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An Invesatigation of 5th and 6th Grade Students' Success Rates in Solving Fraction Problems Having Different Representation Formats

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Abstract

Previous studies show that students have problems with fractions. This reason was seen important make a study that related with the fractions and representation forms. The aim of this study is to investigate 5th and 6th grade students' achievement of solving fraction problems according to their representation styles in the topic of operations with fractions and to reveal ideas of the students about fraction problems according to their representation forms. A mixed method composed of quantitative and qualitative techniques was used in this research. Firstly, the quantitative data was analyzed, and then, the qualitative data was collected by interviewing with the prospective teachers in order to retrieve detailed information from them about the tests prepared according to representation types of fractions and the answers they gave to the questions placed in these tests and to support quantitative findings. "Verbal Representation Test (VERT)", "Visual Representation Test (VIRT)" and "Symbolic Representation Test (SRT)", including 4 questions and developed by the researchers, were used as quantitative data collection tools. The study was conducted with 127 students at 5th and 6th grades of a state school in Bolu-Turkey, in the academic years of 2013-2014. As a result of data analysis, it was found that the means of 6th grade students were higher than that of 5th grade students in all representation forms of problems. When the differences between achievements of the tests were examined, the difference in the symbolic test was only found to be significant. It appeared that there was a positive and significant relationship between the achievements of students in solving fraction problems presented in different representation styles. These results show that the performances of students were affected by the different representation forms.

Keywords: fractions, addition with fractions, subtraction and multiplication, verbal-visual-symbolic representation, mathematics education

INTRODUCTION

The concept of natural numbers is presented to students in elementary school. Additionally; the concept of fractions, despite not a set of numbers, is taught to students in order to make an introduction to rational numbers. From the beginning of elementary school, students begin to learn what a fraction means. Towards the upper grades, fractions with different denominators, comparison and sorting in fractions, and additions, subtractions and multiplications with fractions are learnt. Examining 1st- 4th grade gains in the Primary School Mathematics Curriculum (1-5. Classes) (Ministry of Education, [IMDOP], 2009), it can be said that rational numbers are taught earlier than integers due to the presentation of the concept of fragments. This is because students are more likely to encounter with fractions and rational numbers in everyday life and in the events around them (Altun, 2002).

The word 'Fraction', in the Glossary of Turkish Language Institution, is described as 'a number expressing one or more equal parts of a divided unit" (TDK, 2014). Fractions are used to show fragmental amounts and are quite different from cardinal numbers. While natural numbers answer the question "How many?", fractions give answer to the question "How much?". Furthermore, fractions cannot be obtained by counting (Toluk and Olkun, 2002). Therefore, for elementary school students especially focusing on making operations with counting and natural numbers, fractions seem to be a highly complex and difficult issue (Charalambos and Pitta-Pantazi, 2005). It is stated that the issues encountered here not only arise from the use of different approaches in teaching the concept of fractions but also from the structure of the fractions (Aytekin, 2012; Behr, Harel, Post and Lesh, 1993; Ertuna, 2013). In addition to the students, teacher candidates are experiencing certain difficulties in the concept of fractions as well. In a study conducted on mathematics and classroom teachers; teacher candidates' pedagogical content knowledge related to natural numbers was found to be higher than their

pedagogical content knowledge related to fractions (Şahin, Gökkurt, Başıbüyük, Erdem, Nergiz and Soylu, 2013).

Starting from this point of view; as students understand fractions and rational numbers better, they can deal with real-life problems and situations more easily and understand such problems and situations better (Post, Behr and Lesh, 1982). Mathematics curriculums aim to enable students to use their own thinking and reasoning in the problem solving process and to develop problem-solving strategies and adapt them to mathematical problems and daily life problems. Therefore, students' problem-solving skills are located at the beginning of the skills that need improvement irrespective of mathematical concepts. 'Fractions and operations with fractions' located under the subject area of learning "Numbers and Operations" is one of the mathematical issues in which students need to have this skill. It is seen that different types of problems, problem structures, and display format of the problem are focused on the studies referring to the process of problem-solving. It is stated, examining the studies related to the representation format of problems, that there are four different types of representation formats as; pure mathematical representation, verbal representation, visual representation and mixed representation (Yan and Lianghuo, 2006).

The concept of representation is one of the very important psychological concepts that is used in mathematics education to explain some important facts about the children's way of thinking. Representation is making a copy of the outside world as a skill of the mind, or people's making individual products from their own perspectives (Radford, 2001). In recent years with the use of available technology; multiple representation approach in mathematics education offers significant advantages. The multiple representation approach, which can be defined as the expression of a mathematical concept of relationship in various ways, is used and recommended by many educators. The multiple representation approach is an important factor affecting the teaching and learning of mathematics. This approach can be thought as presenting a mathematical relationship, concept or rule in verbal way, with graphs, tables or algebraic symbols (Durmuş and Yaman, 2005).

Representation methods such as numeric, graphical, verbal and notational etc. can provide a very important contribution in facilitating learning. Presentation of such different representations can help students in the transitional stage from a representation specific the subject area to another representation of the same information, and in the process of understanding the subject and problem solving. Using different representations in the understanding of the concept and its associated elements, and in making abstract facts more concrete by comprehending the relationship between these elements increases the effectiveness of learning/teaching activities (Siegler and Jenkins, 1989).

Especially considering the concepts of fractions and rational numbers; four different formats of representation including verbal, symbolic, objective and model-related, including emerge. Making a transition between these representations, the subject matter can be understood by the students better. In some studies conducted on elementary school students, it is emphasized that they have difficulty in switching between different representations of fractions and rational numbers, that they generalized the rules in a wrong way during the operations and have difficulty in making comparisons. These studies relate the reason for the hardship in learning to the introduction of rules, formula and relationship as is by teachers and to encouraging the rote learning (Haser and Ubuz, 2002; Şiap and Duru, 2004).

In order to achieve a conceptual understanding in fractions and rational numbers, which form the basis for the other subjects of mathematics, different representation formats should be emphasized (Vergnaud, 1983). It has been shown that students have difficulty in solving the problems or in calculations related to fractions, in the representation of fractions or the representations they use while making comparisons of and ordering fractions (Kılıç and Özdaş, 2010; Olkun and Toluk-Uçar, 2007; Soylu and Soylu, 2005; Watanabe, 2002). Therefore, it is important to investigate how student achievement changes when fraction problems are presented in different forms. Due to these reasons, the present study aims to investigate the 5th and 6th graders' achievement level of solving fraction problems depending on the representation form in the subject matter of fractional operations and to reveal their thoughts on the answers they give to each problem in each test in terms of the representation form. For this purpose, answers have been sought for the following problems.

1. Is there a significant difference between VERT, VIRT, SRT scores of fraction problems in terms of the grade levels of the students?
2. Is there a significant relationship between the VERT, VIRT, SRT scores of the students?
3. What are the thoughts of the students about their responses to each test and the questions in these tests?

Limitations should be considered when assessing the utility of the data obtained from this study. First, participants for this study were limited to 5^{th} and 6^{th} grade elementary school students. Second, the participants' cognitive, physiological and personality

factors may affect their study habits, performance and learning styles.

METHOD

The Pattern of the Study

A combined technique in which quantitative and qualitative methods are included together has been used in this study. First, quantitative data were collected and analysed and then qualitative data were collected in order to gather in-depth information related to the fractional problem solving processes of the students and to support the quantitative findings. This combined method is called "explanatory pattern". The reason for choosing this design is the need to support the data collected from the research through a quantitative method with a qualitative method. The stages of explanatory pattern is seen in Figure 1 (Creswell and Clark, 2007, p.71-74; Fraenkel and Wallen, 2006, p.443).

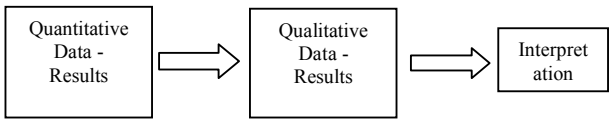


Figure 1. Stages of explanatory pattern

In the first part of the study, the participants were asked to solve fractional problems according to their representation format; the quantitative data collected from these solutions were subjected to statistical analysis. In the second part, 3 participants determined according to the results of the statistical analysis conducted were interviewed and qualitative data were collected.

Since the purpose in the quantitative part of the study was to reveal the existing situation and to describe it as it existed, a screening method was used (Fraenkel and Wallen, 2006 p.396-397). In addition, a relational survey method was utilized due to the fact that the study also aimed to determine the presence and/or degree of exchange between the two variables. A correlation type survey method was used to evaluate the relationships of the scores that students obtained from the fraction problem test prepared according to the representation formats among themselves; and a comparison type relational survey method was used to determine whether there was a difference between the grade levels in terms of these tests (Karasar, 2005).

In the qualitative part of the study, after the completion of the fraction problem tests, according to the representation formats, the views of students on the answers they gave to the problems and on the tests were determined by a semi-structured interview technique.

Study Group

The participant-group in the quantitative part of the study consisted of all the 5th and 6th grade students (127 students) of a state school located in Bolu city centre, in which one of the researchers worked. Examining the Secondary Mathematics Course (5th-8th. Classes) Curriculum (Ministry of Education, [MEB], 2013); it is understood that ,in the 5th grades, the focus is only on the operations of addition and subtraction, but the operations of multiplication and division take place in the 6th grade. The 7th and 8th graders were not included as they progressed to rational numbers. In the qualitative part of the study, in accordance with the purpose of the research, a total of 3 students were randomly selected as participants among the ones with the highest scores from each form of the fraction problems having a different representation format. When determining the students; as it was not possible to make random-assignments if there was only one student with a high score, that student was directly selected as a participant. 1 of the 3 selected students was a 5th grader (girl - successful in VERT), and two were 6th graders (1 girl - successful in VIRT, 1 boy - successful in SRT). Semi-structured interviews were conducted with the participating students Also the participation of the students in the quantitative and qualitative part of the study was on a voluntary basis.

The distribution of the students participating in the quantitative part of the research according to grade level and gender is given in Table 1.

Table 1. Distribution of the study group according to grade level and gender

	Female		Male		Total	
	f	%	f	%	f	%
5th Grade	57	98.3	1	1.7	58	100.0
6th Grade	34	49.3	35	50.7	69	100.0
Total	91	71.7	36	28.3	127	100.0

Collection of Quantitative Data and Data Collection Tools

In this study, in which whether the achievement levels of the secondary school 5th and 6th grade students changed depending on the representation format was investigated; 3 tests, developed by the researchers, were given to the students. The tests consist of fraction problems prepared with reference to different representation formats. Based on these representation formats, fraction problems were named in 3 different ways, including; "Verbal Representation Test (VERT)", "Visual

Representation Test (VIRT)", and "Symbolic Representation Test (SRT)". In each test were four problems with the same numerical expression, but given in different representations. The data obtained from these tests were evaluated in "correct" and "incorrect" categories. The highest score that can be obtained from this test was 4, the lowest score was 0. Sample problems of these tests are given in Figure 2.

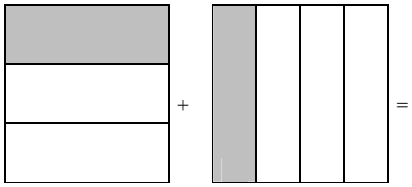
Test Type	Problems
VIRT	Find the result for the operation modelled below 
VERT	Yasemin and her friends first ate $\frac{1}{3}$ of the birthday cake, then $\frac{1}{4}$. According to this, how much of the cake did Yasemin and her friends eat?
SRT	What is the result of $\frac{1}{3}+\frac{1}{4}=$?

Figure 2. Sample problems of VERT, VIRT and SRT's

The problems in the test were prepared by reviewing the literature and taking into consideration the secondary school mathematics curriculum. To ensure the content validity of the two tests, two experts in the field of mathematics education and one assessment and evaluation expert were consulted, and a pilot study of the tests, with final versions, was applied to 86 5th and 6th grade students attending a state school in sessions on different days. After these applications, KR-20 reliability coefficients were calculated to find the reliability of the measurements on the tests. Results of K-20 were .70 for VERT, .62 for VIRT and .76 for SRT, respectively. In cases where the internal consistency coefficients are of .70 and above, the scale is considered to be reliable. However, if there are a small number of problems in the test, this limit can be considered as .60 and above (Sipahi, Yurtkoru and Çinko, 2008: 89). Due to the fact that the number of problems in each test was 4 and less, these values were considered sufficient, and test measurements reliable.

Collection of Qualitative Data

In the qualitative part of the study, students' views on VERT,VIRT and SRT, and their answers to each problem in them were discussed. Approximately 15-minute interviews were conducted with each student. These interviews were conducted one day after the test applications, and were recorded on the tape recorder. The tests solved by the students were given to them after true-false evaluation, and they were asked to express their views on these tests and the answers they gave.

Analysis of the data

Quantitative data of the study were scored after being collected with the data collection tool used. The data obtained as a result of this scoring were transferred to the computer with data forms, and a statistical analysis was performed by a statistical program. A Pearson Product-Moment Coefficient, a parametric test, was used as the scores showed a normal distribution in terms of both grade levels and overall student scores in the statistical analysis of the data; and a t-test was used for independent samples. In addition; the percentages, frequencies and standard deviations of the scores were also benefited from.

In the analysis of the qualitative data, the data obtained from the interviews with students were analysed in the framework of a qualitative research approach. Descriptive analysis method was used to analyse the data obtained from qualitative research. The data obtained from descriptive analysis are summarized and interpreted according to predetermined categories. In this analysis method, direct quotations are frequently included in order to reflect the opinions of the individuals interviewed or observed in a striking way (Yıldırım and Şimşek, 2000, p.224)

RESULTS

In this section, the results obtained from data collected during the survey by measurement tools were grouped under two headings, namely quantitative and qualitative. In the quantitative part, general statistical data of VERT, VIRT and SRT results were given primarily. In the qualitative part, the views of the students on the tests and the answers they gave to the problems were set out in the light of the results obtained from the interviews.

Quantitative Results

General Findings Related to Testing

The distribution of the students giving correct and incorrect answers to VERT, VIRT and SRT is shown in Table 2.

Table 2. Distribution of the answers students gave to the tests

VERT								
	5th Grades				**6th Grades**			
	Correct		Incorrect		Correct		Incorrect	
	f	%	f	%	f	%	f	%
S1	29	50.0	29	50.0	38	55.1	31	44.9
S2	34	58.6	24	41.4	54	78.3	15	21.7
S3	27	46.6	31	53.4	37	53.6	32	46.4
S4	28	48.3	30	51.7	38	55.1	31	44.9
SRT								
	5th Grades				**6th Grades**			
	Correct		Incorrect		Correct		Incorrect	
	f	%	f	%	f	%	f	%
S1	31	53.4	27	46.6	44	63.8	25	36.2
S2	25	43.1	33	56.9	45	65.2	24	34.8
S3	12	20.7	46	79.3	37	53.6	32	46.6
S4	30	51.7	28	48.3	37	53.6	32	46.6
VIRT								
5th Grades					**6th Grades**			
Correct			Incorrect		Correct		Incorrect	
	f	%	f	%	f	%	f	%
S1	29	50.0	29	50.0	36	52.2	32	46.4
S2	28	48.3	30	51.7	47	68.1	22	31.9
S3	10	17.2	48	82.8	29	42.0	40	58.0
S4	27	46.6	31	53.4	29	42.0	40	58.0

Examining Table 2, it is seen that 5th grade students' rate of correct answers for VERT, VIRT and SRT is approximately 50% for problems 1,2 and 4. It is understood that only about 20% of the students gave a correct answer to the problem 3 in VIRT and SRT in particular. Students are expected to be able to make comparisons using their fraction knowledge in this problem. Examining Table 2; it is seen that 6th graders' rate of correct answers for the problems in VERT and VIRT are higher than 50%. In VIRT, however, it is found that the rate of correct answers for problems 3 and 4 is below 50%.

VERT, VIRT and SRT Scores of Students in Terms of Grade Levels

First sub-problems of the research is; "Is there a significant difference between the VERT, VIRT and SRT fraction problem scores in terms of grade levels?". In order to test this sub-problem, the average and standard deviation scores of VERT, VIRT and SRT of the students in each grade level were calculated first. As the VERT, VIRT and SRT scores of 5th and 6th grade students separately showed a normal distribution, a t-test was used for independent sampling to determine the differences between grade levels (see Table 3).

Table 3. VERT, VIRT and SRT score according to grade levels

Test Type	**Grade Level**	**n**	$\bar{X}$	**s**	**t**
VERT	5th Grade	58	2.03	1.35	.127
	6th Grade	69	2.42	1.46	
VIRT	5th Grade	58	1.62	1.24	.075
	6th Grade	69	2.04	1.38	
SRT	5th Grade	58	1.69	1.40	.011*
	6th Grade	69	2.36	1.52	

* p<.05

Examining Table 3, VIRT was found to have the lowest average among the VERT, VIRT and SRT of 5th and 6th graders. Comparing the scores of students obtained from all three tests, 5th grade students were found to have lower scores than 5th graders. Additionally, whether there was a statistically significant difference between the scores of student obtained from each of the three tests was examined by a t-test for independent samples, and it was revealed that there was a statistically significant difference for SRF only. It was proved that there was no significant difference between the other tests in terms of grade levels.

Relationship between VERT, VIRT and SRT Achievements of the Students

The second sub-problem of the research is; "Is there a significant relationship between VERT, VIRT and SRT achievements of the students?". Since VERT, VIRT and SRT scores of all the students showed a normal distribution, it was determined whether there was a significant relationship between the student achievements of these tests or not by calculating

Pearson Product-moment correlation coefficients (see Table 4).

Table 4. The results of the correlation between the table and graph interpretation test scores
(n = 127)

	VERT	VIRT	SRT
VERT	1	.722**	.748**
		.000	.000
VIRT		1	.737**
			.000
SRT			1

** p< .01

Analysing Table 4, it is seen that there is a positive and a high-level significant relationship between VERT, VIRT and SRT's.

Qualitative Findings

In this section, the findings obtained from interviews with the students were presented. The tests solved by the students were given to them after true-false evaluation, and they were asked to express their views on these tests and the answers they gave.

VERT, VIRT and SRT's are the tests numerically identical but differing in terms of representation format. First, students were asked about the similarity of these tests. The three students stated that they were not well aware that the questions in the test were the same. And, during the interviews they realized that the problems were the same but asked in different ways. Below is an excerpt from interviews with students (R: Researcher, S1: Student 1, S2: Student 2, S3: Student 3).

R: 1's show your correct answers, 0's incorrect ones. Now when you look at them, do you notice any similarities in the three tests for each question?

S1: this is 1/3, this is 1/3 and this is also 1/3 (reading the results)

R: Yes.

S1: And this is 1/5, and this is 1/4.

R: So?

S1: All problems are the same.

R: Nice. You realized that all the problems are the same. So, did you notice that while answering the tests?

S1: Of course, not.

Of the participating students, S1 was more successful in symbolic test, S2 in verbal test, and S3 in visual test. After handing out the solved tests to the students and they realized that the problems were the same; they were asked questions about why they gave correct answers in one test and incorrect ones in the other.

Examining the tests of S1, it was revealed that he answered the problem 1 correctly in both symbolic and visual test while answering incorrectly in the verbal test. She said that she did not fully understand verbal problems and the others seemed easier to answer as a type of problem. She told that it was because of the fact that it was easy to determine the type of mathematical operation in the symbolic test, on the other hand, she had to determine the type of operation to be done in verbal test. When asked what problem format he could reach the solution more easily with, she answered as follows:

R: So, when you are given a problem, what do you think would be the easiest way; visual way, verbal way or an algebraic way?

S1: Algebraic (talking about symbolic) would be easier. Because, some figures may not be understood in the others (visual test). She can understand algebra better. She may not understand symbols. He may not understand it in a problem format, either (verbal test). So, it is easier in an Algebraic way.

After the interviews with S1, it was seen that she related her failure in the verbal tests to lack of reading and solving tests,

On the other hand, S2 was more successful in the verbal test. This student stated that she had difficulty in visual and symbolic problems but that she understood the problems in the verbal test better. An excerpt from the interview with the student is as follows:

R: What do we study first regarding fractions at primary school?

S2: Pies

R: A pie, for example! More on shapes. What do we see next?

S2: Algebraic expressions

A: Then, why do you think you were more successful in problems but couldn't answer shape and symbolic problems?

S2: I understand problems better.

R: Then, you have...

Ö2: difficulty with shapes.

R: You do. In what way do you think the problems in mathematics should be asked? Symbolic, visual, or Verbal problems?

S2: Verbal ones.

R: Why?

S2: Because I'm more successful in verbal ones.

The student thinks that verbal problems, which she thinks easier for himself, should be asked in math class. When the same question was asked to the student wanting her to think about the whole class not herself; she stated that more place should be given to visual problems as the fractions were first taught with visual models. Upon this answer, the researcher

asked which one they studied at school and the answer is as follows:

R: What type are the ones we study at school now?
S2: Most closely? What do you mean by 'the one we study at school.'?
R: The ones we study during lessons.
S2: Verbal.
R: Anything else?
S2: Algebraic.
R: We don't study it using shapes yet, sometimes we do.
S2: Yes.
R: I see that you have difficulty with the algebraic ones although we study them at school.
S2: Yes.
R: So, why do you think it is? Why do you think you have difficulty in that?
S2: Well, I don't like algebraic one so much. I don't understand them much. That's the reason.

This student also said that she loved reading books a lot and that that might be the reason she was successful in verbal tests.

Examining the tests of S3, it was seen that she was more successful in the visual test. She was also found to have problems in symbolic test questions in particular. She stated the situation in interviews in the following way:

S3: Sir, I do not understand when I read them (referring to the verbal test), but when I look at the shapes (referring to the visual test) I immediately understand. I can't understand them no matter how many times I read them.

S3 thought that he was unsuccessful in the verbal test due to his reading comprehension problem. The student also expressed that he had difficulty understanding fractions when given directly with numbers but he was able to make sense out of them better when they were given in a visual way.

R: So, what kind of benefits do you think the visualization of such questions will provide?
S3: I don't know, for example, if 5 pieces of a pie chart out of 12 are painted, I can understand it immediately and write it as 5/12.

RESULTS

In this study, investigating whether the fractional problem solving achievements of the 5th and 6th grade students are affected by representation formats, the results are presented in two sections, namely quantitative and qualitative results.

Quantitative Results of the Study

As a result of the study; it is seen that approximately half of the 5th grade students were successful in fraction problems presented in verbal, visual and symbolic ways, except for the 3rd problems in the visual and symbolic tests. When we examine problem 3, it is seen that it is a fractional comparison problem. It is significant that the rate of correct answers to this question in the verbal test is 46.6% while around 20% in the visual and symbolic test. The 6th grade students, on the other hand, were found to have a success rate of above 50% except for the 3rd and 4th questions in the visual test. The success rate of the questions 3 and 4 in the visual test proved to be not so low (42.0%). These findings suggest that the students are more successful in fraction problems involving addition, subtraction and multiplication in particular than in fractional comparison problems. It was shown by the studies on fractions that primary school students, in the question related to fraction description, have difficulty writing the fractions defined by co-pieces separation (Haser and Ubuz, 2001), understanding the basic concepts about fractions (Aksu, 1997), and that they make mistakes in applying fractions to problem solving (Başgün and Ersoy,2001). Soylu and Soylu (2005), in their study, revealed that students had significant learning difficulties with ordering, addition, subtraction in fractions and fraction problems. Studies show that fractional operations are taught in almost every stage of the primary school; however, these are forgotten continuously. The reason for this is attributed to the fact that students memorize rules and algorithms instead of focusing on the meaning of fractions (Şiap and Duru, 2004; Hanson, 1995).

Depending on the grade level; the average scores of 5th grade students proved to be lower than those of the 6th graders in all the problem representation formats among fraction problem solving achievements of the students. These results can be interpreted as grade level increases; there is an increase in fraction solving achievement. Consistent with this result, Aytekin (2012) also demonstrated, in his study on 6th, 7th and 8th grade students, that students' fractional operation and estimation success showed a rise from 6th grade to 8th grade. Examining these differences, it is seen that only the difference in the symbolic test is significant, while those in the other tests are not. The reason for this may be considered to be because algebra was not introduced to the 5th grade students while 6th grade students learned it and encountered symbolic problems more. Additionally, the students' achievements in the visual tests at both grade levels were found to be lower than those of the other tests. Students may have had problems with converting these questions to a mathematical language starting from the models given visually.

A positive significant relationship between the students' fractional problem solving achievements, given in different representation formats, was also revealed. The existence of a high correlation between test results could be attributed to the fact that all of the questions in the tests given in 3 representation

formats involved the same numerical status. With this result in mind, it may be mentioned that the students could reveal the same cognitive structures related to the concept of fractions in the tests with each representation format. Despite the interpretation that same cognitive structures can be used for different representation formats; the difference in the scores for each test can be connected to the fact that answering strategies for the questions change depending on the representation format.

Qualitative Results of the Study

As a result of interviews with students; it was revealed that students were not aware that each question included the same numerical values as tests were applied on different days and the representation formats were different.

It is seen that the student doing better in the symbolic test related his success to the clarity of which operation to be done. Therefore, he did worse in the visual and verbal tests, in which he had to determine what the right operation was. The students, who did better in the verbal test, stated that he understood the question better when he read the verbal problems, and that verbal problems should be asked in maths lesson. When asked to consider everybody else not just himself, the student said that visual problems would be more appropriate since fractions were first taught with shapes. He also related his success in the verbal test to his reading a lot of books. The student doing better in the visual test stated that he could not understand symbolic expression quite well, but that he was able to understand them when he looked at the shapes and figures. In addition to this, he reported that he was bad at the verbal test due to his lack reading comprehension.

Suggestions

The fact that students answer the questions in different representation formats about the concept of fractions suggests that these concepts be dealt with, in the lessons, using all the representation formats. Therefore, if maths teachers plan and present activities containing all the representation formats in the subject matters of fractions, fractional operations, ordering and comparison of fractions in their lessons, then student achievement could be increased. In addition to these activities, questions with different forms of representation should also be included rather than using a single representation format. Thanks to such activities and question types, students are expected to increase both operational and conceptual knowledge.

Talking about different representation formats not only in fractions but also, depending on the suitability of the subject, in other mathematical concepts can facilitate students' learning. Through verbal representation forms, students can become more competent in reading comprehension, which is the first step in problem solving. The second step expected from the students comprehending the problem is to plan and convert the given problem to a mathematical language or numerical expression. Visual representations may be effective at this stage. To do this, they need to visualize and shape the given information or make a mathematical modelling. Here arises the importance of symbolic representations.

Similar studies can also be applied on the same subject at different grade levels. Such an application can be made for various math concepts. It can be examined whether there are differences between the students attending classes in which different representation formats are used and the students attending classes in which different representation formats are not used, in terms of procedural or conceptual knowledge.

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