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The Profile of Students' Errors in Constructing Mathematical Concepts on Gcd and Lcm Topics in Grade VII Junior High School Based on Cognitive Styles

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A B S T R A C T

This study aims to describe students' errors in constructing mathematical concepts when solving problems on GCD and LCM, viewed from their cognitive styles. This study employed a descriptive qualitative approach. Two students were selected as research subjects based on the results of the Group Embedded Figures Test (GEFT), each representing the Field Independent (FI) and Field Dependent (FD) cognitive styles. Data were collected through tasks on GCD and LCM, followed by interviews. The data were analyzed using an iterative model, consisting of data condensation, data display, and conclusion drawing. The research findings indicate that FD students make a wider variety of errors compared to FI students. Pseudo Construction was the most dominant type of error in both subjects, indicating a discrepancy between students' conceptual understanding and their written answers. In addition, FD students showed incomplete conceptual structures and difficulties in using analogies, whereas FI students tended to experience more errors in logical reasoning. Thus, it can be concluded that differences in cognitive styles influence the types and complexity of students' concept construction errors; therefore, learning strategies that emphasize conceptual understanding and are adapted to students' cognitive characteristics are needed.

1. Introduction

Mathematics is a subject studied because it is highly useful and important, as it is applied in various fields of science (Maulidina et al., 2026). Mathematics is one of the areas of study that is continuously used to solve problems in everyday life (Aprillia et al., 2025). From the simplest activities to the advancement of sophisticated technology, humans cannot be separated from mathematics (Wulandari et al., 2021). The challenge in learning mathematics is closely related to students' ability to construct mathematical concepts. Many students tend to

merely imitate procedures demonstrated by the teacher without deeply understanding the underlying concepts. This condition results in a learning process that fails to optimally develop students' thinking and reasoning ability (Ni'mah et al., 2018). Therefore, mathematics learning needs to emphasize the process of constructing concepts based on students' prior knowledge.

Mathematics learning is a process of constructing newly learned concepts that are connected to previously understood concepts (Sutama et al., 2020). Knowledge will be formed when students actively engage in the construction process, allowing prior concepts to be used in learning subsequent concepts (Mayorova, 2021). The active involvement of students in connecting prior concepts with new ones is crucial so that the understanding formed becomes more meaningful and supports success in solving mathematical problems (Sojinu et al., 2025). Therefore, conceptual understanding is a crucial aspect that must be developed in mathematics learning.

Conceptual understanding is a key indicator of success in mathematics learning (Sakina et al., 2026). According to Oktarino et al (2025) conceptual understanding refers to students' ability to comprehend the material, represent it in a simpler form, and apply it in accordance with their cognitive structure. Several studies indicate that many students still experience difficulties in comprehensively understanding mathematical concepts (Takdirmin, 2023). One of the influencing factors is the diversity of students' cognitive styles. Cognitive style plays a role in determining how individuals receive, process, and use information to solve problems (Nurmutia, 2019). These differences in cognitive styles have the potential to result in variations in the types and levels of errors made by students.

According to Baskorowati & Wijayanti, (2020), an error is a form of deviation from what is considered correct or has been agreed upon. Similarly, Sulistio et al., (2019) define an error as a deviation from something that is correct. Aulia & Kartini, (2021) also state that an error is a deviation from correctness. Thus, it can be concluded that an error is a deviation made by an individual in completing a task due to non-compliance with established rules or standards. According to Subanji, (2015), errors in constructing mathematical concepts include Pseudo Construction, Hole Construction, Miss-Analogical Construction, and Miss-Logical Construction. This theory has been applied by Ni'mah et al., (2018) in research on students' errors in constructing mathematical concepts. The occurrence of concept construction errors indicates that differences in students' cognitive styles can influence the process of understanding and solving mathematical problems. The causes of students' errors in solving problems on GCD and LCM material may also be influenced by cognitive style factors. According to (Irfan, 2017), there is a possibility that students experience various types of errors when solving problems. These errors may be caused by a lack of understanding, low self-confidence, and differences in students' cognitive styles.

According to Agoestanto et al., (2019), cognitive style is an important variable that influences students' choices in the academic field and their continuous academic development. Saudi et al., (2018) state that cognitive style essentially focuses on the consistent characteristics of individuals (which does not mean that these

characteristics cannot be changed) in terms of how they think, remember, process information, and solve problems. Meanwhile, Luthfiana & Kurniawan, (2024) define cognitive style as the diversity among individuals in remembering, receiving, and attending to information, which differs across personality and cognitive aspects.

In the context of mathematics, the GCD and the LCM are fundamental concepts that require strong conceptual understanding. Mathematics, as a discipline that emphasizes structure, symbols, and relationships among concepts, requires an appropriate process of knowledge construction (Unaenah et al., 2020). However, research findings indicate that students still frequently make errors in solving GCD and LCM problems, such as errors in identifying prime factors, procedural errors, and inaccuracies in applying concepts. This indicates the presence of concept construction errors that require further analysis.

This study aims to describe the errors frequently made by students, so that it can also contribute to designing more effective teaching methods to improve students' understanding of more complex mathematical concepts in accordance with their needs. Therefore, this study is expected to contribute to efforts to improve the quality of mathematics learning, particularly in the topics of the Greatest Common Divisor (GCD) and the Least Common Multiple (LCM).

2. Methodology

A qualitative approach was employed in this study. The researcher administered the GEFT test to 14 seventh-grade students at SMP Karuna Dipa Palu to classify them based on FI and FD cognitive styles, as well as to identify the conceptual construction errors made. The classification results revealed that there were 5 students with an FI cognitive style and 9 students with an FD cognitive style.

Subsequently, the task on GCF and LCM presented in Figure 1 was administered to 14 students. Based on the analysis of students' work, one subject from each category FI and FD was selected by considering the level of errors, communication skills during the interview, and teacher recommendations. Therefore, the research subjects consisted of two students, namely one FI student and one FD student.

1. Lia will soon celebrate her 13th birthday. She plans to invite orphaned children to her house and give them gift packages. Lia's savings are only enough to buy 60 notebooks and 48 pencils. Each child will receive the same number of notebooks and pencils.
   a) What is the maximum number of orphaned children that can be invited to her birthday party?
   b) How many notebooks and pencils will each child receive?
2. Farhan and Tedi have a routine habit of exercising at a gym. Farhan goes to the gym every 8 days, while Tedi goes every 12 days. On April 15, 2025, Farhan and Tedi went to the gym together for the first time. On what date will they go to the gym together for the second time after April 15, 2025?

Figure 1. Task on GCD and LCM

Subsequently, the researcher identified and classified the errors in constructing mathematical concepts made by students in solving the GCD and LCM tasks, based on the indicators presented in Table 1.

Table 1. Indicators of Errors in Constructing Mathematical Concepts

No.	Indicators of Errors in Constructing Mathematical Concepts	Forms of Errors in Constructing Concepts on GCD and LCM Material
1	Pseudo Construction Errors in concept construction that occur when students have a different understanding of the concept, but what they write does not align with that understanding, resulting in an incorrect answer.	"Correct" Pseudo Construction Students provide a correct answer to a GCD and LCM problem. However, upon further examination, it turns out that the students made mistakes in clarifying their answers.
		"Incorrect" Pseudo Construction Students provide an incorrect answer to a GCD and LCM problem. However, upon further examination, the students actually demonstrate correct reasoning and are able to provide the correct answer.
2	Hole Construction Errors in concept construction experienced by students occur because the thinking structure formed during the process of concept construction is incomplete.	Students provide a correct answer, but the process of concept construction within the student is not appropriate.
		Students provide a correct answer, but the concept is not fully formed in the student's mind.
3	Miss-Analogical Construction A concept construction error caused by students equating one concept with another.	Students provide an incorrect answer because they equate one concept with another.
4	Miss-Logical Construction A concept construction error that occurs when students make mistakes in logical reasoning and have insufficient understanding of the given problem.	Students provide an incorrect answer because they are unable to reason or comprehend the problem correctly.
		Students provide an incorrect answer because they are unable to think logically about the problem.

Adapted from (Ni'mah et al., 2018)

3. Results and Discussion

This study began with the administration of GCF and LCM tasks to all students, which were completed individually. The researcher then identified the abilities and errors made by the students. Subsequently, the researcher analyzed the students' work to categorize the types of conceptual construction errors based on predetermined indicators. Based on the analysis, two research subjects representing FI and FD cognitive styles were selected, considering the level of errors made and the students' communication skills. The FI cognitive style was represented by a student with the initials AFK, while the FD cognitive style was represented by a student with the initials PD. The researcher conducted in-depth interviews with the selected subjects to further explore their thinking processes in solving GCF and LCM problems. The data obtained from students' work and interviews were then qualitatively analyzed to identify and describe the profiles of students' mathematical conceptual construction errors.

The results obtained show that in task number 1, the student with an FI cognitive style made Pseudo Construction and Miss-Logical Construction errors, while the FD student made Miss-Analogical Construction, Pseudo Construction, and Hole Construction errors. In task number 2, the FI student again made Pseudo Construction and Miss-Logical Construction errors, whereas the FD student made Miss-Analogical Construction, Pseudo Construction, and Miss-Logical Construction errors. Thus, overall, the FI subject committed only two types of errors, namely Pseudo Construction and Miss-Logical Construction, while the FD subject committed four types of errors, namely Pseudo Construction, Hole Construction, Miss-Analogical Construction, and Miss-Logical Construction. The following is an explanation for each subject.

Concept Construction Errors by AFK Subjects on GCF and LCM Material

Pseudo Construction errors are the most frequently found in solving tasks on GCF and LCM material completed by the two subjects. Pseudo Construction errors occur when students have a different conceptual understanding, but what they write does not align with that understanding, resulting in incorrect answers as shown in Figure 2.

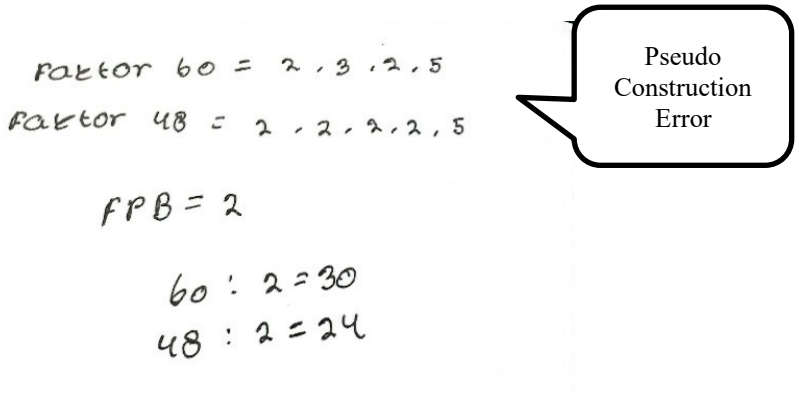

Figure 2. Pseudo Construction Error Made by AFK Subject

The student's answer in Figure 2 shows the occurrence of an error. The student assumed that using a comma (,) in writing prime factors was correct. The answer appeared to be correct at first glance, but upon closer examination it turned out that the student's reasoning did not align with the substantive concept. In this case, the student committed a Pseudo Construction error. Table 2 presents an excerpt from the interview.

Table 2. Excerpts from Interviews Related to This Error :

Interview	Interview Transcript
P9 :	Why did you use a factor tree?
AFK9 :	To find the prime factors of 60 and 48.
P10 :	Okay, after that what else did you do?
AFK10:	I wrote the prime factors of 60 and 48, and then found the GCF of 60 and 48.
P11 :	Is the way of writing the prime factors correct? Should it use a multiplication sign or a comma?
AFK11:	It's correct, you can use either a multiplication sign or a comma.

The dialogue shows that the participant was confident in their answer, stating that writing prime factors could be done using a comma (,). The student who demonstrated this Pseudo Construction error may have been influenced by their habit of solving similar types of problems by listing numbers with commas, without rechecking the underlying concept. This is consistent with the opinion of Indri et al., (2018), who stated that students experiencing Pseudo Construction are usually accustomed to solving problems with the same pattern, so they tend to reuse the same procedure without a deeper understanding. The student also committed a Miss-Logical Construction error in solving the given test problems. Miss-Logical Construction errors occurred across all the problems provided. This error arose because the student was unable to reason logically in connecting concepts, as shown in Figure 3.

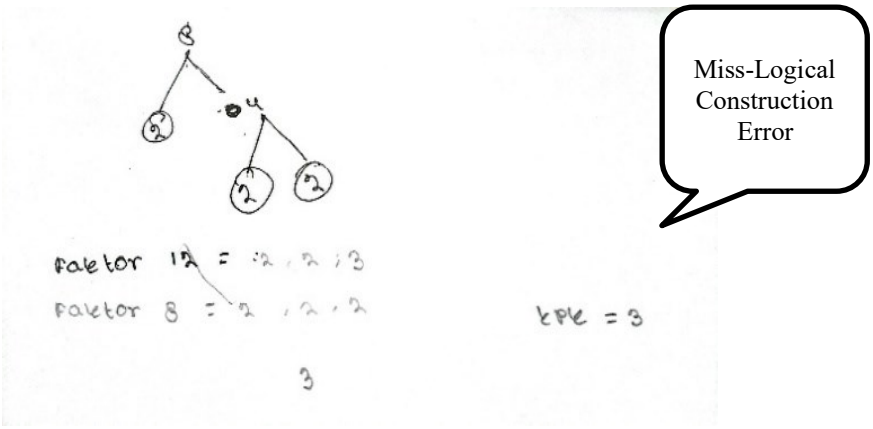

Figure 3. Miss-Logical Construction Error Made by AFK Subject

The error occurred because the student showed inconsistency in reasoning by incorrectly determining the value of the LCM and failing to connect the calculation results with the context of the problem, making the reasoning process illogical. The student committed an error in logical concept construction, referred to as Miss-Logical Construction, in this type of solution. In this case, the student demonstrated a Miss-Logical Construction error. Table 3 presents an excerpt from the interview.

Table 3 . Excerpts from Interviews Related to This Error

Interview	Interview Transcript
P22 :	How did you determine the LCM of 12 and 8?
AFK22 :	By choosing the largest number from their prime factors
P23 :	And after that?
AFK23 :	So the result obtained was 3. That means, from the problem, Farhan and Tedi will go to the gym together for the second time after April 15, 2025, which is 3 days after April 15. Therefore, the answer is April 18, 2025.

Miss-Logical Construction errors in GCF and LCM material usually occur because students do not follow a logical reasoning process in solving problems. Some of the main causes are that students have not deeply understood the basic concepts of GCF and LCM, so the steps they use are either incorrect or out of sequence. In addition, students often confuse when to use GCF and when to use LCM, especially in word problems. The habit of memorizing procedures without understanding their

meaning also makes students prone to logical errors, such as incorrectly determining relevant factors or multiples. A lack of accuracy and failure to recheck their answers further aggravates the mistakes, resulting in final answers that do not match the proper solution. Students give incorrect answers because they are unable to think logically when solving problems (Ni'mah et al., 2018).

Concept Construction Errors by PD Subjects on GCF and LCM Material

The Pseudo Construction errors that occurred in PD subjects were similar to those made by AFK subjects. Pseudo Construction errors occur when students have a different conceptual understanding, but what they write does not align with that understanding, resulting in incorrect answers as shown in Figure 4.

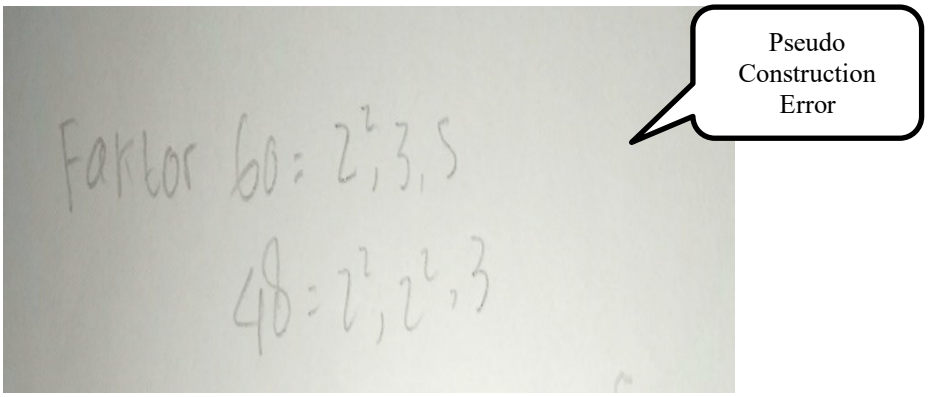

Figure 4. Pseudo Construction Error Made by PD Subject

The student's answer in Figure 4 shows that the student made a mistake. The student assumed that using a comma (,) in writing prime factors was correct. The answer appeared to be correct at first glance, but upon closer examination it turned out that the student's reasoning did not align with the substantive concept. In this case, the student committed a Pseudo Construction error. Table 4 presents an excerpt from the interview.

Table 4. Excerpts from Interviews Related to This Error

Interview		Interview Transcript
P9	:	Why did you use a factor tree?
PD9	:	To find the prime factors of 60 and 48.
P10	:	Okay, after that what else did you do?
PD10	:	I wrote the prime factors of 60 and 48, and then found the LCM of 60 and 48.
P11	:	Is the way of writing the prime factors correct? Should it use a multiplication sign or a comma?
PD11	:	Yes.

The dialogue shows that the participant was confident in their answer, stating that writing prime factors could be done using a comma (,). The student who demonstrated this Pseudo Construction error may have been influenced by their habit of solving similar types of problems by listing numbers with commas, without rechecking the underlying concept. This is consistent with the opinion of Indri et

el., (2018), who stated that students experiencing Pseudo Construction are usually accustomed to solving problems with the same pattern, so they tend to reuse the same procedure without a deeper understanding.

Students also made Construction Hole errors in solving the given test problems. The students' reasoning structure was incomplete. There was a "hole" in the reasoning structure as a result of concept construction, which is referred to as a Construction Hole. The presence of a Construction Hole can be explored more deeply through student interviews. Table 5 presents an excerpt from the interview.

Table 5. Excerpts from Interviews Related to This Error

Interview		Interview Transcript
P12	**:**	Okay. Now, how did you solve part B?
PD12	**:**	I still don't really understand, so I couldn't solve part B.
P13	**:**	Was there nothing you understood from that problem?
PD13	**:**	Nothing, I was confused about how to do it.

Construction Hole errors occur because students are unable to connect the steps of problem-solving in a sequential and logical manner, leaving parts "empty" or skipped in their reasoning process. As a result, the concepts that should serve as links between steps are not used correctly, making the solution incomplete and inconsistent with the proper structure. This is consistent with Sulfriani et al., (2021), who stated that Construction Holes are concept construction errors caused by the incompleteness of students' reasoning structures formed during the construction process. Similarly, Putra et al., (2023) explained that Construction Holes are imperfections in the reasoning structure built by research subjects during concept construction.

Miss-Analogical Construction errors occur when students fail to use or build appropriate analogies between concepts they already understand and new concepts being learned. In other words, students are unable to see similarities in patterns, structures, or relationships among concepts, and therefore cannot apply prior knowledge as a basis for solving new problems. As a result, their understanding becomes incomplete or incorrect because analogies that should help are either not used or misapplied. Table 6 presents an excerpt from the interview.

Table 6. Excerpts from Interviews Related to This Error

Interview		Interview Transcript
P13	**:**	Okay. How about problem number 2?
PD13	**:**	I solved it using GCF.
P14	**:**	How did you know that the problem was a GCF problem?
PD14	**:**	Because problem number 1 already used the LCM method.
P15	**:**	Alright, after reading the problem, what information did you obtain?

Miss-Analogical Construction errors occur because students are unable to utilize similarities in concepts or patterns from previously learned material to solve the problem at hand. Ideally, students should use analogy as a bridge to understand new situations with the correct concept, but the lack of analogy use shows that

relationships between concepts are not deeply understood. This aligns with Hidayanto et al., (2017), who stated that Miss-Analogical Construction errors lead to mistakes in problem-solving, resulting in incorrect answers. Students also committed Miss-Logical Construction errors in solving the given test problems. Miss-Logical Construction errors occurred across all the problems provided. These errors arose because students were unable to reason logically in connecting concepts, as shown in Figure 5.

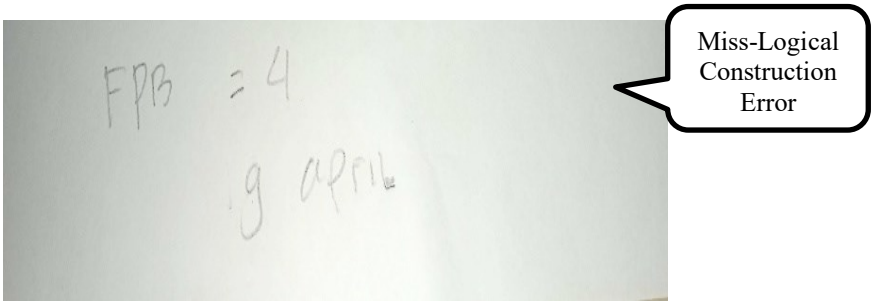

Figure 5. Miss-Logical Construction Error Made by PD Subject

The error occurred because the student showed inconsistency in reasoning by incorrectly determining the value of the LCM and failing to connect the calculation results with the context of the problem, making the reasoning process illogical. The student committed an error in logical concept construction, referred to as Miss-Logical Construction, in this type of solution. Table 7 presents an excerpt from the interview.

Table 7. Excerpts from Interviews Related to This Error

Interview		Interview Transcript
P20	**:**	after writing down the prime factors, what did you do next?
PD20	**:**	I determined the GCD by choosing the prime factors with the smallest exponents
P21	**:**	What did you do after that?
PD21	**:**	So, the result obtained is 4 Therefore, based on the problem, Farhan and Tedi will go to the gym together for the second time after April 15, 2025, which is on April 19, 202

Miss-Logical Construction errors in GCF and LCM material usually occur because students do not follow a logical reasoning process in solving problems. Some of the main causes are that students have not deeply understood the basic concepts of GCF and LCM, so the steps they use are either incorrect or out of sequence. In addition, students often confuse when to use GCF and when to use LCM, especially in word problems. The habit of memorizing procedures without understanding their meaning also makes students prone to logical errors, such as incorrectly determining relevant factors or multiples. A lack of accuracy and failure to recheck their answers further aggravates the mistakes, resulting in final answers that do not match the proper solution. Thus, the lack of accuracy and the habit of not reviewing answers reflect weak reasoning ability and problem comprehension, which ultimately cause students to produce incorrect answers. This is consistent with Hidayanto et al., (2017), who noted that students give wrong answers because they cannot reason or do not properly understand the question.

Differences in error characteristics between FI and FD students show that cognitive style influences how students process information and solve problems (Hasan, 2019). Students with a FI cognitive style tend to have better analytical skills and are able to organize solution steps systematically, although they still make errors in logical reasoning and accuracy. This aligns with Tahir et al., (2021), who stated that FI students tend to make mistakes in accuracy and operations. Meanwhile, FD students display more varied types of errors, such as Pseudo Construction, Construction Holes, Miss-Analogical Construction, and Miss-Logical Construction, reflecting that their conceptual understanding structure has not yet been fully formed.

The findings of this study are also consistent with previous research, which indicates that conceptual construction errors still frequently occur in mathematics learning. According to Mufidah et al. (2021) and Insani et al. (2022), errors in GCF and LCM material are generally caused by a lack of conceptual understanding and students' inability to translate problems into mathematical form, which in turn leads to mistakes in the problem-solving process. Furthermore, given the limited number of research subjects, the findings of this study are exploratory in nature; thus, the results cannot be widely generalized but rather provide an initial overview of students' conceptual construction errors.

4. Conclusion

Based on the results of the study, it can be concluded that seventh-grade students at SMP Karuna Dipa Palu still experience various forms of concept construction errors in solving GCF and LCM problems, which differ according to their cognitive style. Students with a FI cognitive style tend to commit Pseudo Construction and Miss-Logical Construction errors, while students with a FD cognitive style display more diverse errors, namely Pseudo Construction, Construction Holes, Miss-Analogical Construction, and Miss-Logical Construction. The most dominant error among both groups is Pseudo Construction, which indicates a mismatch between conceptual understanding and the answers written. In addition, FD students show incomplete conceptual structures and difficulties in using appropriate analogies, whereas FI students are more prone to errors in logical reasoning. Thus, it can be emphasized that differences in cognitive style influence the types and complexity of students' mathematical concept construction errors in GCF and LCM material.

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