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Students' Cognitive Processes in Understanding Fractions Through the Tourist Context

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Abstract

This research aims to describe students' cognitive processes in understanding fractions through a tourist context. This research method is design research. The data collection technique is through tests and in-depth interviews. The results of this research show that student's cognitive process in understanding fractions through a tourism context is that students first understand the problems in the tourism context of Lake Air Gegas; then students create mathematical models based on context; third, students complete mathematical models based on context; the fourth student creates a solution to the context problem; Finally, students make mathematical conclusions. Through the tourism context, students can solve problems appropriately. The conclusion is that there are five stages of students' cognitive process in discovering the principle of multiplication of fractions, namely students understand the problem through a tourism context, create a mathematical model based on context, complete a mathematical model based on context, create a context problem solution, and end by making mathematical conclusions about the principle of Multiplication of Fractions. Therefore, it is recommended that mathematics teachers use the tourism context as a starting point for mathematics learning.

Keywords: Cognitive Processes, Tourist Context, Understanding Fraction

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INTRODUCTION

Fractions are one of the elementary school mathematics materials that is difficult for students to understand (Widada, Herawaty, Lusiana, et al., 2020). Building an understanding of the concept of fractions is not easy. Understanding the concept of fractions is very important in the development of mathematics and how to use fractions is the basis for learning high-level mathematical concepts Listiawati, et al, (2023). Ozrecberoglu, Aydın, & Aydın, (2022) stated that non-routine problems including fractions are difficult material for students and teachers, and a lack of understanding of the concept of fractions is a very important point of dissatisfaction with mathematical knowledge. Several research results show that there are problems related to learning outcomes, understanding concepts, and the learning process in fractional number material. Mathematics is material that is considered difficult by students to learn mathematics so students experience difficulty in understanding concepts, especially fractions (Pant, 2019; Anggoro, Haji, & Sumardi, 2022). Ambarita, Asri, Agustina, Octavianty, & Zulkardi (2018) stated that mathematics learning achievement in fraction material is still low, the emphasis on learning is only on mastering several procedures and algorithms, and students are passive in the learning process and less creative. Nurutami, Riyadi, & Subanti (2020) said that students' understanding of mathematical concepts is still rote, students are confused in arranging concepts in the form of symbols to solve problems in everyday life, and students are less active in the learning process.

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Adding and subtracting fractions with different denominators is one of the difficult subjects in elementary school. When teaching addition and subtraction of fractions with different denominators, a teacher asks his students to directly equate the denominators of the two fractions (Andari & Setianingsih, 2021). According to Umbara & Suryadi (2019), there are several errors in solving fraction calculation operation problems, namely: 1) conceptual errors, students add and subtract the numerator and denominator of the fraction, do not equate the denominator first or do the denominator equation but in the wrong way; 2) namely principle errors, students solve problems not by the problem sequence, and consistently use the wrong problem-solving method; and 3) carelessness, students are wrong in determining the results of the operation.

Some mistakes made by students in calculating fractions are: students cannot change mixed fractions to improper fractions and vice versa; students cannot simplify fractions and cannot determine the fractional value of a fraction; students make mistakes in equating denominators to solve addition problems in fractions; and when solving subtraction problems students make mistakes by directly subtracting the numerator from the numerator and the denominator from the denominator (Pant, 2019). One of the main causes of students' difficulty in carrying out arithmetic operations on adding and subtracting fractions is that they only memorize formulas and algorithms, do not understand fractions, and assume that the denominator and numerator are two separate whole numbers (Lazić, Abramovich, Mrđa, & Romano, 2017).

Problems related to the ability to apply number concepts can be seen from numeracy literacy skills, based on the 2018 PISA study, a score of 379 was obtained, this score is 7 points lower than the PISA study in 2015. In 2021 the government through the Ministry of Education and Culture will implement a Minimum Competency Assessment, if looking at the content and context used in AKM, there is a very large intersection with the PISA study, namely the use of the number content and personnel and scientific context. Thus, it can be predicted that the results that will be obtained will not be too different from the PISA results or could be lower, one of the contributing factors is the Covid-19 pandemic.

One of the learning models applied to improve understanding of mathematical concepts is the Indonesian Realistic Mathematics Education (PMRI) model using an interactive learning environment. PMRI is the Indonesian version of Realistic Mathematics Education (RME) which offers a mathematics learning process that starts from real things for students. So, mathematics must be connected to reality, close to students, and relevant to people's lives. Hidayatullah & Csíkos (2022) research shows that students will do better if they start exploring fractions in a more realistic approach, such as a fair division context (Lazić et al., 2017). Tsaniya, Darta, & Fisher (2022) put forward 6 (six) PMRI principles, namely, (1) Activity Principle, Reality Principle, Level, Intertwinement Principle, Interactivity Principle, and Guidance Principle.

The use of context in mathematics learning is by the characteristics of PMRI, namely that the context and teaching materials are directly related to the school environment and students. The use of context in learning also has relevance to the characteristics of the independent curriculum and Minimum Competency Analysis, namely: flexibility for teachers in the learning process according to student abilities (teach at the right level) and making adjustments to local context and content, personal context, socio-cultural context, and scientific context. The research results of Jailani, Retnawati, Apino, & Santoso (2020) state that the use of context influences/correlates with increasing learning outcomes, mathematical reasoning, and interest in learning. This research uses a tourism context (natural environment) in Musi Rawas Regency. Baiduri, Putri, & Alfani (2021) stated that the natural environment is one of the most important components in developing learning objectives, content, and processes. So, the learning process is carried out by inviting children to learn in real situations in a natural environment. In this way, children can discover, understand and directly apply the learning process to various aspects of real life. Based on this description, this research aims to describe students' cognitive processes in understanding fractions through a tourist context.

METHODS

The method used in this research is design research (Plomp & Nieveen, 2013). Design research has four stages or phases, namely (1) preliminary research, (2) prototyping stage, (3) assessment stage, and (4) systematic reflection and documentation. In the Preliminary Design stage, researchers reviewed the literature and designed HLT as a predictor of students' cognitive processes. At the literature review stage, researchers examined research related to the concept of elementary school mathematics learning, learning activities, realistic learning, and learning environments. Field observations were carried out by carrying out preliminary research on students to find out whether students were familiar with realistic learning.

Furthermore, the researcher also reviewed the existing curriculum in the PGSD study program to select appropriate courses for the researcher to develop a learning environment using the tourism context of Musi Rawas Regency. Next, the researcher will design the HLT together with the lecturer according to the literature review. In addition, researchers will design learning tools that support HLT. In the Design Experiment stage, researchers carried out a Pilot Experiment and a Teaching Experiment. In the pilot experiment stage, six students will be selected representing 3 different abilities to solve the problems that have been designed. Then, in the Teaching Experiment stage, the learning design will be tested in large groups. This stage aims to test the learning sequence that has been designed and develop an understanding of how the design of the learning sequence works. The Retrospective Analysis stage is analyzing the results of the teaching experiment activities. The things that will be analyzed relate to learning assumptions, assumptions about learning, observation of the process during learning, and analysis of the achievement of learning objectives. If the set learning objectives have not been achieved, then a learning cycle will be carried out in the second phase, but if it has been achieved then the HLT that has been designed will produce students' cognitive processes (local theory). Specifically for this article is preliminary research.

The research subjects were 30 people, namely 4th-grade elementary school students in Lubuklinggau City. The context for learning this fraction is Lake Gegas Tourism. There are three instruments for this research, namely an observation sheet for cognitive process stages, a student response sheet, and an interview guide sheet. Data were analyzed using quantitative descriptive and interview data were analyzed using qualitative descriptive.

RESULTS AND DISCUSSION

In this research stage, 30 (thirty) students were research subjects. This class of students was taught the operation of dividing fractions in the context of the Air Gegas Lake tourist attraction (see Figure 1). Based on fractional learning data through the tourism context in Lubuklinggau City, three things can be explained. That is the student's cognitive process in learning the division of fractions, the student's response to learning, and the percentage of the student's cognitive process stages.

Figure 1. Context of the Air Gegas Lake tourist attraction

Based on the context of the Lake Air Gegas tourist attraction (Figure 1), students are given the following problem. On Saturday the students carried out community service at the Air Gegas Lake tourist attraction. Arriving at the tourist attraction, we were asked to take water in a 2,000-milliliter pot for cooking. After cooking, they were asked to make coffee water in a 250-milliliter cup. Determine how many cups are filled with coffee water. Measure liters, and determine how to divide the water in the pan into cups. Look at the following Figure 2.

Figure 2. Pots and cups measuring 250 ml

Students' Cognitive Process in Learning the Division of Fractional Numbers

Based on the contextual problem of the Lake Air Gegas tourist attraction given to students, a description of the results of an in-depth interview conducted with one of the students representing the group of students with the correct answer can be obtained. The student is Mt. The cognitive process is as follows.

Understanding the problem in the context of Lake Air Gegas tourism

Based on the problems given, students can understand the problem of the tourism context of Lake Air Gegas correctly. The cognitive process is as follows. (Q: Teacher; Gn: Student)

Q : How do you think about the problem given to you?

Gn : OK teacher, I understand that we are asked to brew coffee from 2,000 ml of hot water into a cup until the hot water runs out.

Q : What are the next steps?

Gn : In my opinion, from this problem, it is known that there is 2,000 ml of water in the pan and several cup of seeds, each measuring 250 ml. We boil the water in the pan and we brew as much coffee as the water we boil, namely 2,000 ml.

The results of the interview showed that Gn was able to understand the contextual problems given. Next, Gn was able to create a mathematical model. This is in accordance with Nugroho, Widada, & Herawaty (2019) that the initial process for students to solve a problem is to understand it according to the context. You can also see the research results (Andriani et al., 2020; Herawaty, Khrisnawati, Widada, & Mundana, 2020)

Create a Mathematical Model Based on Context

In creating mathematical models, students create them using pictorial representations such as the results of the following interview.

Q : What can you do next?

Gn : Yes sir, I made it in a pictorial representation. This is the picture [Gn shows the picture he made on a piece of answer paper; see Figure 3.]

Q : What can you say about the representation?

Gn : There is 2,000 ml of water in the pan and there are several 250 ml cups.

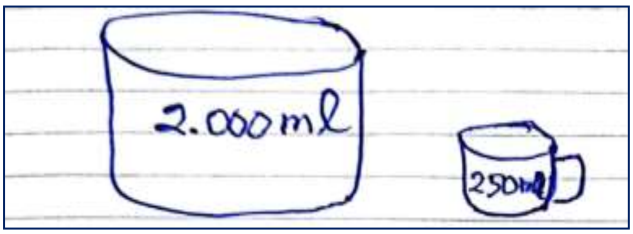


Figure 3. Pot containing 2,000 ml of water and empty 250 ml cup by Gn

Furthermore, students (Gn) are able to complete mathematical models based on context as revealed in the student's cognitive stages (Step-3). It shows that students create mathematical models based on understanding the context (Herawaty, Gusri, Saputra, Liana, & Aliza, 2019; Sukestiyarno, Nugroho, Sugiman, & Waluya, 2023).

Completing Mathematical Models Based on Context

Students (Gn) then successfully solve mathematical problems based on context. It was revealed in the interview as follows.

Q : Reveal what you finished next?

Gn : I poured 2,000 ml of water into 8 (eight) cups, each filled with 250 ml of hot water made from coffee. (See Figure 4)

Q : What can you say from that?

Gn : That means that 2,000 ml of water in the pan can be divided by 250 ml to produce 8 cups.

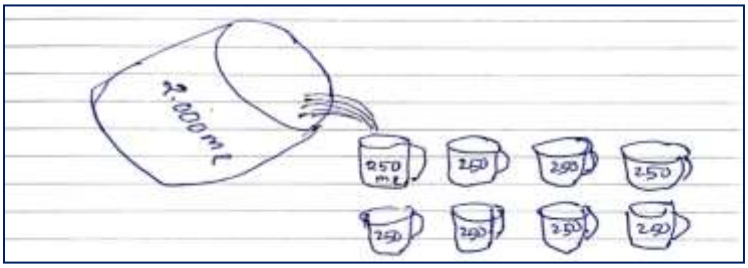


Figure 4. Gn divides the water into 8 cups

Next, students carry out cognitive processes by solving context problems in the form of mathematical processes. It is a process of finding a way to solve the mathematical model he compiled (Salam & Salim, 2020)

Create Solutions to Contextual Problems

Based on solving mathematical models, almost students are able to carry out cognitive processes, namely making contextual problem solutions in the form of mathematical solutions. This can be revealed from the following interview.

Q : What are the next steps?

Gn : Based on the image representation (Figure 4), it can be wrong to say that 2,000-250-250-250-250-250-250-250-250 = 0 (see Figure 5).

Q : What can you conclude?

Gn : 2,000 ÷ 250 = 8

Q : What next in liters?

Gn : I can say that 2,000 ml = 2 liter dan 250 ml = ¼ liter, then 2 ÷ ¼ =8.

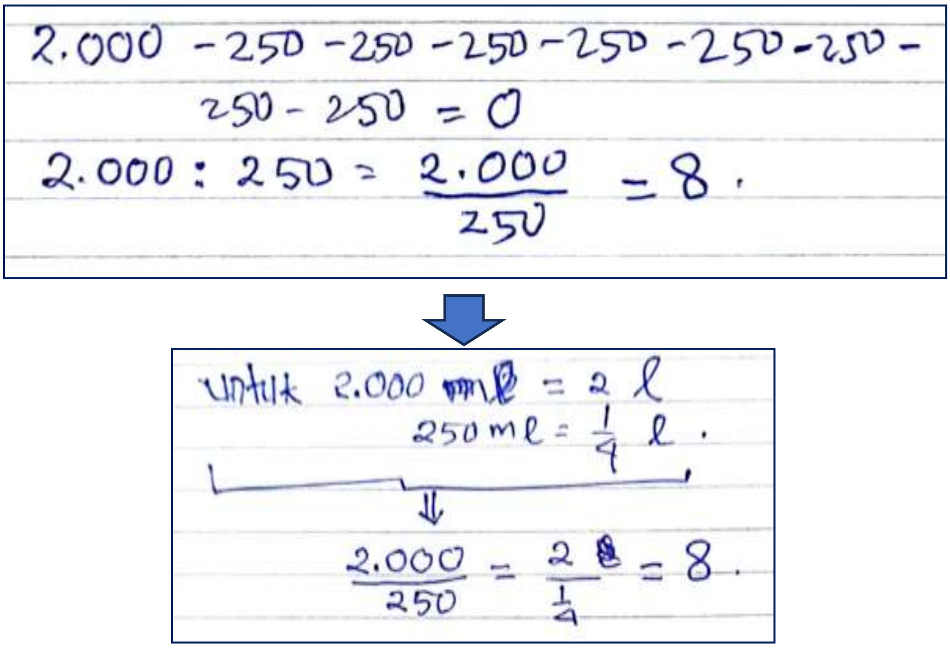


Figure 5. Gn creates context problem solving

In this stage students have achieved a cognitive process in the form of encapsulation to achieve a mathematical object regarding dividing fractions (Hasbi et al., 2019; Widada, Efendi, Herawaty, & Nugroho, 2020).

Make Mathematical Conclusions

Students are completely able to solve problems and formulate mathematical principles formally. It is expressed as follows.

Q : *What can you conclude mathematically?*

Gn : *I can conclude mathematically that,*

$2 \div \frac{1}{4} = 2 - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} = 0$ *and that is that* $2 \div \frac{1}{4} = 8$ *(see Figure 6).*

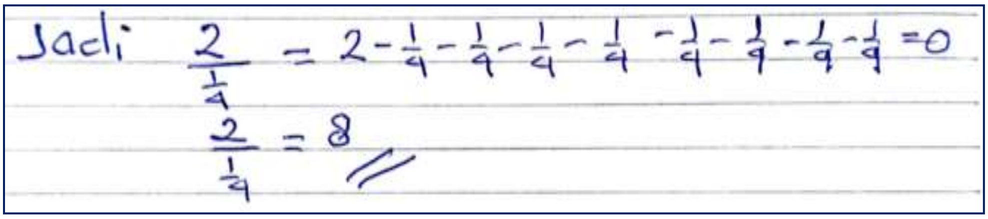
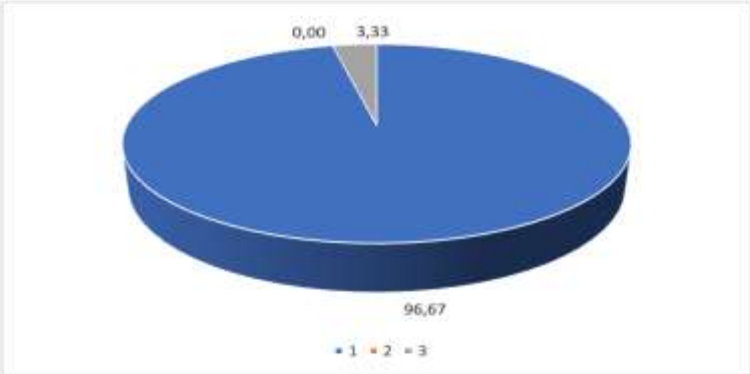


Figure 6. Gn makes mathematical conclusions

Gn shows excellent cognitive processes in understanding the concepts and principles of dividing fractions. It is a complete five stages (Fritz, Ehlert, & Balzer, 2013; Amanat & Reid, 2012). Students could be more meaningful in preparing propositions about fractional operations. Students can state that the division of fractions is a repeated reduction. Through giving contextual problems students can solve abstractions starting from symbolic-active-iconic and can reach the concept of dividing fractions appropriately (Widada, Herawaty, Lusiana, et al., 2020). Thus, Gn is a student who represents students in his class with a cognitive process that starts from enactive, continues with iconic, and ends with symbolic.

Student Responses to Learning

Based on data analysis of student responses regarding learning fractions based on the Lake Gegas Tourism context. This was obtained from the responses of 30 (thirty students) after participating in the lesson. The results can be seen in Figure 7.



Description: 1 = like; 2 = dislike; 3 = just normal

Figure 7. Students' responses to learning fractions through a tourism context

Based on Figure 7, it is found that there are 96.67% of students who like learning fractions in the Lake Gegas tourism context; no one doesn't like it and only 1 person out of 30 people is normal. After being asked by an ordinary student, he answered that he was used to studying mathematics with the help of real media taught by his private teacher. This indicates that all students like learning mathematics through a contextual approach. This is a positive thing for learning mathematics, because so far the majority of students do not like mathematics (Herawaty, Widada, Herdian, & Nugroho, 2020). Students have fun and are motivated to learn fractions through a local tourism context (Andriani et al., 2020).

Percentage of Students' Cognitive Process Stages

Based on observation data regarding the stages of students' cognitive processes, results were obtained in diagram form (see Figure 8).

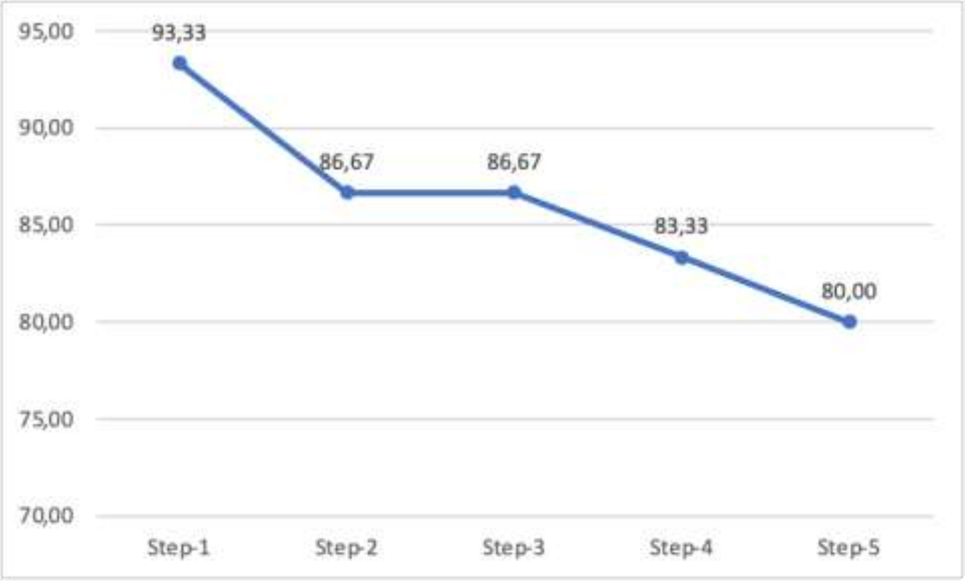


Figure 8. Percentage of each stage of the student's cognitive process

Based on Figure 8, the classical cognitive process stages are as follows. There were 93.33% of students who were able to understand the problems in the context of Lake Air Gegas tourism (Step-1); 86.67% of students were able to carry out Step-2, namely creating a mathematical model based on context; Students were able to complete mathematical models based on context (Step-3) as many as 96.67%; 83.33% of students were able to do Step-4, namely solving context problems; and 80.00% of students were able to make mathematical conclusions (Step-5). This shows that almost all students are able to go through each stage of the cognitive process in understanding fractions in the context of Lake Gegas tourism. To improve the understanding of mathematical concepts, learning must begin with the real objects in daily life, which were culturally oriented concerning horizontal mathematics known as the ethnomathematics (Widada, Herawaty, & Lubis, 2018). Students can build an understanding of operations multiplication and division, including verbal communication, writing, and drawing based on real media from local culture (Widada, Herawaty, Pusvita, et al., 2020).

CONCLUSION

The students' cognitive process in understanding fractions through a tourism context is that students first understand the problems in the tourism context of Lake Air Gegas; then students create mathematical models based on context; third, students complete mathematical models based on context; the fourth student creates a solution to the context problem; Finally, students make mathematical conclusions. Through the tourism context, students can solve problems appropriately. The conclusion is that there are five stages of students' cognitive process in discovering the principle of multiplication of fractions, namely students understand the problem through a tourist context, create a mathematical model based on context, complete a mathematical model based on context, create a context problem solution, and end by making mathematical conclusions about the principle of Multiplication of

Fractions. Therefore, it is recommended that mathematics teachers use the tourism context as a starting point for mathematics learning.

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