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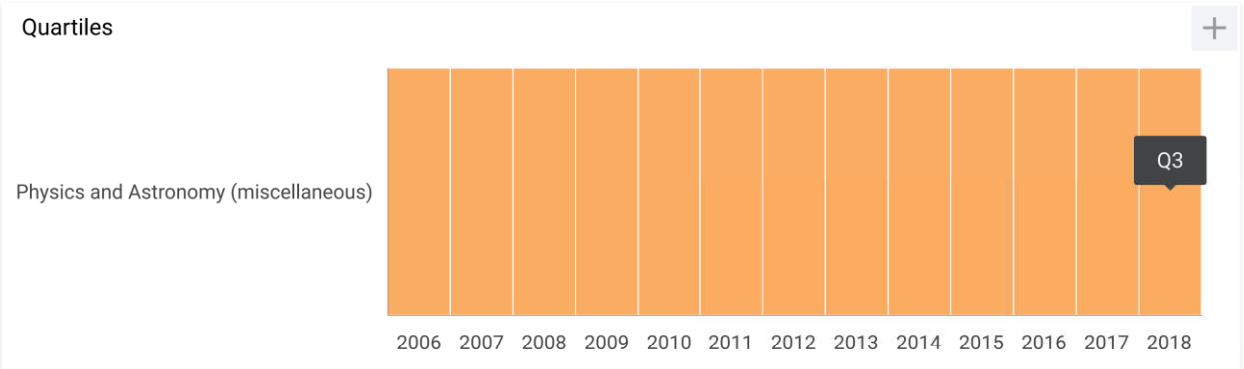

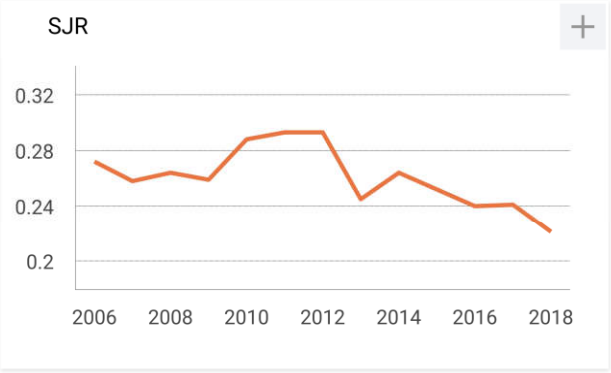
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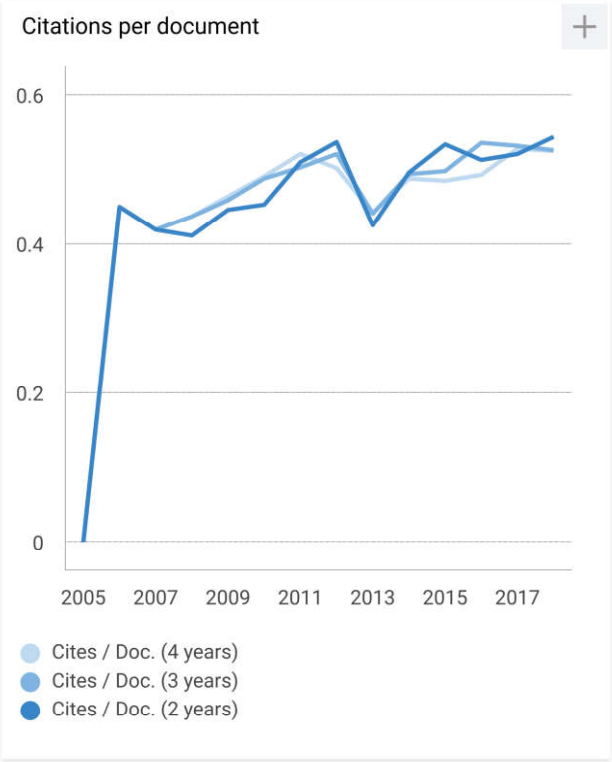
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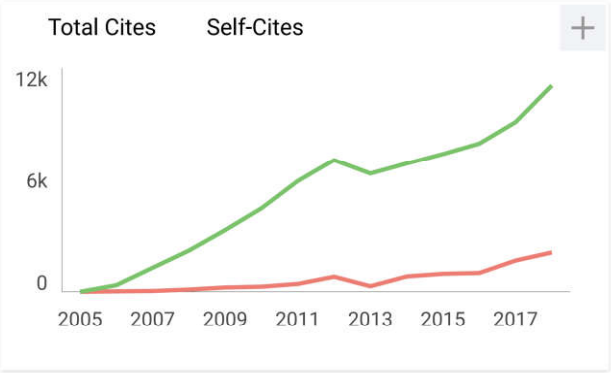
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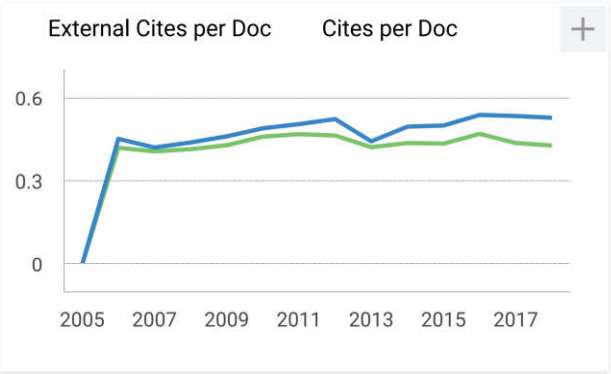
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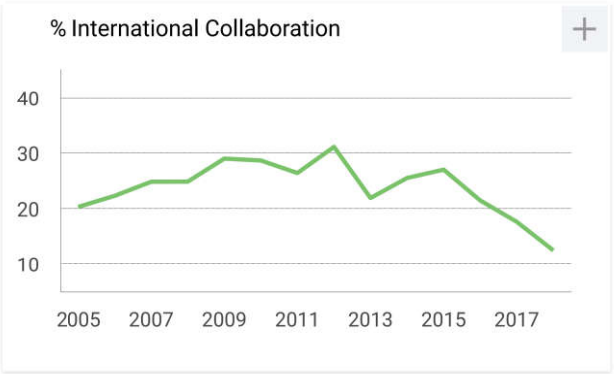
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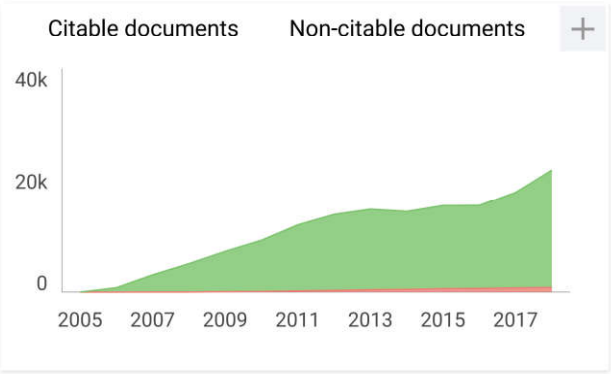
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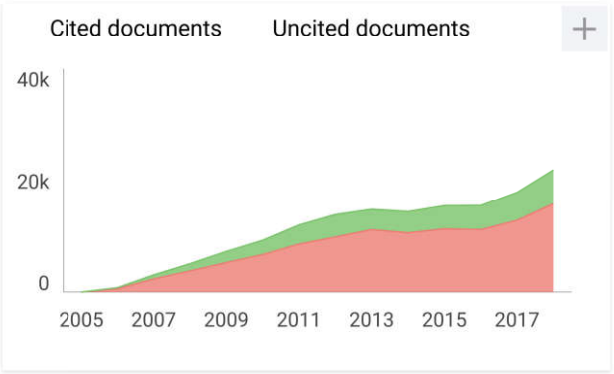
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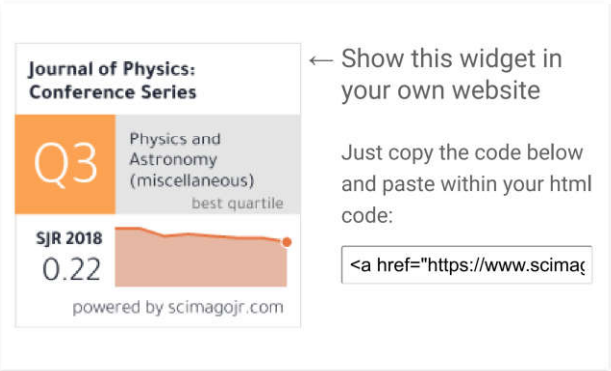
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20-24 November 2018

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Preface: Proceedings of the 2nd International Seminar on Innovation in Mathematics and Mathematics Education 2018

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We are honored to present a collection of articles from the 2nd International Seminar on Innovation in Mathematics and Mathematics Education (ISIMMED 2018) which was conducted in Universitas Negeri Yogyakarta, Indonesia from 20 to 24 November 2018.

The theme of the conference was '*innovative technology in mathematics: new ways for learning, teaching, and researching mathematics'*. In the era of Industrial Revolution 4.0, the use and integration of technology into various aspects of everyday life is rapidly increasing. The availability and development of advanced technology have a great impact on the practices of educational research and classroom activities in the fields of mathematics and mathematics education. This situation becomes a great challenge and motivation for researchers and educators. Various technological innovations have been invented and developed to improve the quality of research and education in the field of mathematics. The advanced technological tools such as computer algebra systems (CAS), interactive and dynamic geometry software, and hand-held devices, have been enabling the effectiveness of mathematics teaching and learning.

During the ISIMMED 2018, scholars, educators, and researchers in the field of mathematics and mathematics education from many countries gathered to share their expertise and works. After a series of review process, 108 articles are selected to be published in this Scopus-indexed proceeding. The remaining articles are published in the regular proceeding.

The editors and the committees of ISIMMED 2018 would to thank the participants who have contributed and shared their scientific works in this proceeding. We also would to to express our gratitude to every committee member for organizing the conference and to Universitas Negeri Yogyakarta for the financial support.

15 March 2019

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The identification of students' didactic obstacles in learning fractions based on the form of the problems

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The identification of students' didactic obstacles in learning fractions based on the form of the problems

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Abstract. This study aims at knowing whether there are didactic obstacles in learning fractions of students in Yogyakarta based on the form of the problems. Those problems include visual, narrative, and symbolic forms. Materials of fractions consist of the concepts of fractions, equivalent fractions, the order of fractions, decimals, percents, addition of fractions, subtraction of fractions, multiplication of fractions, and division of fractions. The method of this study is survey with expost facto approach. The populations are students of Junior High School grade VII in Yogyakarta. The samples are 151 students from four schools in Yogyakarta. The choice of sample is done by stratified proportional random sampling technique. The instrument is diagnostic test with 27 questions that divide into 9 visual forms, 9 narrative forms, and 9 symbolic forms. Based on the result, students have didactic obstacles in visual forms and narrative forms. While in symbolic forms, students did not have didactic obstacles.

1. Introduction

Numbers and operations are one of the most important parts of mathematics learning for students [1]. The results of studies from Mathematical Thinking and Learning said that the main foundation in performing number operations is not only knowing the calculation procedure, but also understanding the relationship between numbers and the properties of the number operations [2]. Many studies said that fractions is the most difficult topic in learning numbers. Even these difficulties do not only occur to students, but also occur to teachers [3].

The most common failure of students in learning mathematics in schools is in fractional material [4]. The results of observations and interviews with teachers in schools also showed that many students made errors in solving fractions and its operations. Many researchers gave special concern to the importance of developing competencies to deal with fractions as it plays important role in everyday life [5]. According to Hassemann [6], some difficulties in learning fractions due to many representations of fractions and various forms of problems related to fractions (visual, narrative, and symbolic forms).

Learning fractions continues to receive serious attention from teachers and mathematicians around the world. Long discussions and debates are still ongoing about whether fractions will be introduced first as a result of calculations from measurements or whether to be conceptually introduced as part of

the whole [7]. Fractions has many representations and interpretations. Different interpretations of fractions $\frac{3}{4}$ can be exemplified in table 1 [8].

Table 1. Different interpretations of fractions

Representations	Interpretations
Measurement	Distance of 3 ($\frac{1}{4}$ unit) from 0 on the number line
Part - Whole relationship	3 from 4 equal parts of the whole
Operator	$\frac{3}{4}$ of something, stretching or shrinking
Quotient	3 divided by 4, $\frac{3}{4}$ is the amount received by each person
Ratio	3 parts of A toward 4 parts of B

Many previous research have been carried out to identify students misconception in learning fractions. According to Brown, misconception is a wrong explanation and not in accordance with the scientific understanding [9]. Misconception in learning fractions cannot be ignored because fractions is fundamental concepts in mathematics and it will influence other higher concepts [10]. The students misconception in fractions showed that students have obstacles in learning fractions.

The learning obstacles can be divided into didactic obstacles that is relationships between students and material; and pedagogic obstacles that is relationships between students and teachers. Because fractions is difficult material, didactic obstacles will be found more than pedagogic obstacles. Didactic obstacles are categorized into three types, those are difficulties in understanding concepts, difficulties in applying principles, and difficulties in using procedures or algorithms [11].

In order to help students who experience didactic obstacles in learning fractions, the teacher must be able to identify the types of those didactic obstacles. The characteristic of the occurrence of didactic obstacles is students' difficulty in carrying out mathematical tasks in fractional material with different form of the problems. Based on the above description, it is necessary to conduct a research to identify students' didactic obstacles in learning fractions based on the form of the problems. The result of this study can be used as a reference in making learning design that can construct students' correct understanding of fractions and its operations.

2. Method

The method of this study is survey with expost facto approach, which is a research that aims to investigate the events that have occurred. Kerlinger defined expost facto research as an empirical discovery that is carried out systematically, the researcher does not control the independent variables because their manifestations have occurred or these variables cannot inherently be manipulated [12]. The populations are students of Junior High School grade VII in Yogyakarta. The samples are 151 students from four schools in Yogyakarta. The choice of sample is done by stratified proportional random sampling technique. Sampling was carried out by referring to the school level based on the national examination scores contained in Permen No. 5 year 2015, namely very good, good, sufficient, and deficient school.

The instrument is diagnostic test with 27 questions. Details of making questions are based on fractions materials and form of the problems. Materials of fractions consist of the concepts of fractions, equivalent fractions, the order of fractions, decimals, percents, addition of fractions, subtraction of fractions, multiplication of fractions, and division of fractions. Whereas the form of the problems include visual, narrative, and symbolic forms. The diagnostic test for didactic obstacles in learning fractions can be seen in table 2.

Table 2. Diagnostic test of fractions

Materials	Form of the problems		
	Visual	Narrative	Symbolic
Concepts of fractions	1*)	2	3
Equivalent fractions	4	5	6
The order of fractions	7	8	9
Decimals	10	11	12
Percents	13	14	15
Addition of fractions	16	17	18
Subtraction of fractions	19	20	21
Multiplication of fractions	22	23	24
Division of fractions	25	26	27
The number of items	9	9	9

*) state the item number

The diagnostic test of fractions provides four answer choices. However, students must determine the truth of the overall choice of answers given. For answer choices that are considered correct, a check mark (√) is given and if the answer choices are considered wrong, then a cross mark (×) is given. This method allows the item to have more than one correct answer or no correct answer at all. Therefore, students must truly understand and master the fractional material with various forms given.

Data is proccessed quantitatively with average score 0 until 4. The categories of didactic obstacles are very not obstacles ($\bar{x} > 3$), not obstacles ($2.33 < \bar{x} \leq 3$), enough obstacles ($1.67 < \bar{x} \leq 2.33$), obstacles ($1 < \bar{x} \leq 1.67$), and very obstacles ($\bar{x} \leq 1$). Two first categories are named not having didactic obstacles and the others are named having didactic obstacles [13].

3. Result and Discussion

The data analysis result from the overall didactic obstacles in learning fractions of Junior High School students grade VII in Yogyakarta can be seen in table 3.

Table 3. Didactic obstacles in learning fractions (all questions)

Categories	The number of students	Percentage
Very not obstacles	24	15.89%
Not obstacles	50	33.11%
Enough obstacles	50	33.11%
Obstacles	16	10.60%
Very obstacles	11	7.29%

Table 3 shows the result of 151 students' answers to 27 questions given. It can be seen that 11 students were in category very obstacles, 16 students were in category obstacles and 50 students were in category enough obstacles in solving fractions problems. So that a total of 77 students or 51% students experienced didactic obstacles on fractional material. While the remaining 74 students or 49% students did not experience didactic obstacles. The average score of 151 students is 2.27 (enough obstacles). It can be said that Junior High School students grade VII in Yogyakarta still have didactic obstacles in learning fractions.

The data of students' didactic obstacles in learning fractions are analyzed in more detail based on the form of the problems. Those problems include visual, narrative, and symbolic forms. The frequency distribution of didactic obstacles based on the form of questions can be seen in table 4.

Table 4. Didactic obstacles in learning fractions based on the form of the problems

Categories	Visual		Narrative		Symbolic	
	The number of students	Percen tage	The number of students	Percen tage	The number of students	Percen tage
Very not obstacles	15	9.93%	24	15.89%	55	36.42%
Not obstacles	35	23.18%	44	29.14%	40	26.49%
Enough obstacles	61	40.40%	35	23.18%	32	21.19%
Obstacles	29	19.21%	29	19.21%	15	9.93%
Very obstacles	11	7.28%	19	12.58%	9	5.96%

Based on the analysis of the problems in visual form, it was found that 101 students or about 66.89% from the total of 151 students had difficulties in working on fractions, and as many as 50 students or about 33.11% had no difficulties. Overall, the average students' score is 2.09 (enough obstacles). So, it can be said that students still experienced didactic obstacles in solving fractions with visual forms.

Based on the analysis of students' scores in narrative form, the result showed that as many as 83 students or around 54.97% had difficulties and 68 students or around 45.03% of the total 151 students had no difficulties in working on fractional problems. Generally, the average score of the students is 2.13 (enough obstacles). So, it can be mentioned that students still had didactic obstacles in solving narrative forms of fractions.

Based on the analysis of the problems in symbolic form, it was found that 56 students or about 37.09% from the total of 151 students had difficulties in working on fractions, and as many as 95 students or about 62.91% had no difficulties. Overall, the average students' score is 2.60 (not obstacles). So, it can be said that students not experienced didactic obstacles in solving fractions with symbolic forms.

The examples of students' answer in the diagnostic test of fractions for visual, narrative, and symbolic forms are discussed as follows.

Figure 1 is the example of student's answer for visual form.

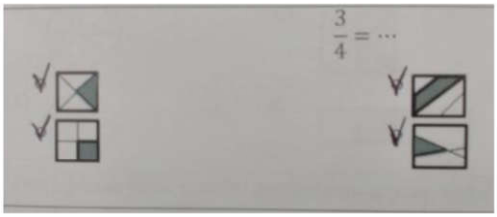

Figure 1. Student's answer for visual form

From figure 1 we can see that the student already knew the concept of fractions that is part - whole relationship, but he forgot that $\frac{3}{4}$ is 3 from 4 equal parts of the whole. All of the pictures are 3 part from 4 whole, but two of them are not from equal parts. This finding showed that students do not have right conceptual understanding about interpretation of fractions. It can be caused by students did not build the concepts of fractions by themselves. Understanding how mathematical conceptions are constructed can help students to build the right conceptual understanding with the aim of encouraging the next learning process [14].

Figure 2 is the example of student's answer for narrative form.

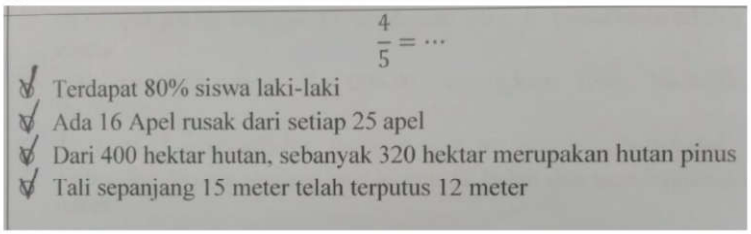

Figure 2. Student's answer for narrative form

From figure 2 we can see that the student already understood the representation of fractions in the narrative form, but he made a mistake in the second choice. He should multiply both numerator and denominator by the same number, but in the second choice he multiplied 4 by 4 and 5 by 5. This finding indicated that students still have difficulty in translating the fractions into word problem. Several studies also showed that all level of students assume that comparing word problem are difficult [15-18].

Figure 3 is the example of student's answer for symbolic form.

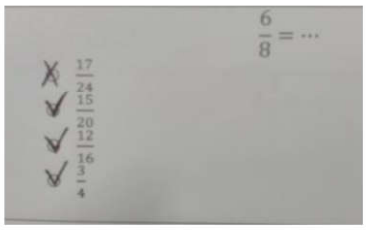

Figure 3. Student's answer for symbolic form

From figure 3 we can see that the student could answer all symbolic form of fractions correctly. He could find all equivalent fraction of $\frac{6}{8}$. This result pointed out that students are accustomed to use formal mathematical knowledge and apply the formula taught in the classroom [19].

4. Conclusion

Based on the result of the research, it can be concluded that generally students in Yogyakarta still have didactic obstacles in learning fractions based on the form of the problems. Students have didactic obstacles in visual forms and narrative forms. While in symbolic forms, students did not have didactic obstacles. Therefore, it is necessary for making learning design that can facilitate students to construct a correct understanding of fractions and its operations. The trajectory in learning fractions should start from concrete to abstract or from informal to formal mathematical knowledge, so that students can solve all forms of fractional problems (visual, narrative, and symbolic). Students should not be treated as passive recipients who only receive materials with using formula and procedure to solve a problem, but students should be given opportunities and guided to the situation to reinvent mathematics concept with their ways [20].

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