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# RECTANGULAR PRISM PERCEPTIONS OF PRIMARY AND SECONDARY SCHOOL STUDENTS BY MODELS*

(İlk ve Orta Öğretim Öğrencilerinin Modeller Yardımıyla Dikdörtgenler Prizması Algıları)

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**Abstract**

The aim of this study is to determine the rectangular prism perceptions of primary and secondary school students by means of models. The study used the scanning model. The study group is composed of a total of 205 students, who are 5$^{th}$, 8$^{th}$, and 11$^{th}$ graders, in a city in Eastern Anatolian region in the fall of the 2010-2011 educational year. The data was obtained through an interview protocol composed (IP) of two open-ended questions about four models that resemble a rectangular prism and was analyzed descriptively. One of the first results of the study is that the rate of naming models properly increases with the grade. The second is that the frequently encountered models are named more properly compared to those that are less frequently encountered and less successfully named in all grades. Lastly, for all models students confuse planar geometric shapes such as square and rectangle; geometric objects such as cube and rectangular prism; and concepts such as side-edge, side-surface, and angle-corner in their naming and reasoning.

**Key-words:** primary and secondary education, geometry, rectangular prism, model

**Özet**

Çalışmanın amacı ilk ve orta öğretim öğrencilerinin modeller yardımı ile dikdörtgenler prizması algılarını belirlemektir. Çalışmada tarama modeli kullanılmıştır. Çalışma grubu 2010–2011 eğitim-öğretim yılı güz yarıyılında Doğu Anadolu Bölgesi'nin bir ilinde 5, 8 ve 11. sınıfta öğrenim gören toplam 205 öğrenciden oluşmaktadır. Veriler dikdörtgenler prizmasına benzeyen dört farklı modelle ilgili iki açık uçlu sorudan oluşan görüşme protokolü (GP) ile toplanmış ve betimsel olarak analiz edilmiştir. Çalışmanın sonuçlarından ilki sınıf düzeyleri arttıkça modelleri doğru isimlendirme oranları artmakta olduğudur. İkincisi de sıklıkla karşılan modellerin nadiren karşılaşılan, tüm sınıf düzeylerinde isimlendirme başarısı çok düşük olan, modele göre daha büyük oranda doğru isimlendirildiğidir. Son olarak tüm modeller için öğrencilerin isimlendirme ve gerekçelerinde kare, dikdörtgen gibi düzlemsel geometrik şekiller ile küp, dikdörtgenler prizması gibi geometrik cisimleri ve kenar-ayrıt, kenar-yüzey, açı-köşe gibi kavramları birbirine karıştırmış olmalarıdır.

**Anahtar Sözcükler:** ilk ve orta öğretim, geometri, dikdörtgenler prizması, model

## Introduction

New information is being produced at a rapid pace in the information age. In such an era, individuals need the skill to analyze information, see relationships between various knowledge, produce new knowledge, and share it with others in order to sustain a life worthy of a human being. As human history testifies, mathematics is one of the most important tools in acquiring these skills (Yenilmez and Can, 2006)

Mathematics contributes to the naming and classification of concepts, to see the relationship between them, and, thereby, to produce new concepts and knowledge (Nakiboğlu, 1999). Moreover, mathematics helps individuals to realize their mental freedom in the process of forming their own thoughts (Busbridge and Özçelik, 1997). Geometry plays an important role in individuals' development of mathematical thinking and their solving of the problems that they encounter in their own lives.

Dealing with concepts like point, line, plane, planary shapes, space, spacial shapes, and the relationships among them; length, angle, area, and volume of shapes, and the measurement of them, geometry is an important element of school mathematics as well as a branch of mathematics (Baykul, 2009). Providing different ways for deeper thinking about and interpretation on the physical environment (NCTM. 2000), geometry helps students develop their reasoning and senses (Akuysal, 2007). For this reason, geometry has become a part of our educational programs as well as other countries (Altun, 2006). Despite the importance given to geometry and its education, it has come to attention through many studies that student success in geometry is low and that they have a problem learning even the most basic geometric concepts (Akuysal, 2007; Çetin and Dane, 2004; Dane, 2008; Mullis and et al., 2000; NCTM, 2000; Prescott, Mitchelmore, & White, 2002). For example, in a study conducted by Akuysal (2007) it was found that students can remember geometric shapes in form and name but cannot make a definition of the shape, relate them to other concepts, and build a causal link. Further, many national examinations and international researches show that Turkish students of primary and secondary schools have low success levels in mathematics in general, and geometry in particular (Ardahan and Ersoy, 2004; Bekdemir and Işık, 2007; MEB-EARGED, 2003; Olkun and Aydoğdu, 2003).

One of the principal reasons for this failure was thought to be the education program, and, thus, the Ministry of Education gradually changed the whole educational program on mathematics in primary and secondary schools since 2005. In the renewed 2005 Primary School Mathematical Education Program (2005 PMEP), activities related to the recognizing, naming, building, drawing, comparing geometric objects and shapes, and grouping them with respect to their certain properties have been emphasized and brought to the fore. This way it was aimed that students could relate the objects that they see in their environment to geometric concepts and terms. Moreover, students were expected to reach generalizations on concrete objects and models examining geometric objects and the elements that form shapes (e.g. rhomboid, right angle, etc.) and their properties (MEB, 2005). The reason for this effort was the idea that primary school students can more easily form their own thoughts from their interaction with their environment and the concrete objects that populate it (Pesen, 2005; Skemp, 1987).

As 2005 PMEP is based on student learning by exploration and understanding, it recommends teachers to use concrete models and equipment in the field of geometry. The reason for this is that educational materials play an important role in making abstract concepts and relations concrete. Accordingly, as the learning-teaching process is enriched by as many and various educational materials, student learning is affected more positively (Bulut, 2004; Toptaş, 2008).

Students often encounter concrete objects that can be related to prism, the most simple and one of the basic elements of space geometry in various situations such as the games they play in their own lives and their school materials. Considering their place in daily life, determining how the concept of prism is perceived by students in primary and secondary education gains more importance. However, there are not enough scientific studies that cover mathematical education programs that were put in practice especially after 2005. Aiming to determine perceptions of students of rectangular prisms, this study is deemed necessary to determine the shortcomings that arise in the process of education and to resolve them, and, further, to contribute to similar studies so far on the subject.

**Aim of the Study**

The aim of this study is to determine the rectangular prism perceptions of primary and secondary school students with the help of models. With this aim in mind, the study tries to find answers to the following problems

1. How do students of 5th, 8th and 11$^{th}$ grades name different models that are similar to rectangular prism and what does the dispersal of these names look like?
2. What justification do students name different models and how do they use geometric concepts in their justifications?

**Study Group**

The research was conducted at three primary schools and three secondary schools in an Eastern Anatolian Region city with middle scale population in the fall of 2010-2011 educational year. In order to increase variety, the research used the maximum variety sampling, one of the purposeful sampling methods. Taking into consideration the results of the 2010 Placement Test (PT) and Higher Education Examination (HEE), three schools were randomly picked for 5$^{th}$, 8$^{th}$, and 11$^{th}$ grades each of which represent low, medium, and high success rates. While these grade levels were being determined, the study focused primarily on the highest grade of each of the schools. However, as the 2008 Secondary School Mathematics Program was implemented only up to the 11$^{th}$ grade during the time the study was being carried out, the 11$^{th}$ grade was chosen instead of 12$^{th}$. The dispersal of the students in the study group was given in Table1.

**Table 1. Number and Percentages of Students according to Grade Level**

| Grade Level | Total | % |
|---|---|---|
| 5$^{th}$ Grade | 84 | 41 |
| 8$^{th}$ Grade | 60 | 29 |
| 11$^{th}$ Grade | 61 | 30 |
| **TOTAL** | **205** | **100** |

 

## The Method

The present study used the survey model. The survey model is a research approach that aims to describe a past or continuing situation as it exists. The model makes an attempt to describe events, individuals, groups or objects involved within their own conditions (Karasar, 2008). In this model, both quantitative data collection methods and qualitative ones such as observation or interviews (Büyüköztürk, Kılıç, Çakmak, Akgün, Karadeniz & Demirel, 2008) can be employed. The present study only employed qualitative data collection methods in consistent with the purpose.

## Data Collection Instrument

The data for the study were collected through an Interview Protocol (IP). The IP includes two structured open-ended questions for revealing how primary and secondary school students perceive rectangular prisms by models. The pilot scheme of the IP was conducted on 30 eleventh grade students. At the end of the pilot scheme, the questions were revised in accordance with the opinions expressed by five field specialists, a Turkish philologist and two math teachers so that any misunderstanding could be eliminated. In this way, the validity of the IP was ensured. The finalized questions were as follows: “Could you write down the geometrical names of the models you see?” and “Could you justify the names you propose?”

## Data Collection and Analysis

In consistent with the purpose of the study, four different models were designed (Figure 1). The model A is a hollow rectangular prism made out of opaque and rigid plastic; the Model B is a hollow rectangular prism made out of glass; the Model C is a stuffed rectangular prism made out of wooden block; and the Model D is a model made out of wooden sticks that display the details of a rectangular prism. All the models are 10cm x 15cm x 20cm.

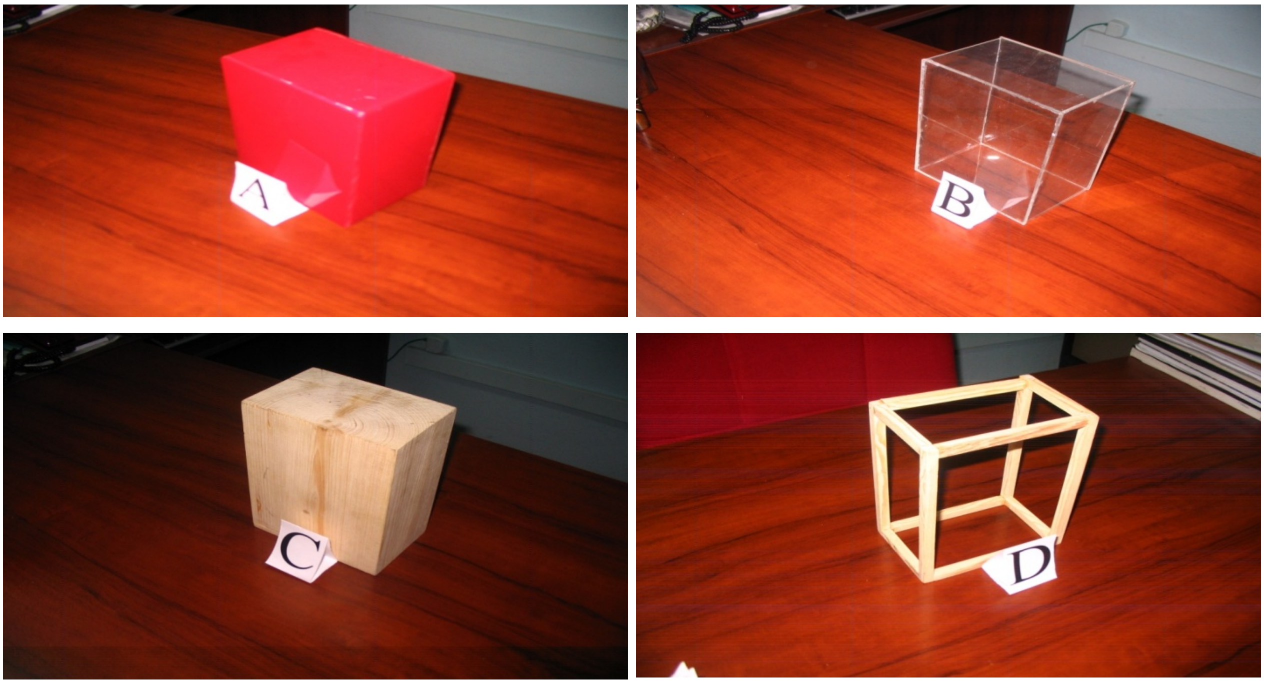


**Figure 1:** The Photographs of the Models Used in the Study

 

As can be concluded from Figure 1, the models A, B and C are the kind of models that students generally see in their course books and use as instructional materials or they encounter in their daily lives. On the other hand, the Model D is relatively rarely encountered by students either during their lessons or in their daily lives.

These models were introduced to each classroom by a particular practitioner and students were granted with an opportunity to study them. During the introduction, the practitioner emphasized that the material, color and weight of the models should not be taken into account during the process of naming and justification and that the size of the models were equal. Afterwards, the models were placed somewhere in the classroom where all of the students could see and study them. Each student was asked to answer the IP within a class time. During the process, practitioners did their best to prevent students from affecting each other.

Each IP form was numbered; the data were computerized and descriptively analyzed. Each model was considered as a theme. The geometrical names provided by the students were grouped under three sub-themes: “correct”, “partially correct” and “incorrect”. Those who did not produce any answers were evaluated as “incorrect”. By taking geometrical definitions into consideration, five lecturers at Primary Math Teaching decided under which sub-theme the geometrical names would fall. The names and justification provided by the students were grouped depending on each sub-theme with a consideration to common emphasizes. With a consideration to grade, tables were drawn regarding the names proposed for each model by grade and the distribution of these names across the sub-themes. Direct quotations were included so that the students’ opinions could be reflected in a proper way.

**Findings and Comments**

In this section the study presents in a table form the data for each model on the first sub-problem, “How do students of primary and secondary school name different models that are similar to rectangular prism?” Then the data obtained on the second sub-problem, “What justification do they have for naming these different models?” was described and direct quotes were made in order to reflect student opinions. At this stage, justifications given by students were grouped according to the common emphases they made. Some of the namings made by the students were grouped by experts, whose opinions were appealed to, in order to ensure a presentation with more concise and simpler tables and exemplification of justifications. Lastly, the data on the third sub-problem, “How is the dispersal of students’ correct or false naming of models according to 5$^{th}$, 8$^{th}$, and 11$^{th}$ grade levels?” is given in a table.

**Naming and Justification regarding Models A, B and C**

The dispersal of the namings according to sub-themes relating to models A, B, and C is given in Table 2.

 

**Table 2.** The frequency and percentages of namings according to the sub-themes of models A, B, and C

| Models | Sub-themes | Namings | 5th grade | | 8th grade | | 11th grade | |
|---|---|---|---|---|---|---|---|---|
| | | | N | % | N | % | n | % |
| Model A | Correct | *Rectangular Prisms* | 11 | 13 | 30 | 50 | 36 | 59 |
| | | *Red, Closed, Transparent, Plastic, Empty, full, Shaped Rectangular Prism* | 1 | 1 | 3 | 5 | 6 | 10 |
| | | *Prism with Rectangular area* | 1 | 1 | - | - | - | - |
| | | *Prisms with Rectangular shape* | 1 | 1 | | | | |
| | | ***Sum*** | **14** | **17** | **33** | **55** | **42** | **69** |
| | Partly Correct | *Fried Prism* | 1 | 1 | - | - | - | - |
| | | *Closed, Square Cube* | 5 | 6 | 2 | 3 | 1 | 2 |
| | | ***Sum*** | **6** | **7** | **2** | **3** | **1** | **2** |
| | False | *Plastic, Opaque, Empty, Red, Glass Rectangle; Square; Square model; Enclosed model; Rhombohedral square; Isosceles Triangle; Rectangular area; Rectangle; Triangle* | 57 | 68 | 25 | 42 | 16 | 26 |
| | | *Irrelevant answers such as Opaque, Red, Box, invisible interior, Closed box, Fire, Corners similar to rectangle, Many angles and similar to square, angle type, prism* | 6 | 8 | - | - | 2 | 3 |
| | | *Those who did not answer* | 1 | 1 | - | - | - | - |
| | | ***Sum*** | **64** | **76** | **25** | **42** | **18** | **29** |
| Model B | Correct | *Rectangular prism* | 11 | 13 | 27 | 45 | 34 | 56 |
| | | *Transparent, Glass, empty inside, white, translucent, red, rectangular prisms without color* | - | - | 4 | 7 | 8 | 13 |
| | | *Prisms with rectangular area* | 1 | 1 | - | - | - | - |
| | | ***Sum*** | **12** | **14** | **31** | **52** | **42** | **69** |
| | Partly correct | *Empty inside/Glass Prism* | 3 | 4 | - | - | - | - |
| | | *Cube, Cube Model* | 5 | 6 | 12 | 20 | 1 | 2 |
| | | ***Sum*** | **8** | **10** | **12** | **20** | **1** | **2** |
| | False | *Rectangular surface, made of glass, empty inside, empty, transparent cube, rectangle, square, Right-angled Triangle, Rectangle, hexagon, circle* | 54 | 64 | 15 | 25 | 16 | 26 |
| | | *Mica, glass, Plastic, window, cage, cup, glass eraser, Geometry, Geometric, Not glass, Model with image, box, water, transparent, thicker, with many angles, and looks like a square, empty inside, fragile, light and irrelevant answers like it looks like a cup.* | 10 | 12 | 2 | 3 | 2 | 3 |
| | | *Those who did not answer* | - | - | - | - | - | - |
| | | ***Sum*** | **64** | **76** | **17** | **28** | **18** | **29** |
| Model C | Correct | *Rectangular prism* | 8 | 10 | 27 | 45 | 34 | 56 |
| | | *Opaque, Wooden, full inside, Wood, Closed Rectangular prisms* | 1 | 1 | 2 | 3 | 8 | 13 |
| | | *Rectangular prism* | 1 | 1 | - | - | - | - |
| | | *Prism with Rectangular area* | 1 | 1 | 2 | 3 | - | - |
| | | ***Sum*** | **11** | **13** | **31** | **51** | **42** | **69** |
| | Partly Correct | *Wooden, Prism that got wooden, Looks like a prism* | 3 | 4 | - | - | - | - |
| | | *Cube* | 8 | 10 | 8 | 14 | 1 | 2 |
| | | ***Sum*** | **11** | **13** | **8** | **14** | **1** | **2** |
| | False | *Model full inside, opaque, closed on the sides, rectangle with many angles, square, circle, rectangle, triangle, rhomboid, rectangular area* | 48 | 57 | 17 | 28 | 16 | 26 |
| | | *Irrelevant answers such as Matter full inside, mate, heavy, closed, wooden, cupboard, box, square plasma* | 11 | 13 | 3 | 5 | 2 | 3 |
| | | *Those who did not answer* | 3 | 4 | 1 | 2 | - | - |
| | | ***Sum*** | **62** | **74** | **21** | **35** | **18** | **29** |

Table 2 gives the rates of correct naming for models A, B, and C, which changes between %13 and 14% for the 5th grade, between 51 % for 55% for the 8th grade, and is 69% for the 11th grade. When justifications for namings for rectangular prism under the sub-theme "correct" are grouped according to common emphases, it was observed that they put emphasis on the corners, sides and, edges of the models; their being formed of rectangles; its having a rectangular base, its similarity to a rectangle; and their reference to their previous knowledge.

Among these students the statements of S-165, S-177, S-199, S-83 and S-170 are as follows:

S-165: *"Because its sides and corners conform to a rectangular prism"*

Ö-177: *"It is called a rectangular prism because it is composed of rectangles"*

Ö-199: "*Objects with rectangular base and a certain height are called rectangular prism; three-dimensional objects that have length, width, and height are called rectangular prisms.*

Ö-83: *"Because a rectangle looks like a prism."*

Ö-170: "*Because our math teachers called such shapes rectangular prisms since the* $6^{th}$ *grade, it remained in our minds as such.*

Moreover some of the students used additional adjectives in their naming that are descriptive of models such as rectangular prisms that are *closed, empty inside*, or *full inside*. The justifications given for these namings can be exemplified as follows.

S-182: *"I said rectangular prism because it had a rectangular base."*

Although some participants made a correct naming, they either provided an irrelevant justification or did not write down any justification at all. This situation can be exemplified by the following statement of the participant with the code name S-124.

S-124: "*It is a mathematical shape, that's why.*"

While the rate of correct naming for models A, B, and C for the $5^{th}$ grade is between 2% and 4%, it is between 0% and 3% for $8^{th}$ grade and 0% for the $11^{th}$ grade. These students named the models as wooden, glass prism; cube and etc. The justification of S-55 who named it a cube is as follows:

S-55: *"It looks very much like a cube because its sides are closed."*

When Table 2 is examined, it will be noticed that the rate of false naming for models A, B, and C changes between 82% and 83% for the $5^{th}$ grade, between 45% and 48% for the $8^{th}$ grade, and is 31% for the $11^{th}$ grade. It was seen that the namings under the "false" subtheme were related mainly to geometric planary shapes such as rectangle, rhombus, and triangle. The justifications of S-79, S65, and S-17, who made namings in the above order, are as follows:

S-79: "Opposing edges are equal to each other. It has 4 edges. It has two long and two short edges."

Ö-65: "Because it has edges of equal length."

Ö-17: "We named it as such because it was a model C triangle."

While some of the students did not provide any names or the models, some of them put irrelevant names such as "opaque," "geometry," "square plasma." Of these students, the statements of S-31, S-87 and S-19 are as follows:

S-31: "Because it is closed and we cannot see the inside."

S-87: "We have seen and covered this subject at school; we even solved problems about it."

S-19: "Model C resembles a square."

**Namings and Justifications for Model C**

The dispersion of the namings for model D according to subthemes are given in Table 3.

**Table 3.** The frequency and percentages of namings according to the sub-themes of model D

| Models | Subthemes | Namings | 5th Grades | | 8th Grades | | 11th Grades | |
|---|---|---|---|---|---|---|---|---|
| | | | n | % | N | % | n | % |
| Model D | Correct | *Skeleton of Rectangular Prism* | - | - | 1 | 2 | - | - |
| | | *The edges of rectangular Prism* | - | - | - | - | 4 | 7 |
| | | ***Sum*** | **-** | **-** | **1** | **2** | **4** | **7** |
| | Partly Correct | *It has corners; rectangular prism without edges.* | - | - | - | - | 1 | 2 |
| | | *I don't know its name but it is not a rectangular prism.* | - | - | 1 | 2 | - | - |
| | | *Skeleton, Edge* | 2 | 2 | - | - | - | - |
| | | *Prism without a surface* | - | - | 1 | 2 | - | - |
| | | ***Sum*** | **2** | **2** | **2** | **3** | **1** | **2** |
| | False | *Rectangular Prism* | 2 | 2 | - | - | 1 | 2 |
| | | *Open, empty inside, wooden, diagonal, airy, rod, empty, naked, open wooden rectangular prism* | 10 | 12 | 25 | 42 | 27 | 44 |
| | | *Prism that is empty inside, prism* | 1 | 1 | - | - | 1 | 2 |
| | | *Cube* | 9 | 11 | 11 | 18 | 2 | 3 |
| | | *empty, cube, empty inside, transparent, wooden, 6 of them, rod, few angles, without edges, rectangular shape; equilateral triangle; circle; square; rhombus; rectangular edge* | 48 | 57 | 16 | 26 | 21 | 34 |
| | | *Frame* | - | - | 2 | 3 | - | - |
| | | *Irrelevant answers such as tile, wooden(open), similar to sphere, wide open, very light and thin, empty inside, made of wood and empty inside, geometric, box or human empty inside and that only has a circumference, transparent, made open.* | 9 | 11 | 1 | 2 | 2 | 3 |
| | | *Those who did not respond* | 3 | 4 | 2 | 3 | 2 | 3 |
| | | ***Sum*** | **82** | **98** | **57** | **95** | **56** | **93** |

As seen in Table 3, while the rate of correct naming is 2% for the 8th grade and 7% for the 5th grade, none of the students at the 5th grade were able to make a correct naming.

The justifications given by S-141 and S-199 for their naming "skeleton rectangular prism" and "edges of rectangular prism" are as follows:

S-141***:*** "*Because it resembles that*"

S-199: "*The object has only edges; it does not have an area or volume.*"

Partial correct naming for the 5th grade was 2%, 3% for the 8th grade, and 2% for the 11th grade. These students used for the model such namings as "*rectangular prism that has edges but no corners; I don't know its name exactly but it is not rectangular prism; skeleton, edges, and prism without a surface.*" Of these students, the justifications of S-165, S-138, S-73, S-21 and S-142 are as follows:

S-165: *"Because it does not have edges and a center of gravity"*

S-138: *"Because there is no prism that is empty; it does not have surface area; geometric objects cannot be empty "*

S-73: *"Because it has bars that look like bones"*

S-21: *"Like a edge model"*

S-142: *"Because it does not have surface"*

The rate of students who made false naming is 98, 8% for the 5th grade, 96% for the 8th grade, and 91% for the 11th grade. While most of these students used planar geometric shape names for the model such as rectangle and square, some of them were observed to have used geometric object names such as rectangular prism, prism that is empty inside, and cube. Of these students the justifications of S-80, S-19, S-120, S-59 and S-9 were as follows:

S-80: *"Because it has both short and long edges like that of a rectangle."*

S-19: *"Model D has four corners like a square but is empty on the sides."*

S-120: "*Because it is composed of rectangles.*"

S-59: **"***Shape is a prism but is empty inside."*

S-9: "*Because it looks like a cube.*"

While some of the students used irrelevant names such as "wide-open," "transparent," and "spherical," some others did not make any naming for the model. Of these students the justifications of S-29, S-154 and S-39 are as follows:

S-29: *"Because its inside is open."*

S-154: *"I named it as such because its sides are not closed."*

S-39: *"It looks like a sphere."*

When justifications for all the models were examined, it was mainly determined that the 5th graders correctly used the basic concepts that are related to the properties of rectangular prism such as right angle, corner, surface, and prism; the 8th graders used correctly the basic concepts of the properties that are related to rectangular prism such as prisms, three-dimension, surface, edges, surface area, and closure; and the 11th graders used the basic concepts that are related to the properties of rectangular prism such as corner, base, dimension, volume, object, parallelism, lateral surface, and lateral area. The statements below of S-23 from the 5th grade, S-137 from the 8th grade, and S-199 from the 11th grade exemplify the case:

 

S-23: *"Because it is rectangular on sides."*

S-19: "*Because it is a rectangle and prism.*"

S-199: *"Objects that have a base and height are called rectangular prism; three-dimensional objects whose width, length, and height are different are called rectangular prism."*

**Discussion, Result and Suggestions**

As very few of the 5th graders, more than half of the 8th graders, and most of the 11th graders made correct naming, it is evident that the rate of correct or partly correct naming increases as the grade level rises. Parallel to this situation, when the justifications for their naming were examined, it was again observed that as the grade level rises, students are seen to use more consistently the basic concepts related to rectangular prisms such as edges, corner, surface, and surface area, and establish relationships between them. Although this is an expected situation, the fact that the increase was considerable especially between 5th and 8th grades can be explained by the activities suggested by (2005 PMEP) such as recognizing, naming, building, drawing, and comparing geometric objects and shapes and to group them according to their certain properties; and the effect of using materials that serve this end (Ministry of Education, 2005). Nevertheless, it was thought that it would be useful to research this situation through various studies.

For model D, while the rate of correct and partly correct naming increases as the grade levels rise, these rates are very low on each grade level. The reason for this might be that mathematical education programs do not include materials that are similar to model D and that, as Pesen, 2005 and Skemp, 1987 put it, students encounter less frequently in their own lives with examples of concrete models than they do with models A, B, and D.

When students' naming and justifications for all models were examined, they were observed to have confused planar geometric shapes such as square and rectangle and geometric objects such as cube, rectangular prism, and the concepts related to them such as edge-side, side-surface, and angle-corner. Moreover, having frequently encountered the models A, B, and C in their education programs or in in-class activities, students tended to perceive that model D, which they encountered rarely or for the first time, was identical with the former models and, thus, they used the same naming and justifications. As Akuysal (2007) points out, the reason might be that students remember geometric shapes as when they learn them the first time and so they cannot establish connections among concepts. In order to resolve this confusion between concepts and relations, prism skeleton models like model D can be made use of during the transition from planar geometric shapes to prisms. To ensure this, teachers might need to have their students do activities such as constructing prism skeleton with bars or straws and then covering their surfaces with paper or similar materials, or forming a prism model by getting together polygonal surfaces and, lastly, filling in them with different materials such as unit cubes and sand.

 

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