

# STUDENTS' ATTITUDES TOWARDS GEOMETRY: A CROSS-SECTIONAL STUDY

Yüksel Dede<sup>1</sup>

Cumhuriyet University, Sivas, Turkey

## ABSTRACT

This study made a case for their affective variables influencing students' attitudes towards geometry as they progress from grade 8 to 11. In the research, the attitude variables were classified as “enjoyment”, “usefulness” and “anxiety”. The research was carried out using quantitative methodology, in particular by using questionnaire, in four primary schools and three high schools in Central Anatolia Region of Turkey. Data analysis involved descriptive and inferential statistics. A significance level of 0.05 was set for all inferential tests. The results of this study were: a) students, in general, enjoy geometry, b) have positive attitudes towards the usefulness of geometry, c) have, in general, high level anxiety for geometry, and d) statistically, there exist significant correlations amongst attitude variables according to the grade levels.

**Keywords:** Geometry, Grade Level, Attitude, Enjoyment, Usefulness, Anxiety.

## 1. INTRODUCTION

### 1.1. Affective Domain in Mathematics Education

Learning mathematics is mostly seen as a cognitive effort (DeBellis & Goldin, 2006) and based on reasoning (Hannula, 2005). But, mathematical thinking and learning is nested with affect (Hannula, 2006). However, it is generally perceived as separate from mathematical thinking (Zan, Brown, Evans & Hannula, 2006). One reason is this; mathematics does not include emotion like humanities, arts or music and so it may be seen as a pure rational vocation. Methodological difficulties in

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<sup>1</sup> [ydede2000@gmail.com](mailto:ydede2000@gmail.com)

empirical studies of affect, in satisfying its reliability and in its methodological design may be shown as any other cause. Besides, in affective studies, absence of a precise definition and barriers for sharing the language used to communicate mathematical affect can be given among other reasons (DeBellis&Goldin, 2006). However, in learning mathematics, like in the other cognitive fields, affect may influence how the students utilize mathematics for their future and how they approach mathematics in contexts. For this reason, affective variables play an important role in influencing the learning atmosphere in any classroom (Meijer, 2007; Meelissen & Luyten, 2008). So affective studies are always at the center of mathematics education (Tsamir &Tirosh, 2009) and it has been studied for various aspects (Clarkson & Hannula, 2004). In the 1960's and 1970's, a research on affect in mathematical education was made, mostly in relation to studies on attitude and anxiety towards mathematics (Zan et al., 2006). Furthermore, some researchers had tried to study the role of affect on mathematical thinking, learning and mathematical problem solving (e.g., DeBellis & Goldin, 1997; Goldin, 2000; Gómez-Chacón, 2005; Hannula, 2006; Wedege & Skott, 2007). Some studies examine the relationship between affect and social interactions in the classroom (e.g., Herbel-Eisenmann, Hoffmann & Seah, 2003). Affective variables are also seen in literature on gender differences, some of which make predictions of future achievement or learning outcomes (Clarkson&Hannula, 2004; Hannula, 2007).

## 1.2. Key Concepts in Affective Domain

In recent years, it has been an increase in the number of studies about the affective domain of mathematics education research (Grootenboer& Hemmings, 2007). Affective factors especially attitudes towards mathematics have been studied since 1970s in mathematics education. But theorisation studies related to affective factors have been conducted recently. General educational, psychological and social psychological studies today help interpreting the role of the affect concept in mathematics teaching (Malmivuori, 2006). McLeod (1992) determined the affective domain in mathematics education by beliefs, attitudes and emotions concepts and stated the differences among these as below:

*... emotions as the most intense and least stable, beliefs as the most stable and least intense, and attitudes as somewhere in between on both dimensions. Beliefs were seen as the most 'cognitive', and emotions as the least so. (p. 107).*

Afterwards, values were also added to these concepts by DeBellis and Goldin (1997). But, the affective domain of mathematics can not be limited to only these four concepts. Outside of these concepts, there are also some other concepts like feeling, motivation, anxiety, and interest. Amongst these four concepts mentioned above, attitudes are likely the one which has been studied most and the other one, values, at least (Hannula, 2004). Goldin (2002) distinguished among these concepts in mathematics education:

*(1) emotions (rapidly changing states of feeling, mild to very intense, that are usually local or embedded in context), (2) attitudes (moderately stable predispositions toward ways of feeling in classes of situations, involving a balance of affect and cognition), (3) beliefs (internal representations to which the holder attributes truth, validity, or applicability, usually stable and highly cognitive, may be highly structured), (4) values, ethics, and morals (deeply-held preferences, possibly characterized as "personal truth," stable, highly affective as well as cognitive, may also be highly structured). (p. 61).*

### **1.3. Definition of Attitude toward Mathematics**

Even though a large number of researches on attitudes towards mathematics have been fulfilled, the attitude concept theoretically needs to be improved. Moreover, the concept of attitude is used without proper definition in many studies. The most obvious problem concerning the attitude appears discrepancy between the espoused and enacted attitudes (Hannula, 2002). Therefore we do not have a clear definition of attitudes in studies of attitudes toward mathematics. We have come across three types of attitude definitions in condition with the explicit definition of attitudes. Those three types of attitude definitions are (Zan & Di Martino, 2007):

a) Attitudes are to determine the negative or positive level of affect combining a certain subject. This definition stands as a simple definition for attitudes and is to be seen as the result of internal and automatic affective reactions in the most general meaning (e.g., McLeod, 1989, 1992). This definition neglects the cognitive element of attitude. However, even those who use this definition mainly relied on

paper and pencil test because of the difficulties of distinguishing emotional disposition from beliefs (Hannula, 2002).

b) A bi-dimensional definition, in which behaviours do not appear explicitly: attitude toward mathematics is therefore seen as the pattern of emotions and beliefs associated with mathematics (e.g., Daskalogianni & Simpson, 2000).

c) Attitudes are formed with three components, one of them is a behavior related to the subject, the other is beliefs related to the subject, and the third one is emotional reaction. This definition shows the multi-dimensional and complex constitution of attitudes. But according to Hannula (2002), this approach is incompatible with the widely accepted opinion concerning other three variables (attitude, beliefs and emotions) of affective domain. Ruffell, Mason and Allen (1998) explained this complex structure of attitudes as follows:

*It is striking that emotional content can flip from being very negative to very positive so quickly in a new setting. Alternatively, it is gratifying that 'good teaching' can have such an effect. But perhaps 'attitude' is not such a stable and reliable construct; perhaps it is highly influenced by social and emotional context, and personal construction of these. Certainly, if a construct can change so radically in a short time, it is unlikely to provide a fruitful taxonomy for research or for the practice of teaching. (p. 15).*

For that reason, attitude in research on mathematics, was the focus search in many dimensions, such as anxiety towards mathematics, the value of mathematics, the enjoyment and usefulness of it, confidence, self-confidence and motivation toward mathematics by the researchers (see Fennema & Sherman, 1976; Tapia & Marsh, 2004). Thus, it is important to select a suitable definition of attitude that will be used in the study (Zan & Di Martino, 2003).

#### **1.4. The Impact of Attitudes on Learning**

Reynolds and Walberg (1992) stated that students' attitudes towards mathematics they had before are very decisive on students' subsequent attitudes despite the indirect effect of home environment and motivation and direct effect of instructional quality. Wilkins and Ma (2003) have stated the mathematical importance of mathematics attitudes as follows:

*A person's mathematical disposition related to her or his beliefs about and attitude toward mathematics may be as important as content knowledge for making informed decisions in terms of willingness to use this knowledge in everyday life. (p. 52).*

However the students' attitudes may vary between a specific subject like geometry, arithmetic, calculus or probability (e.g., Hopkins, Mc Gillicuddy- De Lisi & De Lisi, 1997; Tapia & Moldavan, 2007).

### **1.5. Defining the Measured Attitude Variables**

In this study; enjoyment, usefulness, and anxiety were used as attitude variables. The definitions and explanations of these are as follows:

#### *Enjoyment*

Science (or mathematics) enjoyment refers to the gladness or happiness students feel resulting from their experiences in science (or mathematics) (Cavallo & Laubach, 2001). According to Stipek (2002), enjoyment refers "how much they liked working on math task and how boring they found math to be." (p. 316). It also refers to how a user likes, enjoys or is interested in working or learning (Liu & Johnson, 1998). Enjoyment and positive emotions foster behaviours that enhance learning (Stipek, 2002). The author of this article adopted the definition of the enjoyment of Stipek (2002).

#### *Usefulness*

Usefulness refers "to how a task fits into an individual's future plans, for instance, taking a math class to fulfill a requirement for a science degree." (Wigfield & Eccles, 2002; p. 95). Also, Atweh (2007) clearly reveals the importance of usefulness of mathematics with the following words and these words about the usefulness of Atweh (2007) were also adopted by the author of this article:

*Here I argue that the usefulness of mathematics should not only be demonstrated by using examples from the real world of the student as applications of mathematics, but also mathematical knowledge should be developed through such activities. The development of mathematical knowledge through real world activities demonstrates the usefulness of mathematics at the same time as engaging students. Further, this engagement of mathematics with the life of the student should be an engagement not only with the physical world and the economic world, but also with the social world; not only with the world as the student will experience as an adult, but their*

*current world; it should aim at developing an understanding not only of mathematics but also an understanding of the world. Finally, such engagement should aim at not only reading the world but also, whenever possible, at transforming the world - even to a small degree. (p. 9).*

Indeed, students have a great opportunity to be able to use some geometry subjects, learned in the lesson in their daily life. Vanayan and his colleagues (1997) have also reached the similar outcomes at primary level. According to the results of the research they have implemented on 3rd and 5th graders, they have found that the 5th graders believe in the usefulness of mathematics in daily life, much more than the 3rd graders. Armstrong and Price (1982) determined that both male and female students in the 12th grade see usefulness of mathematics as the most important factor at the decision point of whether or not to take more mathematics. Moreover, a result of a research by Young -Loveridge and her colleagues (2006) supports the same finding. According to this research, the students (from years 2 to 8) consider usefulness of mathematics as a determining factor for their daily life and future career planning. TIMSS-R 1999 results showed the Turkish students also see mathematics as an important element for their future life (MEB-EARGED, 2003). According to the study whose data were based on the TIMSS 2003 project 8th grade students (197.707 students from 46 countries), Kadijevich (2006) determined that the mathematical attitudes are mostly saturated by either usefulness of mathematics (11 countries) or by self-confidence in mathematics. Therefore, in most mathematics curricula, it is emphasized that students should be aware of the point of usefulness of mathematics and geometry (see, MEB, 2005a, b; NCTM, 1989).

### *Anxiety*

Mathematics anxiety can be defined as mental defect, fear of mathematics, a feeling of intense frustration or helplessness when one is required to solve mathematical operations and manipulate numbers or figures (Ashcraft & Faust, 1994). This definition is important because it shows that mathematics anxiety contains both affective and cognitive structures. The author of this article also adopted this definition of the anxiety. On the other hand Bessant (1995) defined mathematics anxiety as a combination of negative attitude towards mathematics learning, fear of success, lack of self confidence and exam pressure. Ma and Xu

(2004) regard mathematics anxiety as feeling discomfort when students are required to do homework/task.

It has been noted in the literature that there are studies that report Turkish students have mathematics anxiety. For example, in the result of the Dede and Dursun (2008) research, it was found out that 8th graders have more anxiety toward mathematics than 6th and 7th graders in spite of statistical insignificance. The outcomes of PISA 2003 support it. According to the results of PISA 2003, it was found out that the students (grade 8 and grade 9) at the age of 15 in Turkey generally have mathematical anxiety and the average of mathematical anxiety in Turkey is higher than in the OECD countries participating the project (Mean index: Turkey: .34, OECD-whole: .10, OECD-mean index: .00; the highest index: Japan: .24, the lowest index: Swedish: -.49) (MEB-EARGED, 2005).

### **1.6. Studies in Relation to Attitudes**

When it is looked over literature related to the subject, it is seen the subject is considered generally as mathematics, more than geometry. If the attitude studies in mathematics education are reviewed it can be seen that attitude towards mathematics is researched with respect to various variables. For example, attitude researches occur toward mathematics (e.g., Tapia & Marsh, 2004) or the usage of technology (computers or calculators) in mathematical teaching (e.g., Forgasz, 2004). In these researches, it was generally tried to indicate the common or separate effects of gender (e.g., Leder & Forgasz, 2002), grade level (e.g., Schofield, 1982) and mathematics achievement over attitude. For instance, it is often reported that a powerful relation between attitude toward mathematics and academics achievement exists, (e.g., Tapia & Marsh, 2004) with reference to this good academic carrier in the future (Lafortune, Daniel, Pallascio & Schleifer, 1999) or to display a desirable attitude toward life-long learning (Horn, Balazsi, Takacs & Zhang, 2006). But, in literature, it is noted that the researches indicate a very low or not statistically significant correlation between mathematical achievement and attitude (e.g., Ma & Kishor, 1997). In addition to these studies, there are a few studies in the literature that investigate attitudes towards mathematics in terms of the relations between enjoyment and anxiety or relations between usefulness and anxiety variables. For

example, Tapia and Marsh (2004) have researched that the students having no mathematical anxiety have great enjoyment, more than the students having high mathematical anxiety. In a similar way, Curtis (2006) has determined that the students, who are aware of the value and usefulness of mathematics in daily life, have lesser anxiety toward mathematics. According to this, having been designed and applied to activities that will provide students more enjoyment from geometry, may in fact have an effect to decrease anxiety level towards mathematics.

## 2. NATIONAL CONTEXT

### 2.1. School Organization and Curriculum

In Turkey compulsory education was extended from 5 years to 8 years with the improvement of the educational system in 1997. The first five years of compulsory education are called as primary school also known as 1st stage, and last three years are called 2nd stage. 7-12 year old students go to 1st stage and 13-15 year-old students generally go to the 2nd stage of primary school. However, high school education was also increased from 3 years to 4 years with an improvement of educational system in 2006 and 15-18 year old students generally go to high school. But in the year 2012 (March, 30), education system in Turkey is radically reconstructed. With this re-constructed system, compulsory education in Turkey is 12 years and elementary education is 4 years while secondary education (secondary level I is 4 years and secondary level II is 4 years) is 8 years. It will be applied in 2012- 2013 education year.

In the Turkish elementary school and high school math curriculum (MEB, 2005a, b), it was emphasized that students' affective development should be taken into consideration when mathematical concepts and skills are developed. As affective domain, the attitudes were taken as self-confidence, self regulation and mathematics anxiety. Mathematics anxiety is considered under the heading affective characteristics with sentences like “should not have as much anxiety as it negatively affects their success in mathematics and their feelings and views about mathematics” (p. 17) and efficacy for self-regulation under the heading with sentences like “don't

get too much excited and panicked in mathematics exams” (p.18). In curriculums, some targets at attitudes are: Enjoyment in dealing with mathematics, thinking mathematics contributes scientific and technological developments, not having too much anxiety which negatively affects mathematics success and feelings and thoughts related to mathematics, belief in mathematics for contributing the logical decisions (MEB, 2005a, b). NCTM (1989) also adopted similar approach and indicated the importance given to the topic with the following manner:

*Learning mathematics extends beyond learning concepts, procedures, and their applications. It also includes developing a disposition toward mathematics and seeing mathematics as a powerful way for looking at situations. Disposition refers not simply to attitudes but to a tendency to think and to act in positive ways. (p. 233).*

In Turkey geometry is taught in the mathematics classes at the primary education level, it has been taught comprehensively as a different class from 9th grade that is the first stage of high school. Geometry was renewed as more based on a constructive approach and it is one of the five learning fields that have placed into the centre of the primary mathematics curriculum, which has begun to be applied progressively since 2006 in Turkey (MEB, 2005a). The other learning fields are numbers, measurement and statistics and probability, and algebra. However in curriculums making connections within learning domains and across domains is emphasized. Thus psychomotor skills such as given below are suggested to be given through concrete materials (MEB, 2005a):

*... They construct geometric figures, mathematical relations, designs and tessellations through paper-folding activities. By cutting papers they construct geometric figures, mathematical relations, designs and tessellations. They use pattern blocks effectively. They use mirror symmetry effectively. They use geometry ribbons effectively. They use geometry square board effectively. They use geometry circular board effectively. They use unit cubes effectively. (p. 21-22).*

Geometry education in Turkey covers these topics through grade levels 8-11: The geometry curriculum in grade 8 contains e.g. triangles, geometric fields, patterns and tessellations, and transformation geometry. In grade 9 it contains e.g. geometric concepts, examining lines analytically, triangles, circles, area and volumes of solids, vectors in plane. In grade 10 it contains e.g. geometric concepts, triangles and

similarity in triangles. In grade 11 contains e.g. polygons, circle, geometric average, areas of polygons region, and areas of polygon regions.

## 2.2. Assessment

Turkish education system is formed around central, large scale exams (Yıldırım, 2008). For example; the 8th graders take the examination for secondary education [Turkish: Ortaöğretim Kurumları Seçme ve Yerleştirme Sınavı- ÖKS] to be able to attend high school. It is thought to be giving more quality to education and the winners have been placed to high schools such as Anatolian High Schools, Science High Schools, and Technical High Schools. Students who don't have any success in the exam attend any high school which gives classical education. After the first grade of high school, students' high school education is classified according to three different fields called as "numeral, verbal, and counterweight". Classes such as mathematics, chemistry, physics, are intensely given in numeral program, classes such as history, literature and geography are given in verbal program. In a counterweight programs, mathematics is taught more intensely in addition to the classes in the verbal program. High school graduates are placed in universities according to their University Entrance Exam [Turkish: Öğrenci Seçme Sınavı - ÖSS] results. The students who are successful in the exam will be placed in any program at the university according to both their scores taken in the exam and their choices.

ÖKS and ÖSS exams are multiple choice tests and conducted annually in one session. Hence, there has been a discussion on the reliability of these exams and how well they assess students' levels of comprehension. Therefore, there has been continuing debate about this issue in Turkey. With updating mathematics curriculums according to constructivist approaches, the coverage and number of annual sessions of ÖKS and ÖSS exams have been continually updated. For example, MEB, starting in 2008-2009 academic year, has begun to impose an exam system called "Achievement Level Test [Turkish: Seviye Belirleme Sınavı - SBS]" for secondary school placements instead of ÖKS that is given only for 8 graders. The fundamental aim here is explained as to spread exam load and stress over years and make students give importance to lessons. Thus, at the end of 6, 7 and 8 grades 70% of scores taken from program of study focused exams, 25% of annual summative

scores and 5% of behavioral score that is obtained predetermined behavior criteria are summed to get each year's "Grade Point" for students that is not based on snapshot exams rather based on various exams and performance criteria. Furthermore, based on the performance of these three grade levels, 25% of 6<sup>th</sup> grade 'Grade Point', 35% of 7<sup>th</sup> grade 'Grade Point', 40% of 8<sup>th</sup> grade 'Grade Point' are summed to obtain "Secondary School Placement" score. Thus, students will be placed to a secondary school according to these final scores (MEB, 2008). However, this exam with three-stages was again updated in 2010 and now the 8th graders only take the SBS. Similarly, beginning in 2010, the exam is now similar to the ÖSS system in terms of subjects. Students take the the Transition to Higher Education Examination [Turkish: Yükseköğretime Geçiş Sınavı - YGS] in April. Those who pass the YGS are then entitled to take the Undergraduate Placement Examination [Turkish: Lisans Yerleştirme Sınavı - LYS], the second-round exam in the new system, which takes place in June. Students who take only the YGS, in which they are required to answer 160 questions in 160 minutes, are eligible to apply to associate's degree programs. There are five LYS sessions, whereas the previous university entrance exam, the ÖSS, lasted approximately 3.5 hours and was held once a year throughout the country (Wikipedia, 2011).

### **2.3. Performance of Turkish Students in Big Comparative Studies**

Geometry is a subfield of mathematics. The visual nature of geometry, its rich history, its links with art, design and cultural differences makes geometry lessons interesting and stimulating (Chambers, 2008). According to Hoyos and Silfverberg (2004), many mathematicians see geometry as a branch of mathematics which at least contains the implementation of algorithms, formulas, or rules in solving and discovering problems. But this feature of the geometry creates problems in its learning and teaching, especially in deductive reasoning. Therefore, although geometry is currently considered an important element of mathematics curricula in many parts of the world, it is known that students could not have improved, on their own, a powerful conceptual knowledge to geometry (Mistretta, 2000). The results of large-scale domestic assessments (e.g., the ÖKS and the ÖSS) and international comparative studies (e.g., Programme for International Student Assessment (PISA)

and Trends in International Advanced Mathematics and Science Study (TIMSS)) point out that generally Turkish students are at low level in mathematics, especially those who are at a rather low level in geometry (The Turkish National Education Ministry-The Educational Research and Development Department (MEB-EARGED), 2003, 2007; The Organization for Economic Co-operation and Development (OECD), 2000). For example, according to the research outcome of PISA 2003, more than 75% of Turkish students at the age of 15 (8th and 9th graders) have the performance of the second level or lower (The lowest performance level is the below of first level, the highest performance level is the sixth level) at the space and shape fields in geometry. In contrast, the average of OECD countries is in the 3rd level (Mean index: Turkey: 417, OECD-whole: 486, OECD-index: 496) (MEB-EARGED, 2003).

On the other hand according to PISA 2003 results, it is found that Turkish students generally enjoy mathematics and they are interested in mathematics (mean index: Turkey: 0.55, OECD-whole: 0.04, OECD-mean: 0.00; the highest index: Mexico: 0.58, the lowest index: Japan: - 0.39). This data shows that Turkish students' well above OECD mean. In spite of this fact, it is interesting to note that self-confidence of Turkish students towards mathematics is close to OECD mean (mean index: Turkey: 0.02, OECD-whole: - 0.02, OECD-mean: 0.00; the highest index: Denmark: 0.24, the lowest index: Japan: -0.53) (MEB-EARGED, 2005). From Third International Mathematics and Science Study-Repeat (TIMSS-R, 1999) similar results were obtained; it is found that Turkish students enjoy learning mathematics (MEB-EARGED, 2003).

### **3. THE PURPOSE AND RATIONALE OF THE STUDY**

At this point of the development of research in mathematics education, question of attitudes is very important and attracts many researchers worldwide. Although excessive and various researches have been made upon the determination of the attitude toward mathematics, scarcity in researches for attitudes in geometry attracts attention. Moreover, even though there has been a significant association between attitude variables such as enjoyment, usefulness and anxiety (Newby,

1998), it is noted that studies investigating students' attitudes towards geometry with respect to these variables has not been conducted much in the literature. Besides it should be noted that it is important to study students' attitudes toward geometry through grade levels (8-11). This is because attitudes are relatively temporary and they can change over time. Hence, a person's attitude today might be different from his/her attitude tomorrow (Munroe, 2002). This change can be more apparent during the adolescence period along with the new experiences (Seah, 2003). Therefore, it is our opinion that this study may make a meaningful contribution to mathematics education research. Hence, in this research, we fill up this deficiency by answering the following questions:

1) Do the variables of students' attitudes toward geometry (enjoyment, usefulness, anxiety) change significantly through grade levels?

2) Is there any significant correlation between the student's attitude variables (enjoyment, usefulness, anxiety) toward geometry?

## **4. METHOD**

### **4.1. Research Design**

In this study, a quantitative approach was used to investigate primary and high school students' attitudes toward geometry measuring enjoyment, usefulness, and anxiety, to allow us to gather views from a potentially large number of students. Therefore, a cross-sectional study design was used because it studies several different groups of people of different ages to compare whether age differences without waiting for longitudinal findings exist in the attitude or behaviour being studied (VanderStoep & Johnston, 2009). In addition, in these studies, data are obtained on each study subjects at a single point in time (Bailey, Vardulaki, Langham & Chandramohan, 2005) and according to Cohen, Manion and Morrison (2000), this type of research involves "indirect measures of the nature and rate of changes in the physical and intellectual development of samples of child drawn from representative age levels." (p. 175). Furthermore, many cross sectional studies are carried out using

questionnaires and the most important advantage of these studies is that in general they are quick and cheap (Mann, 2003).

## 4.2. Participants

This study was limited to determine the present situation of primary (only grade 8) and high school students' attitudes towards geometry. For this purpose, the sample consisted of 215 primary schools (116 female and 99 male with a range age of 14-15 years) and 265 high schools (141 female and 124 male with a range age of 15-17 years) enrolled at primary and high schools in Sivas city of Turkey. Out of the participants, 215 were from grade 8, 90 were from grade 9, 80 were from grade 10, and 95 were from grade 11. The reasons for including 8<sup>th</sup> graders in the sample composed of high school students were: a) 8<sup>th</sup> grade students learn more geometry compared to 6<sup>th</sup> and 7<sup>th</sup> graders, b) their attitudes towards geometry were shaped more compared to 6<sup>th</sup> and 7<sup>th</sup> graders, and c) grade 8 is the last stage of primary school and students attend high school after this stage. So, they carry the affective inclinations toward general mathematics, especially geometry to the beginning of high school education. Table 1 summarizes the characteristics of the participants. Random sampling was used to select the sample and attending 8th graders of 6 classes, at 4 primary schools, and from 9th to 11th graders, in 6 other classes at 3 high schools, in various schools in the district of Sivas (city in Turkey). 10th and 11th graders were selected among the students going to a numeral program. These students generally have higher achievements, in contrast to the students in the other two fields. It was therefore expected to have a better attitude towards mathematics (geometry) (Schofield, 1982; Lianghuo, Seng, Yan, Mei, Pereira, Mendoza & Yee, 2005). It is thought that the sample size was impressive as was the random approach. It would have been beneficial to learn about the method in which the random sample was selected given the different grade levels and classes from which participants were drawn. In terms of the methodology - it is important to offer some explanation as to what might have contributed to low alpha coefficients of the questionnaire used in the present study.

TABLE 1  
Demographic Students' Profile (n = 480)

| Variable           | Primary school     |         | High school        |         |
|--------------------|--------------------|---------|--------------------|---------|
|                    | Number of Students | Percent | Number of Students | Percent |
| <i>Grade Level</i> |                    |         |                    |         |
| Grade 8            | 215                | 100     | -                  | -       |
| Grade 9            | -                  |         | 90                 | 33.9    |
| Grade 10           | -                  |         | 80                 | 30.1    |
| Grade 11           | -                  |         | 95                 | 35.8    |
| Total              | 215                | 100     | 265                | 99.8    |
| <i>Gender</i>      |                    |         |                    |         |
| Female             | 116                | 53.9    | 141                | 53.2    |
| Male               | 99                 | 46.0    | 124                | 46.7    |
| Total              | 215                | 99.9    | 265                | 99.9    |

### 4.3. Data Collection Instrument and Procedure

When it is looked at literature, it is seen to be measured with different methods of attitudes by the researchers. These are self-report methods such as observational methods, interviews and questionnaires, attitude scales, sentence completion, content analysis and projective techniques (Aiken, 1970; Krosnick, Judd, & Wittenbrink, 2005). In this study, the Attitude toward Geometry Scale (ATGS) was used, developed by Bulut, Ekici, Işeri and Helvacı (2002). At first ATGS was composed of 24 items, 11 of them being affirmative and 13 being negative. Unrotated principal components analysis was firstly performed by Bulut and her colleagues. It initially yielded 4 factors with eigenvalues greater than 1 (eigenvalues of 4 factors: 11.31, 1.37, 1.24, and 1.06). Variance explained for all of the factors were also 62.4%. In here, most of items were loaded heavily under factor-I. Then, principal components factor analysis was performed with a varimax rotation by Bulut and her colleagues. It ensures that the factors remain uncorrelated (Field, 2002). But, some items (item no: 12, 13, 14, 4, 8, and 23) synchronously loaded on more than one single factor. Therefore, in order to get more meaningful dimensions these items were discarded, principal components factor analysis was again performed with a varimax rotation. The results showed analysis of variance for the ATGS was 59.5%; for each scale, analysis of variance ranged 44.8% (item no: 1, 2, 5, 7, 9, 11, 15, 17, 20, 22, 24), 7.6% (item no: 3, 16, 18, 19), and 7.1% (item no: 10, 21) respectively. In this way, final version of ATGS was obtained. The ATGS consists of 17 items

designed to measure students' attitudes toward geometry. Through the instrument, the students were asked to indicate how strongly they agreed with each item (1-strongly disagree, 5-strongly agree). Seven items of the ATGS were reversed items and these items were given with an appropriate value for the data analysis. Bulut and her colleagues (2002) reached a three-factor solution from an exploratory factor analysis with the maximum likelihood method of extraction and a varimax, orthogonal, rotation. Factor analysis is a technique used to identify factors that statistically explain the variation and covariation among measures. It reduces a large number of overlapping measured variables to a much smaller set of factors. Hence, it can be viewed as a data-reduction technique (Green, Salkind & Akey, 2000). Exploratory factor analysis of the ATGS using a sample of primary and high school students resulted in three factors identified as enjoyment, usefulness, and anxiety by Bulut and her colleagues. Thus, the ATGS consists of one cognitive attitudinal factor, usefulness of geometry and two affective attitudinal factors, enjoyment and anxiety. The enjoyment factor consisted of 11 items. The usefulness factor consisted of 4 items. The anxiety factor consisted of 2 items. Alpha coefficients for the scores of these sub-factors were found to be .93, .61, and .57 respectively. Therefore the findings obtained from 2nd and 3th factors should be approached more cautious. In the current research, the underlying reasons of using ATGS as data gathering instruments are: a) it contains both cognitive and affective attitudinal so, in this article, the two dimensional definition of attitude were adopted (see Daskalogianni & Simpson, 2000), b) there is a significant association between attitude variables such as enjoyment, usefulness and anxiety (Newby, 1998), and c) The scarcity of research that investigate students' attitudes towards geometry in terms of these attitude variables (enjoyment, usefulness and anxiety). This instrument tries to find out students' attitudes toward geometry concerning following themes (author's translation):

\* *Enjoyment* (11 statements)

#1: "I like discussing the geometry subjects."

#2: "Geometry subjects are boring for me."

#5: "Geometry interests me."

#7: "Geometry is an enjoyable subject for me."

#9: "I learn geometry subjects willingly."

#11: "I would like further information about the geometry."

#15: "I would like to dedicate most of my study time to the geometry."

#17: "I like geometry subjects."

#20: "I would not like to learn geometry subjects."

#22: Time passes very quickly in geometry classes for me.

#24: "Geometry subjects are fun for me."

\* *Usefulness* (4 statements)

#3: "Geometry is the subject that isn't used in daily life."

#10: "Geometry subjects don't help the intellect development."

#18: "It would be better if geometry subjects are not taught in schools."

#19: "I can apply geometry subjects in daily life."

\* *Anxiety* (2 statements)

#10: "I'm afraid of geometry subjects."

#21: "Geometry is hard for me to learn."

In this study, level of enjoyment refers to students' wishing to like geometry and to learn more geometry. Level of usefulness refers to students' perceptions of the use of geometry in daily life. Level of anxiety refers to the extent students had imposed and created anxiety during geometry learning. The ATGS was administered to the selected students from grade 8 to grade 11 in Sivas, within a one-month period during spring term of the 2006-2007 educational terms, during their math classes. It took only ten to fifteen minutes to complete the questionnaire. Directions were provided in written form and the purpose of the study was clearly explained to the students in each class by the researchers. The students were also asked how they felt about answering the instrument and whether any statements were unclear or difficult. Furthermore, the researchers ensured that students' responses of the ATGS would be confidential.

#### 4.4. Data Analysis

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software. Three dependent variables were measured in the study: (1) usefulness toward geometry, (2) enjoyment toward geometry, and (3) anxiety toward geometry. The independent variable was grade level of students. In here, high scores indicated more fully developed attitudes toward geometry for the first two variables. But there is a reverse approach for the last variable. Survey items were analyzed using descriptive statistics. Multivariate Analysis of Variance (MANOVA) and bivariate correlation analysis were also performed to analyze the collected data. The main effect of the independent variable was examined and data were analyzed testing for main effect at the .05 level.

### 5. RESULTS

Explanations towards the research problems are given below:

*Question 1. Do the variables of students' attitudes toward geometry (enjoyment, usefulness, anxiety) change significantly through grade levels?*

Data analysis indicated that the effect of the variable grade level on the three dependent variables enjoyment, usefulness, and anxiety was significant with small effect size (Wilks' Lambda  $F = 0.852$ ,  $p < .01$ , eta squared = .05). So it was concluded that there was enough evidence to say that there was an effect of the grade level on the three dependent variables. Therefore, follow ups were conducted.

Results indicated that the effect of grade level to all of the three dependent variables was significant with a small effect size. There was enough evidence to say that there was an effect of grade level on the variables usefulness  $F(3,475) = 14.546$ ,  $p < .01$ , eta squared = .08), enjoyment ( $F(3,475) = 18.123$ ,  $p < .01$ , eta squared = .10), and anxiety ( $F(3,475) = 9.968$ ,  $p < .01$ , eta squared = .05). Table 2 summarizes the descriptive statistics of the students' scores on the ATGS.

TABLE 2  
Descriptive statistics of the attitudes of students' in terms of their grade levels

| Variable | Grade Level |      |     |         |      |    |          |     |    |          |      |    |
|----------|-------------|------|-----|---------|------|----|----------|-----|----|----------|------|----|
|          | Grade 8     |      |     | Grade 9 |      |    | Grade 10 |     |    | Grade 11 |      |    |
|          | Mean        | SD   | n   | Mean    | SD   | n  | Mean     | SD  | N  | Mean     | SD   | n  |
| U        | 3.14        | .65  | 215 | 3.37    | .88  | 90 | 3.56     | .70 | 80 | 3.70     | .81  | 95 |
| E        | 3.27        | .86  | 215 | 3.31    | .58  | 90 | 3.85     | .88 | 80 | 3.90     | .86  | 95 |
| A        | 2.64        | 1.08 | 215 | 2.94    | 1.16 | 89 | 2.19     | .94 | 80 | 2.24     | 1.08 | 95 |

Note: U=Usefulness, E= Enjoyment, A= Anxiety

On the one hand, as shown in Table 2, from the arithmetic mean of usefulness factor, it is open to increase attitude toward usefulness of geometry with the increase of students' grade level. It is thought that this is due to fact that as grade level increases geometry topics are enriched and deepened. On the other hand, as seen in Table 2 again, the geometry enjoyment situation of there is somewhat neutral (Mean value ~ 3.0) for grade 8 and for grade 9. At first glance, it is seen this data does not match exactly with the previously mentioned results of PISA 2003. However, when looked to the PISA 2003 results in more detail according to the basis of regions, it is seen that the students' enjoyment situation of mathematics differ by the regions. Accordingly, the enjoyment level of mathematics - though it is high in general- appears to be under the Turkey-mean at the location of the current research (Central Anatolia Region) (Mean index: Turkey: .55, mean index (approximately): Central Anatolia Region: .45) (MEB-EARGED, 2003).

In the point of enjoyment from geometry, it is also determined to show the similar way to the former attitude variable (usefulness toward geometry). So, the enjoyment level from geometry is increasing comparatively with grade level. As the grade level is getting higher, students have an opportunity at the same time to observe both the abstract and concrete content and mystery of geometry. It is thought that this is an important result because according to Skemp (1989) adults' interests in mathematics vary with their previous enjoyment levels. In fact, in the above mentioned research of Armstrong and Price (1982), it was found out that enjoyment comes as the third after usefulness of mathematics and confidence in

mathematics as most powerful forces for mathematics teaching. According to results of the research implemented for 16-year-old students from England and Northern Ireland, Ridgway and his colleagues (2007) found out that enjoyment and interest in mathematics play important roles in choices of future courses. Moreover, they expressed that mathematics in the school is not interesting and enjoyable for most students.

On the other hand, the general anxiety towards geometry, according to this data, the attitudes toward enjoyment of geometry and usefulness of geometry in daily life are somewhat neutral (Mean value  $\sim 3.0$ ) for grade 8 and grade 9 positive (Mean value  $> 3.5$ , but  $< 4.0$ ) by the grade 10 and grade 11. According to this, grade 8 and grade 9 declare their attitudes generally somewhat neutral (Mean value  $\sim 3.0$ ), into the searched each three attitude variable. However, although grade 10 and grade 11 declare their visual positive (Mean value  $> 3.5$ , but  $< 4.0$ ) for the first two attitude variable (usefulness and enjoyment), they proclaim negative (Mean value  $> 2$ , but  $< 2.5$ ) for the last variable (anxiety). That is, although they enjoy geometry and have a positive attitude that geometry can be used in daily life; they have anxiety toward geometry. This seems like a dilemma and searching for the reasons ought to be a different research subject. However, the ÖSS mentioned above is thought to be the reason of it. Because, in ÖSS, the questions from geometry subjects fairly have an important function in selecting the candidates that will attend the university. It is thought that this has created extra anxiety among the students. It is stated that, the high examination anxiety among the students in different countries with a similar reason of exams like ÖSS and ÖKS is about 25% and 30%. The high examination anxiety in Turkey is approximately 42% (Yıldırım, 2008).

*Question 2. Is there any significant correlation between the student's attitude variables (enjoyment, usefulness, anxiety) toward geometry?*

Findings show there is a positive and meaningful relationship ( $r = .37$ ,  $p < .01$ ;  $r = .55$ ,  $p < .01$ ;  $r = .48$ ,  $p < .01$ ) between a medium level of enjoyment and usefulness of the attitude variables of 8th, 9th and 10th grade students. For the 11th grade students it has been seen that there exists a positive and meaningful relationship ( $r = .72$ ,  $p < .01$ ) at a high level between these two variables. For the 8th, 10th and, 11th grade students it has been observed that there is a negative and

meaningful relationship ( $r = -.42, p < .01$ ;  $r = -.47, p < .01$ ;  $r = -.58, p < .01$ ) at a medium level between enjoyment and anxiety variables, respectively. For the 9th grade students, it reveals that there is a negative and meaningful relationship ( $r = -.72, p < .01$ ) at a high level between these two variables of attitude. Table 3 summarizes the correlation results.

TABLE 3  
The Correlation between the Variables

| Variable | Grade level |       |        |         |       |        |          |       |        |          |       |        |
|----------|-------------|-------|--------|---------|-------|--------|----------|-------|--------|----------|-------|--------|
|          | Grade 8     |       |        | Grade 9 |       |        | Grade 10 |       |        | Grade 11 |       |        |
|          | U           | E     | A      | U       | E     | A      | U        | E     | A      | U        | E     | A      |
| U        | -           | .37** | -.15*  | 1       | .55** | -.36** | -        | .48** | -.34** | -        | .72** | -.53** |
| E        | -           | -     | -.42** | -       | -     | -.72   | -        | -     | -.47** | -        | -     | -.58** |
| A        | -           | -     | -      | -       | -     | -      | -        | -     | -      | -        | -     | -      |

Note 1: \* refers to  $p < .05$  level, \*\* refers to  $p < .01$  level

Note 2: U=Usefulness, E= Enjoyment, A= Anxiety

From these findings it has been concluded that the correlation between enjoyment and usefulness variables among the 11<sup>th</sup> grade students varies as high, positive and significant compared to other grades' students. Similarly, these findings reveal that the correlation between enjoyment and anxiety variables among 9th grade students varies as high, negative and significant compared to the other students. However, this data also concludes that the correlation between anxiety and usefulness variables among the 8<sup>th</sup> grade students varies and it is lower, negative and significant compared to other grades' students.

## 6. DISCUSSION

As explained, in Turkey, grade 8 is the last stage of primary education, grade 9 is the first stage of high school education. So, students run into a different education atmosphere and culture getting to know new friends, new teachers, a new curriculum and a new environment. The difficulty of this transition process for the students is well-known (Schwartz, 1995). In spite of this, it is indicated that 8th and 9th graders' attitudes toward geometry haven't differentiated to the each three

attitude variables (usefulness, enjoyment, and anxiety) and they have been somewhat neutral (Mean value  $\sim 3.0$ ). It is found that 10th and 11th graders generally display the similar attitudes for the each three attitudes. The students at the each two grade have the attitude that is positive (Mean value  $> 3.5$ , but  $< 4.0$ ) to the usefulness of geometry and the enjoyment of geometry. Upon it, with the increase of grade level, it can be said to have increased the positive attitude to attitude variables "enjoyment" and "usefulness". In fact, there is also some research in the literature which noted that attitude scores decrease while going from elementary school to secondary school (see, McLeod, 1994). Therefore, the development of this positive situation of Turkish students may impact on their mathematics achievement. Because, in an analysis by Yayan and Berberoglu (2004) based on the results of TIMSS-R 1999, it was identified affective factors play very important role on Turkish students' mathematics achievement. However, in our present study, it is seen when the grade level increases, the mathematics anxiety also increases. This case support the results of the study on Turkish population by Dede (2008). It was determined in Dede's study that mathematics anxiety of high school students is at a higher level compared to that of elementary school students.

Another striking result here is that although 10th and 11th grade students have positive attitudes towards enjoyment of geometry and usefulness of geometry, they have anxiety towards geometry. This result coincides with previously mentioned results of PISA 2003 and TIMSS-R 1999. According to these results, Turkish students enjoy learning mathematics and consider mathematics as an important factor for their future life but at the same time they have anxiety towards mathematics. Moreover, as expressed before, 10th and 11th grade students are those who attend in numeral program and are expected to have high achievements in mathematics in general. But, in Dede's study (2008) it was identified that Turkish students having high achievement in mathematics have lower anxiety towards mathematics. Reasons for these differences may be following: a) In our present study, students' anxiety towards geometry, that is, a more specific area of mathematics, are investigated. Therefore, attitudes towards specific issues may vary (see Hopkins et al., 1997; Tapia & Moldavan, 2007), b) Even though 10th and 11th

grade students attend to numeral, in fact, their achievement level in mathematics is not completely known.

The other result of this research is to determine to be significant, positive and medium level correlation between enjoyment of geometry and usefulness of geometry for 8th, 9th, and 10th grades. The positive correlation has actualized at high level for 11th graders. This data presents great importance because of finding out how many of the students at that level use geometry in daily life, they enjoy it more. Therefore, if teachers and curriculum makers take this situation into consideration then shaping the geometry teaching in such a way may provide better atmosphere for students to enjoy geometry, which may increase achievements in mathematics and especially in geometry (Langen, Rekers & Dekkers, 2006). It has been determined that the relation is negative and significant at the medium level for the 8th, 10th and 11th graders among the anxiety factors toward the geometry and enjoyment. The negative relation has actualized at the high level for 9th graders. It has been also determined that the relation is the negative and significant at the medium level for the 9th, 10th, and 11th graders among the anxiety factors toward geometry and the usefulness of geometry in daily life. This negative relation has actualized at the lower level for 8th graders. This data is important because it shows that how much, especially high school students, use geometry in their daily life, whereas anxiety levels among them toward geometry decrease at the same rate.

## **7. LIMITATION AND FURTHER STUDY**

This research presents the differences between the three attitude variables according to the grade levels and correlates them with each others. However, it should not be forgotten that there are many factors such as teaching methods, teaching materials, the density of curriculum, ÖSS and ÖKS and frequency of exams which may affect Turkish students' attitudes (Koca & Şen, 2002). Also, Reynolds and Walberg's (1992) following words support this:

Mathematics attitude, on the other hand, appears to require qualitative components as reflected by students' perceptions of their teacher's clarity of

expression and instructional support. It appears, for example, that students are more likely to acquire favorable attitudes toward mathematics if they perceive the classroom context (e.g., teachers) in a positive light. (p. 324).

With this reason, the author of this article have agreed that the results of the research identify with the reasons, of the available situation and will be a beginning point to find the probable solving ways, especially for the next researches that have a generally qualitative side. The study was limited to only four primary schools (215 students) and three high schools (265 students) in the city centre of Sivas, Turkey. Although this sample size is not small, a larger sample size might be needed for determining Turkish students' attitudes towards mathematics. Selecting sample from only one city also might be a limitation of this study. Therefore, future studies on this topic might choose larger sample sizes from various cities. In this research, just three attitude variables were examined. Therefore, various variables different from attitude variables studied in this research might be used to conduct further research. Although the alpha coefficient of factor 3 of the questionnaire used in this study is acceptable, it is very small (the alpha coefficient of .57 is, although acceptable, but quite low). Therefore, the results obtained from this factor could be treated cautiously. Moreover, although this study made a case for their affective variables influencing students' attitudes towards geometry as they progress from grade 8 to 11, it is difficult (as shown in this study) to conclusively state which aspects of students' attitudes are responsible for students' liability towards geometry.

In spite of the limitations given above, it is thought that this study may have meaningful contribution to mathematics education research in two ways: a) It looks at attitudes through grade levels (8-11), and b) it presents context of Turkish mathematics education which is interesting in terms of comparative and cultural view. Therefore, it is thought that this study will be a good reference point for comparative and cultural studies.

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