım & Şimşek, 2008).

2.2. Participants

This investigation was realized with 36 PMTs (11 males and 25 females) studying in mathematics teaching department in Turkey. The participants of the study were given names such as S1, S2, S3, …, S36. First, it was determined that the PMTs have no information about GeoGebra and its use. The participants were volunteers to participate and had taken the lessons of Mathematics Teaching Methods I-II, Basic Concepts of Mathematics and Instructional Technologies and Materials Design. So that the PMTs could have the required pedagogical content knowledge to design GeoGebra activities. It was a desired condition for the participating PMTs to have acquired the knowledge about how to teach mathematics to elementary school students and to have discussed this in the class.

2.3. Procedure

The current research was carried out within a 14-week period (three class-hours per-week). Firstly, GeoGebra training was given to the PMTs by the first author within the context of "Computer-assisted Geometry Teaching". Then, the PMTs were shown how to develop activities to be used in teaching of different subjects of mathematics and geometry lessons by means of GeoGebra. At the end of this process, the PMTs were asked to randomly select from among the acquisitions determined considering the content of the mathematics curriculum in Turkey and then to design activities to contribute to the accomplishment of the selected acquisition by using GeoGebra and then to submit this as an assignment. A total of 36 activities were designed by the PMTs working individually by using GeoGebra for five weeks. Finally, the views of the PMTs having been subjected to a 14-week GeoGebra training program about three questions were elicited. The first question is about the effect of GeoGebra and the activities they prepared through GeoGebra on their PD; the second one is about the effect of mathematics teaching to be conducted through GeoGebra on students' academic development and the third one is about the possibility of their using GeoGebra in their classes when they become teachers. For this purpose, a form was given to the PMTs to write their views about the questions. Below is given the Computer-assisted Geometry Teaching lesson.

1st week: Introduction, educational basis of GeoGebra, GeoGebra and multiple-representations, user interface of GeoGebra.

2nd week: Presentation called "Basic concepts", Algebra view, and Graphic view (drawing board).

3rd week: Terms and explanations concerning the use of computer in education, spreadsheet view, input bar, menu bar.

4th week: Objectives, advantages, limitations of computer-assisted teaching, toolbar buttons-2D, GeoGebra activities.

5th week: Teaching mathematics and computer, basis of interactive geometry, toolbar buttons-2D, GeoGebra activities.

6th week: Presentation called "DGS in the curriculum", toolbar button-2D, GeoGebra activities.

7th week: Toolbar buttons-3D, GeoGebra activities.

8th week: Toolbar buttons-3D, GeoGebra activities.

9th week: Activity sharing, GeoGebra activities.

10th-14th weeks: Designing activities.

2.4. Data collection and analysis

In order to determine the views of the PMTs about GeoGebra and its use, three open-ended questions were used in the study after the completion of the 14-week process of GeoGebra training and designing of GeoGebra activities. These three questions were submitted to the scrutiny of an expert holding a PhD degree in the field of mathematics education and then the required corrections were made in line with the expert opinions. The PMTs were asked to write their views in the form given to them. Moreover, no time limit was set for the students to answer these questions.

Content analysis was used to analyze the PMTs' responses. In the content analysis, it is intended to create certain frameworks by making sense of the raw data and then to arrive at some certain codes and themes to classify the data (Patton, 2002). Thus, for these questions, separate data analyses were conducted. Before the analysis of the collected data, numbers were assigned to the participants and then the responses were coded separately for each individual participant. After that, the themes derived from the responses of one PMT were compared with the responses of the other PMTs. In this way, the themes were determined and then it was checked whether the consistency was attained within each theme itself. Then each theme was compared with the other themes and the participants' responses. Thus, common themes were obtained. While conducting data analysis, it was seen that some participants gave responses including more than one theme. As each of these responses refers to a different meaning, such responses of the participants were included in different themes.

3. Findings

In this section, the views of the PMTs about GeoGebra and its use will be addressed under three headings: the effects of GeoGebra on the PD of the PMTs; the effect of mathematics teaching by using GeoGebra on the students' academic development, the possibility of the PMTs to use GeoGebra in their professional life.

3.1. The Effect of GeoGebra on the PD of the PMTs

The findings derived from the analysis of the PMTs' responses to the question "What do you think about GeoGebra activities and GeoGebra on your PD?" are presented in Table 1.

Table 1. Positive effects of GeoGebra on the PMTs' PD

Main Categories	f (%)	Related effects		f
Pedagogical dimension	30 (83.3%)	Tool to	facilitate learning	16
			make teaching more effective	9
			produce better drawings	5
			make learning more permanent	5
			facilitate classroom management	1
The dimension of enhancing teaching process	22 (61.1%)	Tool to	visualize	17
			increase the choices of instruction	7
			concretize	4
			increase exemplification	2
The dimension of contribution to the conceptual understanding of students	16 (44.4%)	Tool to	teach concepts	7
			eliminate/prevent misconceptions	4
			see the details	4
			develop thinking	3

			understand the logic of a subject	2
			prevent rote learning	1
Affective dimension	13 (%36,1)	Tool to	draw interest/attention	5
			motivate/increase motivation	5
			provide enjoyable learning environment	3
			endear the lesson	3
Others	10 (%27,8)	Tool to	keep up with the age	5
			prepare exam questions	4
			improve achievement	1

As can be seen in Table 1, all of the PMTs stated that GeoGebra has positive effects on their PD. These positive effects are classified under five dimensions, which are pedagogical dimension, the dimension of enhancing teaching process, the dimension of contribution to the conceptual understanding of students, affective dimension and others. High majority of the PMTs (83.3%) stated that within the pedagogical dimension, GeoGebra could be used to facilitate learning, to make teaching more effective, to produce better drawings, to make learning more permanent and to facilitate classroom management. In this regard, Ö5 expressed his opinion as follows "Even I had difficulties in trigonometry, after conducting activities with GeoGebra I understood how to teach it better". Ö19 mentioned how GeoGebra makes teaching more effective by stating that "GeoGebra will provide us with more applicable and effective instructional environments". The effect of GeoGebra on the PD of the PMTs by providing them with a tool to produce better drawings is mentioned by Ö6 with the statement of "When we use GeoGebra program, we can produce more scientific and accurate drawings". Ö34 thinks that GeoGebra is a good material to make learning more permanent with the expression of "We may not always find time to develop materials for our students. This program can serve the function of supplementary materials by creating more permanent and visual image in the mind of the student". With the statements of "I think I will be able to make good use of time and planning in terms of both exams and presentations", Ö15 emphasizes the time management and planning, two important components of classroom management.

More than half of the PMTs (61.1%) stated that GeoGebra could make contributions to the enhancement of teaching process. In this dimension, it is mentioned that GeoGebra can be used in mathematics lessons as a tool to visualize subjects, to increase the choices of instruction, to concretize and to increase exemplification and thus contribute to the teachers in teaching process. In this regard, Ö35 indicated that GeoGebra could be used as a means of visualization in teaching mathematics by stating that "It is quite difficult to teach abstract concepts, topics of analytic geometry, rotating and reflexive shapes. It is necessary to visualize to make them more comprehensible". Ö19 mentioned the idea that GeoGebra can be used as a tool for concretization by saying "We can use it to concretize abstract mathematical operations". The idea that GeoGebra can be used to increase exemplification and choices of instruction which are in the dimension of enhancing teaching process was expressed by Ö31 in the following way: "We, as teachers, frequently avoid drawing some shapes in mathematics and geometry classes as we think that they are difficult to draw or that if I draw them, students can experience great difficulties in imagining them; yet, such shapes can be easily drawn in computer environment. Thus, we can have broader presentation alternatives. We can show more examples to our students".

The PMTs (44.4%) stating that GeoGebra contributes to students' conceptual understanding focused on its effects as a tool to be used for concept teaching, elimination/prevention of misconceptions, seeing the details, thinking development, understanding the logic of a subject, prevention of rote learning. The effect of GeoGebra on PD such as concept teaching and development of thinking was mentioned by Ö21 saying "I need to give information to my students about shapes and concepts and demonstrate this information in an applied manner. In this regard, GeoGebra broadened my horizon". On the other hand, the expressions of Ö29 "As it can show live demonstrations of theorems and can proceed one step forward and backward, students can understand the demonstrations of theorems better" shows that GeoGebra has a contribution to the PD as a means of understanding the logic of a subject and seeing details. The effect of GeoGebra on the elimination of misconceptions is mentioned by Ö12 as "Through GeoGebra, some misconceptions of students can be eliminated". Finally, Ö36

emphasized that GeoGebra can prevent rote learning by stating that "Our teachers got us to memorize formulas without properly knowing geometric figures. Therefore, when I saw this computer-assisted program, I thought that I could teach students better".

Some PMTs (36.1%) stated that the use of GeoGebra has some effects on affective dimension. In this regard, the PMTs are of the opinion that GeoGebra can be used as a tool to draw interest/attention, to motivate or increase motivation, to make learning environment more enjoyable and to endear mathematics. Emphasizing that GeoGebra can contribute to PD as a tool to draw students' attention and increase their motivation, Ö22 stated that "It draws students' attention and increases their motivation. Thus, students' motivation to participate in lesson increases and their curiosity arises". The effect of GeoGebra on PD by creating an enjoyable learning environment and increasing motivation was mentioned by Ö2 as "As the instruction will be more enjoyable by doing exercises on GeoGebra, it will be easier to motivate students". On the other hand by stating that "It can be useful to endear geometry to students", Ö7 indicated that GeoGebra is a tool to endear the lesson by his expression as "GeoGebra can be an effective tool to endear geometry to students".

Finally, more than one fourth of the PMTs (27.8%) stated that GeoGebra contributes to their PD as a tool that can help them to keep up with the age, prepare exam questions and enhance the academic achievement. The potential effect of GeoGebra to contribute to PD by helping to keep up with the age was mentioned by Ö3 with the statement of "As a result of developing technology and contemporary conception of education, it seems to be not possible to teach everything on the blackboard". Ö32 indicated how GeoGebra could contribute to their PD by helping them to prepare exam questions as "While preparing my exam questions, instead of drawing geometrical figures in the questions by hand, I can use this program to draw these figures in the future". By stating that "Students' achievement can promote our success as teachers" Ö31 shows that she thinks that GeoGebra not only enhances students' achievement but also teachers' performance.

3.2. The Effect of the Mathematics Teaching by Using GeoGebra on Students' Academic Development

The findings obtained from the analysis of the PMTs' responses to the question "What do you think that mathematics teaching by using GeoGebra can affect students' academic development?" are presented in Table 2.

Table 2. The effect of GeoGebra on students' academic development

Theme	f (%)	Sub-theme	f
Promoting learning	24 (66.7%)	Meaningful learning	11
		Permanent learning	7
		Learning through concretization	7
		Individual learning	7
		Effective learning	6
		Internalized learning	1
Providing functionality	24 (66.7%)	Increasing academic achievement	14
		Broadening the horizon	4
		Preventing misconceptions	3
		Keeping up with technology	3
		Promoting reinforcement	3
		Encouraging participation in class	3
		Providing guidance	1
		Overcoming information deficiency	1
Imparting skills	16 (44.4%)	Higher level thinking skills	11
		Creativity skill	7
		Mental visualization skill	5
Developing positive attitudes	13 (36.1%)	Increasing interest in the lesson	7
		Finding the lesson enjoyable	6
		Overcoming the fear of mathematics	3
		Loving the lesson	2
		Changing the perspective of the lesson	2

Facilitating	12 (33.3%)	Increasing motivation	1
		Increasing desire to research	1
		Learning	6
		Understanding	3
		Thinking	2
		Visualization in mind	1
		Seeing details	1
		Internalization	1
		Recalling	1

As can be seen in Table 2, majority of the PMTs are of the opinion that GeoGebra can contribute to students' academic achievement in terms of promoting learning and providing functionality. Of the PMTs, 44.4% stated that GeoGebra could impart some skills to students, 36.1% stated that it would help students develop positive attitudes and 33.3% stated that it would facilitate the learning process. The PMTs stated that GeoGebra could promote learning by improving meaningful learning, permanent learning, concretization, individual learning, effective learning and internalization. For example, indicating the positive effects of GeoGebra on effective, permanent and meaningful learning, Ö34 stated that: "It allows students to learn mathematics efficiently. Instead of memorizing formulas, student can achieve more permanent learning by understanding the logic of the figures. It might be easier for students to understand abstract things". On the other hand, Ö9 mentioned students' meaningful learning by means of concretization stated that "It allows students to see how events are taking place; thus, they can make sense of them". Claiming that GeoGebra could provide many opportunities for individual learning, Ö14 expressed her opinions as follows "For example, let's take the subject of triangles in geometry; if a student himself/herself draws a triangle, with the help of feedbacks he/she can better understand what comes from where and how it happens".

The PMTs arguing that GeoGebra provides functionality (66.7%) mostly focused on its cognitive effects on students' academic lives such as increasing academic achievement, broadening the horizon, preventing misconceptions, keeping up with technology, helping to reinforce, encouraging participation in class, providing guidance and overcoming information deficiency. For instance, with this statement "Such different ways of instruction can certainly broaden students' horizon. They increase students' achievement. They can provide guidance for students", Ö23 indicates that GeoGebra can broaden students' horizon, increase their academic achievement and provide guidance for them. On the other hand, Ö36 emphasized that GeoGebra could prevent misconceptions and help to overcome information deficiencies by stating that "The frequency of observing misconceptions and information deficiencies in students will considerably decrease". Ö3 argued that GeoGebra could help students keep up with technology with this statement "As children are growing up in a developing and changing world in a close interaction with technology, they find such applications more enjoyable and interesting". Ö9 pointed to its effect on class participation "It can increase active participation in class". Finally, Ö5 pointed out that GeoGebra could contribute to the reinforcement of learning by stating that "In my opinion, GeoGebra should be used as an activity; that is, to visualize what has been taught in the traditional style of lecturing".

The PMTs stating that GeoGebra could impart some skills to students mentioned three skills that are higher level thinking skills, creativity skills and mental visualization skills. In this regard, the explanation of PMTs such as considering an issue from different perspectives, seeing the cause-result relation, interpreting concepts and analytic thinking are interpreted as high level skills. On the other hand, statements related to new designs, originality, viewing the life in different respects and improving imagination were addressed under the heading of creative skills. For instance, Ö20 mentioned these three skills by stating that "As it enables students to think multi-dimensionally and visually, it can promote students' academic thinking. Through this program, new designs and new mathematical methods can be discovered; thus, it can contribute to their academic development".

Some PMTs stated that GeoGebra would develop students' affective characteristics. Here affective characteristics manly refer to developing positive attitudes and the positive attitudes to be developed in students were mentioned to be increasing interest in the lesson, finding the lesson enjoyable/interesting, overcoming the fear of mathematics, loving the lesson, changing students'

perspective of the lesson, increasing motivation and increasing desire to research. For instance, with her statements "As students will find GeoGebra more interesting and a different way of learning the lesson, their view of the lesson may change a bit. They will enjoy the lesson", Ö19 indicated that GeoGebra would increase students' interest in the lesson, make the lesson more enjoyable for students and change the perspective of the lesson. Ö24 argued that students could overcome their fear of mathematics and increase their motivation through GeoGebra by stating that "Students' motivation and interest in the lesson increase. Today, mathematics has become students' most feared school subject. In my opinion, students will be able to overcome this fear by using GeoGebra".

PMTs also maintained that GeoGebra would provide some opportunities for students to facilitate their cognitive activities. These are facilitating learning, facilitating understanding, facilitating thinking, facilitating visualization in mind, facilitating seeing details, facilitating internalization and facilitating recalling. One of the PMTs thinking that GeoGebra will facilitate learning, Ö22 expressed her opinion "Student can see and understand a mathematics subject; which he/she could not understand previously as it was abstract, in its three-dimensional form". On the other hand, Ö32 mentioned that GeoGebra would facilitate understanding by stating that "I think that students will be able to understand operations related to geometrical figures in this way more easily as they are visual". While Ö35 maintained that GeoGebra would facilitate thinking by stating that "As it directs students to thinking, particularly to analytic thinking, students' academic achievement will be positively affected by this", Ö8 argued that GeoGebra would facilitate recalling by stating that "Mathematics has always been taught us on the board. This has resulted in weak recall or prevention of our learning". Finally, with her following statement, Ö31 indicated that GeoGebra would enable students to see details and visualize in mind "By means of GeoGebra, students can see the most complex figures more easily and visualize them in their minds". Ö33 expressed his opinions about the effect of GeoGebra on students' internalization of knowledge with this statement "As it is difficult to internalize abstract concepts, this program reifies them. Thus, students can more easily internalize them".

3.3. PMTs' Possibility of Using GeoGebra in their Professional Life

The PMTs were asked the question "What do you think about using GeoGebra in your classes when you become a teacher?" and the findings obtained from their responses are presented in Table 3.

Table 3. PMTs' views about using GeoGebra

Views	f (%)	Reasons / Conditions for Using		f
I will use	14 (38,9%)	For	geometry subjects	5
			visualization	3
			retention	3
			keeping up with the technology age	2
			teaching concepts	2
			establishing links with the daily life	1
			making better use of time	1
			concretizing abstract concepts	1
			making the lesson more interesting	1
I will use but	22 (61,1%)	When	the conditions are suitable	11
			I use the program effectively	3
		For	(some) geometry subjects	8
			teaching abstract concepts	6
			visualization	6
			designing activities	2
			establishing links between concepts	1
		After	the presentation of the subject	1

When Table 3 is examined, it is seen that all of the PMTs are willing to use GeoGebra. However, while some of the PMTs expressed their reasons for using the program (38.9%), the majority of them (61.1%) stated that their use of the programs depends on some conditions. Of the PMTs stating that they want to use GeoGebra in their future professional lives, five of them pointed out that they want to use it particularly for teaching geometry subjects. One of these five teachers is Ö31 and she expressed her opinions as follows: "Instead trying to draw a figure on the board in a geometry lesson, I can draw

this figure more accurately with my students by using GeoGebra in the computer environment". Some PMTs stated that they want to use GeoGebra in their professional lives as it enhances visualization and retention. In this regard, while Ö20 expressed his opinions as follows "By producing three-dimensional drawings, I will try to develop students' thinking capacity", Ö11 stated that "There is no need to ponder with GeoGebra, it is practical and increase retention; we can also solve the problem at the same time. It is very convenient". Other reasons mentioned by PMTs for using GeoGebra are to keep up with the technology age, to facilitate concept teaching, to make better use of time and to concretize abstract concepts. In this regard following explanations were provided by Ö12 "In order to be successful, teachers need to be open to innovations in their fields and to actualize themselves. Our age is a technology age. Therefore, we need to use technology while teaching our subjects" and by Ö15 "I will use it to make better use of time and to teach concepts to students more effectively".

The PMTs stating that their use of GeoGebra in their professional lives depends on some conditions most frequently mentioned the existence of a smart board and a computer lab and characteristics of the subject and students suitable for the use of program. For instance, Ö15 emphasized that "Depending on the characteristics of the subject and also those of students, environment and school, I think I will be able to use it". Ö24 also pointed out the varying conditions of schools in different geographical regions "It will be difficult to use this program if I am appointed to the eastern regions of the country because there are no smart boards or computer labs in schools in these regions". Some PMTs stated that GeoGebra should only be used while teaching three-dimensional geometry subjects requiring analytic thinking. In this connection, Ö2 stated that "When I become a teacher, I am certainly thinking of using this program while teaching three-dimensional objects, not every subjects, because it is really difficult to teach and learn three-dimensional objects; yet, they can be very clearly demonstrated in GeoGebra". Some PMTs stated that they would use GeoGebra to teach and visualize abstract concepts. This is pointed out by Ö36 as follows "I want to preset abstract concepts to students by concretizing them" and is explained by Ö9 "It should be preferred for teaching subjects for which students experience difficulties in visualizing in their minds". Some PMTs stated that they cannot use this program effectively and if they manage to use it effectively then they will prefer to use it. In this regard, Ö33 stated that "For now, I cannot use it; otherwise, it would be a waste of time because I am not qualified enough to use this program. When I can use this program effectively, I will use in my classes". Finally, PMTs stated that they want to use GeoGebra to design activities, to establish links between concepts and after presenting the subject. For instance, Ö25 stated that "If I use it, it will be easier to develop activities", Ö9 "I will enhance my classes with related visuals and activities" and Ö26 "After the presentation of a subject, I am thinking of using it for students to see figures and to understand the subject better".

4. Results and Discussion

The purpose of this study is to investigate the views of PMTs who had no experience of DGS program before the completion of GeoGebra activities designing process about GeoGebra and its use. In this respect, it was intended to determine the PMTs' views about the effects of GeoGebra on their PD, on the academic development of their students and using the program when they become a teacher. Though this study, was conducted with 36 PMTs, the findings are not enough to make generalizations. Despite this limitation of the study, on the basis of the findings, it can be argued that PMTs have positive views about GeoGebra and its use in general. Similarly, in many studies, PMTs and teachers stated positive views about GeoGebra (Aktümen et al., 2011; Baltacı et al. 2015; Baltacı & Yıldız, 2015; Mwingirwa & Miheso-O'Connor, 2016; Tatar, 2013). On the other hand, in the study of Kaleli-Yılmaz (2015), it was also found that there are some teachers having negative feelings about the use of technology in mathematics classes.

All of the PMTs participating in this study stated that GeoGebra activities designing processes had positive effects on their PD. This can be interpreted as the PMTs' considering GeoGebra as an effective tool to be used in teacher education for their PD. As a matter of fact, GeoGebra can provide many opportunities for them to concretize and visualize subjects so that students can learn better and solve problems by dynamically researching mathematical relationships and to create interactive on-

line learning environments (Dikovic, 2009; Hohenwarter et al., 2008). Therefore, it is an expected situation that the PMTs think that GeoGebra will have positive effects on their PD. Similarly, it is known that GeoGebra can make important contributions to mathematics teacher education (Baltacı & Baki, 2016) and learning environments generated by using GeoGebra positively affect PMTs (Zengin et al., 2013). When the PMTs' views about the effect of GeoGebra on their PD were examined, it was found that they think that this process has positive effects on their pedagogical knowledge, on enhancing the learning environment, on students' conceptual understanding and affective dimensions. Within the pedagogical dimension, the PMTs most frequently emphasized the effect of GeoGebra on facilitating learning and classroom management, making teaching more effective, producing better drawings and permanent learning. On the other hand, they think that GeoGebra can contribute to their PD by enhancing the teaching process. Within this dimension, they mentioned that GeoGebra could be used as a tool to visualize, to increase choices of presentation and exemplification in mathematics lessons and to concretize. The PMTs stating that GeoGebra can promote students' conceptual understanding mostly focused on concept teaching, elimination/prevention of misconceptions, seeing details, promoting the development of thinking, understanding the logic of a subject and prevention of rote learning. In fact, technological learning environments allow teachers to select learning methods tailored to the needs of students and to apply them in their classes (NCTM, 2000). The findings of the current study are parallel to the findings reported by Zengin et al. (2013), who argued that the use of GeoGebra could improve visualization, facilitating comprehension, retention and concretization. Given that mathematics deals with abstract subjects (Baykul, 2009), the PMTs' thinking that by using GeoGebra, they can improve their students' achievement by concretizing and visualizing subjects and promote permanent learning can be interpreted as a sign that they will use technology in their classes to teach mathematics. Thus, it can be concluded that the use of GeoGebra can help PMTs to teach mathematics more effectively and integrate technology into their classes.

Moreover, within the affective dimension, the PMTs mentioned the effects of GeoGebra in terms of drawing students' interest/attention, increasing their motivation and endearing mathematics lesson by creating more enjoyable learning environments. This views of the PMTs is considered as a sign that they will be able to provide effective teaching by integrating technology and pedagogy and thus rendering classes more enjoyable for students. These findings concur with the findings reported by Aktümen et al. (2011) concluding that mathematics teachers believe that with GeoGebra, important contributions can be made to students' learning process and lesson preparation and students' attitudes towards mathematics classes can be changed.

Some of the PMTs stated that GeoGebra has positive effects on their PD as a tool that can be used to keep up with the age, to prepare exam questions and to promote achievement. Therefore, these PMTs are of the opinion that GeoGebra can improve them and help them to keep up with the age thus they will not fall behind the age. Moreover, they think that they can save time by producing drawings in computer environment. Hohenwarter and Preiner (2007) pointed out that due to its features such as affordances it offers and saving time GeoGebra is preferred in mathematics teaching and learning.

The PMTs also stated that GeoGebra would contribute to the academic life of their students as well as their PD. They mentioned that GeoGebra can have many other positive effects such as promoting students' learning and providing functionality, imparting skills to students, helping them develop positive attitudes and facilitating learning, understanding, thinking, visualization in the mind, seeing details, internalization and recall. Similar findings were found in the study by Dikovic (2009) reporting that GeoGebra helps students to understand mathematics better and to solve problems by dynamically researching mathematical relationships. This is also supported by Van De Walle et al. (2012/2010) arguing that by integrating technology into classes, it can be turned into a tool that can promote students' learning. In here, the PMTs stating that GeoGebra provides functionality mostly focused on its cognitive effects on students' academic lives. These effects are increasing academic achievement, broadening horizon, preventing misconceptions, keeping up with technology, helping reinforcement, encouraging students to participate in class and overcoming information deficiencies. It is particularly important that the PMTs consider GeoGebra as a tool to impart higher level skills to students such as thinking from different perspectives, recognizing cause-effect relationships, interpreting concepts and analytic thinking and also creativity and visualization skills. In fact, in the

renewed mathematics curriculum in Turkey, a great emphasis is put on the inculcation of these higher level skills (MoNE, 2013). Moreover, these findings concur with the findings reported by Baltacı et al. (2015) stating that the PMTs think that GeoGebra facilitates mathematical thinking by allowing reasoning and interpretation.

PMTs think that GeoGebra also improves students' affective characteristics. These affective characteristics are centered on developing positive attitudes. The positive attitudes to be developed by students; according to the PMTs, are increasing interest in the lesson, finding the lesson enjoyable/interesting, overcoming the fear of mathematics, loving the lesson, changing the perspective of the lesson, increasing motivation and promoting the desire to research. These findings can be interpreted as GeoGebra can help to establish a convenient and interesting learning environment in mathematics classes, has a potential for students to discover themselves and thus can increase interest in the lesson (Baltacı et al., 2015). In fact, during the activity designing process, the PMTs lived the experiences to be lived by students.

PMTs also mentioned that GeoGebra can also provide some opportunities for students' cognitive development. These are facilitating and promoting learning, understanding, thinking, visualization in the mind, seeing details, internalization and recall. Given that visualization can play an important role in today's mathematics education (Majerek, 2014), these findings seem to be remarkable. In this connection, Dikovic (2009) stressed that GeoGebra can provide many opportunities for students to visualize the mathematical process and acquire an intuitional viewpoint. Furthermore, these views of the PMTs concur with the statements of high school students found in the study conducted by Kutluca and Zengin (2011) using activities and applications developed through GeoGebra. The high school students stated that they use GeoGebra willingly and enthusiastically, the information they learned previously by memorizing can be retained more easily when visualized by using GeoGebra, the program enhances visualization and provides a discovery-based learning environment enabling them to recognize the relationships between mathematical concepts.

Moreover, it is a remarkable finding that all the PMTs stated that they would like to use GeoGebra in their professional career. However, while more than half of the teachers stated that their use of GeoGebra in their professional lives depends on some conditions and the rest of them stated that they would use GeoGebra and expressed their reasons for using it. Here the reasons presented by the PMTs are mostly pedagogical such as learning is permanent, instruction is related to the daily life and making better use of time. Other reasons presented by the PMTs are associated with enhancing learning environment such as visualization and concretization to improve students' conceptual understanding while teaching geometry subjects and concepts.

While some of the teachers stating that their use of GeoGebra depends on some conditions aside from their own competencies, some other associated it with reasons arising from only their own competencies. For instance, factors such as presence of computer labs and smart boards, curriculum, structure and content of the subject were considered to be factors aside from teacher competencies; yet, factors such as effective use of the program was considered to be related to teacher competencies. These show similarities with the theoretical framework of obstacles in front of the technological integration proposed by Ertmer et al. (1999). These results; as stated by Hohenwarter et al. (2008), pinpoint the fact that teachers may experience difficulties in technology use due to obstacles such as instructional environments and classroom management. The PMTs stating that they would not use GeoGebra due to internal factors are believed to see themselves incompetent in terms of using technology (Karagiorgi & Charalambous, 2004; Niess, 2005). In fact, in some studies, it was concluded that PMTs and teachers think that the training they received in their undergraduate education is not enough to integrate technology into their mathematics classes (Kaleli-Yılmaz-2015) and that they see themselves inadequate for using GeoGebra (Aktümen et al., 2011; Tatar, 2013). Therefore, it would be useful to provide students with environments where they could practice the use of GeoGebra throughout their undergraduate education.

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