



Learning obstacles analysis of lowest common multiple and greatest common factor in primary school

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Abstract

This research aims to find learning obstacles for students studying LCM and GCF as a reference in preparing teaching materials that can overcome these obstacles. This research involved 74 grade V students at three public schools in Bandung, Indonesia. The research method used in this study was case study research—data collection techniques using triangulation by providing tests, interviews, and documentation. Data analysis techniques use data collection, reduction, presentation, and conclusions. The results show three categories of learning obstacles: ontogenic, epistemological, and didactic. The ontogenic obstacle was found because the students understood multiples, factors, and arithmetic operations on natural numbers in solving LCM and GCF problems. Epistemological obstacles were discovered because of the limited context in which students understood the concepts of LCM and GCF, so they could not use them in contexts such as word problems. Didactical obstacles were found from learning that was given by the teacher procedurally using factoring methods, namely prime factorization or factor trees. Therefore, these obstacles must be anticipated by designing learning designs that can facilitate learning trajectories, focus on concepts, and make learning more meaningful.

Keywords: greatest common factor; lowest common multiple; learning obstacles

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Introduction

Mathematics is a science that is obtained by reasoning. This is meant not to mean that other knowledge is obtained not through reason, but that mathematics emphasizes activities in the world of ratio (reasoning) (Suherman, 2003). Learning mathematics is a process of interaction between teachers and students involving logical thinking about mathematical concepts and structures (Hudoyo, 2000). Mathematics is also seen as a science used to construct and hone thinking skills in everyday life. Therefore, studying mathematics can improve thinking logically, systematically, critically, and creatively (Kemdikbud-ristek, 2022). Mathematics is one of the subjects studied by students in elementary school. Mathematics is not easy for students to learn because the facts show that many students still experience obstacles in learning mathematics, which makes learning outcomes low (Yeni, 2015).

Based on the research of Stacey (2011) showed low student learning outcomes in learning mathematics because students have a low ability to connect mathematical concepts with events that exist in real life. This is caused by several factors, namely, the mathematics learning developed by the teacher is limited to memorizing formulas and understanding some concepts so that learning becomes less meaningful (Ishartono et al., 2016). In addition, based on the Trends in International Mathematics and Science Study (TIMSS) 2015 survey, Indonesian students' mathematics has not shown satisfactory achievement. Indonesian students' mathematics ranks 44th out of 49 countries with a score of 397. This score is still quite far from the international average score of mathematics, which is 500 (IEA, 2015). The questions tested in TIMSS measure reasoning, problem-solving, and argumentation abilities related to everyday life. The low ability of Indonesian students to solve everyday problems using mathematical concepts is because students experience difficulties in learning mathematics.

Student's difficulties in learning mathematics can be found in the materials studied by students, especially in elementary schools, one of which is the material for the Lowest Common Multiple (LCM) and Greatest Common Factor (GCF) (Ayu & Nurafni, 2022; Fauzan et al., 2020). This can be seen from the results of Meilani and Maspupah's research (2019), students do not understand what is meant by factors, multiplication, multiplication, as well as the division which are prerequisite materials in studying LCM and GCF. Likewise, from the research results of (Mufidah & Fauziah, 2021), students made mistakes in understanding the questions and determining how to solve story problems using the LCM and GCF. This is because students do not know how to choose the ratio of factors, do not write down the factorization of prime numbers, and do not understand how to do word problems.

Several studies on LCM and GFC focus on developing learning using certain learning approaches, models, or methods, such as using the RME approach (Fauzan et al., 2020), using problem-based learning models (Li & Tsai, 2021), and implementing APIQ (Arithmetic Plus Quantum Intelligence) creative mathematics game method (Rahman, 2018). In addition, research on LCM and GCF misconceptions was conducted by (Sutarto, 2021) on fourth grade elementary school students. The misconceptions in this study were that students experienced misconceptions due to factors, the weak concept of multiplication and prime numbers, and the

inability of students to distinguish multiples and factors of a number. None of these studies have focused on analyzing the learning difficulties experienced by students in learning LCM and GCF.

Students who experience learning difficulties result in errors in solving a problem. From these student mistakes, obstacles arise when learning, known as learning obstacles (Brousseau, 2002). Learning obstacles are categorized into three types (Brousseau, 2002): (1) Ontogenic obstacle, namely the obstacle caused by the learning given, is not by the level of students' thinking. If the learning that students receive is at a level that is too high for their level of thinking, then they experience difficulties in understanding mathematical material. If, on the contrary, the learning that students receive is at a level that is too low for their level of thinking, then students will not experience the actual learning process; (2) Epistemological obstacles are due to limited contexts that are known to students. Students can understand concepts partially, so they cannot use these concepts to solve different problem contexts; and (3) Didactical obstacles, namely obstacles that occur because of the learning given by the teacher. The learning provided by the teacher influences the construction of students' understanding of studying material. Therefore, the teacher is essential in facilitating students' understanding of concepts.

This study will analyze the characteristics of learning obstacles in LCM and GCF material in fourth grade of primary school. This research investigates the factors of students' learning obstacles related to LCM and GCF in the problem-solving process. It is hoped that this research can assist teachers in developing learning process designs on LCM and GCF materials to overcome these learning obstacles. It is also expected to be a reference material and provide motivation to develop further research.

Methods

The research method used in this study was a case study conducted at three public elementary schools in Bandung, Indonesia. This study involved 74 grade five students as subjects from three different school characteristics, and each school took one class to take the test. The samples taken in this study used a purposive sampling technique. Purposive sampling is a sampling technique through various considerations (Sugiyono, 2017). The characteristics of students with high, medium, and low abilities are the reason for taking the sample in this study.

The data source used in this study was obtained from primary data sources, namely sources or sources that provide data directly. Data collection techniques from test results, interviews, and documentation. The test is used to identify learning obstacles in LCM and GCF materials. The test consists of five questions with validity and reliability through expert judgment. The interviews were conducted with several students to confirm the test results by digging up the data as completely and as deeply as possible so that the researcher's understanding of the existing phenomena followed the students' own understanding. Furthermore, documentation is in document analysis, such as textbooks and teachers' learning tools when teaching LCM and GCF. The data analysis technique uses triangulation, namely checking data from test results, interviews, and documentation concerning the validity and

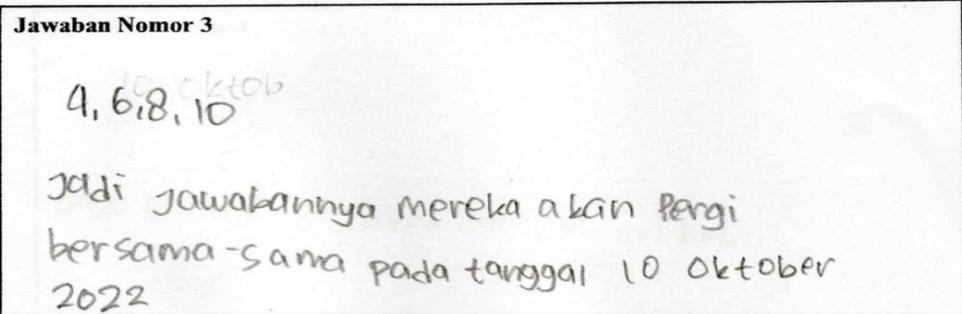
reliability of this study (Sarosa, 2012). The results of the analysis are presented with a narrative method.

Results

After the researchers conducted tests on grade five students and identified the learning obstacles found in the LCM and GCF materials, there were three categories of learning obstacles : ontogenic, epistemological, and didactical.

Ontogenic obstacles

An ontogenic obstacle occurs in the application of the LCM concept. The incompatibility of teaching materials or didactic designs used by students in learning causes students to think about the material for applying the LCM concept. In Figure 1, the following is an example of the answers of students who experience ontogenic obstacles.



Soal Nomor 3
Ibu Siti, Ibu Dini, dan Ibu Neni suka berbelanja ke pasar Gedebage. Ibu Siti pergi berbelanja setiap 4 hari sekali, Ibu Dini pergi berbelanja setiap 6 hari sekali, dan Ibu Neni pergi berbelanja setiap 8 hari sekali. Jika pada tanggal 5 Oktober 2022 mereka pergi berbelanja bersama, pada tanggal berapa mereka akan pergi bersama-sama lagi?

Jawaban Nomor 3
4, 6, 8, 10
jadi jawabannya mereka akan pergi bersama-sama pada tanggal 10 Oktober 2022

Translation:
Question number 3
Mrs. Siti, Mrs. Dini, and Mrs. Neni like to go shopping at the Gedebage market. Ibu Siti goes shopping every 4 days. Ibu Dini goes shopping every 6 days, and Ibu Neni goes shopping every 8 days. If on October 5, 2022, they go shopping together on what date will they go together again?
Answer number 3
4, 6, 8, 10
so, the answer is they will go together on October 10, 2022

Figure 1. Student's obstacles in applying the LCM concept

In Figure 1 above it can be seen that students experience obstacles in understanding and solving problems appropriately. Figure 1 above occurs because students do not understand the concept of LCM, so students look for multiples of the numbers in the problem. Students only fixate on the answer by looking for multiples of the numbers in the question. Students conclude

that the numbers written in the questions are interconnected and answer the questions with the next series on the numbers in the problem. Students need to fully understand the use of the LCM concept in solving the questions above.

Epistemological obstacles

Students understand the material well but need help to use their understanding in solving problems in various contexts, one of which is story problems. Students experience difficulties interpreting questions into appropriate mathematical solutions, so students write wrong answers. Figure 2 below is an example of the responses of students who experience epistemological obstacles.

Soal Nomor 1
Amel memasang lampu di kamarnya dengan dua warna lampu yang berbeda, yaitu warna merah dan warna biru. Lampu berwarna merah menyala setiap 3 menit sekali dan lampu berwarna biru menyala setiap 4 menit sekali. Amel menyalakan lampu berwarna merah pada pukul 20.00 WIB dan lampu berwarna biru pada pukul 20.15 WIB. Pada pukul berapa kedua lampu akan menyala bersama-sama?

Jawaban Nomor 1
merah
20.00 → 20.03 → 20.06 → 20.09 → 20.12
20.15 → 20.19 → 20.23 → 20.27 → 20.31

Translation:

Question number 1
Amel installed lights in her room with two different lights, namely red and blue. The red light flashes every 3 minutes, and the blue light flashes every 4 minutes. Amel turned on the red light at 20.00 WIB and the blue light at 20.15 WIB. At what time will both lights come on together?

Answer number 1
Red: 20.00 → 20.03 → 20.06 → 20.09 → 20.12
Blue: 20.15 → 20.19 → 20.23 → 20.27 → 20.31

Figure 2. Student's obstacles in applying the multiplication concept

The student answers in Figure 2 above show that students experience obstacles in understanding the meaning of the questions. Students understand the concept of multiples but need help to use it in contexts like the story questions above. Students need to be corrected in determining when the blue light starts to turn on. Students also need help concluding the results of the answers, so students cannot answer questions from the questions correctly.

Didactical obstacles

The learning given by the teacher influences the construction of students' understanding of the LCM and GCF material they learn. The teacher plays an essential role in facilitating students' understanding of concepts. As a result, if the learning carried out by the teacher is not by the flow of student learning it results in a didactical obstacle. Figure 3 below is an example of the answers of students who experience didactical obstacles in understanding multiples.

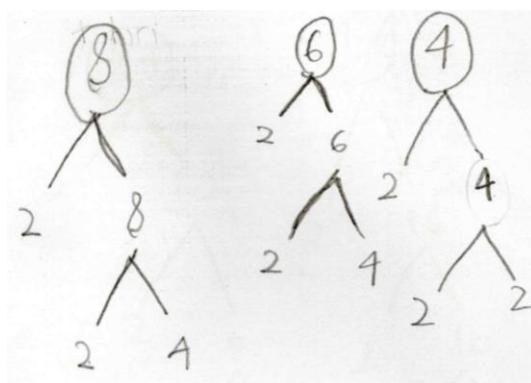


Figure 3. Student's obstacles in factoring numbers

In Figure 3 above, it can be seen that students experience obstacles in factoring using prime factorization or factoring trees. A factor tree is a way to find all the prime numbers of a number written along with their factor pairs. For example, in Figure 3 above, the number 8 forms the first branch of the tree, namely prime number 2, and its partner, namely 4, which means 2 multiplied by 4 equals 8. However, students answered with the first tree, namely 2 and 8, so the concept of multiplication between the two factors is two multiplied by 8 equals 16. In addition, students do not fully understand if the factor tree stops when it has the last branch of all prime numbers.

Discussion

First, the ontogenic obstacle is the discrepancy between the teaching materials or didactic designs provided with students' thinking levels, categorized as Brousseau (2002). This is because the teaching materials used by students are still very procedural, so there is a jump in students' thinking in studying the LCM and GCF material (Desriyati, 2015). Students learn LCM and GCF material procedurally from abstract matters so that the flow of students' thinking is not bridged from a basic understanding of both the factor concept, the multiple concepts, and the LCM and GCF concepts (A'Yun & Rahmawati, 2018). Therefore, the level of thinking

students receive is too high and students have difficulty understanding the LCM and GCF materials.

Another student obstacle, namely the epistemological obstacle, means that obstacles to the learning process occur due to the limited context students know (Brousseau, 2002). Students need help using multiple to solve the story problems presented. The limitations of the context that students learn are because students only receive an understanding of the concept as a whole so when faced with a different context students experience difficulties in using it (Suryadi, 2019). The causes of the obstacles are the lack of variety of multiples or LCM questions, and the lack of practice questions in the form of story questions (Meilani & Maspupah, 2019)(Meilani & Maspupah, 2019). Therefore, students have difficulty understanding and interpreting word problems in mathematical form.

Furthermore, the obstacle that occurs is the didactical obstacle, namely the difficulties experienced by students due to the learning carried out by the teacher (Brousseau, 2002). Students experience problems in how to factor using prime factorization or factor trees. This is because the planting of the concept of prime factorization or factor trees taught by the teacher does not provide a comprehensive meaning. In instilling concepts, the teacher must provide many experiences to students in various situations and can also facilitate students' thinking and learning trajectory possibilities (Rohimah, 2017). These student Obstacles are because students have difficulty understanding the concept of prime numbers and the use of factor trees in finding all the prime numbers of a number. This happens because the learning done by the teacher is still very procedural (Yensy, 2020). Students are given examples of working procedures using factor trees and memorizing these procedures (Khairiyah, 2019). The teacher does not provide other variations in problem-solving and does not provide alternatives to look for multiples other than the factor tree technique (Hadi, 2016). Therefore, the learning provided by this teacher impacts students' understanding which is only procedural, not conceptual.

Conclusion

The characteristics of learning obstacles in the LCM and GCF are ontogenic, epistemological, and didactical. The ontogenic obstacle was found due to the students' thinking leaps in understanding the concept of multiples, factors, and arithmetic operations on natural numbers in solving LCM and GCF questions. The epistemological obstacle was found due to the limited context in which students understood the concepts of LCM and GCF, so they could not use them in contexts such as word problems. Didactical obstacles were found from teacher learning given procedurally in solving LCM and GCF problems. The teacher focuses on the procedures for solving LCM and GCF problems by factoring, namely prime factorization or factor trees, so understanding the concepts of LCM and GCF is not discussed in depth. This study suggests that this learning obstacle can be studied further and used as a reference for developing learning process designs or teaching materials to overcome the learning obstacles found in the LCM and GCF.

The findings of this study can be used for teachers to develop learning designs that can anticipate learning obstacles that occur in LCM and GCF materials. This learning design can also facilitate students' learning trajectories, focus on concepts, and make learning more meaningful. The limitation of this research is that more respondents can be added to get more findings.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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Author Contributions

Muhammad Rifqi Mahmud: Conceptualization, writing - original draft, editing, and visualization; **Turmudi:** Reviewing, validation, and supervision; **Wahyu Sopandi:** Reviewing, validation, and supervision; **Siti Maryam Rohimah:** Writing - review, editing, and methodology; **Inne Marthyane Pratiwi:** Investigation, formal analysis, and resources.

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