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INVESTIGATING ACHIEVEMENT LEVELS OF SIXTH GRADE STUDENTS REGARDING ORDERING INTEGERS

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Abstract: The aim of this study was to investigate middle school sixth grade students' achievement levels regarding ordering of integers. Partipants were 262 sixth grade students from one public middle school in Etimesgut district of Ankara. Data were collected via a questionnaire. Findings indicated that achievement levels of the participants in ordering questions were moderate.

***Keywords*:** Integer, ordering, achievement levels, sixth grade students

Introduction

Integers have a crucial role in learning mathematics by understanding it because results of many studies investigating the integer conception revealed that integer is both complex and requires great effort to learn (Dereli, 2008; Janvier, 1983; Kilhamn, 2008; Mc Corkle, 2001). Since there are strong prerequisite relationships among integers and other issues, a student who already has learning difficulties in integers will find it difficult to succeed in the following subjects such as algebra (Lamb et al., 2012; Vlassis, 2004).
Integers are one of the mathematics topics in the mathematics curriculum as of 6^{th} grade, and the topic of integers is quite important because it is functional in the other following topics. The role of integers in the development of higher level mathematical concepts, such as algebra, makes it one of the most important and essential conceptual subjects in the middle school mathematics curriculum (Christou & Vosniadou, 2012, Vlassis, 2004). When students get to second term of sixth year, they begin to learn algebra that is based on integers. Furthermore, teaching and learning rational numbers and exponential numbers that are based on integers begin in seventh grade and continue in eighth grade. This situation indicates that the topic of integers should be handled and studied differently at different levels. Hence, it is significant to conduct a study which shows students' achievement levels regarding integers. The results of such a study would give valuable information related to ordering of integers.

Methods

The Research Method and Participants

In this study, the cross-sectional survey design was used in order to identify students' achievement levels. Cross-sectional survey design includes collecting data at a single point in time from a sample that represents the population (Fraenkel and Wallen, 2006). Data was collected from 262 students who were sixth grade students in one of the public middle schools in the Etimesgut district, Ankara.

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Instrument and Data Collection

A questionnaire was developed to identify middle school sixth grade students' achievement levels related to ordering of integers. The questionnaire was composed of two open-ended items. Explanations and details of two items are given below.

The first item in the questionnaire measures the students' knowledge of ordering integers. In the question, three girls' comparisons of their hair lengths were given and these comparisons included negative integers. Students were expected to explain the ordering of these integers, which represented girls' hair lengths. The 1nd question is presented in Figure 1 below:

Question 1:

Simge and Rüya are comparing their hair length to their friend Yağmur's hair length. Simge states that her hair is +4 cm compared to Yağmur's hair and Rüya states that her hair is3 cm compared to Yağmur's hair. Who has the shortest hair? Write the girls' names in order of their length from the shortest to the longest.

Figure 1. The first item in the questionnaire

The second item in the questionnaire was developed by the researcher, measures the students' knowledge of ordering integers. In the question, all buttons of an elevator were given in the figure and ground floor was represented as zero. Students were expected to identify the numbers of the elevator buttons, which were pressed by Ayşe and the nurse. The second question is presented in Figure 2 below:

Figure 2. The second item in the questionnaire

Question 2:

When Ayşe took the elevator from the ground floor in a hospital, she pressed the wrong elevator button. She went to the radiology service instead of the blood collection service. With the aid of a nurse in the elevator, the upper floor was pressed. Identify the number of buttons which were pressed by Ayşe and the nurse. Please explain your answer.

Ayşe:
……
……
……

Nurse:……
……
……
……..

In general, the aim of asking these questions was to get knowledge about students' achievement levels regarding ordering of integers.

Three mathematics educators in the Middle School Mathematics Education program of two different universities had evaluated the items of the questionnaire in terms of appropriateness of the items in relation to the objectives and the purposes of the study, the table of specification, the usage of mathematical terms, and the clarity of the statements.

As part of reliability study for items of the questionnaire, two researchers analyzed students' answers. A correlation of 98% was found between the two scorings.

In order to identify the achievement levels of the students, rubrics were developed by the researchers for each objective to evaluate the achievement levels of the participants.

Findings

In the first question, students were asked to order girls' hair lengths from the shortest to the longest. Sixth grade students' answers were analyzed according to the rubric below:

Table 1. Rubric for question 1

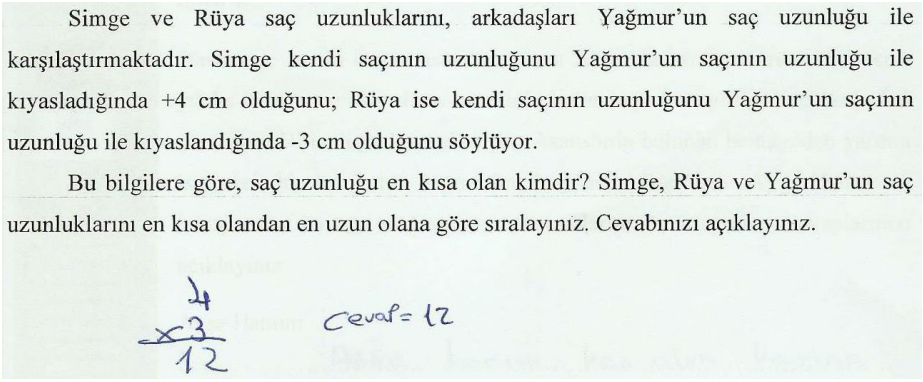
Scores	Answer Types
0	No answer/ Had no mathematical understanding
1	Ordered the girls' hair lengths incorrectly
2	Ordered some girls' hair lengths correctly but some incorrectly
3	Ordered some girls' hair lengths correctly but some were not evaluated
4	Ordered girls' hair lengths correctly but without explanations or with inappropriate explanations
5	Ordered girls' hair lengths correctly but had limited mathematical knowledge
6	Ordered girls' hair lengths correctly with an acceptable explanation

To summarize, students' answers were coded as 1 and 2 if their answers were wrong and their answers were coded as 3, 4, 5 and 6 if their answers were correct.
The frequency of answers 262 6th grade students' answers are presented in Table 4.16 below:

Table 2. Frequency of the Answers for Question 1

Codes	0	30	(11.5%)
	1	51	(19.5%)
	2	9	(3.4%)
	3	37	(14.1%)
	4	58	(22.1%)
	5	31	(11.8%)
	6	46	(17.6%)
Total		262	(100.0%)

To illustrate, the incorrect answer of Participant 24, which is an example of "had no mathematical understanding", is presented below:
The response of Participant 24 is as follows:

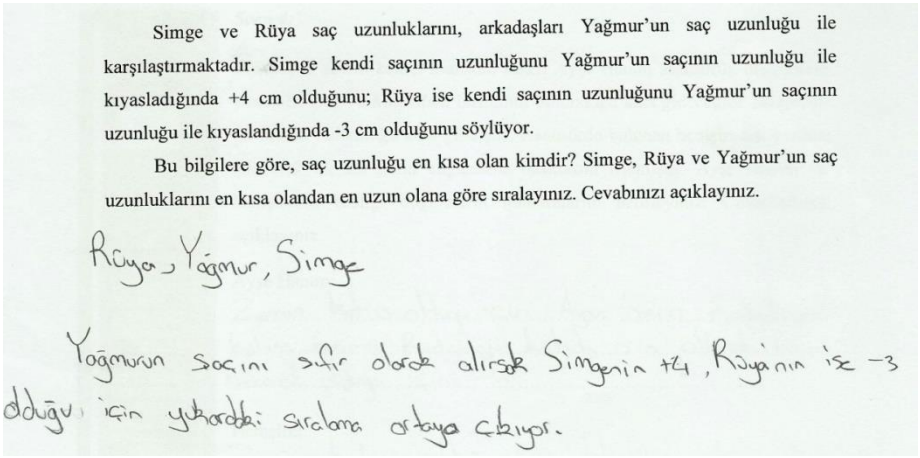

Simge ve Rüya saç uzunluklarını, arkadaşları Yağmur'un saç uzunluğu ile karşılaştırmaktadır. Simge kendi saçının uzunluğunu Yağmur'un saçının uzunluğu ile kıyasladığında +4 cm olduğunu; Rüya ise kendi saçının uzunluğunu Yağmur'un saçının uzunluğu ile kıyaslandığında -3 cm olduğunu söylüyor.

Bu bilgilere göre, saç uzunluğu en kısa olan kimdir? Simge, Rüya ve Yağmur'un saç uzunluklarını en kısa olandan en uzun olana göre sıralayınız. Cevabınızı açıklayınız.

4
x3
12
Cevap= 12

Figure 3. Answer of participant 24 to Item 1

As observed in the participant's response, "4x12=12" was not relevant to the correct answer of item 2.
To illustrate, the correct answer of Participant 92 is presented below:
Participant 92: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Bu bilgilere göre, saç uzunluğu en kısa olan kimdir? Simge, Rüya ve Yağmur'un saç uzunluklarını en kısa olandan en uzun olana göre sıralayınız. Cevabınızı açıklayınız.

Rüya, Yağmur, Simge

Yağmurun saçını sıfır olarak alırsak Simgenin +4, Rüyanın ise −3 olduğu için yukarıdaki sıralama ortaya çıkıyor.

Figure 4. Answer of participant 92 to Item 1

As can be seen in the participant's answer, Participant 92 ordered the girls' hair lengths from the shortest to the longest correctly. Rüya's hair length is the shortest; Simge's hair length is the longest according to the student's answer.

In the question 2, students were asked to express the numbers of the elevator buttons which were pressed by Ayşe and the nurse. Ayşe pressed -4 and the nurse pressed -3, which are the correct answers to this question. Students' answers were analyzed according to the rubric presented below.

Table 3. Rubric for question 1

Scores	**Answer Types**
0	No answer/ Had no mathematical understanding
1	Ordered buttons incorrectly
2	Ordered some buttons correctly but some incorrectly
3	Ordered some buttons correctly but some were not evaluated
4	Ordered buttons correctly but without explanations or with inappropriate explanations
5	Ordered buttons correctly but had limited mathematical knowledge
6	Ordered buttons correctly with an acceptable explanation

To summarize, students' answers were coded as 1 and 2 if their answers were wrong and their answers were coded as 3, 4, 5 and 6 if their answers were correct.

The results obtained from the analyses of the answers are presented in Table 4.

Table 4. Frequency of the answers for question 2

Codes	0	47	(17.9%)
	1	83	(31.7%)
	2	11	(4.2%)
	3	6	(2.3%)
	4	45	(17.2%)
	5	5	(1.9%)
	6	65	(24.8%)
Total		262	(100.0%)

To illustrate, the correct answer of Participant 3 for item 2 is presented below:

Participant 3:

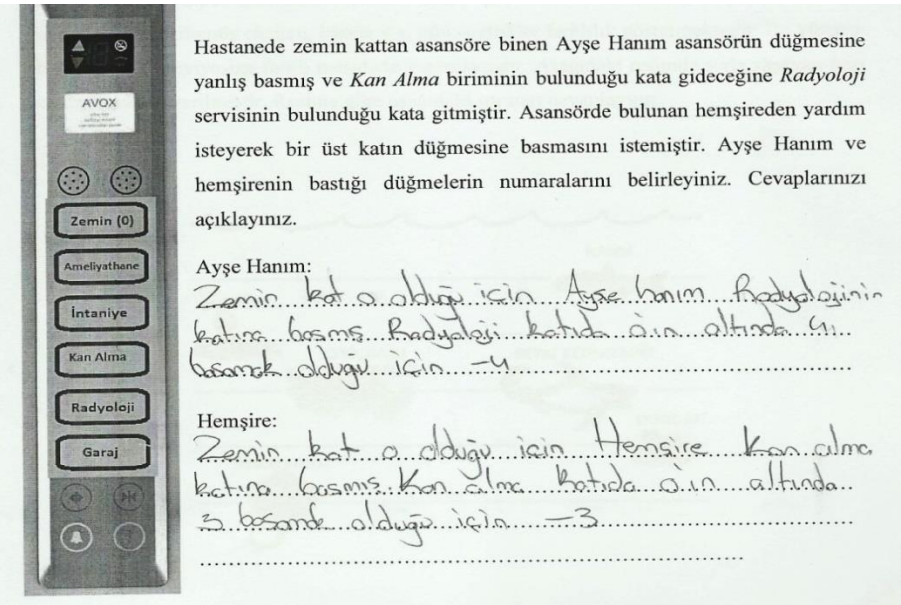

Figure 5. Answer of participant 3 to Item 2

As can be seen in the participant's answer, Participant 3 expressed the numbers of the elevator buttons as Ayşe pressing -4 and the nurse pressing -3.

Conclusion

To address the research question, the achievement levels of students in ordering of integers investigated. This high achievement level of students might be due to their experiences in the three understandings of number; namely, an ordinal, a cardinal, and a formal understanding of number (Bishop et al., 2013; Clements & Sarama, 2007). In more detail, students have experience related to cardinality of numbers so this experience might help students to identify integers. Another reason of the high achievement level of students might be due to their internal representations regarding negative numbers before they receive formal school instruction on negative integers (Peled, Mukhopadhyay & Resnick, 1988). In other words, before students learn the concept of integer in the school, they hold some information and experience related to negative numbers.

According to the results of middle school sixth grade students' answers to the ordering questions, it was found that nearly two third of them correctly answered ordering questions 1 and nearly half of them correctly answered ordering questions 2. More specifically, the number of students who answered ordering question 1 correctly was 172 out of 269. For ordering question 2, 121 students among 269 students answered the question correctly. A reason of this finding may be the case that students learn counting and reasoning about smaller and greater, children experienced ordering, initially (Bishop et al., 2013). In other words, they used to order reasoning about smaller and greater. However, reasoning about greater and smaller with negative numbers is difficult for students when the findings of İşgüden (2008) are taken into account. Students still think that the way to compare two negative numbers is the same as the way to compare two positive integers (Julie et al., 2013). This erroneous way of thinking might be the reason why the achievement level of students in the ordering questions was not high. To be more specific, the moderate achievement level of students in ordering question 1 may derive from students' reasoning about smaller and greater because many of the students solved these questions using the strategy of comparing instead of representing each hair length as an integer and then ordering these integers. As mentioned previously, students learn to reason about smaller and greater in early grades (Bishop, 2013 et al., 2013). The reason underlying the moderate achievement level of students in ordering question 2 might be students' challenges in understanding gradual parts of the question. In more detail, students have to answer the first part of the question before they answer the second part of the question.

Recommendations

Findings of the present study were limited with two questions of the questionnaire since when different questions were asked related to the concept of ordering integers, different findings could be reached. Furthermore, a similar study might be conducted in private schools to investigate private middle school students' understandings regarding the concept of ordering integers. Some recommendations might be made considering the sample of the study. In order to generalize the findings of the study to a population, the same study could be replicated with a

sample randomly selected from nationwide schools in such a way that the sample would be representative of all sixth grade students in Turkey.

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