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Analysis of the Misconceptions of 7th Grade Students on Polygons and Specific Quadrilaterals[1]

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ABSTRACT

Purpose: This study will find out student misconceptions about geometrical figures, particularly polygons and quadrilaterals. Thus, it will offer insights into teaching these concepts. The objective of this study, the question of "What are the misconceptions of seventh grade students on polygons and quadrilaterals?" constitutes the problem sentence of the research. **Research Methods**: The study was conducted in five different schools in Gaziantep, and the data consist of 229 students who are in the seventh grade. In the quantitative part, descriptive statistics, t-tests and one-way ANOVA tests were applied by using SPSS 17.0 software. **Findings:** The results indicate that students display various misconceptions about polygons and special quadrilaterals. When the students were asked to draw squares, rectangles, trapezoids and equilateral quadrangles, almost all the participants drew prototype figures. It was discovered that, as the level of academic success increased, the risk of misconception decreased in return. **Implications for Research and Practice**: In the research, students displayed certain misconceptions when questions about the concept of diagonals were presented. Furthermore, in diagnostic test results, the outcome that the intermediate-level students had more misconceptions compared to low-level students might be because the low-level students left more questions blank. By means of conducting qualitative studies, it is possible to determine the thoughts that cause misconceptions. In the lesson content, permanent formula and prototype figures should be avoided. Instead, lessons should be imparted in the manner that reflects actuality and that expresses the core of the perceived subject.

[1]This study was compiled by the thesis study of Mustafa ÖZKAN, called "Analysis of the Misconceptions of 7th Grade Students on Polygons and Specific Quadrilaterals" published by the Faculty of Social Sciences of Cukurova University.

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Introduction

Geometry is a field of mathematics which is encountered by almost every individual during their educational life. This scientific field, an inseparable part of curricula, gives us information about how the students should reason spatial concepts. Considering the origin of word, geometry comes from Greek, and it is regarded as a scientific field which analyzes the sizes and forms of objects. However, various technological advancements and academic studies show parallelism in furtherance of the era; thus, this definition is not adequate. A more general definition that belongs to German Mathematician Klein (1849-1925), and has been adopted by most mathematicians, is as below:

> *"When 'S' is a set, and 'G' is a group consisted of the transformations that turn 'S' into 'G'; analysis of the features of 'S' set that remain unchanged (invariant) under the transformations which are the elements of G, is called as geometry.* (Kaya, 2005, 11)."

This statement by Klein can be explained based on his definition, "the study of the features of space that remain invariant under the transformations of a given group" (Tuluk, 2014). This definition might be interpreted as it expresses geometry by a group of transformations by uniting it around an algebraic definition, and these transformations are created with the help of the points, which are not geometrical concepts. One of the principles and standards of National Council of Teachers of Mathematics (NCTM) (2000) concerning school mathematics is geometry. Geometry is also present in the origin of spatial intelligence that helps to deeply analyze and interpret events that are occurring around us. In this context, correcting mistakes in geometry learning is of vital importance, especially in terms of developing studentthinking systems. This scientific field plays an effective role in the development of conceptual and intellectual skills by making progress in association with the figures and their features. Hizarci, Kaplan, İpek and Isik (2004) consider geometry as an independent scientific field that brings a view to the individual, makes thinking easier, and fosters the ability to come to a solution by visualizing figures.

Problem Status

Through associating and transferring concepts to operations,permanent learning will result. This knowledge will also increase problem-solving skills. In general, there are three main factors in solving a problem: mistakes, errors, and misconceptions. Misconceptions are conceptual errors that occur systematically (Oliver, 1986). Among these three factors, the most dangerous is undoubtedly misconceptions, as they are both systematic and permanent. In addition, they are obstacles that stand before further learning.

In order to discover the reasons behind these misconceptions and correct them,various studies worldwide have been executed. While focusing on specific quadrilaterals, De Villiers (1994) and Turnuklu & Aktas (2013)pointed out that, in order to find a solution for these misconceptions, it was crucial to provide explanations by means of a hierarchal classification method. Okazaki & Fujita (2008) and Fujita (2012) expressed that prototype samples may cause misconceptions. In addition, Ubuz and Ustun (2003) concluded that, depending on academic success, students used the samples that they were given first. It was observed that students had difficulties with respect to the semantic relations of words and figures (Robert, 1995), and that they fell into misconceptions because they were not able to establish conceptual relationships, even when using analogies (Fonseca & Cunha, 2011). In studies carried out about concave and convex polygons (Ward, 2004; Lipovec, 2009), geometrical objects (Incikabi& Kilic, 2013), parallelograms and trapezoids (Aktas& Aktas, 2012), misconceptions about geometry were analyzed. In a study Cutugnol & Spagnolo (2002) executed about the concept of a triangle, they explained the necessity of frequently acquainting the students with such concepts in daily life. On the other hand, Edward and Ward (2004) pointed out that figures should be provided systematically during lessons. Elements of polygons are also among subjects that have been investigated (Heinze, 2002; Sandt & Nieuwouldt,2003; Gutierrez, Pegg & Lawrie, 2004; Picreign, 2007).

When analyzing the literature, one can see that the concepts of angles, triangles, and quadrilaterals have been widely analyzed. Furthermore, geometrical figures such as trapezoids, squares, rectangles, and parallelograms have also been analyzed separately or in groups. However, in a hierarchal figure, the concept of polygons and specific quadrilaterals are not taken into great consideration. This study will find out the misconceptions students have towards geometrical figures, particularly polygons and quadrilaterals. Thus, it will offer an insight into teaching these concepts.

The objective of this study, the question of "What are the misconceptions of 7th grade students on polygons and quadrilaterals?" constitutes the problem sentence of the research. In order to realize the objective of this study, the answers for sub-problems below have been investigated.

1. What are the misconceptions of 7th grade students on polygons (concave and convex, diagonals, and angles)?
2. What are the misconceptions of 7th grade students on specific quadrilaterals (main characteristics, parallelism, height, and area)?
3. Is there a significant difference among the misconceptions of students, according to academic success?

The Importance of Research

In order to provide effective learning, teachers must reinforce the mathematical relations that the students possess. In this respect, each concept has a separate significance, as the clarity and diversity of concepts playa great role in enabling meaningful learning for students. (Fidan, 1996; 192). Otherwise, in an educational climate in which conceptual mistakes and errors are not corrected, effective learning might not be realized. If these mistakes are not discovered and corrected, we might encounter these as permanent failures in the system. Therefore, teachers must determine such mistakes and misconceptions and remove the situations that might constitute an impediment for further learning. At the same time, when teachers notice what kind of difficulties with which the students are struggling, they can find opportunities to analyze both their own teaching methods-techniques and the process itself. Thus, research might help teachers in the further teaching process.

A result analysis of the examinations held in accordance with world standards reveal that Turkish students are not successful, on average,in the field of geometry. In all subjects, Turkey is below the world average. The country also has the lowest averages in subjects such as geometrical figures and measures, as mathematics is the most problematic field for Turkey. This situation requires a review of mathematics curricula, particularly of geometry dimensions and geometry teaching (Yucel, Karadag and Turan, 2013; 31).

Although there are geometrical acquisitions in each stage of primary education, the stage in which polygons and quadrilaterals are a primary focusis the seventh grade. At this level, besides their main characteristics, the perimeter, domain, and problems of polygons and specific quadrilaterals are also available. In other words, basic information about polygonsis provided at this stage.

This research will determine whether concepts related to geometry education included in the mathematics curriculum of 7th grade studentshave been learned. Thus, misconceptions of students will be discovered, and a substructure for the necessary measures will be set up. It is expected that findings will guide teachers, subject experts, academics, and program development specialists on the issue of mathematics and concept teaching.

Method

Research Design

This research is a study of descriptive survey model that was carried out in order to determine the misconceptions of 7th grade students on polygons and specific quadrilaterals during the education term of 2013-2014.

Research Sample

Numerical distribution of the report card scores of the students participating in the research is given in Table 1.

Table 1
Numerical Distribution of Academic Success Rate of Students (Report card scores for mathematics)

Score Received	*Number of People (n)*	*Number of People (%)*
1	12	5.2
2	37	16.2
3	87	38
4	50	21.8
5	43	18.8

In Table 1, numerical distribution of the academic success rate of students is given. While the report card score for 38% of the participants was a three, it was one for 5.2% of the students.

Research Instrument and Procedure

The data of this research was collected by means of a "Diagnostic Test" (See. Supplement 1). While preparing the diagnostic test, learning fields, sub-learning fields, and acquisitions about "Polygons and Quadrilaterals" included in the 2013-2014 seventh-grade mathematics course book were analyzed. A table of specifications was created basing upon these acquisitions. The distribution was created in the manner that it would be completely in parallel with the steps of the table of specifications. In this direction, concepts acquired and possible mistakes were determined. In order to prevent complications, and due to confidentiality, a coding system, i.e., K1, K2, K3…K229, was applied on the diagnostic test answered by the students, taking the order of application into consideration. As a result of the diagnosis, mistakes that students might have made are given in Supplement 2. (See. Supplement 2).

Validity and Reliability

In the analysis of quantitative data, descriptive statistics, t-tests and one-sided ANOVA tests were applied by means of SPSS 17.0. In addition, in order to determine the mistake types and misconceptions, a descriptive analysis was carried out by using the relevant literature (Ubuz,1999; Akuysal, 2007; Aktas ve Aktas, 2012; Karatas, O.Kose, & Costu, 2003). The ordering was carried out through the misconceptions exhibited towards the analysis of questions, and the items were inserted into the diagnostic test, accordingly.

While classifying the academic success of students, their math score was based on the report card from the first term. Depending on the score on the report card, coding was applied aslow, for the students withscores of 1 and 2 (L); intermediate, for the students withscores of 3 (I); and high, for the students withscores of 4 and 5.

In order to increase the reliability of research, the data obtained from Diagnostic Test were analyzed by another specialist in the field of mathematics. As a result of a calculation using the Consensus formula (Consensus + Dissensus) X 100 suggested by Miles andHuberman (1994), consent rate among the coders was determined as 92.

Results

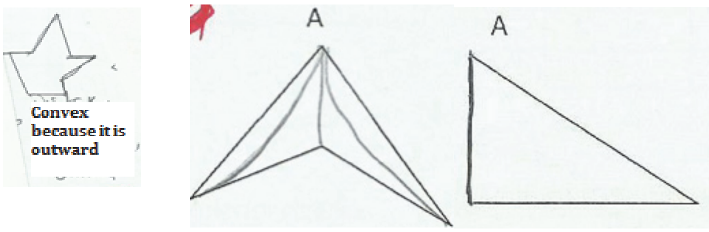
Findings Related to the First Sub-goal

Percentage values and frequencies related to the answers given by the seventh-grade students to the questions on the concepts of concave, convex, diagonal, edge, perimeter, and angle in polygons, and the percentage values and frequencies of student misconceptions are given in Table 2. From this point of view, an answer was sought out for this question "What are the misconceptions of 7th grade students on the polygons (concave and convex, diagonal, and angle)?".

Table 2
Misconceptions and Descriptive Statistical Results of the Answers Given by the Students on Polygons (Concave, Convex, Diagonal and Angle)

Question	*Correct*		*Wrong*		*Blank*		*Misconception*		*Concepts*
	f	%	*f*	%	*f*	%	*f*	%	
1	188	82.1	33	14.4	8	3.5	33	14.4	Concave Convex
							77	33.6	Diagonal
2	130	56.8	87	38	12	5.2	51	22.3	Drawing A Single Diagonal
							42	18.3	Diagonal in A Triangle
3	86	37.6	137	59.3	6	2.6	6	2.6	Edge
							138	60.3	Total
5.3.	63	27.5	143	62.4	23	10	143	62.4	Diagonal
4	42	18.3	70	30.6	117	51.1	70	30.6	The Number of Total Triangles Constituted by a Polygon
6.1.	129	56.3	19	8.3	81	35.4	19	8.3	
7.4.	119	52	64	27.9	46	20.1	64	27.9	
19.1	42	18.3	61	26.6	126	55	62	27.1	
7.1.	172	75.1	25	10.9	32	14	25	10.9	Perimeter
5.1.	137	59.8	72	31.4	20	8.7	73	31.9	Interior Angle
6.2.	102	44.5	51	22.3	76	33.2	51	22.3	
7.2.	105	45.9	75	32.8	49	21.4	75	32.8	Interior Angle
17	41	17.9	44	19.2	144	62.9	44	19.2	
5.2.	117	51.1	75	32.8	37	16.2	74	32.3	Exterior Angle
6.3.	138	60.3	17	7.4	74	32.3	17	7.4	
7.3.	109	47.6	65	28.4	54	23.6	67	29.3	
18	73	31.9	40	17.5	116	50.7	40	17.5	

In Table 2, the distributions of the answers given by the students on the relevant questions are shown. Furthermore, percentages and frequencies of the misconceptions of students about polygons and specific quadrilaterals are given. The students had misconceptions on the concepts of concave and convex (14.4%), diagonal (33.6%), total diagonal (60.3%), the number of triangles created in one polygon (27.1%), perimeter (10.9%), interior angle (22.3%), and exterior angle (17.5%). The examples of students' misconceptions are given in Figure 1.



(K133) (K5) (K132)

Figure 1. *Examples of Misconception on the Concepts of Concave-Convex and Diagonal*

In Figure 1, the student with code no. K5 limited the expression of convex with only stepping out. The student with code no. K132 was asked to draw the diagonals of a given figure, and the student tried to create a diagonal by evaluating the concept of edge differently. The same student made a drawing that accepted that the diagonals were located only in the interior part of the polygonal region. In addition to these, the student with code no.K133 confused the concepts of diagonal and edge, and tried to create a diagonal in a triangle.

In Table 2, when looking at four questions, Question4, Question6.1, Question7.4, and Question19.1, that are related to each other, students were asked to determine and describe the total number of triangles created by a diagonal in a polygon. In the fourth question, when asked what (n-2) stands for in the formula of $(n-2).180^{o}$, 51.1% of the students left it blank and 30.6% fell into misconceptions. The students with misconceptions expressed the statement of (n-2) algebraically.

Findings Related to the Second Sub-goal

Regarding the second sub-goal of this study, the results of the diagnostic test for the question of "What are the misconceptions of 7th grade students on the specific quadrilaterals (main characteristics, parallelism, height and area)?" are indicated in Table 3.

Table 3
Misconceptions and Descriptive Statistic Results of the Answers given by 7th Grade Students to the Question on Specific Quadrilaterals

Question	*Correct*		*Wrong*		*Blank*		*Misconception*		*Concepts*
	f	%	*f*	%	*f*	%	*f*	%	
8.1	196	85.6	21	9.2	12	5.2	19	8.3	Square
21	112	48.9	26	11.4	91	39.7	25	10.9	
9	29	12.7	159	69.4	41	17.9	159	69.4	Square (Area)
11.1	193	84.3	9	3.9	27	11.8	9	3.9	Square (Parallelism)
20.4	80	34.9	78	34.1	71	31	78	34.1	
8.2	179	78.2	38	16.6	12	5.2	37	12.6	Rectangle
10.1	192	83.8	5	2.2	32	14	5	2.2	
10.2	187	81.7	8	3.5	34	14.8	8	3.5	
10.3	174	76	16	7	39	17	16	7	Rectangle (Parallelism)
11.3	198	86.5	6	2.6	25	10.9	6	2.6	
20.3	100	43.7	60	26.2	69	30.1	60	26.2	
10.4	174	76	14	6.1	41	17.9	14	6.1	Rectangle (Diagonal)
8.3	160	69.9	56	24.5	13	5.7	55	24	Trapezoid
11.2	145	63.3	51	22.3	33	14.4	51	22.3	Trapezoid (Parallelism)
20.2	113	49.3	47	20.5	69	30.1	47	20.5	
14	32	14	80	34.9	117	51.1	80	34.9	Trapezoid (Area)
15.2	133	58.1	30	13.1	66	28.8	30	13.1	Trapezoid (Height)
16	85	37.1	35	15.3	109	47.6	35	15.3	
8.4	170	74.2	49	21.4	10	4.4	49	21.4	Parallelogram
12.2	23	10	143	62.4	63	27.5	143	62.4	Parallelogram (Height)
15.1	133	58.1	31	13.5	65	28.4	31	13.5	
20.1	138	60.3	20	8.7	71	31	20	8.7	Parallelogram (Parallelism)
20.5	149	65.1	11	4.8	69	30.1	11	4.8	
12.1	65	28.4	89	38.9	75	32.8	89	38.9	Parallelogram (Area)
8.5	186	81.2	25	10.9	18	7.9	24	10.5	Equilateral Quadrangle
15.3	59	25.8	99	43.2	71	31	99	43.2	Equilateral Quadrangle Height
11.4	155	67.7	34	14.8	40	17.5	34	14.8	Equilateral Quadrangle (Parallelism)
13	40	17.5	80	34.9	109	47.6	80	34.9	Equilateral Quadrangle (Area)
22	43	18.8	72	31.4	114	49.8	71	31	

When Table 3 is analyzed, it can be observed that the subject on which the misconception was lowest is specific quadrilateral rectangles. On average, 8.6% of the students exhibited misconceptions towards the subject of rectangles. The specific rectangle on which the misconception was highest is the equilateral quadrangle. On average, 26.8% of the students exhibited misconceptions about the equilateral quadrangle. Student misconceptions about the subject of squares, parallelograms, and trapezoids are given in Table 3.

Regarding Table 3, examples of student misconceptions are expressed below.

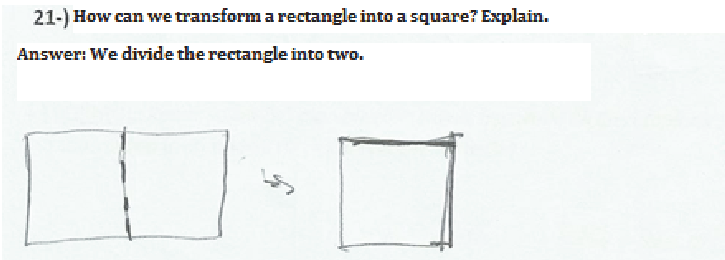
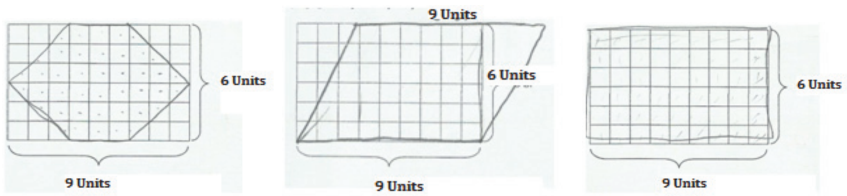


Figure 2. *Misconception example related to the concept of squares*(K163)

The 21th question was addressed to the students for the determination of a conceptual error about the main characteristics of squares. The misconception of the student with code no.K163 was tha the/she regarded the square as a half rectangle, depending on the figure.

When Table 3 is analyzed, it can be seen that the students expressed misconceptions on the ninth question. For the ninth question, the students were asked to answer, "*Which one is the regular polygon with the largest area that can be drawn into the figure below? Calculate the area of this polygon.*" In other words, the students were asked to draw a regular polygon with the largest area, inside the unit squares, within the specified domain. As a result, 69.4% of the students exhibited misconceptionson the ninth question. In Figure 3, geometrical figures drawn by the students with code numbers K25, K83 and K199 regarding the ninth question are expressed.

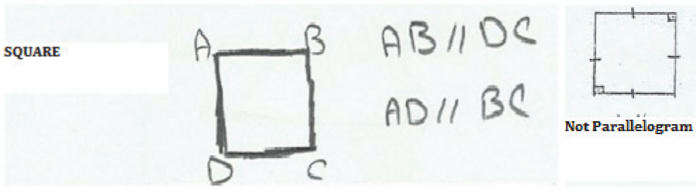


(K25) (K83) (K199)

Figure 3. *Misconception example related to the concept of area in squares*

When Figure 3 is analyzed, it can be observed that the students tried to create different figures. Furthermore, the students were not able to insert the expression of "regular" into the figure, and that they tried to expand the area by increasing the number of edges of the polygon. In Figure 3, the student with code no. K25 drew a hexagon, the student with code no. K83 drew a parallelogram, and the student with code no.K199 drew a rectangle.

In Table 3, it is indicated that students displayed misconceptions regarding parallelism in squares. In Question11, students were asked to describe and draw figures that have parallel edges. Overall, 3.9% of the students expressed misconceptions on the concept of parallelism in squares. In Question20.4, the students were given ready figures and were asked to describe which were parallels; 34.1% of the students expressed misconceptions. In Figure 4, the answers provided by the student with code no. K53 to Question 11.1 and Question20.4 are given.

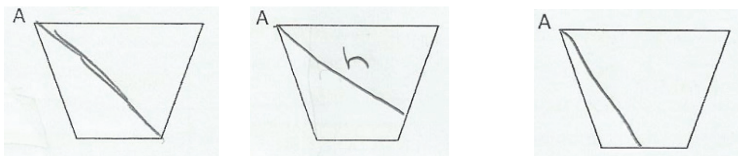


(Question 11.1) (Question 20.4)

Figure 4. *Sample answer regarding the concept of parallelism in squares*

In Figure 4, the answers given by the student with code no.K53 to Question11.1 and Question20.4are indicated. When the student was asked to draw a square in Question11.1, he drew it correctly and expressed the parallelism accurately. However, in Figure 4, it is indicated that the same student failed to expressed the parallelism of a square given in Question20.4. In other words, the student knew the definition, but applied it incorrectly.

When Table 3 is analyzed, it can be seen that 13.1% of the students exhibited misconceptions regarding height in trapezoids. In Question15.2, students were given a trapezoid figüre and asked to draw the height that is required for the area, from a constant a point. In Figure 5, the answers of the students with code numbers K112, K133 K180 and K194are given.

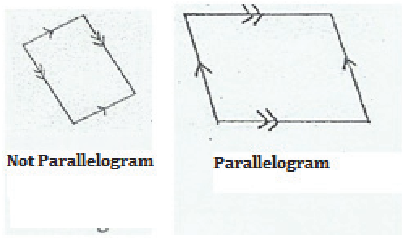


(K112) (K180) (K194)

Figure 5. *Misconception example regarding the concept of height in trapezoid*

In Figure 5, different answers given to Question15.2 by the students with code numbers K112, K180 and K194 are indicated. The student with code no.K112 drew the height as a diagonal. The student with code no.K180 lowered the height to a different edge. The student with code no.K194 expressed misconceptions on the place that he/she took down the height, even though the edge of height he/she drew was correct.

In Table 3, 8.7% of the students fell into misconception on Question20.1, and 4.8% of the students on Question 20.5 when they were asked about the concept of parallelism in parallelograms. The answers given to Question 20.1 and Question 20.5 by the student with code no. K31 regarding differently placed parallelograms are indicated in Figure 6.

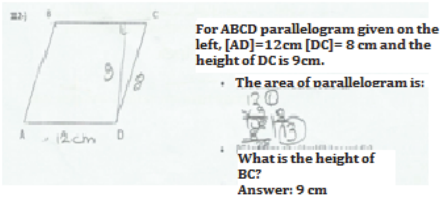


(Question20.1) (Question20.5)

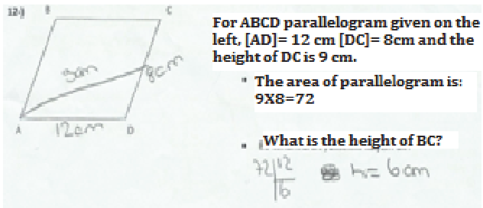
Figure 6. *Sample answer regarding the concept of parallelism in parallelograms*

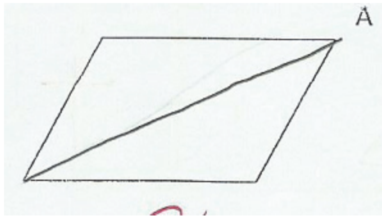
Two parallelograms, as seen in Figure 6, were provided to the students. The placement of the figure in Question20.1was different than the placement in Question20.5. The student with code no. K31 answered Question 20.1 as "it is not a parallelogram," and answered Question 20.5 as "it is a parallelogram." Here, it can be observed that the student does not understand parallelograms conceptually.

When Table 3 is analyzed, 62.4% of the students exhibited misconceptions on Question12.2, and 13.5% exhibited misconceptions on Question15.1. In Question12.2, the concept of height was given within the problem, and students were asked to calculate the area. Students who displayed misconceptions were not able to lower the height to an edge in this question. Similarly, in Question 15.1, a ready parallelogram figure and a constant A point were given. The students were asked to draw the heights that belong to the A side. In Table 3, when the analyses of Question12.1 were taken into consideration regarding the concept of area in parallelograms, it was observed that 38.9% of the students displayed misconceptions. Below in Figure 7, the answers given by the students with code numbers K86, K180, and K133 are provided. In Figure 10, the answers given by the students with code numbers K5 and K46 are indicated.



(K86)



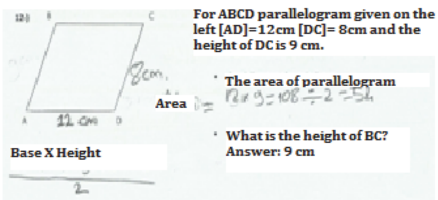


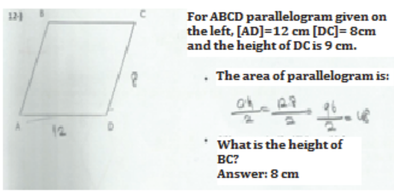
(K180) **(K133)**

(Question15.1)

Figure 7. *Misconception example regarding the concept of height in parallelograms*

In Figure 7, the student with code no.K86, knew the concept of area, but displayed misconceptions regarding the edge to which the height belongs. The student with code no.K180 lowered the height to the correct edge. However, the student did not apply the height that he/she took down from the A side on the IDCI line, but used this height in the interior part of the parallelogram. In Question15.1, it can be seen that when the student with code no.K133 was asked to draw a height for a constant A point in a parallelogram, he/she drew the concept of height as a diagonal.





(K5) (K46)

Figure 8. *Misconception example regarding the concept of area in parallelograms*

The misconception of students with code numbers K5 and K46 regarding the concept of area is given in Figure 8. The student took the half of base and height and calculated the area accordingly. Moreover, while the student with code no.K5 used the concept of height, the student with code no.K46 did not use this concept and, instead, multiplied the edge with anotherand took its half.

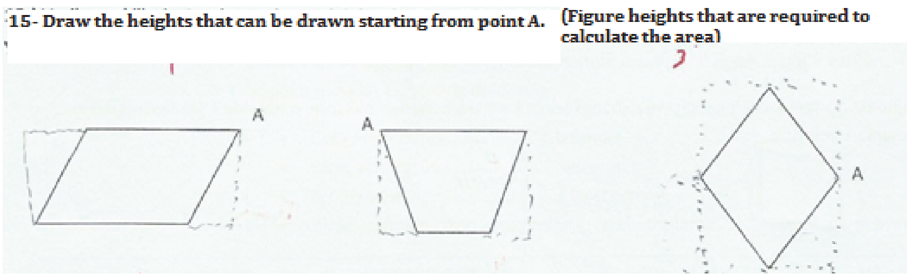


Figure 9. *Sample answer of the student with code no.K70 regarding the concept of height*

In Figure 9, the student with code no.K70 combined the figures and created a rectangle in order to calculate the height of these three geometrical figures. In the operation of finding the height, creating a rectangle will give correct results for parallelograms and trapezoids. Contrary to these to figures, it was expressed as a misconception in the equilateral quadrangle.

Findings related to third sub-goal

In order to analyze whether there was a significant difference between academic success levels and misconceptions of the students, the question, “Is there a significant difference among the misconceptions of students according to academic success?” was asked as the fourth sub-goal, and the relevant results are given in Tables 4 and 5.

Table 4
Descriptive Statistic Results of Academic Success Rates

Academic Success Status	*n*	*M*	*SS*
Low (L)	49	2.11	1.15
Intermediate (I)	87	2.34	1.28
High (H)	93	1.55	0.09

In order to determine whether there was a significant difference between academic success and misconceptions of the students with different academic success levels, a one-sided variance analysis was carried out, with a significance level of $p \leq 0.01$. According to the results of this variance analysis, the average of low academic success levels (N= 49) was determined to be 2.11; the average of intermediate academic success levels (N=87) was determined to be 2.34, and the average of high academic success levels (N=93) was determined as 1.55.

Table 5

Variance Analysis Results of the Misconception in Accordance with Academic Success Rates

Source of Variance	*Sum of Squares*	*sd*	*Mean Squares*	*F*	*P*	*Significant Difference*
Inter-group	28.749	2	14.374	11.371	.000	L-H, I-H
Intra-group	285.684	226	1.264			
Total	314.432	228				

According to Table 5, there is a significant difference between academic success and misconceptions. $F(2, 226)=11.37$, $p<.01$. The results of Tukey's multiple comparison test point out that, as success in mathematics increases, the risk of misconception decreases. In other words, the students included in the high grouphad fewer misconceptions when compared to the students in the low and intermediate groups.

Discussion and Conclusion

Various students displayed misconceptions when questions about the concept of diagonals were addressed to them. In particular, when they were asked to draw diagonals located inside a polygon, most of the students created wrong or incomplete drawings. Similarly, in the qualitative research Owens (2005) carried out, he found out that the students expressed difficulties in creating diagonals. Accordingly, diagonals that needed to be drawn on an edge were usually ended after one or two diagonal(s).

In addition, in relation to the concept of diagonals, it was found out that the students confused the concept of diagonals with the concepts of edge or height. The students believed that the presence of a diagonal was inside a triangle, and searched for a diagonal inside the triangle in the questions asked. Similarly, when the literature is analyzed, findings that are in parallel with these results have been found (Sandt and Nieuwouldt, 2003; Gutierrez, Pegg and Lawrie,2004; Pickreign, 2007; Basisik, 2010). However, in a study Basisik (2010) carried out, he reached the conclusion that students believed the diagonals were not constituted by the lines that combine the consecutive edges. The reason for this might be explained asthe study was at the fifth grade level, or the students' oral skills were not entirely developed.

The participant students were asked what (n-2) stood for in the formula of $(n-2).180^0$. However, the students displayed misconceptions on the concept of a triangle constituted by diagonals coming out of an edge inside the polygon (30.6%). Similarly, as expressed by King and Schattschneider (1997), drawing a relevant object when revealing an invisible relationindicates a significant potential (Tutak, 2008). It can be said that the students were not able to use this potential, and their visualization skills were not entirely developed.

Concerning polygons, the students displayed misconceptions partially on the concepts of concave and convex (14.4%). When looking at the diagnostic test, it was observed that the students either confused the concept due to the origin of the word, or they misperceived the concepts of concave and convex. This is because the students had a basis on incurvating or indenting. Similar to this result, Lipovec (2009) also analyzed the definition of concave and convex polygons. Even though the reasons behind misconceptions were not the focus of this work, it was discovered that the students confused the concepts of concave and convex.

We revealed misconceptions in rectangles (26.2%) and squares (34.1%) on the concept of parallelism. First, the students were asked to draw a square and rectangle.Then, they were asked about the parallelism of the opposing edges. In general, prototype figures were drawn. Even though most of the students expressed the concept of parallelism in these figures drawn parallel to the raw line, they did not mention parallelism in a given figure. This outcome shows parallelism along with the findings of Fujita and Jones (2007). However, Van Hiele pointed out that students at the fifth-grade level did not express a misconception of this kind (Brumbaugh&Rock, 2006). However, as this study was carried out on seventh grade students, it can be said that they have not yet reached that level. There is a presence of misconceptions. Hershkowitz (1990) revealed that students had a tendency to make generalizations. Similarly, Turnuklu and Berkun (2013) observed thatstudents believed that squares and rectangles were not parallel because their edges were not inclined. Another misconception was that students expressed a rectangle as a figure constituted by the combination of two squares, or by two short and two long edges, making four in total. In parallel with these findings, similar studies were carried out by Heinze (2002), Ubuz and Ustun (2004), Akuysal (2007), Pickreign (2007), Okazaki and Fujita (2007), Basisik (2010), and Berkun (2011).

According to the research results, the students had misconceptions about the concept of trapezoids. One such misconception is the status of being parallel. In relation to this feature, the students could draw the prototype figures they were given, but they were not able to show parallelism, or showed it incorrectly. In a similar study carried out by Dogan et al. (2012), they discovered that students knew basic trapezoid figures in general, but they also called a figure a trapezoid that did not have parallel edges. In another study, Nakahara (1995) reached the conclusion that the students were unable to establish the connection between parallelogram and trapezoid.

In addition, while the students stated that the expression of height should be included in the formula to calculate the area of the trapezoid,in another question that required an operation, they were not able to express the height. Here, the students found it easier to express themselves through the figures drawn in parallel with the top and lower base row. However, when a question that included a rotation was asked to the students, that they had misconceptions when creating a figure, expressing the height and, accordingly, perceiving the parallelograms. In parallel with these findings, similar studies in the literature have been carried out by Fujita and Jones (2007), Okazaki and Fujita (2007), Basisik (2010), Berkun (2011), Dogan et al.(2012), and Turnuklu, Gundogdu-Alayli and Akkas and Akkas (2013). There might be many reasons for misconceptions regarding trapezoids. The reason behind misconceptions on this subject might be that the students think of the word "trapezoid" as an object that does not have certain rules in daily use. Furthermore, in a study carried out by Turnuklu, Gundogdu-Alayli and Akkas (2013), they expressed that the semiotic structure of the word of trapezoid might be a research subject. In the studies carried out by Dickson, Brown and Gibson (1984), they realized that the presence of the same features is not mentioned in a different stance of a given figure. Moreover, in a study carried out by Schafer and Atebe (2008), they observed that teaching geometrical figures with vague terminology caused some misconceptions. As it can be understood from here, different stances and states of trapezoids might cause misconceptions.

Concerning equilateral quadrangles, student misconceptions were discovered. Most students matched the equilateral quadrangle with only the feature of being “equilateral” on all the edges. Accordingly, there are misconceptions stemmed from this. Among these misconceptions, the feature of being parallel is neglected. Basisik (2010) also reached similar results. Students displayed misconceptions especially when they were asked about different formats of equilateral quadrangle. In a study carried out by Pickreign (2007) along with candidate teachers, participants focused on seeing the equilateral quadrangle as a lateral figure. In this study, a square figure was rotated. It was evaluated as a way of perception that the candidate teachers called this newly created figure anequilateral quadrangle.

When the relationship between misconceptions and academic success was analyzed, it was observed that the students with high math scores had displayed fewer misconceptions than the students with intermediate and low success. A similar study that was executed in light of the information obtained from the personal details section of the diagnostic testwas conducted by Ubuz (1999), who expressed that there may have been a parallel increase with the students’ level of geometry knowledge.

In diagnostic test results, the outcome that the intermediate-level students had more misconceptions compared to low-level students might be because the low-level students left more questions blank. As the conclusion that there was a misconception was taken under evaluation in terms of the mistakes, the questions that were left blank were not considered as misconceptions. Furthermore, the tendency of the intermediate-level students to answer the questions was more than that of the low-level students, which increases the risk of making mistakes.

Students misperceived the concept of diagonals in polygons, and accordingly, they mostly confused diagonals with edges. In addition, misconceptions were discovered in determining the number of total diagonals. The students had misconceptions on the concept of a triangle constituted by diagonals coming out of an edge inside the polygon. Moreover, various students left the questions on this subject blank.

The students were unable to realize that the polygon that had the largest area which could be placed into a certain domain was a square. When the students were asked to draw squares, rectangles, trapezoids, and equilateral quadrangles, almost all the participants drew prototype figures. In addition to this, although they showed the parallel edges correctly for the squares and rectangles, they exhibited misconceptions on the concept of parallelism for trapezoids and equilateral quadrangles. Furthermore, students had misconceptions that figures such as rectangles, squares, and trapezoid were not parallelograms. In addition, as the level of academic success increased, the risk of misconception decreased in return.

This study was carried out at the seventh grade level. In other studies, it is possible to analyze the presence-absence of misconception on polygons and specific quadrilaterals at different educational stages. By means of conducting qualitative studies, it is possible to find out the thoughts that cause misconceptions. Moreover, by conducting comparative studies, the way misconceptions affect further learning can be examined.

In the lesson content, permanent formula and prototype figures should be avoided. Instead, the lesson should be taught in the manner that reflects actuality and that expresses the core of the perceived subject. It is important that curricula and source books are prepared in this direction. Furthermore, teachers can be recommended to request students to construct classification practices about polygons. Aside from certain prototypes, when different stances of the same figure are taught, learning will be more permanent for the students.

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7. Sınıf Öğrencilerinin Çokgenlerde Ve Özel Dörtgenlerde Yaptıkları Kavram Yanılgılarının İncelenmesi

Atıf:

Özkan, M. & Bal, A. P. (2017). Analysis of the misconceptions of 7th grade students on polygons and specific quadrilaterals. *Eurasian Journal of Educational Research*, 67, 161-182, http://dx.doi.org/10.14689/ejer.2017.67.10

Özet

Problem Durumu: Kavramların işlemlerle ilişkilendirilmesi ve aktarım sağlanılması sonucunda kalıcı öğrenmeler olacaktır. Bu da beraberinde problem çözme becerilerini arttıracaktır. Genel olarak da bir problemi çözmede üç temel faktör vardır. Hata, yanılgı ve yanlış kavramlar. Yanlış kavramlar, sistematik olarak ortaya çıkan kavram hatalarıdır (Oliver, 1986). Bir diğer ifadeyle kavram yanılgılarıdır. Bu üç faktör içerisinde en tehlikeli olanı elbette ki kavram yanılgılarıdır. Çünkü kavram yanılgıları hem sistematik hem de kalıcıdır. Ayrıca sonraki öğrenmelerin önündeki bir settir.

Kavram yanılgılarının tespiti, nedenleri ve giderilmesi için hem ulusal hem de uluslar arası birçok çalışma yapılmıştır. De Villiers (1994) ve Türnüklü & Aktaş

(2013) yaptıkları çalışmalarda özel dörtgenler üzerinde durmuş ve bu yanılgıların çözümü için hiyerarşik bir sınıflama yöntemleriyle anlatım yapma gerekliliğini ortaya koymuşlardır. Okazaki & Fujita (2008) ve Fujita (2012), prototip örneklerin kavram yanılgısı oluşturduğunu ifade etmişlerdir. Bunun yanı sıra; Ubuz ve Üstün (2003) de yaptıkları çalışmada akademik başarıyı temel almak suretiyle, öğrencilerin ilk verilen örnekleri kullandıkları sonucuna ulaşmıştır. Öğrencilerin kelimelerin anlamsal ilişkilere ve şekil görüntülerine takıldıkları (Robert, 1995) ve analoji yapmalarına rağmen kavramsal ilişkiyi kuramadıkları (Fonseca & Cunha, 2011) için kavram yanılgısı yaptıkları görülmüştür. Elbette ki genel manada bu çalışmaların yanı sıra özele inilerek yapılan çalışmalar da mevcuttur. Konkav ve konveks çokgenler (Ward, 2004 ve Lipovec, 2009), geometrik cisimler (İncikabı &Kılıç, 2013), paralelkenar ve yamuk (Aktaş & Aktaş, 2012) gibi çalışmalarda geometride yapılan kavram yanılgıları araştırılmıştır. Cutugnol & Spagnolo (2002), üçgen kavramı üzerine yaptıkları çalışmada öğrencilerin günlük hayatta kavramlarla sıkça karşılaştırılması gerektiğini belirtmiştir. Aksine Edward ve Ward (2004) ise; sistematik olarak şekillerin ders içerisinde verilmesi gerektiği vurgusunu yapmaktadır. Çokgenlerin elemanları da (Heinze, 2002; Sandt & Nieuwouldt,2003; Gutierrez, Pegg & Lawrie, 2004; Picreign, 2007) yine araştırılan konular arasındadır.

Araştırmanın Amacı: Literatür incelendiğinde, açı, üçgen ve dörtgen kavramlarının çokça incelendiği görülmektedir. Bunun yanı sıra yamuk, kare, dikdörtgen ve paralelkenar gibi geometrik şekillerin ayrı ayrı veya gruplar halinde incelendiği de mevcuttur. Ancak hiyerarşik bir şekilde çokgen kavramı ve özel dörtgenler bütüncül olarak ele alınmamıştır. Bu çalışma geometrik şekiller üzerinde özellikle de çokgenlerde ve özel dörtgenlerde öğrencilerin yapmış oldukları kavram yanılgıları tespit edilerek, bu kavramların öğretilmesine ışık tutacaktır.

Bu çalışmanın amacı "7. sınıf öğrencilerinin çokgenler ve özel dörtgenler ile ilgili kavram yanılgıları nelerdir?" sorusu, araştırmanın problem cümlesini oluşturmaktadır. Bu çalışmanın amacını gerçekleştirebilmek için aşağıdaki alt problemlere yanıt aranmaktadır.

1. 7. Sınıf öğrencilerinin çokgenlerle ilgili (iç bükey ve dış bükey, köşegen ve açı) kavram yanılgıları nelerdir?
2. 7. Sınıf öğrencilerinin özel dörtgenlerle ilgili (temel özellikleri, paralellik, yükseklik ve alan) kavram yanılgıları nelerdir?

Akademik başarıya göre öğrencilerin kavram yanılgıları arasında anlamlı bir farklılık var mıdır?

Araştırmanın Yöntemi: Bu araştırma 2013-2014 öğretim döneminde yedinci sınıf öğrencilerinin çokgenler ve özel dörtgenler ile ilgili kavram yanılgılarını belirlemek amacıyla yapılan bir çalışmadır. Bu amaç doğrultusunda nicel veriler kullanılmıştır. Bu araştırmanın evrenini Gaziantep ilinde bulunan öğrenciler oluşturmaktadır. Çalışma evreni oluşturulurken oranlı küme örnekleme yöntemi seçilmiştir. Oranlı küme örneklemi yapmak için, evren, önce araştırma bulguları açısından önemli farklılıklar getirebileceği düşünülen alt evrenlere ayrılmıştır. Böylelikle aynı türden gelebilecek bulgular şansa bırakılmamıştır. Bu şekilde evrenin, daha temsili olduğu ifade edilebilir. Gaziantep'te bulunan farklı sosyo-ekonomik düzeyde bulunan toplam beş okuldaki 229 adet 7.sınıf öğrencileriyle gerçekleşmiştir. Nicel verilerin analizinde betimsel istatistikler, t testi ve tek yönlü ANOVA testi SPSS 17.0 paket programıyla uygulanmıştır. Ayrıca hata türlerinin ve kavram yanılgılarının belirlenmesi, ilgili literatürden yararlanılarak betimsel analiz uygulanmıştır. Araştırmanın güvenirliğini artırmak için Teşhis Testi'den elde edilen veriler matematik eğitimi alanında bir başka uzman tarafından da analiz edilmiştir. Kodlayıcılar arasındaki uyuşma oranı .92 olarak hesaplanmıştır.

Araştırmanın Bulguları: Öğrencilerin; iç bükey ve dış bükey, köşegen, toplam köşegen, bir çokgen içerisinde oluşan üçgen sayısı, çevre, iç açı ve dış açı kavramlarında farklı oranlarla yanılgıya düştükleri görülmektedir. Öğrencilerden bir çokgende bir köşegenin oluşturduğu toplam üçgen sayısını belirlemeleri ve betimlemeleri istenmektedir. Bu bilginin tespiti için $(n-2).180^{o}$ formülündeki (n-2) 'nin ne anlama geldiği sorulduğunda, öğrencilerin %51.1'i boş bırakmış ve %30.6'sında da kavram yanılgısı yapmıştır. Genel olarak en az kavram yanılgısının yapıldığı özel dörtgen de dikdörtgendir. Eşkenar dörtgen ve paralelkenarda yükseklik kavramı verilmiş ve alan hesaplanması istenmiştir. Kavram yanılgısı yapan öğrenciler, bu soruda yüksekliği, ait olduğu kenara indirememişlerdir. $F(2, 226)=11.37$, $p<.01$. Tukey çoklu karşılaştırma testi sonuçları, Matematik başarısı arttıkça kavram yanılgısına düşme oranının azaldığını ortaya koymaktadır. Bir başka ifadeyle; akademik başarısı yüksek grupta bulunan öğrencilerin, orta ve düşük grupta bulunan öğrencilerden daha az kavram yanılgısına düştüğü görülmektedir.

Araştırmanın Sonuçları ve Önerileri: Araştırmada, köşegen kavramı ile ilgili sorulara cevap alındığında öğrencilerin bazı kavram yanılgılarının olduğu görülmüştür. Ayrıca, teşhis testi sonuçlarında, orta seviye öğrencilerin düşük seviyedeki öğrencilere kıyasla daha fazla yanılgıya sahip oldukları sonucu, düşük seviyedeki öğrencilerin daha fazla soruyu boş bırakması neden olabilir. Çünkü kavram yanılgılarının tespiti için cevaplanan sorular değerlendirilmeye alınmış ancak boş bırakılan sorular hatalar bağlamında değerlendirilmemiştir.

Bu çalışma yedinci sınıf düzeyinde gerçekleştirilmiştir. Diğer çalışmalarda, farklı eğitim kademelerinde çokgenler ve özel dörtgenlerde kavram yanılgısının olma-olmama ve neden olduğu durumları incelenebilir. Nitel çalışmalar yapılmak suretiyle, yanılgıya sebebiyet veren düşünceler tespit edilebilir. Ayrıca karşılaştırmalı çalışmalar yapılarak; kavram yanılgılarının sonraki öğrenmeleri nasıl etkilediği araştırılabilir. Öğretmenlere hiyerarşik anlatımı ve öğrencilerine çokgenler arasındaki sınıflama çalışmaları yapmaları önerilebilir. Belirli prototiplerden başka; aynı şeklin farklı duruşları, öğrencilere gösterildiğinde öğrenmenin daha kalıcı olacağı düşünülmektedir.

Anahtar Kelimeler: Kavram yanılgısı, özel dörtgenler, çokgenler, akademik başarı, geometri.