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It's Not a Miscalculation - It's a Misconception! Uncovering Epistemological Obstacles in Preservice Teachers' Mathematical Literacy Tasks

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Abstract

This study identified and analyzed epistemological obstacles experienced by prospective elementary school teachers in solving mathematical literacy tasks on plane geometry material. This study employed a case study method, involving 24 students from a university, which was located in Cimahi City, West Java. The diagnostic test served as the research instrument and the data were analyzed using a thematic analysis approach to uncover various epistemological obstacles encountered by undergraduate students, including misconceptions regarding the properties of plane figures and difficulties in applying geometric concepts to mathematical literacy tasks. Epistemological obstacles arise due to the students' inability to connect abstract concepts with practical contexts, as well as their limited understanding of basic geometric concepts. These obstacles primarily stem from misconceptions about fundamental concepts of plane figures, difficulties in applying geometric concepts in contextual situations, and procedural learning approaches that lack conceptual depth. This research contributes to developing geometry learning strategies at the elementary school level, which can ultimately improve the overall quality of mathematics education.

Keywords: *epistemological obstacle, mathematical literacy, plane geometry.*

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi dan menganalisis hambatan epistemologis yang dialami oleh mahasiswa calon guru sekolah dasar dalam menyelesaikan tugas literasi matematis pada materi geometri bidang datar. Penelitian ini menggunakan metode studi kasus dengan melibatkan 24 mahasiswa dari sebuah universitas yang berlokasi di Kota Cimahi, Jawa Barat. Test diagnostik digunakan sebagai instrument penelitian, dan data dianalisis menggunakan pendekatan analisis tematik untuk mengungkap berbagai hambatan epistemologis yang dialami oleh mahasiswa, termasuk miskonsepsi terhadap sifat-sifat bangun datar dan kesulitan dalam menerapkan konsep geometri pada tugas literasi matematika. Hambatan epistemologis muncul karena ketidakmampuan mahasiswa dalam menghubungkan konsep-konsep abstrak dengan konteks praktis, serta keterbatasan pemahaman terhadap konsep dasar geometri. Hambatan-hambatan ini terutama berasal dari miskonsepsi mengenai konsep dasar bangun datar, kesulitan dalam menerapkan konsep geometri dalam situasi kontekstual, dan pendekatan pembelajaran prosedural yang kurang mendalam secara konseptual. Penelitian ini memberikan kontribusi terhadap pengembangan strategi pembelajaran geometri di tingkat sekolah dasar, yang pada akhirnya dapat meningkatkan kualitas pendidikan matematika secara keseluruhan.

Kata kunci: *hambatan epistemis, literasi matematis, bangun datar.*

INTRODUCTION

Epistemological obstacles in plane geometry are often caused by students' inability to understand the relationships between geometric elements, such as the properties of angles and sides in plane figures. These obstacles can arise due to teaching approaches that emphasize procedures over conceptual understanding, a lack of applicative contexts, or the students' limited spatial visualization abilities, closely relating to their level of mathematical literacy. The mathematical literacy not only includes the ability to perform calculations but also the capacity to think mathematically, formulate, use, and interpret mathematics to solve problems in real-life contexts. This involves the application of concepts, procedures, facts, and tools to describe, explain, and predict various phenomena.

In the era of globalization and advancements in information technology, mathematical literacy has become one of the key competencies that individuals in the 21st century must possess (Habibi & Suparman, 2020; Rizki & Priatna, 2019). It is not only related to the ability to calculate but also includes the capacity to formulate, use, and interpret mathematics in various real-life contexts (OECD, 2018). Regarding to the international assessments such as PISA, mathematical literacy is used as an indicator to measure students' ability to think critically and solve context-based problems (Andari & Setianingsih, 2021; Lestari et al., 2022; Muhaimin et al., 2024). Therefore, strengthening mathematical literacy has become an important agenda in the education system of various countries, including Indonesia.

In Indonesia, the development of mathematical literacy has been integrated into the national curriculum (Stacey, 2011; Widjaja, 2011). This encourages teachers to connect the teaching material with real-life contexts and emphasize conceptual understanding over rote memorization of formulas (Chandler-Olcott et al., 2015; Maryani & Widjajanti, 2020). In this context, the role of elementary school teachers becomes crucial, as they are responsible for laying the foundational mathematical thinking skills of students (Kurniasih et al., 2021).

Therefore, pre-service elementary school teachers, particularly the students in the Primary Teacher Education (PGSD) program, are required not only to master basic mathematics content but also to understand how to deliver it in a contextual and meaningful way for the students.

However, various studies have shown that pre-service teachers often face serious challenges in understanding and solving mathematical literacy tasks. Research has found that while pre-service teachers perform well on basic literacy tasks, they struggle with more complex problems (Yustitia et al., 2020). Their ability to solve problems using Polya's steps is generally weak, with only a small portion demonstrating strong problem-solving skills (Yayuk & Husamah, 2020). Pre-service teachers face specific difficulties in translating real-life problems into mathematical terms and lack sufficient knowledge of relevant mathematical topics (Novita et al., 2022). They may be able to solve algorithmic problems correctly, but fail when faced with context-based problems that require deeper understanding, indicating the presence of more fundamental and systematic cognitive barriers. (reducing pada Compound complex stc).

One form of this barrier is epistemological obstacles, which are difficulties that arise not due to ignorance, but because of the way individuals misunderstand or limit their understanding and organization of knowledge (Nansiana et al., 2024). In the context of mathematics education, epistemological obstacles can manifest as the use of incorrect intuition, excessive generalization (Subroto & Suryadi, 2018), reliance on procedural thinking, belief in a single solution method, or misconceptions that have been formed since previous education stages (Kadarisma & Amelia, 2018; Nansiana et al., 2024). Pre-service elementary school teachers who experience this obstacle may view a mathematical procedure as the "only truth," making it difficult for them to accept alternative approaches or representations in solving problems.

For example, some students may use the conventional multiplication algorithm to solve a contextual problem about price comparison but they fail to interpret the meaning of "per unit" in the question. This is not due to ignorance of the multiplication operation, but rather a lack of understanding of the mathematical meaning behind the context presented. Such barriers not only affect the student's performance but also will carry over into their teaching practice in the future (Woltron & Götz, 2025). If they not addressed early on, these misconceptions will be transferred to their students, reinforcing the chain of mathematical understanding weaknesses from one generation to the next (Abakah & Brijlall, 2024).

Several previous studies have addressed similar issues, such as pre-service mathematics teachers often struggle to develop effective lesson plans and face ontogenic, didactic, and epistemological obstacles (Prabowo et al., 2022). Besides, pre-service teachers face challenges in mathematization, interpreting graphs, and connecting variables in problems (Kabael & Barak, 2016). Other studies have examined pre-service teachers' perspectives on students' mathematical difficulties (Bingolbali et al., 1991), and investigated pre-service teachers' performance on PISA items (Aydoğan Yenmez & Gökçe, 2023). In line with this, Pre-service mathematics teachers experience epistemological obstacles in the concept of derivatives due to a lack of understanding of explicit and implicit similarities, which indicates the limited context that the students possess (Puspita et al., 2023).

However, there is still a lack of research in Indonesia that specifically examines epistemological obstacles in depth within the context of mathematical literacy tasks for pre-service elementary school teachers. Artigue (2019), in his research offers a new approach to understanding and addressing epistemological obstacles in mathematics education. This study emphasizes that epistemological obstacles are not just misconceptions, but rather part of the process of constructing students' knowledge that needs to be addressed pedagogically. Furthermore, Huang and Li (2020), through their work highlight the importance of developing mathematical literacy as a key competency for the 21st century. They emphasize that mathematical literacy includes not only the ability to calculate, but also the ability to think critically, reason, and apply mathematical concepts in various real-life contexts. More specific research on epistemological obstacles was conducted by Rosjanuardi and Jupri (2022) found that many students have difficulty understanding trigonometry concepts due to limited prior knowledge and previously formed cognitive biases, which hinder the formation of new, more appropriate understandings.

Meanwhile, Angraini et al. (2024) conducted an innovative study entitled "Augmented Reality for Cultivating Computational Thinking Skills in Mathematics Completed with Literature Review, Bibliometrics, and Experiments for Students". This study not only reviews literature and bibliometric data but also involves direct experiments using augmented reality technology to improve students' computational thinking skills in mathematics, which can indirectly also support increased mathematical literacy. Finally, Radiamoda (2024) in her study maps the various difficulties faced by students in learning mathematics in general. The findings in this study provide important contributions to understanding the internal and external factors that influence students' achievement of mathematical competence, including in topics such as plane geometry. Overall, the studies provide significant contributions to enriching the understanding of epistemological barriers, the importance of mathematical literacy, and challenges in learning geometry in elementary schools. This study provides an important theoretical basis for designing more effective and contextual pedagogical interventions for elementary mathematics education.

This gap serves as the primary foundation for this research. There are still few studies that explore epistemological obstacles in the process of solving mathematical literacy tasks. They has been no systematic mapping of the types of epistemological difficulties experienced by pre-service elementary school teachers and how their mindset is formed when facing contextual problems. In fact, a more comprehensive understanding of the root causes of these issues is crucial for designing appropriate and effective pedagogical interventions in teacher education.

Based on the research background, this study aims to identify and analyze the forms of epistemological obstacles encountered by pre-service elementary school teachers in completing mathematical literacy tasks. This research is expected to provide conceptual contributions to the understanding of mathematical thinking barriers faced by pre-service teachers, as well as practical contributions in designing teaching strategies and teacher training that emphasize meaning-making, reflection, and conceptual understanding. Thus, it is hoped that pre-service elementary school teachers graduates will be better prepared to foster meaningful and contextual mathematical literacy among elementary school students.

METHODS

This study aims to deeply examine the epistemological obstacles experienced by pre-service elementary school teachers in completing mathematical literacy tasks related to plane geometry. They are difficulties related to how individuals understand and construct mathematical knowledge, meaning these obstacles cannot be directly observed from the final outcomes but rather through the thinking processes, representations, and reasoning involved. A case study method is applied to achive those problems and they are employed to investigate and intensively analyze diverse phenomena in depth (Cohen et al., 2007). This method allows the researcher to conduct in-depth exploration of phenomena within a real and specific context. In this case, the research context is limited to a group of students in a particular learning activity, which makes the unit of analysis more focused and detailed.

The sample in this study consists of 24 pre-service teachers enrolled in a mathematics education course at a university in Cimahi City, Indonesia. The sample was selected using a purposive sampling technique (Creswell & Creswell, 2018) and its selection criteria include: (1) the students who are actively attending lectures that directly discuss plane geometry material; (2) the students who already have a basic understanding of mathematics from previous levels and experience in learning mathematics at the university level, and (3) the students who have mathematical literacy tasks that can be analyzed to identify potential epistemological obstacles. The selection of the location and sample also took into accoount access avaibality, the researcher's academic proximaty to the participants, and the relevance of the learning context to the issues being studied.

The data in this study were collected through mathematical literacy tests and in-depth interviews. The test was designed based on indicators from the OECD framework for mathematical literacy (OECD, 2018), That is, the formulation, use, and interpretation of mathematics in real-life contexts. The interviews were conducted in a semi-structured manner to delve deeper into the participants' thinking processes. The instrument was validated by three mathematics education experts through assessments of the alignment of indicators, clarity of items, and relevance to the research objectives. Revisions were made based on expert feedback and followed by limited trials to ensure the readability and effectiveness of the instrument in the context being studied.

The data analysis was conducted using a qualitative approach through thematic analysis for the diagnostic test results and content analysis for the interview data. The process followed by the stages starting from reading the data, coding, theme identification, and extracting meaning from the forms of epistemological obstacles that emerged. Content analysis was conducted inductively to uncover patterns of difficulties in conceptualization, representation, and procedures revealed through interviews. To ensure the validity of the data, multiple strategies were employed, including data triangulation, member checking, and collaborative discussions among researchers to minimize potential bias and to enhance the overall credibility and trustworthiness of the findings.

To gain deeper insight into the epistemological obstacles encountered by pre-service teachers when completing mathematical literacy tasks, this study used semi-structured interviews. The approach was chosen to obtain a more comprehensive understanding of the participants' thinking processes and to explore factors that could not be directly observed from the diagnostic test results, such as misconceptions and difficulties that occurred during learning. The interviews were designed to explore the challenges participants faced in understanding and applying geometric concepts and to identify barriers that emerged as they attempted to relate mathematics to real-life situations. Those were conducted individually with each participant to give them the opportunity to explain their experiences more openly and in greater depth.

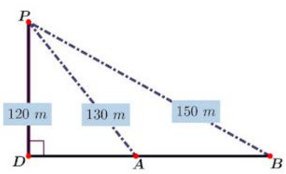
The interviews included questions related to understanding basic geometric concepts, such as the relationship between sides and angles in plane figures; difficulties in applying formulas and mathematical concepts in real-life situations; limitations in problem-solving strategies, including reliance on incorrect formulas or overly procedural methods; and the influence of self-efficacy, or the participants' confidence in facing challenging mathematical tasks.

The data obtained from the interviews were analyzed using content analysis inductively, to identify recurring patterns of difficulties and key themes that emerged from the participants' experiences. The results of these interviews were then compared with the diagnostic test data to provide a deeper understanding of the epistemological obstaclesfaced by the participants.

RESULTS AND DISCUSSION

The results of the analysis of epistemological obstacle could be seen from the following students' responses.

Table 2. Epistemological Obstacle

No	Question	Alternative Answer to the Question	Learning Obstacle that Occur
1 .	Observe the following image!  An observer is at the top of a tower at a height of 120 m. He sees the Safir ship at a distance of 130 m and the Lofura ship at a distance of 150 m. The story is illustrated with the following diagram,  If the base of the tower (D), the Safir ship, and the Lofura ship are collinear, then: a. What is the formula to determine the lengths of AD	a. The length of AD, observe triangle ADP $AD^2 = AP^2 - DP^2$ The length of BD, observe triangle BDP $BD^2 = BP^2 - DP^2$ b. $AD = \sqrt{AP^2 - DP^2}$ $= \sqrt{(130)^2 - (120)^2}$ AD = 50 $BD = \sqrt{BP^2 - DP^2}$ $= \sqrt{(150)^2 - (120)^2}$ BD = 90 The distance between A and B *AB* = *BD – AD* = *90 – 50 = 40* c. Thus, the distance between the two ships, or the distance between the Safir Ship and the Lofura Ship, is 40 *m*.	a. Since the student begins answering by using the triangle area formula, namely $AD = \frac{2\ x\ Luas}{DP}$ and $BD = \frac{2\ x\ Luas}{DP}$, this indicates that the student does not use an epistemic process in generating the answer, this tends to be an epistemological obstacle. b. Performing calculations according to answer a, resulting in less accurate results. c. When concluding, the student does not replace A with the Sefir Ship and B with the Lofura Ship. Epistemological Obstacle: Incorrect understanding of basic concepts; lack of

	and BD? b. What is the distance between A and B? c. What can you conclude based on the answer to part (b)?		mastery of prerequisite material; and limited ability to perform algebraic manipulation.
2.	 Observe the following image! Mr. Sapto has a rectangular yard with a length of p meters and a width of (p−4) meters. The yard is used for raising free-range chickens by installing a bamboo woven fence around the yard. a. Create a formula to determine the perimeter of the rectangle! b. If the length of the yard is 14 meters and the cost of installing the fence per meter is Rp. 75,000, how much will Mr. Sapto need to pay to install the fence? c. What can you conclude based on the answer to part (b)?	a. Perimeter of the rectangle $K = 2\ (p + l)$ $= 2\ (p + (p\text{-}4))$ $= 2\ (2p - 4)$ $K = 4p - 8$ Therefore, the formula to determine the perimeter of the yard is $K = 4p - 8$. b. $K = 4p - 8$ $= 4.14 - 8 = 48$ Cost Required $= K \times 75000$ $= 48 \times 75000$ $= 3600000$ c. Therefore, the cost required for Mr. Sapto to install a fence with a perimeter of *48 m* is *Rp.3.600.000*	a. Since the student only answers with the general perimeter formula $K = 2(p + l) = 2p + 2l$, this indicates that the student does not use an epistemic process in generating the answer, tending towards an epistemological obstacle. b. The student directly multiplies the length by the fence installation cost, 14 x 75000 = 1050000. c. Conclusion is based on the answer to question b. Epistemological Obstacle: Incorrect understanding of basic concepts regarding perimeter, length, and width; limited ability to perform algebraic manipulation; lack of mastery of prerequisite material.
3.	Observe the following image!  Mr. Febri has a house with a sketch as shown above. The roof of the house consists of 2 identical rectangular sections. The size of the roof tiles installed on the house is 30 cm x 20 cm per piece. Mr. Febri wants to make roof support pillars from wooden materials in the form of isosceles triangles so that the front view of his house's roof will appear sturdy. a. **I**f the length is up and the width is all, determine the	a. The roof and tiles have the same shape, which is rectangular, so the way to determine the area is by using the formula, $Area = p \times l$ b. Roof Area $= p \times l$ $= 12 \times 10$ $= 120\ m^2$ $= 1200000\ cm^2$ Tile Area $= p \times l$ $= 30 \times 20$ $= 600\ cm^2$ Number of Tiles = $\frac{Roof\ Area}{Tile\ Area} = \frac{1200000}{600}$ = 2000 c. Therefore, the number of tiles needed to cover Mr.	a. The student considers the formulas for the area of the roof and the tiles to be different, indicating that the student does not use an epistemic process in generating the answer, tending towards an epistemological obstacle. b. The student does not convert the unit of roof area, Number of tiles = 30x 20 = 600 c. Conclusion based on calculations in a and b Epistemological Obstacle: Incorrect understanding of

	formula for the area of the roof and the area of the tiles! b. How many tiles are needed to cover Mr. Febri's roof? c. What can you conclude based on the answer to part (b)?	Febri's house roof is 2,000 pieces.	basic concepts regarding the area of a rectangle; limited ability to perform algebraic manipulation; lack of mastery of prerequisite material.
4.	Read the following text! Creating a Garden Mr. Rustam has an empty plot of land in front of his house with a perimeter of 20 meters. The land will be made into a flower garden. a. If the garden to be made by Mr. Rustam is rectangular, create a formula to determine its length and width! b. What are the dimensions of the length and width so that the area is maximized? c. Suppose the length and width are two numbers whose sum is constant. If the difference between the two numbers becomes smaller, conclude the product of the two numbers!	a. Formula to determine Length and Width, $K = 2(p+l)$ $20 = 2(p+l)$ $p+l = 10$ $p = 10 - l$ $l = 10 - p$ b. Possible length and width to maximize the area, $P+l = 10$ (from half of the perimeter) $p=9$ m and $l=1$ m $p=8$ m and $l=2$ m $p=7$ m and $l=3$ m $p=6$ m and $l=4$ m $p=5$ m and $l=5$ m c. The smaller the difference between the length and width, the larger the area, and vice versa.	a. The student answers with the area formula $L = p \times l$ or the perimeter formula $K = 2(p + l)$, indicating that the student does not use an epistemic process in generating the answer, tending towards an epistemological obstacle. b. The student will divide the perimeter of 20 m into length and width, p = 11 and $l = 9$ $L = p \times l = 11 \times 9 = 99$ c. The larger the length and width, the greater the area. Epistemological Obstacle: Incorrect understanding of basic concepts regarding area and perimeter of a rectangle; limited ability to perform algebraic manipulation; lack of mastery of prerequisite material.

As shown in Table 2, data analysis reveals that the majority of students experience conceptual misconceptions. This is evident from the difficulty in recognizing the relationships between various plane geometry, as demonstrated by 78% of students making errors in calculating the area and perimeter of triangles and rectangles, primarily due to a lack of understanding of the relevant formulas. This finding is supported by studies that show common errors, including confusion between area and perimeter calculations (Reinke, 1997), misconceptions about plane geometry, and limited understanding of basic principles such as the Pythagorean theorem (Dwijayanti et al., 2022). These issues stem from a lack of adequate mathematical subject knowledge and pedagogical content knowledge, particularly in understanding students' thinking and teaching strategies (Yilmaz & Demir, 2021).

To address these epistemological obstacles, it is crucial to incorporate teaching strategies into the mathematics curriculum and teacher training programs that prioritize conceptual understanding over rote memorization. Teachers must be trained to identify and address the students' misconceptions, as well as integrate real-world applications of mathematical concepts to enhance their relevance. Furthermore, the curriculum should focus on spatial visualization and problem-solving skills, which are vital for overcoming barriers related to geometric reasoning. In doing so, we can better equip pre-service teachers with the tools needed to foster mathematical literacy among their future students and to ensure that they are prepared to face the challenges of 21st-century education.

Another finding is the difficulty in connecting the material to real-life experiences. This is evident from only 22% of the students, being able to link geometric concepts to real-world applications, indicating challenges in transferring classroom knowledge to everyday contexts. Studies show that mathematics students often struggle to connect pure mathematical knowledge with practical applications (Hayal, 2018). Pre-service teachers tend to rely on familiar examples learned in school, which shows their limited ability to create new connections with the real world (Pirasa, 2016). Many pre-service elementary school teachers lack a strong foundation in basic geometry, making it difficult for them to correctly define basic shapes and figures or create accurate representations (Marchis, 2012). In addition, pre-service mathematics teachers face challenges in mathematical proof, particularly in transformation geometry, including difficulties in applying concepts, visualizing geometric objects, and understanding mathematical language and notation (Noto et al., 2019).

In the interviews, the students shared various epistemological obstaclesthey faced when completing mathematical literacy tasks, particularly in geometry. Many students admitted to having difficulty understanding the relationships between geometric elements. For example, Student A said, "I often get confused about how to connect the side length with the Pythagorean theorem in triangles, especially when the problem asks for a geometric explanation." Additionally, students also mentioned errors in applying formulas, as Student B explained, "Sometimes I feel confused when I have to choose the right formula for different problems, and sometimes I end up using the wrong formula."

Student C also had trouble connecting geometric concepts to real-life situations, saying, "I know the formula, but I can not imagine how that formula is applied in everyday life or vice versa, like calculating the area of a roof." Another issue was low self-confidence, as Student D expressed, "Sometimes I feel unsure about my ability to solve math problems, especially those involving geometry. It makes me hesitant to try more complex methods."

When asked about problem-solving strategies, most students relied on basic and simple methods. Student E stated, "I usually just use the formula without considering whether it is the most appropriate solution or not. Sometimes, I just follow the procedure without thinking further." These interview results align with the diagnostic test data, which showed that many students experienced misconceptions in geometry and formula application. These barriers are also evident in the limited problem-solving strategies and the lack of ability to connect mathematics to real-life contexts.

Pre-service teachers also have limitations in their problem-solving strategies. Interview data revealed that most students rely on simple and often inappropriate strategies to solve geometry problems, with only 13% demonstrating the ability to use various methods. Research has found that pre-service teachers tend to depen on a limited number of strategies, often using simple arithmetic operations or cross-multiplication (Arican et al., 2018). Over-reliance on these basic methods can hinder their ability to recognize proportional relationships in geometry similarity problems. However, interventions such as problem-solving mathematics classes and collaborative learning can help develop a variety of strategies, including logical reasoning, pattern recognition, and equation solving (Bjuland, 2007). Although there have been improvements, pre-service teachers still show weaknesses in applying a variety of problem-solving skills, using mathematical terminology correctly, and fully understanding the problems (Barham, 2020). The strategies used by pre-service teachers include cognitive approaches (rehearsal, elaboration, organization), metacognitive approaches (critical thinking, self-regulation), as well as other approaches such as prediction, planning, monitoring, and evaluation (Gurat, 2018).

The final finding is significant epistemological obstacles related to geometry that affect the students' mathematical literacy. This is evidenced by 87% of participants reporting low self-confidence when engaging on plane geometry tasks. Additionally, epistemological obstacles were also identified related to proof, generalization, alternative solution strategies, and problem-solving, particularly in the context of online learning. The students face challenges in critical thinking related to proof, generalization, alternative solutions, and problem-solving during online learning (Luritawaty et al., 2024). These obstacles are more commonly found in the students with moderate to low algebraic thinking skills (Nansiana et al., 2024). Self-efficacy plays an important role in mathematical literacy, where higher self-efficacy correlates with better performance in formulating, using, and interpreting mathematical problems (Yulianah et al., 2022). Domain-specific epistemological beliefs directly affect mathematical performance, while general epistemological beliefs have an indirect effect (Schommer-Aikins & Duell, 2013). The students with a stronger mathematics background show greater consistency between general epistemological beliefs and domain-specific epistemological beliefs. This finding highlights the importance of well-structured learning experiences that focus on conceptual relationships, procedural flexibility, and geometric visualization to overcome epistemological obstacles and improve mathematical literacy.

Research on epistemological obstacles in geometry learning highlights challenges at various levels of geometric thinking. Kandaga et al., (2022) identifying epistemological obstacles at each level of the van Hiele model in transformation geometry among pre-service mathematics teachers. To overcome these obstacles, Miftah et al., (2020) used Didactical Design Research, developing learning concepts and activities tailored to the students' needs. Their approach, included analyzing learning obstacles and creating hypothetical learning trajectories, proved effective in overcoming students' obstacles. Cesaria & Herman (2019) Focusing on polyhedron learning in middle school, identifying ontogenetic and epistemological obstacles. Ontogenetic obstacles arise from inadequate understanding, while epistemological obstacles stem from mismatched teaching materials. This study emphasizes the importance of preparing materials that align with students' characteristics to minimize these obstacles. These findings highlight the complexity of geometry learning and the need for targeted interventions to overcome epistemological challenges.

These findings highlight the complexity of geometry learning and the need for targeted interventions to overcome epistemological challenges. However, further research is needed to explore the relationship between epistemological obstacles and mathematical literacy in greater depth. Future studies could examine how specific epistemological obstacles in geometry, such as misconceptions or limitations in spatial reasoning, affect students' overall mathematical literacy. Additionally, this research could investigate the long-term impact of overcoming epistemological obstacles on the students' ability to apply mathematical concepts in real-life situations. Comparative studies across different educational systems, such as between primary and secondary education or in different cultural contexts, could reveal variations in the types and severity of these obstacles. Furthermore, exploring how teacher training programs and pedagogical strategies can be adapted to address these epistemological obstacles would be a valuable direction for future research, ultimately contributing to the improvement of mathematical literacy and problem-solving skills among students.

CONCLUSION

The study reveals that pre-service elementary school teachers face significant challenges in mathematical literacy, particularly in geometry. These include difficulties in understanding geometric relationships, errors in formulas, and struggles connecting mathematical concepts to real-world situations. The main obstacles are conceptual misconceptions, weak problem-solving skills, and low self-efficacy. To address these issues, teacher education programs should focus on enhancing teaching strategies and emotional factors like self-efficacy. A holistic approach, emphasizing conceptual understanding, problem-based learning, and realistic mathematics education can help teachers connect mathematical concepts to real-world contexts. Teacher training should include reflective practice, collaborative learning, peer feedback, and hands-on experience with real-world problems. Further research should evaluate the impact of these strategies on teaching effectiveness and student learning outcomes.

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