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Mental Images of Middle School Sixth and Eighth Grade Students about the Concept of Decimal Number[i]

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Abstract In this study, it was aimed to reveal the ideas of the secondary sixth and eighth grade students about the concept of decimal via mental images. Moreover, within the scope of this study, the differences between the mental images of the sixth and eighth grade students about the concept of decimal number will be investigated according to their class levels. For these purposes, this study was carried out with a total of 212 students studying in the sixth and eighth classes of a state school in Bursa in the second semester of the 2016-2017 educational year. The research data was obtained as a result of the students' completing the statement of "A decimal number looks like a/an … because it …" As a result of the analyses, it was observed that the participant sixth and eighth grade students created a total of 162 valid mental images in relation to the concept of decimal. From these analyses, it was understood that the students perceived the decimal as equivalent to such different concepts as ball, pastry, money, etc. The mental images created by the participant sixth and eighth grade students in relation to the concept of decimal were gathered and evaluated under the categories of *complexity, roundability, phased progressiveness, additivity, subtractability, multipliability, divisibility, solvability* and *other* of decimals.

Keywords Mathematics, Decimal Number, Mental Image

1. Introduction

In life under the increasing effect of science and technology, the importance of mathematics is great. Although daily living occupations have existed in humans' lives since very old times, mathematics is an effective means of daily life in such areas of life as art, science, industry and agriculture [1]. So it can be said that the way of presenting mathematics is important in the positive or negative judgment developed by individual [2]. Hence, mathematics has an important role in every area of life. Mathematics can be explained as "a system composed of ideas and relations developed as the process of consecutive abstractions and generalizations" [3]. Mathematics can be possible through concepts' being meaningful and useful, these concepts' being acquired through associating with one another and transferring to daily life. However, this does not take place easily for some mathematical concepts and one of the reasons is individuals. There are many factors affecting educational achievements of individuals. We can mention metaphoric perception at this point [4].

The concept of decimal, too, appears as one of the most difficult and complex subjects taught at primary and secondary stages. In this scope, there are problems especially in relation to students' conceptual learning of decimal representations [5, 6, 7]. In this scope, in many of previous studies [1, 5, 8, 9, 10, 11, 12], it was reported that the students had many misconceptions about the decimal for the primary and secondary mathematics.

Of these studies, as a result of the one of the research [5] carried out with the aim of determining the fourth and the fifth grade students' misconceptions and mistakes about decimal representations, it was reported that the students had misconceptions of disregarding the decimal, dividend-focused thinking, opposite thinking, long system thought, denominator-focused thinking, thought of column exceeding and bilateral thinking. As a result of a study [8], it was found that the ninth grade students had many misconceptions about repeating decimals such as overgeneralization, misexperience and limited perception. Bell and Baki [9] found in their study that the high school students had such misconceptions about decimals as understanding digit values, ranking decimals, density of decimals, effect of multiplication and division on numbers, establishing relationships between fractions and decimal fractions and interpretation of units not included in the decimal system. Moreover, as a result of a different study

[10] carried out with the aim of revealing the seventh and eighth grade students' misconceptions and mistakes about the decimal representation, it was determined that the participants secondary students had different misconceptions such as inability to understand the meaning of the decimal, thinking that multi-digit decimals are smaller, thinking that multi-digit decimals are bigger, not regarding zero as a digit value and thinking that zero does not have a meaning. Moreover, in this study, it was found that the students had such misconceptions as naming the digits on the fraction side of a decimal incorrectly, assuming that zero makes a number smaller, disregarding the comma of a decimal, perceiving the comma of a decimal as a separate separating two different numbers and inability to comprehend the relationship between fractions and decimals. A study was carried out with the aim of investigating if the students perceived how many decimals were included at the same time in the group when a group of decimals were represented in tables and graphs and if there was a difference between their perception durations of the biggest of these decimals. As a result of the study, it was found that when decimals were represented in graphs, the students perceived how many numbers were included at the same time in the group and they perceived the biggest one in a shorter time [11]. Moreover, in a study, it was determined the primary education seventh and eighth grade students' misconceptions about decimals. In this scope, it was reported that the students had different misconceptions about the comparison of decimals (e.g., a decimal with more digits on the decimal part is bigger) and the multiplication of decimals (the result of a multiplication is always bigger than multipliers, as it is in natural numbers) [1].

The findings obtained in these studies that the students had many misconceptions about the concept of decimal number indicate that students have difficulty in making sense of and using the concept of decimal number. One of the important reasons of this difficulty is the perception and statement of decimal numbers differently from whole and natural numbers because of their many characteristics. Revealing and changing this perception can be possible through mental images. Mental images (metaphors) are powerful mental tools structuring, guiding and controlling thoughts which students can use to understand an abstract and difficult-to-understand phenomenon [13]. They are especially powerful in the understanding and explaining educators' practices [14]. Moreover, learning the unknown, keeping what is learned in mind and remembering when necessary is possible through these mental tools [15]. Metaphors explain abstract principles over concrete examples [7]. A mental image covers the explanation of a concept, a phenomenon or an event by likening it to another concept, phenomenon or event [16]. Hence, in math learning, secondary school students' metaphorizing the newly-learned concept of decimal number allow for making sense of new information concretely. In the literature review, a similar study made on this subject cannot be found. For this reason, in this study, it was aimed to reveal secondary school sixth and eighth grade students' ideas/thoughts about the concept of decimal number through mental images. With this aim, answers were sought to the following research questions:

1) What are the mental images created by the secondary school sixth grade students about the concept of decimal?
2) What are the mental images created by the secondary school eighth grade students about the concept of decimal?
3) Under which groups can the mental images created by the sixth grade students about the concept of decimal be gathered according to their shared characteristics?
4) Under which groups can the mental images created by the eighth grade students about the concept of decimal be gathered according to their shared characteristics?
5) Do the mental images created by the secondary school students about the concept of decimal differ according to class level?

2. Materials and Methods

In this section, detailed information will be given about the students participating in this study prepared with the aim of revealing secondary school sixth and eighth grade students' mental images about decimals, the research model, the data collection tools, the data collection and analysis methods.

2.1. Research Model

In this study, the “phenomenological” design, one of the qualitative research designs, was used. Phenomenological studies allow for focusing on phenomena of which individuals are aware but they do not have a deep understanding and describing the world researched via the learner's viewpoint [17]. In this study, too, because of the examination of the secondary sixth and eighth grade students' mental images about decimals, this model giving the opportunity to reveal the students' viewpoints and understandings of the concept of decimals was used in the study.

2.2. Participants

The participants of this study were the 212 sixth and eighth grade students taking education in a middle school (Selcuk Hatun Secondary School) in Bursa in the second semester of the 2016-2017 educational year. In the following table, detailed information was given about the participant students.

Table 1. Information about the Participants of the Study

	Sixth grade		Eighth grade		All	
	f	%	f	%	f	%
Female	53	25.00	54	25.47	107	50.47
Male	55	25.94	50	23.59	105	49.53
Total	108	50.94	104	49.06	212	100.00

As it is understood from the data, 50.47% of the participant students were female and 49.53% were male. Moreover, from the analyses, it is observed that more than half of the students (56.94%) were the sixth graders.

2.3. Data Collection Tools and Collection of Data

The data of the study was collected by using the "Metaphors for Decimals Questionnaire" prepared by the researcher. The first section of the questionnaire includes information about the names, surnames and class levels of the students. In the second section of the questionnaire, there is a statement to be completed by the students read as "A decimal looks like a/an …. because it ….". The data of this study was collected by administering this questionnaire to 212 sixth and eighth grade students taking education in a secondary school in Bursa. At this stage, in the first gap of the second section of the questionnaire, the students were asked to write a metaphor about decimal numbers and in the second gap, they were asked to write in detailed the reasons why they wrote that metaphor. The students completed this questionnaire within about 20 minutes.

2.4. Data Analysis

The sets of data obtained as a result of the administrations carried out within the scope of this study were evaluated through the content analysis method.

In the content analysis, firstly sets of data are conceptualized, then they are grouped according to these concepts and finally, starting from here, themes are determined for research data in the light of these groups.

In this scope, the sets of research data were analyzed by carrying out the stages of *coding of data, coding of themes, arrangement and description of data according to codes and themes* [16]. Procedures to be used in the content analysis may differ according to the purpose of an analysis and the kind of material to be analyzed. In this study, in the analysis and interpretation of the obtained data, firstly the mental images which the participant sixth and eighth grade students created in relation to the concept of decimal number. Then, the mental images were separately examined at each class level and grouped according to their shared characteristics. The points having taken into consideration when grouping the obtained metaphors were the source of the created metaphor and the sub-theme under which thoughts and discourses attributed from the source of the metaphor to its subject were gathered. For example, the source of the metaphor stated as "decimal numbers look like human brain because they are complex" was determined as the "human brain" and the thought attributed to decimal numbers was determined as *complexity*. Some metaphors having determined as insignificant and not served the purpose of the study were taken within the scope of the study. At this stage, as a result of the analyses, *nine* different sub-themes/groups, namely the *complexity, phased progressiveness, roundability, solvability, additivity, subtractability, multipliability, divisibility* and *other* characteristics of *decimal numbers*. In this process, it was paid attention to the abstraction process of the concept to give these sub-themes. Following this, the third and fourth research problems allowing for the obtaining of an important part of the research data composed the most general two themes. After that, the research findings were interpreted by using these themes, sub-themes and codes.

The research data was analyzed by using *categorical analysis* and *frequency analysis* made via Excel. In these analyses, the codes and the sub-themes obtained within the scope of the study were reduced to numbers after the above-mentioned processes. Hence, the reliability of the study tried to be achieved and its subjectivity tried to be decreased. Moreover, when writing the reports in relation to the research findings, attention was paid to make the research data *reasonable, appropriate to individuals' experiences, plausibility, importance* and *legibility*.

3. Results

In this section, mental images which the sixth and eighth grade students had in relation to the concept of decimal number were analyzed and interpreted within the context of the research problems taken within the scope of the study. In this scope, the participant sixth and eighth grade students (212 students) created a total of 162 valid mental images about the concept of decimal number. These mental images were presented in the light of the determined research problems.

3.1. Mental Images of the Students about Decimal

The first problem determined within the scope of the study was stated as "What are the mental images created by the sixth grade students about the concept of decimal?" The mental images created by the sixth grade students in relation to this research problem were given in Table 2.

Table 2. Mental Images of the Sixth Grade Students

	Mental Image	f		Mental Image	f
1	Ball	5	30	Tangerine	1
2	Pastry	4	31	Road	1
3	Apple	3	32	Shoe	1
4	Eraser	3	33	Human	1
5	Colliding vehicle	3	34	Goalkeeper	1
6	Pizza	2	35	Pencil	1
7	Orange	2	36	Friend	1
8	Change	2	37	Things in a mess	1
9	Bread	2	38	Tomato	1
10	Cake	2	39	Marbles	1
11	Jigsaw	2	40	Book	1
12	Messy room	2	41	Litter	1
13	Toy	1	42	Lesson	1
14	Abacus	1	43	Bird	1
15	Housewife	1	44	Fruit	1
16	Train	1	45	Ladder	1
17	Roll	1	46	Skateboard	1
18	Hair	1	47	Washing Machine	1
19	Film	1	48	Knot	1
20	Numeral Lottery	1	49	Enemy	1
21	Rubber	1	50	Rock	1
22	Slap	1	51	Mixed Kebab	1
23	Bead	1	52	Full Bread	1
24	Marble	1	53	Mail	1
25	Ice-Cream	1	54	Lemon	1
26	Number-*	1	55	Chewing Gum	1
27	Curly Hair	1	56	Water Melon	1
28	Lightning	1	57	Knife	1
29	Potato	1			

In the analyses, it was observed that the participant students created 57 different metaphors about the concept of decimal. The total number of metaphors created by the students was determined as 77. It was understood that the students mostly created the mental images of “ball”, “pastry”, “apple”, “eraser” and “colliding car”.

The second problem was stated as “What are the mental images created by the eighth grade students in relation to the concept of decimal?” and the findings obtained; in other words, the images created by the eighth grade students about the decimal were presented below.

In the analyses, it was observed that the participant eighth grade students created 71 different metaphors about the decimal number. It was also determined that the eighth grade students created a total number of 86 metaphors. It was also understood that these students stated mostly the mental images of “wheel”, “apple”, “cake”, “pastry” and "bowling ball". Moreover, the metaphors created by the participant eighth grade students such as “ball”, “money”, “hair” and “car” are among the metaphors which they created mostly in relation to the concept of decimal number.

Table 3. Mental Images of the Eighth Grade Students

	Mental Image	f		Mental Image	f
1	Tire	4	37	Electricity	1
2	Apple	3	38	Lightning	1
3	Cake	3	39	Human	1
4	Pastry	3	40	Rope	1
5	Bowling Ball	2	41	Clothes	1
6	Ball	2	42	Coal	1
7	Change	2	43	Cell	1
8	Hair	2	44	Laundry	1
9	Car	2	45	Stain	1
10	Fruit	2	46	Shoe	1
11	Stone	2	47	Eye-glasses	1
12	Thunderbolt	1	48	Nail Polish	1
13	Problem	1	49	Treadmill	1
14	Fractions	1	50	Screw	1
15	Chocolate	1	51	Armchair	1
16	Steering Wheel	1	52	Orange	1
17	Jigsaw	1	53	Marbles	1
18	Water Melon	1	54	Magnet	1
19	Toys in a mess	1	55	Clock	1
20	Heart	1	56	Circle	1
21	Tangerine	1	57	Room	1
22	Meal	1	58	Law	1
23	Things in a mess	1	59	Panda	1
24	Friend	1	60	Bottle Cap	1
25	Tomato	1	61	Pi Number	1
26	Things in the closet	1	62	Brain box	1
27	Even Account	1	63	Bleach	1
29	Installation Pipes	1	64	Eternity	1
30	Special meal	1	65	Equation	1
31	Fabric	1	66	Problem	1
32	Ball of String	1	67	Litter	1
33	Sugared Water	1	68	Plum	1
34	WhatsApp Friend	1	69	Slide	1
35	Player in the Game	1	70	Book	1
36	Google Translation	1	71	Walnut	1

That the frequency of the mental images/metaphors obtained within the scope of the study changed between 1 and 11 was understood as a result of the analyses. In this scope, when the mental images created by the participant sixth and eighth grade students about the concept of decimal number were examined together, it was found that these participant students mostly used the mental images of “ball” (7 students), “pastry” (7 students), “apple” (6 students). Moreover, similarly, the mental images of “cake” (5 students and “change” (4 students) were also included among the mental images mostly used by the participant students.

3.2. Groups related to the Mental Images of the Students

The third research problem was stated as “Under which

groups can the mental images created by the sixth grade students about decimal numbers be gathered according to their shared characteristics?" In this scope, the valid mental images created by the sixth grade students were separately examined and grouped according to their shared characteristics. At this stage, the mental images of the students were gathered under *nine* different sub-themes/groups, namely the *complexity, phased progressiveness, roundability, solvability, additivity, subtractability, multipliability, divisibility* and *other of the decimal number*. In the tables given below, the mental images included in these groups and the descriptive analysis results belonging to these mental images were given.

Table 4. The Mental Images Created by the Sixth Grade Students in relation to the *Complexity, Phased Progressiveness and Roundability*

Complexity		Progressiveness		Roundability	
Metaphor	f	Metaphor	f	Metaphor	f
Jigsaw	2	Abacus	1	Ball	5
Road	1	Housewife	1	Change	2
Curly Hair	1	Train	1	Bead	1
Human	1	Book	1	Marble	1
Mixed Kebab	1	Lesson	1	Rock	1
		Ladder	1	Goalkeeper	1
		Film	1		
		Skateboard	1		
Total	6	Total	8	Total	11

In the light of the findings obtained from the above-given table, it was understood that the participant sixth grade students mostly created the mental image of "jigsaw" under the sub-theme of *complexity*; similarly, they mostly created the mental images of "ball" and "change" under the sub-theme of *roundability*. Likewise, the students created such different mental images as "abacus", "housewife" and "train" under the sub-theme of *phased progressiveness*.

Table 5. Mental Images Created by the Sixth Grade Students about the *Additivity, Divisibility* and *Other* categories of Decimals

Additivity		Divisibility		Other	
Metaphor	f	Metaphor	f	Metaphor	f
Messy room	2	Pastry	4	Watermelon	1
Toy	1	Apple	3	Ice-cream	1
Number	1	Eraser	3	Numeral Lottery	1
Things in a mess	1	Pizza	2	Knife	1
Marbles	1	Orange	2	Bird	1
Litter	1	Bread	2	Washing Mach.	1
Enemy	1	Cake	2		
		Train	1		
		Fruit	1		
		E-mail	1		
		Potato	1		
		Lemon	1		
		Tangerine	1		
		Pencil	1		
		Rubber	1		
		Roll	1		
		Tomato	1		
Total	8	Total	28	Total	6

In the above-given table, it was understood that the participant sixth grade students mostly created the mental image of "messy room" under the sub-theme of *additivity* and the mental images of "pastry", "apple" and "eraser" under the sub-theme of *divisibility*.

Table 6. Mental Images Created by the Sixth Grade Students in relation to the *Subtractability, Solvability* and *Multipliability* of Decimals

Subtractability		Multipliability		Solvability	
Metaphor	f	Metaphor	f	Metaphor	f
Chewing Gum	1	Colliding vehicle	3	Hair	1
		Slap	1	Shoe	1
		Friend	1	Knot	1
		Lightning	1		
Total	1	Total	6	Total	3

As it is seen from Table 6, the participant sixth grade students mostly created the mental image of "colliding vehicle" under the sub-theme of *multipliability*. Similarly, they created the mental image of "chewing gum" under the sub-theme of *subtractability* and the mental images of "hair", "shoe" and "knot" under the sub-theme of *solvability*.

The fourth research problem was stated as "Under which groups can the mental images created by the eighth grade students about decimals be gathered according to their common characteristics?" In this scope, similar to the mental images of the sixth grade students, the valid mental images created by the eighth grade students were separately examined and grouped according to their shared characteristics. At this stage, the eighth grade students' mental images, as it was the case in the sixth grade students, were gathered under *eighth* different themes/groups, namely the *complexity, phased progressiveness, roundability, solvability, additivity, subtractability, multipliability, divisibility* and *other of the decimal*. In the tables below, the mental images included in these groups and the descriptive analysis results belonging to these mental images were given.

Table 7. Mental Images Created by the Eighth Grade Students in relation to the *Complexity*, *Phased Progressivity* and *Divisibility*

Complexity		Progressivity		Divisibility	
Metaphor	f	Metaphor	f	Metaphor	f
Fractions	1	Clock	1	Pastry	3
Meal	1	Eternity	1	Cake	3
				Apple	3
				Tangerine	1
				Chocolate	1
				Heart	1
				Jigsaw	1
				Watermelon	1
				Cell	1
Total	2	Total	2	Total	15

As it is seen from the above-given table, the participant eighth grade students created the mental images of "meal",

"fractions" under the sub-theme of *complexity* and the mental images of "clock" and "eternity" under the sub-theme of *phased progressiveness*. Moreover, as a result of the analyses, it was observed that the eighth grade students mostly created the mental images of "pastry", "apple" and "cake" from among the mental images grouped within the scope of the sub-theme of *divisibility*.

Table 8. Mental Images Created by the Eighth Grade Students in relation to the *Additivity, Subtractability* and *Roundability* of Decimals

Additivity		Subtractability		Roundability	
Metaphor	f	Metaphor	f	Metaphor	f
Hair	2	Coal	1	Wheel	4
Room	1	Stain	1	Bowling Ball	2
Toys in a mess	1	Shoe	1	Ball	1
Things in mess	1	Eye-glasses	1	Orange	1
Book	1	Nail-polisher	1	Marbles	1
Friend	1	Human	1	Stone	1
Tomato	1	Screw	1	EvenAccount	1
Walnut	1	Toys Player	1	Circle	1
Plum	1	WhatsApp friend	1	Ball ofString	1
Apple	1	Clothes in closet	1	Law	1
Magnet	1			Panda	1
Fruit	1			Bottle Cap	1
Fabric	1				
Stone	1				
Litter	1				
Total	16	Total	10	Total	16

The findings obtained from the above-given table indicate that the participant eighth grade students mostly created the mental image of "hair" under the sub-theme of *additivity*. Similarly, from the analyses, it was also understood that the eighth grade students mostly created the mental images of "wheel" and "bowling ball" under the sub-theme of *roundability*.

Table 9. Mental Images Created by the Eighth Grade Students in relation to the of *Solvability, Multipliability* and *Other* Sub-Themes of Decimals

Multipliability		Solvability		Other	
Metaphor	f	Metaphor	f	Metaphor	f
Car	2	Problem	1	Clothes	1
Thunderbolt	1	Pi Number	1	Slide	1
Elektricity	1	Brain box	1	Laundry	1
Lightning	1	Bleach	1	GoogleTransl.	1
Human	1	SugaredWater	1	Install. Pipes	1
		Equation	1	Armchair	1
		Rope	1	Treadmill	1
		Problem	1	SteeringWheel	1
				Special meal	1
				Fruit	1
Total	6	Total	8	Total	10

Moreover, it was understood from the information included in this section that the participant students created mostly the mental image of "car" under the sub-theme of *multipliability*. Similarly, it was also observed that these students created different metaphors such as "problem", "pi number", "brain box" under the sub-theme of *solvability*.

3.1. Differences between the Mental Images of the Sixth and Eighth Grade Students about Decimals

The fifth research problem included within the scope of this study was stated as "Do mental images created by the secondary school students about decimal numbers differ according to class level?" The mental images/metaphors created by the sixth and eighth grade students in relation to this research problem were evaluated by comparing within the context of seven different categories determined within the scope of the study. The obtained sets of data were presented in tables below.

Table 10. Descriptive Analysis Results in relation to the Comparison of the Mental Images of the Sixth and Eighth Grade Students

	Sixth G.	Eighth G.	All
Sub-Themes/Groups	f	f	f
Divisibility	28	15	43
Roundability	11	16	27
Phased Progressivity	8	2	10
Additivity	8	16	24
Complexity	6	2	8
Multipliability	6	6	12
Solvability	3	8	11
Subtractability	1	10	11
Other	6	10	16
Total	77	85	162

In the analyses, it was found that while the mental image sub-theme/groups which the sixth grade students (36.35%) created mostly was related to *divisibility*, the one which the eighth grade students (18.87%) created mostly was related to *additivity* and *roundability*. It was also found that while the sub-themes/groups about which the sixth grade students created most mental images were determined as *roundability* (14.28%), *phased progressivity* (10.40%) and *additivity* (10.38%), the ones about which the eighth grade students created most mental images were *divisibility* (17.46%), *roundability* (18.87%) and *additivity* (18.87%). However, it was determined that while the sub-themes/groups about which the sixth grade students created least mental images were *subtractability* (1.30%) and *solvability* (3.90%), the ones about which the eighth grade students created least mental images were *complexity (*2.35%) and *phased progressiveness* (2.35%).

The most important difference between the sub-themes/ groups including the mental images of the participant sixth grade students in relation to the concept of decimal number and the ones including the mental images of the eighth grade students in relation to this concept was observed in the sub-themes of *subtractability* (1.30% and 11.80% respectively) and *divisibility* (36.35% and 17.46%

respectively). When these differences were examined, it was determined that while the eighth grade students created more metaphors related to the *subtractability* sub-theme, the sixth grade students created more metaphors in relation to *divisibility* sub-theme related to the concept of decimal number.

Moreover, when the mental images created by all the participant students in relation to the concept of decimal number were examined, it was observed that more than half of the sixth and the eighth grade students (53.81%) explained the decimal number with mental images included in the sub-theme of *divisibility*. Moreover, it was understood that the other metaphors created by these students mostly gathered under the sub-themes of *roundability* (33.15%) and *additivity* (29.25%).

4. Conclusions and Suggestions

In this study carried out with the aim of revealing the secondary school sixth grade students' thoughts about the concept of "decimal number" by means of metaphors, it was understood from the findings that the participant secondary school students created a total of 162 mental images in relation to the decimal number. 77 of these mental images were created by the sixth grade students and 85 were created by the eighth grade students.

In this study, these mental images/metaphors created by the participant students about the concept of decimal number were grouped under *nine* different sub-theme/groups. These sub-themes were the *complexity, phased progressiveness, roundability, solvability, additivity, subtractability, multipliability, divisibility* and *other of the decimal number*. When these themes were examined, it was observed that an important part of the metaphors created by the secondary school students within the scope of this study were related to the sub-theme of *divisibility*. In other words, the participant students metaphorized decimal numbers generally by using their divisibility characteristic. Besides this sub-theme, the sub-themes of *roundability* and *additivity* were found as the themes for which a lot of mental images were created. In other words, in addition to their divisibility characteristic, it was also found that the participant students created most mental images in relation to the additivity and roundability characteristics of decimal numbers. When their class levels were taken into consideration separately, it was observed that while the sixth grade students emphasized mostly the mental images related to the sub-themes of *divisibility* and *roundability*, the eighth grade students emphasized mostly the mental images related to the sub-themes of *additivity, roundability* and *divisibility*. In both classes, it is attracting attention that the students made the most emphasis on the sub-theme of *divisibility*. This finding indicates that the participant students emphasized mostly the divisibility aspect of the decimal number. As a result, more than half of the participant secondary school students explained the concept of decimal number with the metaphors/mental images included in these sub-themes. This points to the fact that these students understood the concept of decimal number correctly and internalized it.

The mental images of all the participant students about the decimal number emphasized the *divisibility, additivity* and *roundability* characteristics and subsequently the *multipliability, subtractability* and *solvability* characteristics of decimal numbers. Again this indicates that the participant students were knowledgeable of this concept. It is seen in this study that examples used when teaching decimal numbers in the classroom affect students. For this reason, using examples from daily life may make the teaching of this concept more effective and learning more permanent. However, a part of the participant students used mental images emphasizing the complexity of decimal numbers. These negative metaphors/images created by these students point to the fact that some students have negative viewpoints about decimal numbers. With modifications to be made during the learning process, this negative viewpoint can be changed. This research indicated that the participants found decimal number complex and gave different metaphors about the applications and solutions on decimal numbers. It is required to give more importance in education and organize different teaching or learning methods about the decimal concept.

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