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Teaching Techniques and Activities for the Education of the Gifted Young Scientist

I'm Discovering Conics and Designing Buildings with Conics

ABSTRACT: There are three stages in this activity. At the first stage, it is provided that gifted students learn the subject of conic through discovery learning method. By this way, the formation of misconceptions that students frequently encounter in mathematics has been prevented. At the second stage, gifted students have been asked to draw the conical objects which they encounter in their daily life. Thus, it has contributed to the development of gifted students' creativity. At the third stage, gifted students have been asked to design a buildings consisting of conics. Moreover, gifted students have been informed that the buildings which they have been asked to design, would be evaluated according to the criteria which set before. And then, the building design model has been done by gifted students.

Key words: Mathematical giftedness, creativity, architecture, conics

Serkan KULOGLU, Manisa Science & Art Center, Manisa, TURKEY. E-mail: serkankuloglu@hotmail.com

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INTRODUCTION

In the studies conducted in recent years, there have been important changes in thoughts and a number of innovations about what mathematics is and to what extent and how it should be taught at primary level. New approaches in mathematics education, instead of just learning math, put the individuals in the center of learning by relating mathematics to the real life, as in parallel with the definition of mathematics (Ersoy, 2000; Bransford et al., 1999; Xin & Zhang, 2005; Polya, 1981. In this respect, differentiations in which problem-based learning environment is provided, individual differences are taken into account, should be made in education while gifted students develop their skills in the field of mathematics (Budak, 2008; Kok, 2012, Batdal-Karaduman, 2010; Kuloglu & Uzel, 2013; Assouline & Lupkowski–Shoplik, 2005).

One of the most important problems encountered in mathematics education is the formation of misconceptions in teaching. Misconception is not a mistake; also it is not a false answer because of the lack of knowledge. Misconception is that it takes the place of a concept in mind, but is different from the scientific definition of the concept. If a student explains with their reasons that his/her mistakes are correct and is self-confident, we can say that the student has a misconception. Surely, all misconceptions are mistakes, but all mistakes aren't misconceptions. Misconception is defined as the behaviors which are arisen form the false beliefs and experiences (Drews, 2005; Breigheith & Kuncar, 2002; Yasa & Kursat, 2008; Baki, 2006). In this sense, misconceptions that gifted students gain unwittingly and unconsciously in the teaching process and his/her previous experiences about various concepts used in daily life, should primarily be removed or education design which won't cause misconceptions, should be introduced (Breigheith & Kuncar, 2002; Jonnes & Tanner 2000; Ryan & Williams, 2007; Baki, 2006).

Krutetskii (1976) states that gifted individuals who have mathematical predisposition, have an advanced mathematical thinking unlike other individuals. Miller (1990) states that mathematical giftedness is an uncommon high skill to understand the mathematical thinking system and mathematical reasoning. The identification and development of this skill is very important in gifted education (Ervynck, 1991; Cho, & Dong Jou, 2006; Hoffman & Grialou, 2005; Assouline & Lupkowski–Shoplik, 2005; Miller, 1990).

Conic, in mathematics, is an important subject in geometry teaching. However, there are some problems in the teaching of this subject. If the education is conducted with an approach based on memorization and if it is not a student-centered education, students may have misconceptions about the types of conics. Also, students can forget what they learnt in a very short time. The shape about general appearance of conics is presented below (see Figure 1).

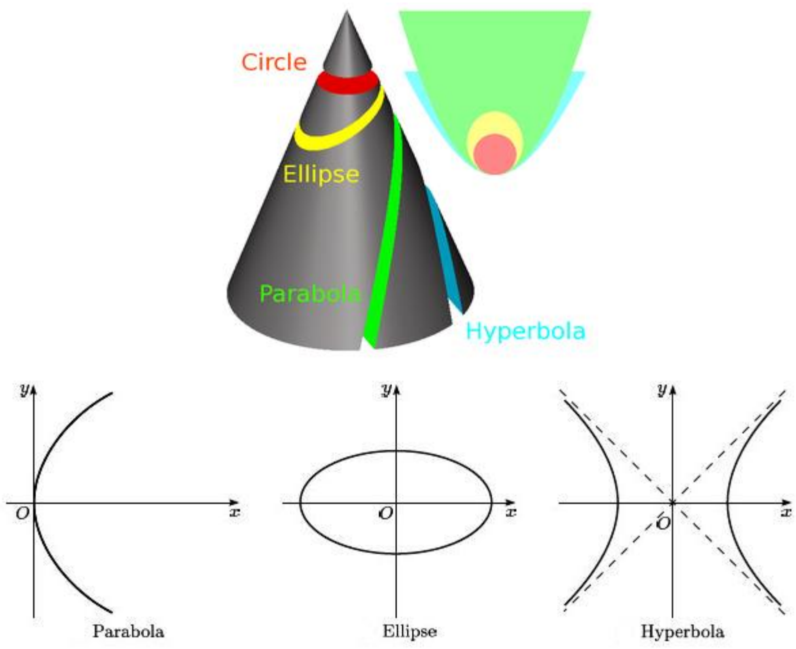


Figure 1. Conics (Wikipedia, 2013)

Conic is the locus where points have constant distance proportion to a fixed point and a straight line on the plane. This constant proportion is called eccentricity and it is indicated by 'e'. The image and the type of conic is changed according to the situation whether eccentricity value is lower than one (e <1), equal to one (e = 1) and higher than one (e >1).Students may mistake the definition of these three different types of conic or the relationship between the value of eccentricity and one (1) or they have misconceptions about this topic. In this activity, students are provided to do individual drawings and designs in teaching the conics. Students will discover the differences between the three different types of conics; ellipse, parabola and hyperbola on their own and hereby the information that they learn will become more permanent. In this activity, it is aimed to teach gifted secondary school students the following outcomes permanently;

- Students can describe the basic elements of conics
- Students can classify the conics according to their features
- Students can explain parabola, ellipse and hyperbola.

In this activity, gifted students are given the opportunity to prepare their individual work. With the guide of educator, gifted students have the opportunity to do drawings and designs about conics by associating with daily life. While drawing, it is provided that students notice the drawings obtained at different points, are different. Through this activity it is aimed to develop the analytical thinking skills, the imagination and the creativity of gifted students.

The Implementation of the Activity

Necessary equipment for the activity is ruler team, A3 size unlined paper, drawing pens, crayons and erasers. At the beginning of the activity, it should be emphasized that students need to draw meticulously and pay attention to the instructions given by educator in drawing process. At the beginning of the activity, it will be effective in increasing interest and attention to give gifted students the information about the development of conics in the history of science. That students do research about Apollonius on this topic can increase their interest for the activity.

This activity which will be implemented for gifted students is suitable for 6, 7 and 8 grade. It is recommended that this activity should be applied to a group of three students or a group of more students.

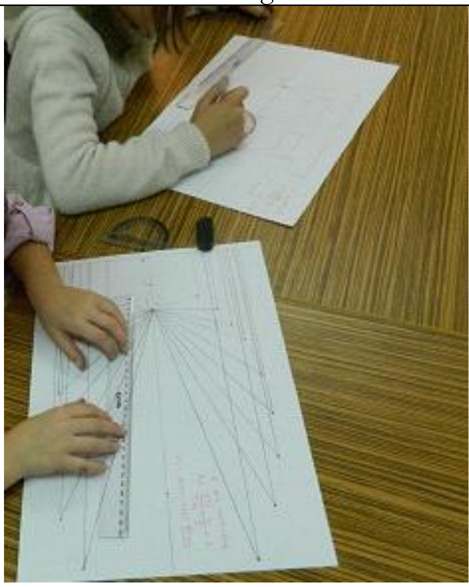
There are three stages in this activity. At the first stage, students will comprehend the subject. At the second stage, students will be asked to relate what he learnt with daily life by concretizing. At the third stage, students will produce designs about conics.

The First Stage

After it is briefly told the historical process of the conics to gifted students, by using their paper in a horizontal position, they are asked to draw a 'd' straight line (transverse axis) which divides their paper into two. Then, the students will be asked to constant 'F' point (focal point) that is at a certain distance to constant 'd' straight line. After this stage, some students will be asked to take a 'T' point (peak point) which is just in the middle of 'F' point and 'd' straight line, some students will be asked to take a 'T' point (peak point) which is between 'F' point and 'd' straight line and closer to 'F' point, some students are asked to take 'T' point (peak point) which is between 'F' point and 'd' straight line and closer to 'd' straight line. After that, by drawing 'k' straight line which passes through 'T' point and 'F' point and which is perpendicular to 'd' straight line, gifted students will be asked to take 'H' point perpendicular to the intersection of 'd and k' straight lines. Then, the students will be asked to find the eccentricity (e) proportion by dividing IFTI length to ITHI length. By maintaining the obtained proportion, it will be asked from the students to find other points on the top and bottom of 'k' straight line like 'T' point. After students find sufficient number of points, these points will be combined with the curve. Then, students will be asked to find the differences between these shapes and the underlying cause of these differences. After examining the shapes and discussions, it is explained to students that the shape whose value of eccentricity is e <1, is called as ellipse; the shape whose value of eccentricity e=1, is called as parabola and the shape whose value of eccentricity e<1, is called as hyperbola. The implementation photos which are examples of the explanation are presented below (see Table 1).

Table 1. First stage of the conics activity

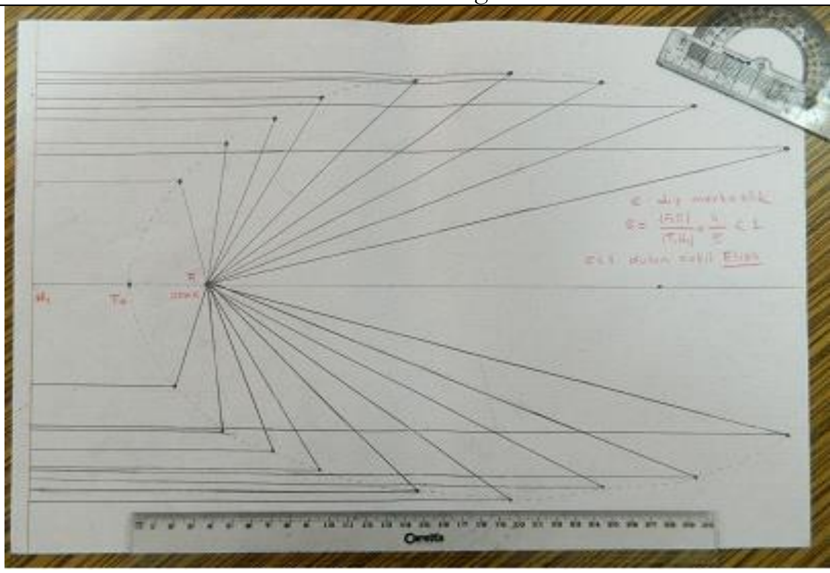
While students were doing individual drawings



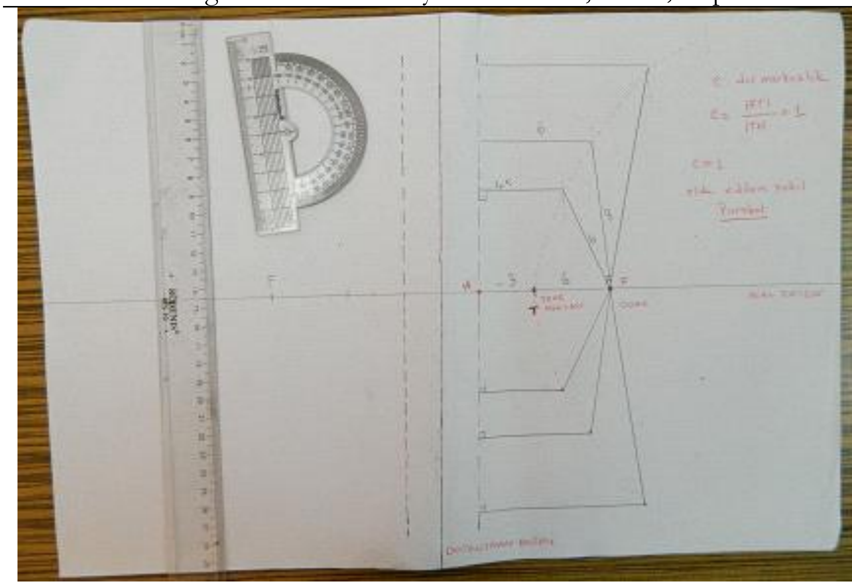
While the student choosing the eccentricity proportion less than 1, was drawing

While the student choosing the eccentricity value equal to 1,was drawing

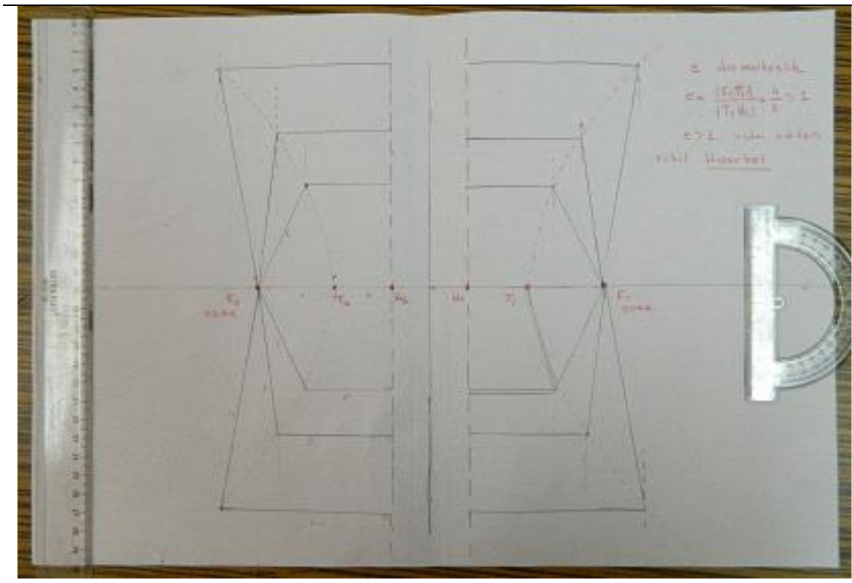
While the student choosing the eccentricity proportion higher than 1, was drawing



Drawing whose eccentricity value is e <1, Conic; ellipse



Drawing the eccentricity value is e = 1, Conic; parabola



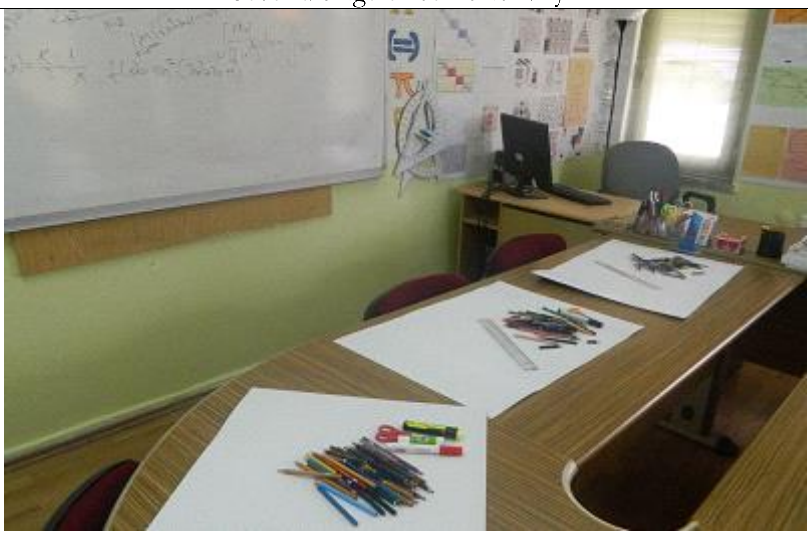
Drawing whose eccentricity value is e> 1, Conic; Hyperbola

At the first stage of the activity, students have learned the general definition of conics through the discovery learning method. They have seen the basic elements of conics and the differences between them by drawing on their own. While the students were drawing the conics, they learnt the concepts of principal axis, conjugate axis, focus peak, vertex, directrix and eccentricity. According to the eccentricity value, they learnt to classify the conics by discovery learning.

The Second Stage

At the second stage, students are asked to think about where they can see parabola, ellipse and hyperbola shaped objects and where conical objects can be used in daily life. Then, students are asked to draw pictures of conical objects that they encountered or may encounter in their daily lives. After giving students the necessary materials for drawing, a certain time must be determined and drawing activity begins when it is said that the student who draws the most and different conical objects, will score the highest score. Within the specified time, students think about many conical objects and their creativity is developed in this way. The implementation photos which are examples of the explanation in the second stage of the activity are presented below (see Table 2).

Table 2. Second stage of conic activity

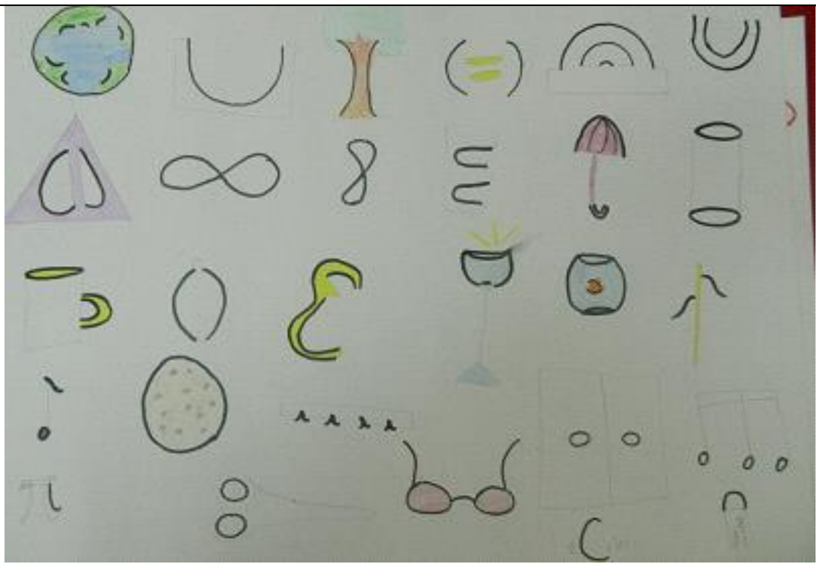


Necessary preparations and materials for drawings

While gifted students were drawing conical objects in daily life

While gifted students were drawing conical objects in daily life

While gifted students were drawing conical objects in daily life



Students' works at the second stage

Students' works at the second stage

Students' works at the second stage

At the second stage, students related with the abstract concepts that they learnt with everyday life by thinking tangible objects in their lives. At this phase, the number of conical objects that students drew (fluency) and the situation of conical objects' creating different groups (flexibility) is scored. Fluency represents productivity (Runco, 1991).

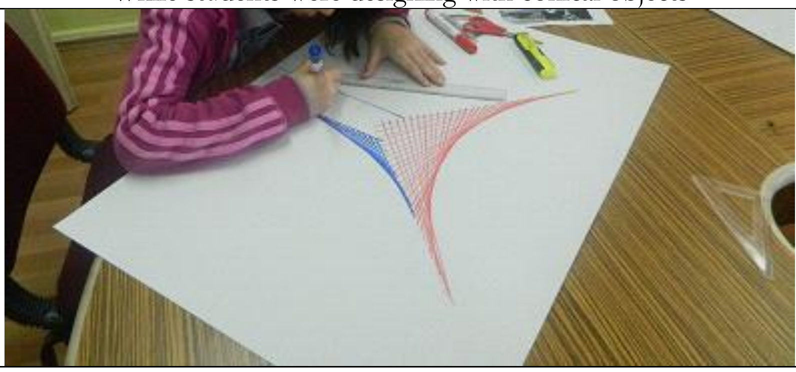
The Third Stage

At his stage, students were asked to design a building or structure by using conics. At this stage, students used the information and concepts that they had learnt before, to design. Students were informed that these designs would be evaluated according to functionality, stability and plurality of conical objects (See Appendix). After giving students the necessary materials, students are asked to be the first to draw design within a specified time. The implementation photos which are examples of the explanation in the third stage of the activity are presented below (see Table 3).

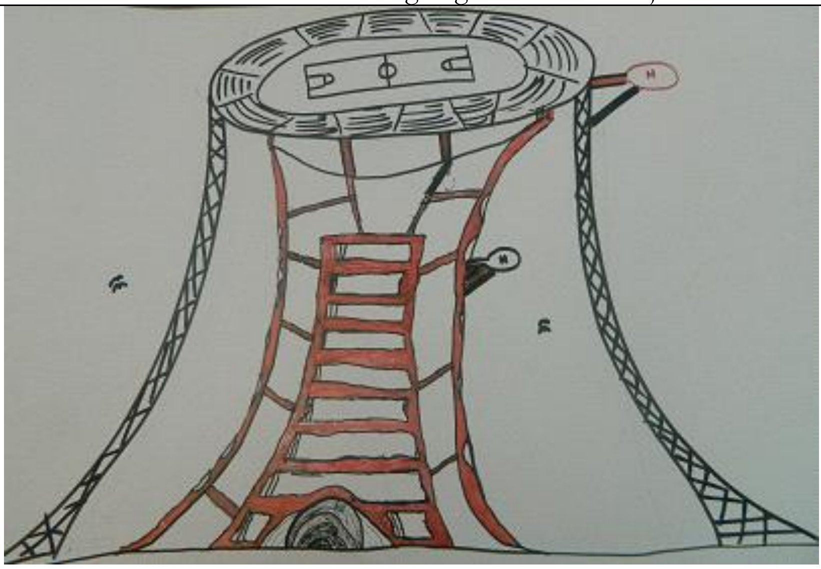
Table 3. Conic activity third stage

While students were designing with conical objects

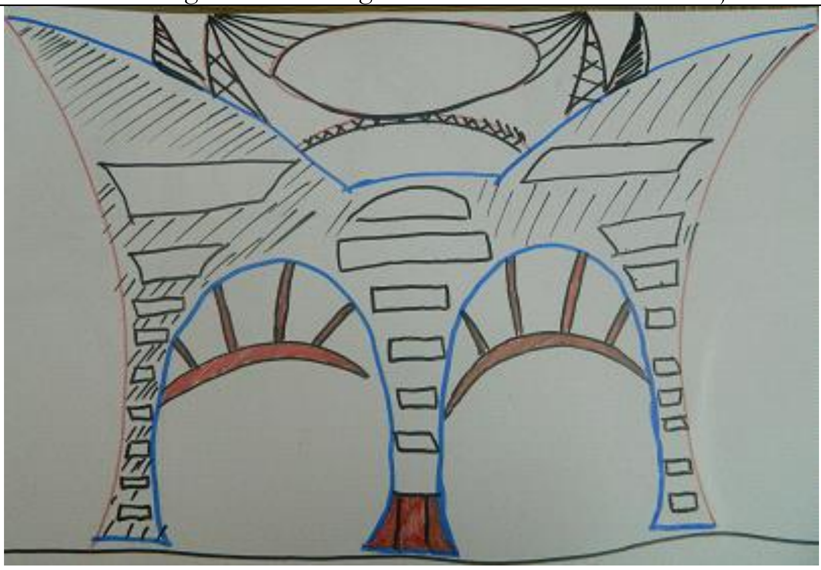
While students were designing with conical objects



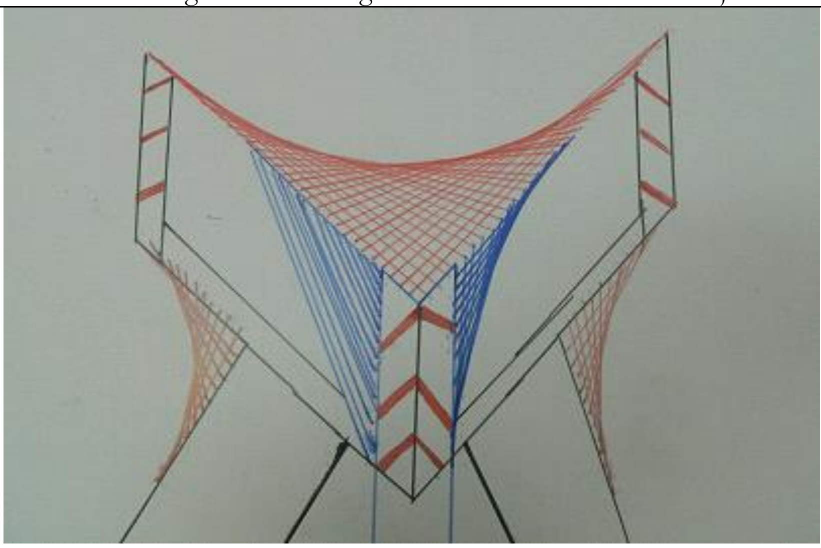
While students were designing with conical objects



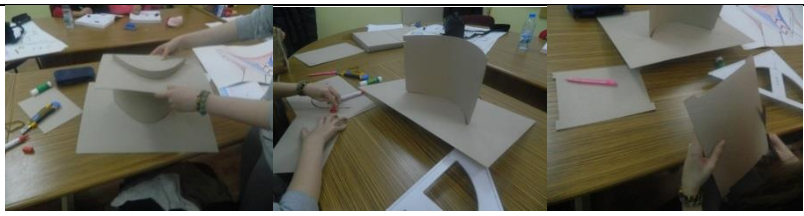
The building-structure designs of students from conical objects



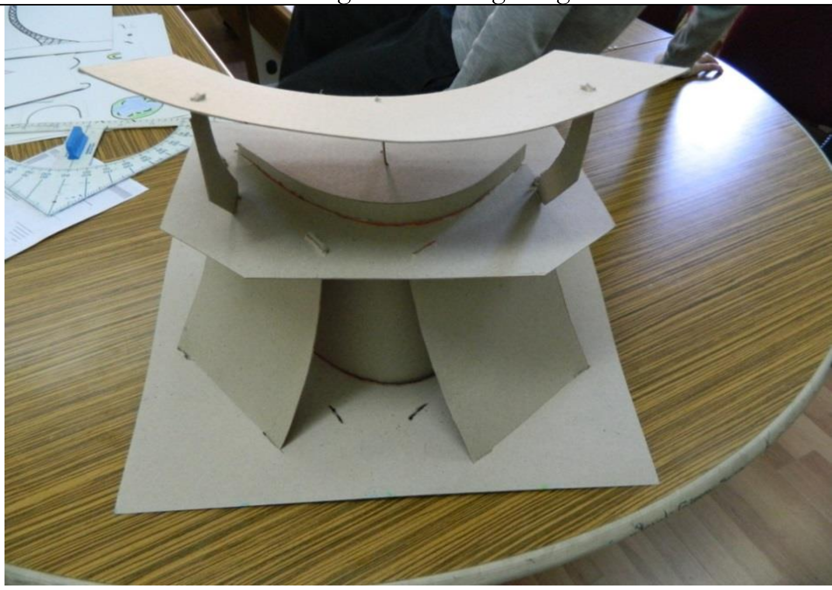
The building-structure designs of students from conical objects



The building-structure designs of students from conical objects



The stages of building design



The final version of the building made from conical objects

At the third stage, students used their knowledge and concepts that they had learnt, to design. They tried to develop new ideas in a short time. Moreover, the building designs that students did, were evaluated according to certain criteria (stability, using of conical objects and functionality) (See Appendix). At this stage, students could find the opportunity to develop their imagination and creativity while designing buildings.

CONCLUSION AND DISCUSSION

Gifted students want to learn the information of the field which they are curious about and interested in; they also want to use the information which they learn (Tomlinson, 1999; Silverman, 1998; Sak, 2010). Whereas in our country, in pre-school, elementary, middle and high schools, subjects are often at information level. As the support courses are repetitions of school programs, unfortunately these programs are far away from meeting specific learning needs of gifted students. These activities to be applied for gifted students in special education should meet the needs of students; help students to recognize their personal skills and enable students to use their potentials at highest level by improving their potentials (SACs Directive, 2007; Sak, 2010; Kirk & Gallagher, 1989; Budak, 2008; Batdal-Karaduman, 2010; Kok, 2012). Students should improve their personal skills in a systematically and programmatically to use their skills in the most effective way. In general, gifted children need special cases to develop their creativity (Renzulli, 1999). In the activity, students were provided free working environment and had the opportunity to emerge individual differences. Through this special situation, students found the opportunity to reveal the concepts that they had learnt, by the designs which they did on the basis of their capacity. Thus, the learning environment in which students could develop their creativity was created. At the second stage of the activity, that students drew conical objects is about fluency and the dimension of flexibility of creativity. However, as fluency represents productivity, fluency doesn't develop creativity a lot actually. In fact, originality is more important in terms of creativity (Runco et al., 2011). At the third stage, students designed a unique and an original building by using conics. Originality is different from common and useless ides (Torrance, 1995; Runco, 1991; Runco et al., 2011). To be limited by just the fluency is one of the major problems in the activities that gifted students do. In addition, originality and flexibility must be developed. In this respect, this activity contributes to the development of neglected dimension of creativity.

As well as associating the subject in Math's activities with daily life, activities should be designed to develop their imagination and creativity. Moreover, that gifted students know that their products will be evaluated according to certain criteria may contribute to the formation of the expected quality in the product.

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Appendix 1. Designing of Conic Building Rubrics

Student Name	**1th Dimension: Stability**	**2nd Dimension: Visuality and Originality**	**3th Dimesion: Functionality**	**4th Dimension: Using of Conical Objects**	**Total Point**
	Excellence : 4 point Good : 3 point Normal : 2 point Partially adequate : 1 point	Excellence : 4 point Good : 3 point Normal : 2 point Partially adequate : 1 point	Excellence : 4 point Good : 3 point Normal : 2 point Partially adequate : 1 point	Excellence : 4 point Good : 3 point Normal : 2 point Partially adequate : 1 point	