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# EXAMINING THE DIFFICULTIES EXPERIENCED BY 8TH GRADE STUDENTS ON THE SUBJECT OF SQUARE ROOT NUMBERS

## (8. SINIF ÖĞRENCİLERİN KAREKÖKLÜ SAYILAR KONUSUNDA YAŞADIKLARI GÜÇLÜKLERİN İNCELENMESİ)

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## ABSTRACT

The aim of this study is to examine the difficulties experienced by the 8th grade students in learning square root numbers. The research was designed in accordance with the descriptive survey model. The sample of the research was composed of 53 students from 8th grade who were studying in an elementary school in Erzurum province during the 2012-2013 academic year. This 10 open-ended questioned test developed by the researcher as data collection tool was prepared for measuring the misconceptions of the pupils about the square root numbers (Cronbach = 0.79). When the mistakes and misconceptions revealed in data analysis were examined, it was observed that the students did not subject the square root to operation while sorting the square root numbers on the numerical axis; they performed incorrect rulings on the four basic arithmetic operations; and they were not able to create relationship between the area of the quadratic section and square root numbers. Suggestions were made to remedy such mistakes by the students.

**Keywords:** Square Root Numbers, Learning Difficulties, Mistake, Misconception.

## ÖZ

Bu çalışmanın amacı ortaokul sekizinci sınıf öğrencilerinin kareköklü sayıları öğrenmede yaşadıkları güçlüklerin incelenmesidir. Araştırma betimsel (descriptive) tarama (survey) modeline göre tasarlanmıştır. Erzurum ilinde bir ilköğretim okulunda 2012-2013 öğretim yılında 8. sınıfta okuyan 53 öğrenci örneklemi oluşturmaktadır. Veri toplama aracı olarak araştırmacı tarafından geliştirilen 10 açık uçlu sorudan oluşan bu test öğrencilerin kareköklü sayılar konusu hakkındaki kavram yanılgılarını ölçmek için hazırlanmıştır(cronbach = 0.79). Verilerin analizinde ortaya çıkan hatalar ve kavram yanılgıları incelendiği zaman, öğrencilerin kareköklü sayıları sayı doğrusunda sıralarken karekökü işleme tabi tutmamaları, dört işlemlerde yanlış kurallamalar yaptıkları, karesel bölgenin alanı ile kareköklü sayılar arasındaki ilişkiyi kuramadıkları görülmüştür. Öğrencilerin bu hatalarına yönelik önerilerde bulunulmuştur.

**Anahtar Kelimeler:** Kareköklü Sayılar, Öğrenme Güçlükleri, Hata, Kavram Yanılgısı.

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## INTRODUCTION

Mathematics is the sum of operations with which we try to solve the problems in our lives by counting, calculating, measuring and drawing. Today, the basic objective of mathematics instruction is to enable people to adopt analytical thinking ability in mathematical calculations, thus enabling them to obtain a method of thinking that will assist them in daily life situations via problem solving logic.

An instruction, which is appropriate to the structure of mathematics, must be oriented towards enabling students to understand the concepts and operations involved in mathematics and to form connections between these concepts and functions (Alakoç, 2003). The attitudes of individuals towards mathematics, their interest in mathematics, their willingness for mathematical operations in daily life and their consideration of seeing themselves as successful or unsuccessful have a direct effect on the effectiveness of mathematics instruction (Akay and Boz, 2010).

According to Van de Walle (1989), an appropriate instruction for mathematics course must be oriented towards the following three objectives (Reported by Baykul, 1995).

1. Helping students to understand the concepts related to mathematics,
2. Helping students to understand the operations related to mathematics,
3. Helping students to form the relations between concepts and operations.

Mathematics is an abstract subject that involves the successive abstraction and generalization process of relations. The reason why mathematics is difficult for students results from the fact that mathematics is abstract. This results from the inability to learn the abstract concepts of mathematics. Students regard mathematics as difficult since they cannot concretize the concepts and associate the subjects in mathematics with daily life situations. If these abstract concepts are taught to the students by concretizing them, the difficulties experienced and mistakes made by the students can be eliminated or minimized.

Two primary reasons for failure in mathematics can be attributed to similar causes for every age group. These causes can be classified as follows:

- The fact that mathematics requires constant study,
- The fact that education system prevents students from learning mathematics by understanding,
- The fact that mathematics is based upon understanding rather than learning and memorizing,
- The fact that mathematics is the most abstract of all sciences (Moralı, Köroğlu and Çelik, 2004).

According to Baki (1996), misconceptions are the most significant factor that causes students' low level of success in mathematics. Students' daily experiences and the experiences that they gain in school education constitute the most important reason for the emergence of misconceptions in students. The misconceptions, which are obtained in this way, result from the fact that the students use the information that they consider logical by utilizing their existing knowledge. Recnick's (1983) statement "Students do not come to schools with blank brains" explains this condition in the best manner. Mestre (1987) explains the relationship between misconceptions and the individuals' experience as follows: Every individual has some models and theories of thinking that she/he possesses and that she/he forms in relation with all experiences. These models of thinking can be erroneous and deficient in interpreting the life and conveying what people think. These constitute the foundations of misconceptions. These misconceptions must be identified, and materials must be developed to decrease or prevent mistakes (Baki, 1996).

Conceptual knowledge does not merely consist of knowing the definition and the name of the concept, but at the same time, providing opportunity for abstract structures and concepts with similar feature to make transition among each other (Akgün, Işık, Tatar, İşleyen and Soylu, 2012). According to Fidan (1985), concept is the sum of abstract structures formed by the objects, situations and actions that have same features. In such learning, people learn to use the name concept for all the objects that have appropriate features. In other words, it is to exclude objects which do not have that feature from that concept (Arı, Üre and Yılmaz, 1999).

Misconception is the knowledge that is formed as a result of individuals' daily life experiences.Therefore, this knowledge, which is not verified or proven, results in to learn the concepts harder.

Square root numbers are among the subjects that students experience difficulty in learning. Although this subject is considered as an unnecessary and complicated operation by students, it is used in many different fields of science. The reason why students experience difficulty in square root numbers is that they fall into misconception. Misconceptions exhibit different qualities than the random mistakes that students make. People can correct a random mistake that they make. However, if a certain misconception exists in people, the first thing that they do when they make a mistake is to defend themselves accordingly and try to prove to those who convince them that what they know is correct (Cankoy, 2009).

Mathematics instruction is of great importance in the instruction process, and it has a present continuity. As long as problems continue to be experienced in learning the basic concepts, it will be difficult to learn new concepts. Misconceptions about this subject may cause students to experience many problems in different subjects. Many studies have to be conducted in order to find the insufficient concepts in mathematics instruction. Previous

studies conducted in the field of mathematics revealed misconceptions and mistakes that were experienced by students from different class levels and subject levels. Research showed that the students experienced difficulty in performing the four basic arithmetic operations; they were not able to show the numbers in the numerical axis; they had trouble in operations with symbolic expressions; and they fell into misconception since they performed operations by memorizing (Bilgin and Akbayır, 2002; Cengiz, 2006; Özkan, 2011; Gelici, 2012; Pesen, 2008; Şandır, Ubuz and Argün, 2007; Yenilmez and Avcu, 2009). In another study, it was concluded that the instruction was given via the play method in order to increase the difficulties experienced by students in the subject of square root numbers and not to fall into misconceptions and learning the subject in this manner was enjoyable and it increased the attention towards mathematics (Özdemir, 2011).

Learning square root numbers constitutes the basis of solving the questions that involve square root expressions. Therefore, it is important to learn the subject of square root numbers completely and to identify the existing misconceptions on this subject. Selection of this subject sets forth the importance of this study since very few studies were conducted on this subject in the literature.

The main problem in mathematics courses is the failure to teach students the basic concepts. For instance, insufficient learning and misconceptions, which are formed in secondary education, are conveyed to high school level, and this condition carries with it important problems in mathematics instruction. Research was conducted in order to eliminate these problems. This study was prepared in order to determine learning difficulties, insufficient learning and misconceptions of students in the subject of square root numbers, and to contribute to the elimination of these misconceptions.

### Research Problem

In this study, an answer was sought to the question "what are the difficulties experienced by the 8$^{th}$ grade students in the subject of square root numbers?". In the scope of this research problem, answers were sought to the following questions.

1) What kind of problems do 8$^{th}$ grade students experience in the subject of square root numbers?

2) What are the misconceptions that 8$^{th}$ grade students have in the subject of square root numbers?

## METHODOLOGY

### Research Model

An attempt was made in this study to determine the common mistakes, misconceptions and difficulties experienced by 8$^{th}$ grade students in the

subject of square root numbers. The research was designed in accordance with the descriptive survey model in order to identify students' opinions, their ideas on the subject, their mistakes in problem solving and their learning difficulties. Descriptive research has great contribution to the investigation of knowledge. The survey model was used to identify the types of knowledge such as the habits, attitudes and opinions of people (McMillan and Schumacher, 2011).

**Population and Sample**

The population of this study is composed of 8th grade students who are studying in the 2012-2013 academic years. However, to ensure the accessibility of the researcher and easier conduct of the research, the sample is composed of a total of 53 students (20 females and 33 males) taken from two 8th grade classrooms in a secondary school of the Ministry of National Education located in Yakutiye district of Erzurum province by using non-probability sampling. This sample was formed in this manner in order to reach the individuals more easily and save on money and time (Büyüköztürk, 2010).

**Data Collection Tool**

In order to determine the mistakes, learning difficulties and misconceptions of the students in the subject of square root numbers, a form consisting of 12 open-ended questions was prepared in accordance with objectives to ensure content validity after a table of specifications appropriate to the objectives and to aims in the teaching program of the Ministry of National Education was prepared. The opinions of two mathematics teachers and an academician who was an expert in the field of mathematics instruction were sought, and necessary revisions were made. In view of these revisions, two questions, which were considered erroneous according to expert opinions, were removed, and a test consisting of 10 open-ended questions was prepared. An attempt was made to prepare questions that were appropriate to every objective in the test. These questions were put to the students for one course hour after the subject of square root numbers was taught. Well-structured open-ended questions give students the opportunity to express the reasons for their answers in their own words, and reflect their high level thinking skills (Gronlund and Linn, 1990).

**Data Analysis**

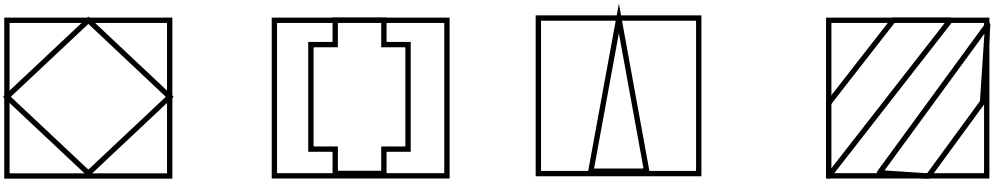
Descriptive statistics methods as well as percentage and frequency calculations were utilized in order to analyze the data in this study that was conducted to identify the misconceptions of 8th grade students in the subject of square root numbers and to determine whether this subject was learned. These sets of numerical data were given as tables. The answers given by students to all questions were categorized as "incorrect" and "correct". Unanswered questions were categorized as "blank". These were graded as "0", "1" and "2"

respectively. In view of the analysis conducted via the SSPS 20.0 program, the reliability coefficient of the test was found to be 0.79 via Cronbach's Alpha reliability test.

## FINDINGS

In this section, the questions were examined in accordance with the research problems. Firstly, the obtained findings and questions were given. Then, percentage and frequency values of students were shown in tables. Finally, the results of students' mistakes and misconceptions were presented.

### Findings Regarding Question One



"The floors of four rooms with different dimensions were covered with quadratic wood parquets in the numbers given above. In view of this, which room floor will not be in square form among the rooms that have been covered with the above-given models of parquet?"

**Table 1: Evaluation Result of Question One**

| | f | % |
|---|---|---|
| Incorrect | 9 | 17.0 |
| Correct | 31 | 58.5 |
| Blank | 13 | 24.5 |
| Total | 53 | 100.0 |

This question was asked in order to measure whether or not students could explain the relationship between perfect square natural numbers and square roots of these numbers with models and whether they could identify square roots of these numbers. A total of 58.5% of the students gave a correct answer to this question. Those who gave incorrect answers were preoccupied with the figures in the question, and they thought that the wood parquets had to be quadratic and the models within wood parquets had to be proper figures.

### Findings Regarding Question Two

"Show the places of numbers $\sqrt{14}, \sqrt{41}, \sqrt{60}, \sqrt{73}$ in the numerical axis."

**Table 2: Evaluation Result of Question Two**

| | f | % |
|---|---|---|
| Incorrect | 26 | 49.1 |
| Correct | 14 | 26.4 |
| Blank | 13 | 24.5 |
| Total | 53 | 100.0 |

This question was asked in order to get students to show the square roots of non-perfect square numbers in the numerical axis. A total of 49.1% of the students answered this question incorrectly. Students were not able to comprehend the bigness and smallness relationship. Some students correctly ordered the numbers, but they were not able to determine between which numbers they had to place them. The students who answered incorrectly in this manner were not able to understand the concept of square root, and they perceived the square root symbols as if they were parentheses.

**Findings Regarding Question Three**

"The horse shown in the figure moved $\sqrt{75}$ km away and came back $\sqrt{32}$ km. As a result of this movement, how many kilometers did this horse move away from its original place?"

**Table 3: Evaluation Result of Question Three**

| | f | % |
|---|---|---|
| Incorrect | 32 | 60.4 |
| Correct | 10 | 18.9 |
| Blank | 11 | 20.8 |
| Total | 53 | 100.0 |

This question was asked to measure whether the students comprehended addition and subtraction operations in square root numbers. The majority of students removed the numbers in square roots while performing subtraction operation in square root numbers. That is to say, students regarded the square root symbol as a parenthesis, and directly performed the operation. Many of the students who gave incorrect answers had the misconception that $\sqrt{x} - \sqrt{y} = \sqrt{x - y}$. Some students preferred adding the given values without understanding the question.

**Findings Regarding Question Four**

"What is the smallest number with which we must multiply $\sqrt{90}$ in order for it to become a whole number?"

**Table 4: Evaluation Result of Question Four**

| | f | % |
|---|---|---|
| Incorrect | 29 | 54.7 |
| Correct | 12 | 22.6 |
| Blank | 12 | 22.6 |
| Total | 53 | 100.0 |

This question was asked to measure the level at which students could write a square root number as $a\sqrt{b}$. A total of 54.7% of the students gave incorrect answers to this question whereas 22.6% of them gave correct answers. The students who answered incorrectly were not able to factor the square root number down to its prime factors and write it as $a\sqrt{b}$. Some students tried to multiply the square root number by itself.

**Findings Regarding Question Five**

$5\sqrt{7}$ km/h

$4\sqrt{8}$ km/h

$5\sqrt{3}$ km/h

"The speeds of rabbits, cats and dogs are given above. Sort their speeds in ascending order."

**Table 5: Evaluation Result of Question Five**

| | f | % |
|---|---|---|
| Incorrect | 25 | 47.2 |
| Correct | 21 | 39.6 |
| Blank | 7 | 13.2 |
| Total | 53 | 100.0 |

A total of 39.6% of the students gave correct answer to this question. The students who gave incorrect answer performed the sorting in accordance with the number outside the square root or the magnitudes of the number inside the square root. Instead of writing $x\sqrt{y} = \sqrt{x^2.y}$, these students performed the sorting in accordance with the number outside or inside the square roots. Some students performed the sorting by implementing this rule as $x\sqrt{y} = \sqrt{x.y}$. It

was concluded that these students were not able to fully comprehend the square root concepts.

**Findings Regarding Question Six**

"Find the result of $\sqrt{2} \cdot \sqrt{3} \cdot \sqrt{4} \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{4}$ =?"

**Table 6: Evaluation Result of Question Six**

| | f | % |
|---|---|---|
| Incorrect | 18 | 34.0 |
| Correct | 23 | 43.4 |
| Blank | 12 | 22.6 |
| Total | 53 | 100.0 |

The aim of this question was to measure the level at which the students could perform multiplication operation in square root numbers. A total of 43.4% of the students gave correct answer to this question. The students who gave incorrect answers overlooked the square root expression, and directly performed multiplication operation. Some of them multiplied the numbers having the same square root expression, but they made mistakes in the operation since they did not remove the square root symbol. Some of them took one of the numbers having the same square root expression, overlooked the others and performed multiplication operations. These students did not fully understand the subject of square root expressions.

**Findings Regarding Question Seven**

"Find the result of $\frac{\sqrt{12}+\sqrt{27}}{\sqrt{3}}$ =?"

**Table 7: Evaluation Result of Question Seven**

| | f | % |
|---|---|---|
| Incorrect | 26 | 49.1 |
| Correct | 20 | 37.7 |
| Blank | 7 | 13.2 |
| Total | 53 | 100.0 |

The aim of this question was to measure the integrity of students' operational knowledge. An attempt was made to determine what kind of mistakes the students made while performing addition and division operations in square root numbers. The students who answered incorrectly had the misconception that $\sqrt{x} + \sqrt{y} = \sqrt{x + y}$ while performing addition operation in square root numbers. Some students made mistakes in terms of operational

knowledge by performing incomplete reduction on the square root expressions that they decomposed as $x\sqrt{y}$ without performing the addition operation.

**Findings Regarding Question Eight**

"Find the result of $\frac{\sqrt{0,09}+\sqrt{2,89}}{\sqrt{0,49}}$ =?"

**Table 8: Evaluation Result of Question Eight**

| | f | % |
|---|---|---|
| Incorrect | 23 | 43.4 |
| Correct | 12 | 22.6 |
| Blank | 18 | 34.0 |
| Total | 53 | 100.0 |

Just like the previous question, this question also measured the operational knowledge. Students' answers show parallelism with the answers given to the previous question. The students made mistakes in turning the decimal numbers into fractions. Just like the previous question, the students had the misconception that $\sqrt{x}+\sqrt{y}=\sqrt{x+y}$. One student performed the necessary operations without taking the number with perfect square outside the square root, and solved this question by reducing the square root symbols while performing the division operation at the last stage.

**Findings Regarding Question Nine**

"What is the perimeter of a quadratic section that has an area of 60 $m^2$?"

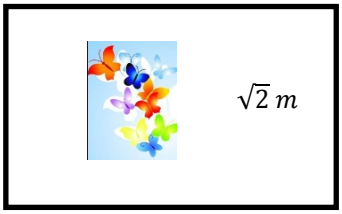
**Table 9: Evaluation Result of Question Nine**

| | f | % |
|---|---|---|
| Incorrect | 34 | 64.2 |
| Correct | 8 | 15.1 |
| Blank | 11 | 20.8 |
| Total | 53 | 100.0 |

The aim of this question was to measure the level at which the students could form the relationship between square root numbers and the area of a square. A total of 15.1% of the students gave correct answer to this question. The students who gave incorrect answers were not able to comprehend the relationship between the concept of square root and the area of a square. Rather than finding a side of a square, the area of which was given, some students took half of the area and considered this result as one side's length of

the square. One student took half of the area and calculated the perimeter. These mistakes resulted from the fact that the previous knowledge was not fully comprehended. Several students regarded the area itself as the side and calculated its area again while they were supposed to calculate the perimeter. It can be stated that these mistakes resulted from students' lack of knowledge and the fact that they were not able to fully ıunderstand the square root concept.

**Findings Regarding Question Ten**




"A painting in quadratic section form was hanged on the wall in quadratic section form given above. What is the area covered by the empty section on the wall in $m^2$?"

**Table 10: Evaluation Result of Question Ten**

| | f | % |
|---|---|---|
| Incorrect | 32 | 60.4 |
| Correct | 4 | 7.5 |
| Blank | 17 | 32.1 |
| Total | 53 | 100.0 |

The majority of students gave incorrect answer to this question. Only 4 students answered this question correctly. Many of the students who gave incorrect answers performed an operation as $x\sqrt{y} - \sqrt{y} = x$. That is to say, the students tried to subtract one side from the other side instead of finding their areas. Some students tried to find the result by calculating the perimeters of both shapes. It was observed that the students experienced difficulty in squaring a square root number.

## CONCLUSION, DISCUSSION AND SUGGESTIONS

The aim of this study was to determine the misconceptions, mistakes and errors of the students in the subject of square root expressions. The data, which were obtained from the conducted knowledge test, were analyzed in the research.

The students experienced difficulty in deciding between which numbers that they would write a square root expression for on the numerical axis. Students were not able to fully comprehend the greatness and smallness relationship. Some students disregarded the square root expression in this question, and tried to place it on the numerical axis in accordance with the numbers in it. This condition resulted from the fact that the students were not aware of that the square root would also be subjected to an operation. In his study, Özkan (2011) asked a similar question to first-year high school students, and found that the success level was higher than the other questions.

In the questions that featured addition and subtraction operations in square root numbers, many of the students performed the operation by adding or subtracting the numbers in the square root expression. It was observed that the majority of the students had the misconception that $\sqrt{x}-\sqrt{y}=\sqrt{x-y}$ or $\sqrt{x+y}=\sqrt{x}+\sqrt{y}$. Some students tried to find the result in $x\sqrt{y}-\sqrt{y}=x$ subtraction operation by subtracting the square root expressions. The students did not regard the square root as an operation. It was concluded in similar studies that the students performed operations by perceiving the square root symbol as a parenthesis (Cengiz, 2006; Özkan, 2011; Şenay, 2002).

Many of the students made mistakes in sorting the square root expressions according to their magnitudes. It was observed that the students performed the sorting by paying attention to just the number outside the square roots or the number inside the square root instead of performing it as $x\sqrt{y}=\sqrt{x^2y}$. It was observed that the students fell into misconception in taking a number, which was outside the square root, into the square root. In his study, Cengiz (2006) found that the students experienced difficulty in taking the exponent of the number.

It was found that the students experienced difficulty in the questions that included the multiplication and division of two square root terms, and they had the misconception that only the coefficients of the square root term would be multiplied or divided.

The students were not very successful in taking the square root concept while calculating the area of a quadratic section. In this question, the students regarded the area as a side of the square, and they tried to calculate the area of the square again. It was observed that many of the students had the misconception that $x=\sqrt{x}$. It was observed that students lacked knowledge about the previous subjects. Cengiz (2006) and Özkan (2011) reached the same conclusion in their studies that they conducted with first grade high school students

Students must be able to learn the concepts in mathematics in a meaningful way. Instead of giving the prepared mathematical rules to the students and expecting them to memorize these rules in learning-teaching

process, a teaching method must be utilized, which will enable the students to find and discover these rules on their own. The students must be encouraged to develop their own problem-solving strategies. Student's mistakes made must not be characterized as failure. By learning via trial and error, the students must learn from their mistakes and figure out how to correct these mistakes (Cengiz 2006).

Incorrect knowledge and concepts in students' minds must be changed or the lacked ones must be completed. In order to achieve this, teachers must know the incorrect opinions and knowledge that is indirectly or clearly expressed by the students. Teachers must structure the instruction on this basis, clearly set forth the incorrect opinions and clarify new opinions and concepts (Özer, 1997). Teachers must reveal the existing misconceptions in students' mind before teaching them new concepts. This may decrease the misconceptions in students after instruction (Büyükkasap and Samancı, 1998).

Conceptual knowledge and operational knowledge must be given in a way that they complement one another. Students must sense and see the relationship between operations and concepts in mathematics; solve the problems by seeing and sensing; and improve their way of thinking in problem solving processes. If there is deficiency in the essential prerequisite knowledge, it must be mastered before giving the subjects. Examinations, which are not for grading purpose, must be performed in order to identify and to eliminate students' lack of knowledge and mistakes at the end of every subject given (Cengiz 2006).

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