Students' learning obstacles in understanding of fraction concept during online learning

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Abstract. This study described students' learning obstacles in understanding fraction concepts at elementary schools during online learning. The subject was 38 person of fifth-grade students of elementary schools in Bandung and Pekanbaru, Indonesia. In this study, data was collecting through tests, interviews, and curriculum documents. The data was analyzed by reducing, presenting, and making conclusions. The results show that students faced three learning obstacles: ontogenic, epistemological, and didactical. The ontogenic obstacle is caused by students' inability to understand that the fraction parts must be the same. The epistemological obstacle is an obstacle caused by the inability of students to understand the equivalence of fractions. The didactical obstacle is caused by the teaching material presented had not introduced the concept of fractions comprehensively, so the students cannot interpret fractions ultimately.

INTRODUCTION

Mathematics is one of the main subjects for elementary school students. It has a lot to do with students' daily lives. Therefore, it is necessary to understand the material as early as possible for Elementary School students. It also affects the next level in Middle School to Higher Education.

One of the materials taught in elementary school is fractions. Fractions are one of the essential materials in learning mathematics. Fractions material is the core and challenge in the primary mathematics curriculum (NCTM, 2000). This material is the basis of various further materials such as decimal, rational, ratios, social arithmetic, and various other materials studied at Elementary School, Middle School, and Higher Education. Therefore, it is needed to embed the proper concept of fractions when students are still in Elementary School. If students have a precise and in-depth understanding of the fraction material, they will quickly move on to the following material. On the other hand, if students fail to understand the fraction material, for example, there is a learning obstacle that causes misconceptions in the fraction material, they will find it challenging to continue to other material related to the fraction material (Rosli et al., 2020).

Understanding fractions is essential for students' future success (Braithwaite, Tian, & Siegler, 2017). Understanding fractions will be required in various works. A recent large-scale survey of employees in America found that around 68% said they used fractions and decimals in their work (Braithwaite, Tian, & Siegler, 2017). Fractions are students' first guide to abstraction in mathematics (Wiest & Amankonah, 2019). Fractions are a fundamental material that plays a critical role in learning algebra and advanced mathematics material (Iskenderoglu, 2017; Jones, 2011).

Learning about fractions in elementary school starts with developing fractions meaning and concept, comparing fractions and their value, and fractions operation (Wiest & Amankonah, 2019). Seven abilities-based hierarchical levels of understanding fractions arrange an understanding of fractions in elementary school students (Nicolaou & Pitta-Pantazi, 2014). The seven abilities are introducing fractions, definitions and mathematical explanations, argumentation, justification, the relative magnitude, representation, the relationship of fractions to decimals, percentages, division, and reflection. Practically, students in the third grade understand the meaning and use of fractions to represent part of a whole, part of a set, and place fractions on the number line. This understanding is expanded and refined at all primary and secondary levels (NCTM, 2000). So, the first thing taught to students in Elementary Schools is introducing fractions based on the learning sequence. The introduction of fractions involves developing the meaning and concept of fractions. This material is necessary as an initial concept in fractions material and a starting point in learning fractions.

Some studies reveal that understanding fractions were considered a complex concept for elementary school students (İskenderoğlu, 2017). The study reported being the lowest-ranked topic (Braithwaite, Pyke, & Siegler, 2017). Fractional arithmetic becomes a particular challenge for students. It still found students who have obstacles in understanding fractions, even though they have previously understood the concept of integers. The concept of fractions was considered difficult for students than other topics in the curriculum of elementary school. Students got obstacles to understand fractions as numbers and how to perform in operations numbers (Aliustaoğlu, Tuna, & Biber, 2018). The National Assessment of Educational Progress (NAEP) results test also showed that students' understanding of the fraction concept was inadequate (Wiest & Amankonah, 2019).

Every learning is inseparable from a problem. It is including the problems experienced by teachers and students in learning mathematics. One of the problems experienced by the students was learning obstacles. Learning Obstacle is one of the realities that have an impact on didactic design studies (Nicolaou & Pitta-Pantazi, 2014).

The term obstacle refers to a learning difficulty caused by external factors; it is called didactic design. Three types of learning obstacles are the ontogenic obstacle, didactical obstacle, and epistemological obstacle. Ontogenic is the level of difficulty of the didactic situation that can lead to obstructing the learning process. If it is too difficult, students have constraints to join the learning process. On the contrary, if it is too easy, students will be stunted in development or incompatible with their intellectual abilities. Didactic refers to the sequence, stages, and ways of presenting curriculum materials that impact the continuity of students' thought processes or the inaccuracy of students' conceptions. Meanwhile, epistemological is limited understanding of a person about something associated with a specific context according to his learning experience (Wiest & Amankonah, 2019).

The progress of life in the 21st century demands information and communication technology in all aspects of life. This includes the world of education. Learning is directed to use information and communication technology to be more effective and efficient. Both universities and schools have begun implementing this by using electronic learning and internet networks, also known as online learning. Coupled with the Covid-19 outbreak in early 2020, the government appealed to learn from home learning activities (Zhafira et al., 2020). This is done to break the chain of virus spread and maintain the security and safety of students and educators.

With this appeal, the learning process is carried out from home by utilizing technology and internet media. Almost all schools that previously conducted face-to-face learning in their respective schools now have to adapt the online learning model.

This research continues the previous studies on students' learning obstacles in understanding the concept of fractions. The results of this research will serve as a foundation for teachers and next researchers in developing effective learning designs related to the concept of fractions in elementary schools.

METHOD

This research is a qualitative study. A qualitative study has a relationship with the ideas or views of the subject under study (Gall et al., 2010). This research used a case study method to explain certain phenomena, such as individuals, programs, and processes (Suryadi, 2019). A case study was considered the proper method to reveal students' learning obstacles in introducing fraction concepts to the third-grade elementary school students.

The subjects of this study were the fifth-grade students of elementary schools in Bandung and Pekanbaru, Indonesia, with 38 students. In this study, data was collecting through tests, interviews, and curriculum documents. 1) *test* to see learning obstacles related to the introduction of fraction concepts of the fifth-grade elementary school students; 2) *interview* to reveal the students' mindset and to find out how the teacher taught the introduction of fractions at the third grade of elementary school; and 3) *documentation* to analyze the third-grade students' textbooks used in the learning process. The test provided in the research consists of five essay questions, while interviews are randomly conducted with five students to further confirm their test response outcomes.

The data were analyzed through 1) *data reduction*, the researcher recorded all student responses in answering questions related to the introduction of fractions concept; 2) *data presentation*, the researcher began to classify the types of student responses and identify them based on their difficulty and 3) *describe/verify,* the researcher analyzed in detail the types of student learning obstacles in the introduction of fractions at the third grade of elementary school students based on the theory of learning obstacles.

RESULTS AND DISCUSSION

Based on the results of research conducted, a total of five questions were conveyed to 38 students of the fifth-grade of elementary schools who had previously studied the basic concepts of fractions. Students experience problems in answering three of the five questions given. Of the 38 students, overall (100%) students experienced obstacles in answering question number 1c. A total of 25 students (74%) experienced problems in question number 2h, and as many as 12 students (66%) experienced obstacles in answering question number 2i. Furthermore, overall (100%) students also experienced obstacles in answering questions 1b and 1d. The researcher then identified the students' learning obstacles based on the theory that had been explained previously. The analysis result of students' learning obstacles on the introduction of fractions concept are as follows:

1.1. Ontogenic Obstacle

The first question provided several shapes that were divided into four parts. A portion of a quarter was shaded. Students were asked to find $\frac{1}{4}$ part. The student's answer is represented in figure 1.

Question no. 1c: Which part is $\frac{1}{4}$? Students are asked to state the reasons.

Subject 1 thought the color shape was $\frac{1}{4}$. It appears that subject 1 did not understand that the parts of fractions must be the same size. To confirm the subject 1's answer, the researcher conducted an interview with the subject 1 as follows:

Researcher   : What is this picture?
Subject 1   : It's a circle, ma'am.
Researcher   : How is the circle divided?
Subject 1   : The circle has lines, so it's divided into four parts.
Researcher   : What was asked in the question?
Subject 1   : We were asked to determine if this picture is one-fourth or not.
Researcher   : In your opinion, is this picture one-fourth?
Subject 1   : Yes, ma'am, it's one-fourth.
Researcher   : Why do you say it's one-fourth? What's the reason?
Subject 1   : Well, there are four parts here, so one part is one-fourth.

Based on this excerpt from the interview, it can be concluded that the student understands that the fraction $\frac{1}{4}$ can be represented by a picture divided into 4 parts. However, there are still many students who don't yet understand that the fractional parts should have the same area size.
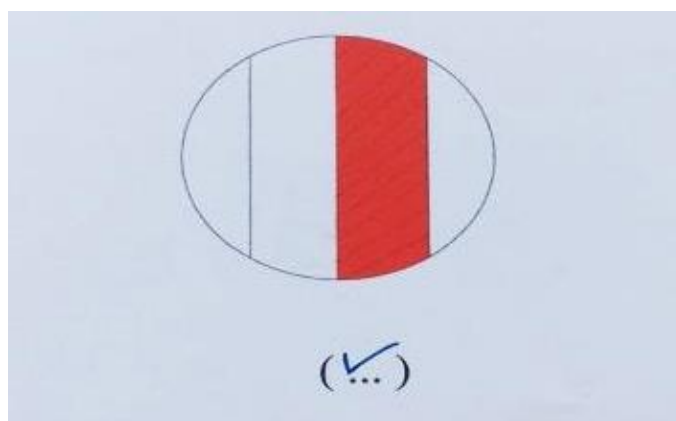

Figure 1. Subject 1's answer

Furthermore, it also found students' obstacles to determine picture-based fraction value. Students provided a shaded picture, and they were asked to determine fraction value based on the picture. They got difficulty identifying the fraction formed by the picture. It is shown in the following figure.

Question no. 2h and 2i: Write down the fractional value of colored fractions!
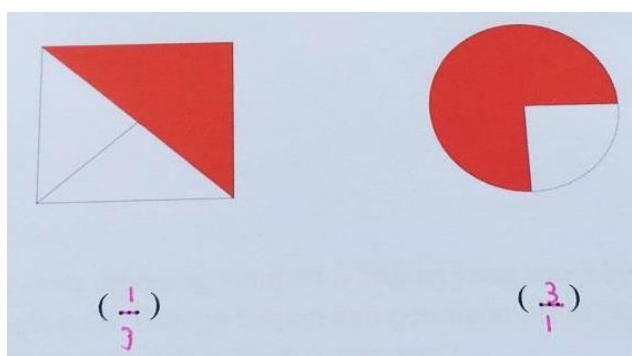

Figure 2. Subject 2 and subject 3's answers

Figure 2 shows the students' inability to understand the pictures presented, and they were

unable to determine the fraction size in the picture. In practice, students answered correctly for fraction pictures with clear parts (separated by a line). However, they had a problem determining the fraction size in question. It was no line in the colored part. Students count the number of colored sections as one part. In this problem, students are required to be able to identify the image, which is a representation of the fractional number $\frac{1}{4}$. It turns out that most students have not been able to do this. This means that the questions given are still too difficult for students. It can be concluded that students experienced learning obstacles in ontogenic. The ontogenic obstacle is an implicit reflection that is deadlocked because the owned mental objects are insufficient to deal with the problems given. In this case, the type of ontogenic obstacle experienced by students is a conceptual ontogenic obstacle, namely the type of difficulty related to the conceptual level contained in the design that is not by the child's condition seen from previous learning experiences. Thinking or conceptual demands that are too high can cause children to lose their learning orientation, so they are frustrated (Suryadi, 2019).

1.2. Epistemological Obstacle

Moreover, the researcher also provided questions related to fractions as part of a set. Students were asked to determine whether the picture was $\frac{1}{4}$ or not. The result described students did not understand that fractions are part of a set. It can be seen from the students' answers in figure 3.

Question No 1b and 1d: Which part is $\frac{1}{4}$? Students are asked to state the reasons.
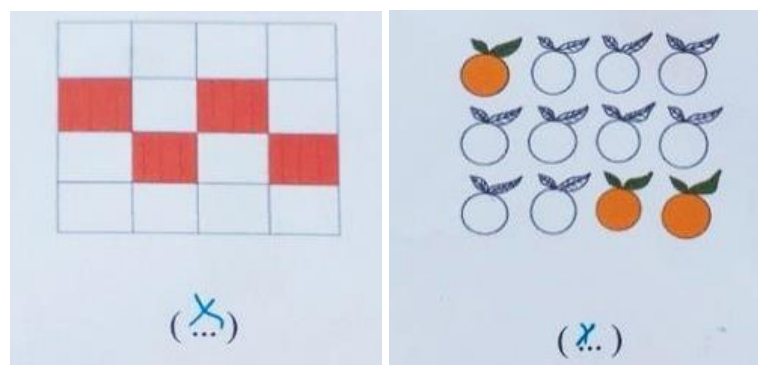

Figure 3. Subject 4 and subject 5's answers

In Figure 3 on the left, students were able to reveal that the picture in question was four over 16, which is written $\frac{4}{16}$. They were unable to connect $\frac{4}{16}$ was equal to $\frac{1}{4}$ with the concept of fractions worth. Likewise, on the right picture, students seem to understand that the picture shows three over 12. Students did not comprehend that $\frac{3}{12}$ was equal to $\frac{1}{4}$. This learning obstacle was related to the limited context of students' knowledge or epistemological obstacle. In this case, students find a different context from the context they previously studied. Epistemological obstacles are not related to the learning approach used by the teacher but as a result of the nature of the mathematical concept itself. Epistemological obstacles have several relationships with conceptions or misconceptions in mental objects, concept images, and students' points of view or thoughts. Often the mathematical concepts that students have are based on definitions they know from their point of view. This can be one of the obstacles for students to think mathematically to solve problems (Fuadiah, Suryadi, & Turmudi, 2017).

Based on the analysis of student learning obstacles, it can be seen that most students experience ontogenic and epistemological obstacles in understanding the basic concepts of fractions.

1.3. Didactical Obstacle

Teachers' teaching strategies cause didactical obstacles, methods, and teaching materials used. That the didactical obstacle related to the student's inability to understand the introduction of fractions concept completely.

Research result indicated that the teaching method did not involve the environment and students' learning experiences in teaching. The teaching and learning process kept up the activities on textbooks by providing examples in the textbook. It was in line with the student's statement, stating that they had never encountered some of the questions given before.

Based on the analysis of the textbooks, it was found that the missing material of introducing fraction concepts. A concept should be explained before getting into other concepts, but it was not included in the textbook, such as the concept of fractions meaning. The textbooks described the fraction generally. However, according to experts, students should learn several meanings of fractions to understand fractions completely. Besides, a fraction is also interpreted as a measurement, quotient, and comparison.

Furthermore, the following material is an equivalent fraction. It is a requirement to perform addition and subtraction operations. The student's textbook analysis results have not been a detailed explanation of the equivalent fraction. So, it might cause students difficulties in carrying out the addition and subtraction operations for equal and unequal fractions.

Meaningful learning can be created by the interaction between students and various parties (Brousseau et al., 2015). The use of textbooks as the only source in teaching and learning does not realize meaningful learning for students. Students should be actively involved in learning to create equilibration. Equilibration is a process to achieve higher levels of cognitive function through gradual assimilation and accommodation. Equilibration is established when students try to understand something new. Existing schemes and knowledge cannot perform it. It would appear a process of restoring balance called equilibrium in which students experience a meaningful learning process (Fauzi & Suryadi, 2020).

CONCLUSIONS

Based on the data obtained, it can be concluded that students experienced various obstacles in introducing fractions concepts. These obstacles involve 1) ontogenic obstacles due to the student's inability to understand that the fraction parts must be the same. Students were not able to understand the picture presented, so they were unable to determine the fractions on the image; 2) epistemological obstacles, caused by the student's inability to understand the equivalent of fractions; and 3) didactical obstacle, caused by student's inability to understand the introduction of fractions concept completely. The findings are expected to be used as a reference for teachers who teach the material to introduce the basic concept of fractions in elementary schools to design teaching materials in line with the real problems experienced by students. This study is limited only to the concept of fractions and is conducted on a limited number of participants. Therefore, further research is needed to examine students' learning obstacles in fraction operations with a larger number of participants to make the research findings more comprehensive.

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