

BUILDING THREE-DIMENSIONAL GEOMETRIC SOLID MODELS THROUGH DEMONSTRATION-PERFORMANCE METHOD

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ABSTRACT

In this study, an activity was designed to teach the third grade content standard "identifies the surfaces, vertices, and edges of cubes, square prisms, rectangular prisms, triangular prisms, cylinders, cones and sphere models" within the "Faces and Surfaces of Geometric Objects" topic. The activity aimed to support active learning by having students construct models of cube, square prism, rectangular prism, triangular prism, cylinder, cones and sphere. The learning-teaching process was based on active learning and demonstration-performance. The activity was carried out with 22 students. It was observed that the students enjoyed their time in the activity process. All the students managed to build at least two models. The level of students' achievement of the purpose of the activity was assessed through the "Checklist for Level Identification." The assessment revealed that all students performed at a "good" level.

Keywords: geometric solids, active learning, demonstration-performance method.

GÖSTERİP YAPTIRMA TEKNİĞİ İLE GEOMETRİK CİSİM MODELLERİ YAPMA

ÖZ

Bu çalışmada ilkökul üçüncü sınıf matematik öğretim programında yer alan "Geometrik Cisim Modellerinin Yüzleri ve Yüzeyleri" konusuyla ilgili "Küp, kare prizma, dikdörtgen prizma, üçgen prizma, silindir, koni ve küre modellerinin yüzlerini, köşelerini, ayrıtlarını belirtir." kazanımına yönelik etkinlik hazırlanmıştır. Etkinliğin amacı küp, kare prizma, dikdörtgenler prizması, üçgen prizma, silindir, koni ve kürenin yüzlerini, ayrıtlarını ve köşelerini öğrenciyi aktif kılarak uygulamalı olarak görmelerini sağlamak, soyut olan bu kavramların modellerini yaptırarak somutlaştırmak ve öğrenmeyi kolaylaştırmaktır. Öğrenme-öğretme sürecinde aktif öğrenme ve gösterip yaptırma yöntemi temel alınmıştır. Etkinlik 22 öğrenci ile uygulanmıştır. Etkinlik sürecinde öğrencilerin istekli oldukları ve eğlendikleri gözlenmiştir. Tüm öğrenciler en az iki tane model yapmayı başarmıştır. Öğrencilerin etkinliğin amacına ulaşma düzeyleri "Düzy Belirleme Kontrol Listesi" ile değerlendirilmiştir. Değerlendirme sonucunda tüm ölçütlerin "İyi" düzeyde gerçekleştiği belirlenmiştir.

Anahtar kelimeler: geometrik cisim modelleri, aktif öğrenme, gösterip yaptırma tekniği.

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INTRODUCTION

Mathematics, being a discipline that is encountered in all aspects of daily life, is being taught to individuals in a systematic way beginning with the first years of school education. Altun (2000) expresses that it is difficult to fit mathematics into a definition, and states that mathematics deals with abstract concepts such as numbers, points, sets and relations between them.

The elementary mathematics teaching program emphasizes conceptual learning, procedural fluency, making connections between mathematical concepts, communicating mathematically using its language, terms and numbers, forming mathematical models, reasoning, choosing appropriate strategies to express relationships between objects in mathematical terms, and having problem solving skills (Ministry of National Education [MoNE], 2015). The program is designed to provide students with opportunities to create mathematical meanings with concrete experiences and express different mathematical ideas.

In this context, teaching mathematics should support creating opportunities for students to understand that mathematics is part of real life, and to feel that mathematics is worth the effort. Accordingly, mathematics should be dealt with in an order that goes from simple to difficult and concrete to abstract. Also, to address students with different needs, abilities, and performance levels, it is important to use concrete tools and materials and apply game-based practices in mathematics lessons (MoNE, 2015).

The teachers can benefit from active learning strategies to build a student-centered teaching. Active learning is a learning process in which the learner is responsible for the learning process and is given the opportunity to make decisions and self-regulation about various aspects of the learning process and is forced to use his mental abilities during learning by the complex instructional processes (Açıkgöz, 2004).

In active learning, the student processes and reproduces the shared information with his own strategies instead of repeating the

transferred information. Students interact with one another, research, think and explore for learning by sharing their problems and knowledge (Açıkgöz, 2004).

In order for the learning-teaching process to be effective in the classroom, it is necessary to choose an appropriate teaching method (Demirel, 2009). The main methods used in mathematics lessons are; lectures, teaching with definitions, guided discovery, using scenario, making analysis, demonstration-performance, experimental activities, games, etc. (Altun, 1998). The activity shared in this article requires students to build models. A technique that can be used in such a lesson is demonstrate-performance method.

The demonstration-performance method is usually implemented in lessons that involve teaching how to use a tool, how to apply a rule through all steps, and practical applications of mathematical concepts by engaging students in experiencing the practice. In this technique, demonstration is teacher-centered and performance is student-centered, students learn by doing. This technique has a great place in active learning because it is a teaching method that supports robust learning for students (Tok, 2009).

The demonstration-performance method is practiced especially in geometry lessons.

- Measuring an angle with a protractor,
- Drawing a circle with a compass,
- Constructing triangles, quadrilaterals,
- Making solids from carton or clay,
- Creating various patterns by using geometric shapes and objects

are activities that require physical activity besides mental activity. Lessons involving these activities may be designed using the demonstration-performance method (Altun, 1998).

Since the activity involves making 3D models, demonstration-performance method is used to help students participate actively in the lesson, to support conceptual learning by concretizing the information they learn, and to increase permanence of the knowledge. After the application, a game is played so that the students communicate using mathematical language and reinforce what they have learnt.

ACTIVITY IMPLEMENTATION

In this study, the researcher designed an activity for teaching the content standard "identifies the surfaces, vertices, and edges of cubes, square prisms, rectangular prisms, triangular prisms, cylinders, cones and sphere models" within the "Faces and Surfaces of Geometric Objects" topic in the third grade mathematics teaching program. The researcher observed that the students had difficulty in comprehending this topic and thus developed this activity to enrich the content and make the learning process easier and more enjoyable. This activity was implemented in the 3rd grade of a state primary school in the Seyhan district of Adana province in 2016-2017 education year. A total of 22 students, 14 female and 8 male, participated in the study. The activity took place in two lesson hours. The goals of the activity are to help students examine vertices, edges, and faces of cube, square prism, rectangular prism, triangular prism, cylinder, cone, and sphere actively by constructing their models and to make these abstract concepts more concrete to support students' comprehension.

The implementation phases of the activity are as follows:

1. Firstly, the students examined the geometric solids brought into the classroom and told their observations about the vertices, edges, and faces of these solids. Students were encouraged to ask questions and to express their opinions.



Photograph 1. *Geometric Solids in the Classroom*

2. At this phase, students discussed among themselves how to make models similar to the geometric solids that they had examined.



Photograph 2. *Students Examine the Geometric Solids*

3. The information shared by the students about the faces, vertices, and edges of these objects is summarized, and an explanation about the construction of the 3D models is provided.
4. At this phase, students made models of geometric objects with the information they obtained at the beginning of the lesson. The materials used in model making are given below.

Materials

- ✓ Playdough
- ✓ A box of toothpicks

Model construction is explained below step by step:

- The students first rolled small pieces of playdough and rolled it into small balls.



Photograph 3. *Rolling the Playdough*

- Students were encouraged to recognize that the playdoughs that they rolled looked like sphere and the playdough containers looked like cylinders.
- They used these balls as vertices of the objects.
- They formed the edges of objects by dipping toothpicks into the vertices.



Photograph 4. *Building Models of Geometric Solids 1*

- Some students could place toothpicks after a few attempts.



Photograph 5. *Building Models of Geometric Solids 2*

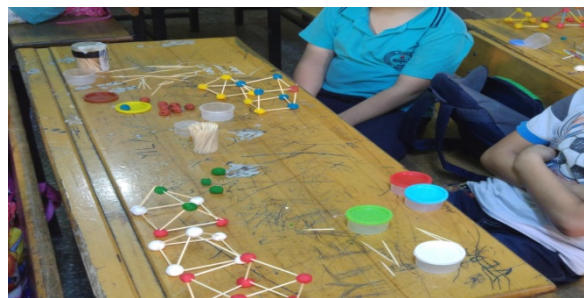


Photograph 6. *Building Models of Geometric Solids 3*

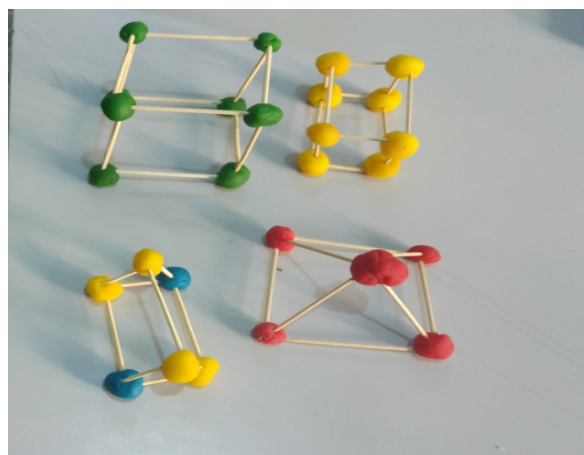
- When students were making the models, the opportunity to re-look at the wooden models was also given.



Photograph 7. *Examples from the Products 1*



Photograph 8. *Examples from the Products 2*



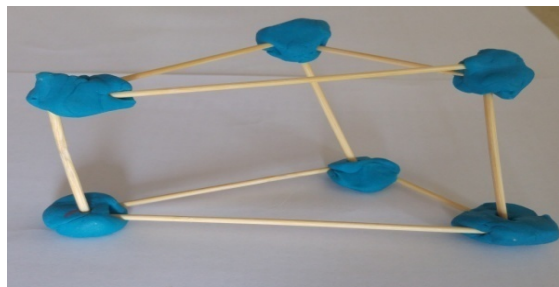
Photograph 9. *Examples from the Products 3*

- Students were asked to note the number of edges, corners, and faces of the objects they made.
- One of the constructed cube models was shown to the students and they were asked whether this was a cube or not. All of the students said that it was a cube. Then, a model of a cube with playdough covering the space between the toothpicks was shown (Photograph 10) as a comparison to the models that they constructed. It was emphasized that a cube has six square faces and that the faces of the models they built should be closed to represent an actual cube.



Photograph 10. *A Cube Model*

- Then, a non-prototype triangular prism example (triangular bases are not isosceles or equilateral triangles) made by the teacher was presented to the students and the students were asked whether it was a triangular prism.



Photograph 11. *A Non-prototype Triangular Prism*

- When students see this example, they could not immediately decide what it was. After examining the shape, some students said that it was a triangular prism, but some other students said that it was not a triangular prism. One of the students replied "Miss, this is not like the ones that we see in the book, I think it is not a triangular prism.", another student said "I did not understand what it was, it does not look like anything.", and another student responded "I think it is a triangular prism since the bases are triangles." Students

who could not identify the model as a triangular prism stated that they thought so because the sides of the triangles in the prism are not congruent to each other.

- In response to these answers, examples of different real life objects in the form of prisms were also shown to students and sample diversity was provided.
- At this phase, the teacher used a control list for product assessment. Students were asked to describe on the model the geometric shapes of the faces of the cube and prism models they have made and tell how many vertices and edges there were. In this context, the questions such as "How many vertices are there? How many edges are there? And in what geometric shape do the faces resemble?" were asked to the students.

The "Checklist for Level Identification" prepared by the researcher was used to determine the level of student performance. The five criteria set for this list are measured at four levels: "low 1," "middle 2," "good 3," and "very good 4." After all students have been assessed, the arithmetic mean of each criterion was calculated. The findings are presented in Table 1.

Table 1. *Checklist Frequency and Arithmetic Mean*

Criteria	Level					$\bar{X}$
	N	Low f	Middle f	Good f	Very Good f	
1. The student examined the wooden models given before the activity.	22	0	6	7	9	3,13
2. The student followed the directions given in the activity process.	22	0	7	6	9	3,09
3. The student tried to create a model in the activity process with persistence.	22	0	6	6	10	3,18
4. The student made a product by the end of the activity.	22	0	4	9	9	3,22
5. The student correctly answered the questions about the model.	22	1	5	6	10	3,13

When the mean of the criteria determined in the checklist given in Table 1 are examined, it is seen that all the criteria were satisfied at the "Good" level. According to the data in Table 1, students completed the activity successfully.

In order to reinforce the knowledge learned by the students and to make the lesson more fun and active for the students, a game (Guess Who I am) based on guessing geometric solids was played. At the beginning of the game, the geometric solids are placed in a bag in front of the students and one student is selected and her

eyes are closed. The selected student plunges her hand into the bag and grabs an object. The student examines the object by feeling its faces, vertices, and edges, and then makes a guess about which solid it is. After finding the correct answer, a new student is selected and the game is continued in this way.



Photograph 12. *Guess Who I am Game 1*



Photograph 13. *Guess Who I am Game 2*

At the end of the lesson, as a complement to this game, a worksheet is distributed to the students to assess their learning (Appendix 1). In the worksheet, properties of geometric solids are listed and students are asked to identify the geometric solids.

BİL BAKALIM BEN KİMİM?					
Köşe sayım	Ayrıtlar (kenar) sayım	Yüz sayım	Yüzlerimin özellikleri	Bil bakalım ben kimim?	
8	12	6	Tüm yüzlerim ve ayrıtlarım birine eşittir. Yüzlerimin tümü karesel bölgedir.	Küp	
8	12	6	Alt ve üst yüzlerim birbirine eşit karesel bölgedir. Yan yüzlerim dikdörtgen bölgedir.	Kare prizma	
8	12	6	Yüzlerim düz ve dikdörtgen bölgedir. Karşılıklı yüzler eşittir.	Dikdörtgen prizma	
6	9	5	Alt ve üst yüzlerim birbirine eşit üçgen bölgedir. Yan yüzlerim üç tane dikdörtgen bölgedir.	Üçgen prizma	
Yok	Yok	2	Alt yüzüm daire şeklindedir. Diğer parçam (üst tarafım) eğri yüzeydir.	Silindirik	
Yok	Yok	3	Alt ve üst yüzlerim birbirine eş daire şeklindedir. Yan yüzüm açıldığında dikdörtgen bölgedir.	Silindirik	
Yok	Yok	1	Yalnız bir eğri yüzüm var.	Küre	

Photograph 14. *A Completed Worksheet*

CONCLUSIONS and SUGGESTIONS

This activity was implemented in order to help students actively examine the vertices, edges, and faces of cube, square prism, rectangular prism, triangular prism, cylinder, cone and sphere and also to facilitate student learning by using concrete objects in the lesson. The models students made are actually one dimensional. However, as observed in this lesson, these models could be effective for students to examine the faces and especially the vertices and edges of geometric solids.

Some students had very soft playdough during the activity and therefore they had difficulty in keeping the toothpicks upright. The students made their first model very slowly and during the first model construction, they examined the wooden models more. It was observed that they were more comfortable making the second, third model and felt less need to look at the wooden models. Students generally gave correct answers to questions about one dimensional models they made. In particular, they easily expressed the names and numbers of the geometric shapes on the faces of the models. The students even did not want to go to the recess during this activity and they said that the time passed very quickly during the lesson. Student comments such as "Miss, let's do mathematics in all classes today" and "Let's never go out" indicate that the students were happy to be active in the lesson. In addition, the students wanted to play "Guess Who I am" game later on. This game was played in Turkish lesson by placing object names into the bag.

The use of soft and sticky playdough by some students during the construction of the models caused these students to have some difficulties. To prevent such problems, students may be asked to bring high quality playdough. Students learned with joy and fun because they actively participated in the activity. Despite the fact that there were some students who were challenged, all of the students could make at least two models. It was a lesson that all students could participate and learn. Also, when non-prototype prism examples were shown to the students, some students were confused and could not identify the solid. For this reason, apart from typical, known prism examples, it may be useful to show different

prism examples to students, to provide sample diversity and to prevent misconceptions.

In the game "Guess Who I am" the students competed with each other to participate in the game. At the end of the lesson, students expressed that they had a lot of fun and that they had forgotten that they were in a lesson. One of the students said that the game was very exciting, another student expressed that he forgot he was in a lesson while playing the game, and someone else said that playing games in mathematics lessons made her feel good.

In the active learning approach applied throughout the lesson, students were encouraged to work in cooperation. Considering the results obtained from the activity, active learning and collaborative working approaches may be used in the teaching of other topics in mathematics lessons.

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Appendix 1

Worksheet

GUESS WHO I AM

Number of vertices	Number of edges	Number of faces	Properties of faces	Guess who I am
8	12	6	All my faces and edges are congruent to each one. All my faces are square.	
8	12	6	My bases are square and congruent to each other. I have rectangular lateral faces.	
8	12	6	I have flat rectangular faces. Opposite faces are congruent to each other.	
6	9	5	My bases are triangles and congruent to each other. I have 3 rectangular lateral faces.	
None	None	2	My base is a circle. My other part is a curved face.	
None	None	3	My bases are circles and congruent to each other. My lateral face forms a rectangle when it is flat.	
None	None	1	I have one curved face.	