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Numeracy Skills of Students in Solving Geometry Problems within the Bengkulu Context

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Abstract: This study seeks to delineate the numeracy competencies of students in the geometry domain, framed by the cultural context of Bengkulu. Employing a qualitative descriptive approach, the research involved 35 students from Grade XI. A of State High School 1 Bengkulu Tengah. The methodology included the use of open-ended numeracy tests specifically designed for geometry. Data analysis was conducted using descriptive statistics to delineate the spectrum of numeracy competency levels among the students. The findings showed that 4 students (13.33%) were at a low level of numeracy, 24 students (80.00%) at a medium level, and 2 students (6.67%) at a high level. Further analysis of students' numeracy skills across different geometric levels highlighted average proficiency scores of 81.66% in visualization, 66.67% in analysis, and a notably lower 40.00% in deduction. These results underscore the influence of culturally relevant numeracy problems on student performance. Consequently, these insights have significant implications for educational practices, particularly in the curation of instructional materials aimed at enhancing students' numeracy competencies.

Keywords: descriptive analysis, geometry domain, numeracy competency, cultural context of Bengkulu.

▪ INTRODUCTION

The adoption of the "Merdeka" Learning Curriculum across various educational levels in Indonesia has had profound implications for classroom learning outcomes. The curriculum is designed with the strategic aim of promoting holistic and contextually relevant learning experiences, thereby ensuring that education resonates with students' lived realities (Pusmendik-Kemendikbud, 2022). To facilitate the attainment of these educational goals, the Indonesian government has instituted the minimum competency assessment (in Indonesian AKM), which focuses on enhancing literacy and numeracy skills (Rokhim et al., 2021). This approach is consistent with global educational standards where mathematical literacy is acknowledged as an essential educational outcome, evident in frameworks like PISA and TIMSS. In the era of 21st-century education, there is a pronounced need for students to excel in critical competencies including problem-solving, mathematical communication, and teamwork (Soulé & Warrick, 2015). Thus, the development of numeracy skills has become a fundamental aspect of classroom pedagogy.

Numeracy skills (mathematical literacy) are essential as one of the international education standards (Drew, 2012). Especially in Indonesia, the national assessment focuses on mathematical literacy (Susanta et al., 2023). In learning mathematics in class, it is necessary to develop numeracy skills. In learning, students must master at least five essential skills: problem-solving, reasoning, communication, connections, and representation (National Council of Teachers of Mathematics, 2000). This is relevant to numeracy skills, which are identifying, solving problems, and communicating (Geiger et

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al., 2015). Through this ability, students can choose and apply knowledge to solve mathematical problems (Sumirattana et al., 2017).

The current problem is the achievement of learning outcomes in schools that are not optimal. In particular, the achievement of Indonesian students' skills in mathematics learning is still low. This is evidenced by the 2018 PISA survey data for the mathematics category; Indonesia is at level 1 with a ranking of 7 from the bottom (73) and an average score of 379 (Schleicher, 2019; OECD, 2017). Data in 2022 also shows the same achievement, where the average performance in mathematics is 366, with a ranking of 9 from the bottom (OECD, 2023). Meanwhile, AKM data shows that in 2023, nationally, only 41.14% of high school students have numeracy competencies above the minimum (Pusmendik-Kemendikbud, 2023).

Empirical data related to students' ability to solve AKM mathematics problems involving students in Bengkulu City shows that in the four contents, the achievements are numbers of 54.47%, algebra 46.44%, geometry 33.15%, and uncertainty data of 18.81% (Susanto et al., 2023). Furthermore, observation data from the final semester assessment of one of the grade X at senior high school number 1 Bengkulu Tengah showed that the achievement of students' ability to solve problems on average was still below the school's minimum completeness criteria, the results of interviews with class teachers, Anjasmoro M.Pd.Mat also showed that, in general, students still had difficulty solving high-level or numeracy-type problems. On average, students still had trouble understanding questions and choosing the proper procedure to solve problems, especially problems related to everyday life.

The development of AKM-based problems embedded in familiar contexts has yet to produce significant improvements in students' numeracy skills. Research by Susanto, Susanta, and Irsal (2022), highlights that while incorporating a Bengkulu cultural context had a moderate effect, students' abilities were still classified as "sufficient" on average. This suggests that numeracy competencies remain relatively low. Mathematical literacy, a critical component of numeracy, is essential for students to effectively navigate mathematical tasks. As outlined by (Development, 2017), mathematical literacy includes communication, mathematization, representation, reasoning, problem-solving strategies, the use of symbols and formal language, technical operations, and the application of mathematical tools. Measuring these abilities can encourage students to think critically and solve problems (Ming, 2012).

A persistent challenge in mathematics education is students' difficulty with specific content areas, particularly geometry. Studies and observations consistently identify geometry as one of the most challenging domains for students. The National Council of Teachers of Mathematics (NCTM) emphasizes that students' geometric competencies should include understanding, visualization, analysis, and spatial reasoning (Pratikna et al., 2020). Empirical studies have consistently shown that students' mastery of geometry lags behind other mathematical domains. For instance, Susanta, Susanto, and Maizora (2021), reported that students' geometry proficiency stood at only 36.39%, significantly less than in other areas of mathematics. The reality in schools shows that students experience difficulties in solving geometry problems (Sulistiowati, D. et al., 2018). Geometry is a branch of mathematics that is considered difficult and feared by students (Adolphus, 2011). Initial observations at senior high school number 1 Bengkulu Tengah corroborate these findings, revealing that while students manage to articulate and explain geometric concepts using tangible tools or real-world objects, they encounter significant challenges with abstract geometric tasks. This difficulty is mirrored in their underperformance in geometry-related assessments.

Given the pivotal role of geometry in mathematical education, there is a pressing need to scrutinize instructional methodologies, specifically in the design of student tasks. An effective strategy for enhancing geometric competence might involve context-based problem-solving. Numerous studies have affirmed the positive impact of local cultural contexts on mathematics education. For example, (Susanta, Sumardi, & Susanto, 2022), demonstrated that mathematics problems framed within local cultural contexts can serve as enriching educational resources, simultaneously bolstering students' connection to their cultural heritage. Nur et al. (2020), explored the benefits of integrating ethnomathematical approaches into problem-solving, while (Stroyer et al., 2018), highlighted the synergy between cultural contexts and mathematics education. The local or cultural context in learning can bridge literacy skills in solving real problems (Susanta, Sumardi, & Zulkardi, 2022). Other studies also show that using context can motivate students to complete tasks (Clarke & Roche, 2018).

Despite the expanding research on leveraging local cultural contexts in mathematical instruction, there is a paucity of studies specifically exploring how cultural contexts can enhance students' numeracy competencies within the geometry domain, particularly when assessed through levels of geometric thinking in the context of Bengkulu. This makes this study different from previous studies with a focus on studying students' numeracy skills in solving problems in the Bengkulu context. In light of this research gap, this study aims to address the following research question: How do students demonstrate numeracy competencies in solving geometric problems when framed within the Bengkulu cultural context?

1. How is the description of students' numeracy competency in solving geometry problems within the Bengkulu context?
2. How is the student's competency based on geometry level in solving problems with the Bengkulu context?

▪ METHOD

Participants

The population in this study consisted of students in grade XI of Senior Highg School number 1 Bengkulu Tengah, which consisted of 8 classes. The sample selection technique used purposive sampling, which was adjusted to the research objective to describe students' numeracy competence in solving geometry problems. This study involved 30 students from Grade XI of State Senior High School 1 Bengkulu Tengah. The selected class, XIA, comprised 12 male and 18 female students. There are two reasons for selecting this sample, first this subjek was chosen due to the relatively homogeneous distribution of students' initial abilities, which facilitated more accurate observation of their numeracy skills. Second, students had already covered trigonometry in their curriculum, making it feasible to conduct diagnostic assessments. Interview subjects were randomly chosen based on observed patterns in their levels of geometric ability.

Research Design and Procedure

This study employs a descriptive research method with a qualitative approach to analyze data by describing or depicting it as it is observed (Sugiyono, 2019). The research focuses on comprehensively understanding issues by creating a detailed and complex portrayal, incorporating perspectives from informants (Creswell, 2014). Specifically, this study aims to describe students' numeracy competencies in the geometry domain within the Bengkulu context across three levels of geometric thinking: visualization, analysis, and deduction.

The proceduer of research began with the development of the main research instrument, consisting of numeracy questions on geometry contextualized in Bengkulu for high school students. The instrument underwent evaluation by two experts: a mathematics education lecturer and a high school mathematics teacher. The instrument was validated based on expert judgment (logical validity) and deemed suitable for data collection. The subsequent steps involved selecting research participants to take the diagnostic test. Following the administration of the test, data tabulation and analysis of students' performance were conducted. Interviews were carried out to further verify and triangulate students' numeracy abilities as demonstrated in their test responses. These interviews, grounded in students' written answers, served to validate the findings.

Research Instruments

Data were gathered through diagnostic tests and unstructured interviews. The diagnostic tests focused on numeracy within the context of Bengkulu, particularly trigonometry. These tests emphasized the application of triangle area calculations and trigonometric ratios in right-angled triangles. The test items were developed with reference to the AKM numeracy framework, specifically targeting the "applying" and "reasoning" levels (Wijaya & Dewayani, 2021), as well as PISA questions (OECD, 2013). The tests assessed students' geometric abilities in accordance with van Hiele's levels of geometric thinking.

Two test items were developed for the study. This limited scope was informed by an initial survey revealing that students' ability to solve mathematical problems was constrained by time. To ensure that students remained focused during problem-solving, the number of questions was deliberately kept minimal. So, it is necessary to limit the diagnostic questions so that students' abilities can be measured optimally. Therefore, the researcher limited the diagnostic questions to 2 questions. Another consideration in choosing these questions is so that the analysis can be carried out in depth.

The test items were contextualized using scenarios relevant to Bengkulu (Problem-1: a park in Bengkulu, and Problem 2: the height of the Bengkulu View Tower) to integrate real-world applications of geometric concepts, particularly triangles. The Bengkulu context was selected for the question by analyzing documents and references related to Bengkulu culture and adjusting them to the material being tested. In this study, the focus of the material analyzed was geometry, so the analysis of the Bengkulu context was relevant to geometry. The results of the analysis selected two aspects of geometry, namely the Bengkulu Park and the Bengkulu View Tower Building.

The scoring of students' numeracy skills in the geometric domain was based on the three van Hiele levels: visualization, analysis, and deduction. The visualization level evaluated students’ ability to recognize geometric objects or shapes presented in the questions. The analysis level assessed their ability to identify and document properties of these shapes in relation to the problem. At the deduction level, students were expected to establish relationships among the properties, derive formulas, and perform calculations accurately. The scoring rubric for assessing students' numeracy skills is presented in Table 1.

Table 1. Scoring guidelines

Level	Score	Criteria
Visualization	1	Fully meets the criteria for the answer
	0	Incorrect or does not meet criteria
Analysis	1	Fully meets the criteria for the answer
	0	Incorrect or does not meet criteria
Deduction	1	Fully meets the criteria for the answer
	0	Incorrect or does not meet criteria

The research instrument underwent logical validation by two subject-matter experts. This measurement focuses on four aspects: material, construction, language, and question context. In measuring validity using an instrument with a Linkert scale, namely: (1) strongly disagree, (2) disagree, (3) entirely agree, (4) agree, and (5) strongly disagree analysis based on expert assessment tendencies and conclusions given (valid or invalid). The evaluation confirmed that the instrument satisfied the criteria for validity in terms of content, construction, language, and contextual relevance. Both experts concurred that the numeracy instrument was appropriate for data collection purposes. Empirical testing was also conducted with 18 students from Grade XI, and reliability analysis was performed using Cronbach's alpha. The analysis produced a Cronbach's alpha value of 0.704, indicating a high level of reliability. Based on these results, the test instrument was deemed suitable for use in data collection.

Data Analysis

The data in this study were analyzed descriptively and qualitatively. Students' numeracy competencies are described based on three geometry levels: visualization, analysis, and deductive (Rouadi & Husni, 2014). In carrying out data analysis in this study, it refers to the interactive analysis proposed by Miles and Huberman (2005), namely, data reduction, data presentation, and concluding. At the data reduction stage, the data is sorted based on the student's ability level and tabulated. Then, the data is presented as tables or graphs, and conclusions are drawn. Data analysis was also carried out on the results of verification interviews based on the tendency of students to answer at each level of ability they have. The interview was carried out based on the analysis of student answer sheets based on the geometry level. Each level was selected for three students to be interviewed. Interview data was described descriptively based on the symptoms found in the study.

▪ RESULT AND DISSCUSSION

Description of Research Findings

The data for this study were obtained from the responses of 30 students to two numeracy problems. The analysis focused on exploring three levels of numeracy skills within a geometric context. Students' general numeracy abilities were categorized into three levels based on their scores, with total scores converted to a scale of 0–100: low (0–

33), medium (33–66), and high (66–100). Table 2 summarizes the results of the numeracy score analysis.

Table 2. Description of test results

Level	Score Range	Number of Students
Low	x<33	4 [13.33%]
Medium	33≤x<66	24 [80.00%]
High	66 ≤x< 100	2 [6.67%]

Based on the data in Table 2, it can be concluded that the overall numeracy competency of the students falls predominantly within the medium category, representing 80.00% of the participants. This indicates that most students exhibit a moderate ability to solve numeracy problems. However, only two students (6.67%) demonstrated high-level numeracy competency, suggesting that the development of students' numeracy skills, particularly in solving geometric problems, remains suboptimal.

Further analysis was conducted to evaluate numeracy competency at the three geometric levels: visualization, analysis, and deduction. Students' responses to each problem (Problem 1 and Problem 2) were examined based on these levels. The proportion of correct responses at each geometric level, as determined by the assessment rubric, is illustrated in Figure 1.

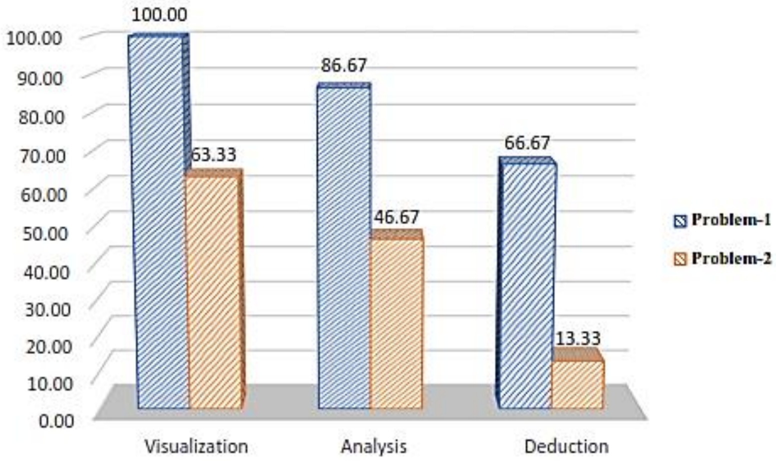


Figure 1. Numeracy competency based on geometric levels

The figure demonstrates that, on average, students performed better on Problem 1 compared to Problem 2. For Problem 1, 100% of the students successfully achieved the visualization stage, indicating their ability to accurately construct the geometric shapes or figures required by the problem. However, performance at the analysis and deduction levels declined, with 86.67% of students achieving the analysis stage and 66.67% reaching the deduction stage. These results suggest that while students' geometric skills in solving Problem 1 were generally strong, there was room for improvement, particularly in the higher-order thinking skills required at the deduction level.

In contrast, for Problem 2 which was more challenging only 19 students (63.33%) succeeded at the visualization stage, demonstrating their understanding of the geometric shape by accurately constructing it. At the analysis stage, the success rate dropped to 46.67%, and only 13.33% of students reached the deduction stage. These findings suggest that students' ability to solve numeracy problems based on the van Hiele levels was significantly weaker for Problem 2.

Visualization Level Competency

The visualization level was evaluated based on students' ability to correctly identify and construct geometric shapes from the objects provided in the problem. The assessment criterion focused on the accuracy of the geometric illustrations students produced while solving the test problems.

For Problem 1, the findings revealed that all students (100%) accurately depicted the intended park illustration, which was represented as a rectangle. This high success rate demonstrates the students' proficiency at the visualization stage for this problem. An example of students' answers at the visualization level for Problem 1 is depicted in Figure 2 below.

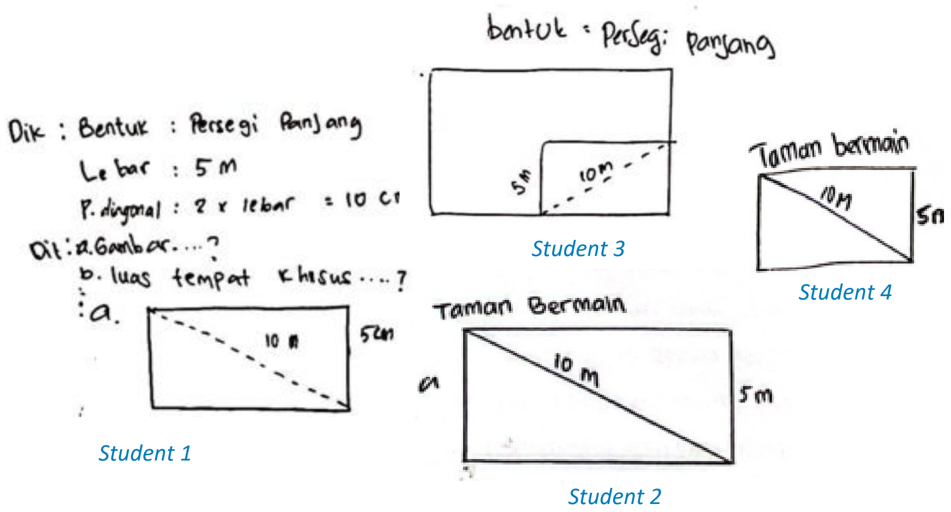


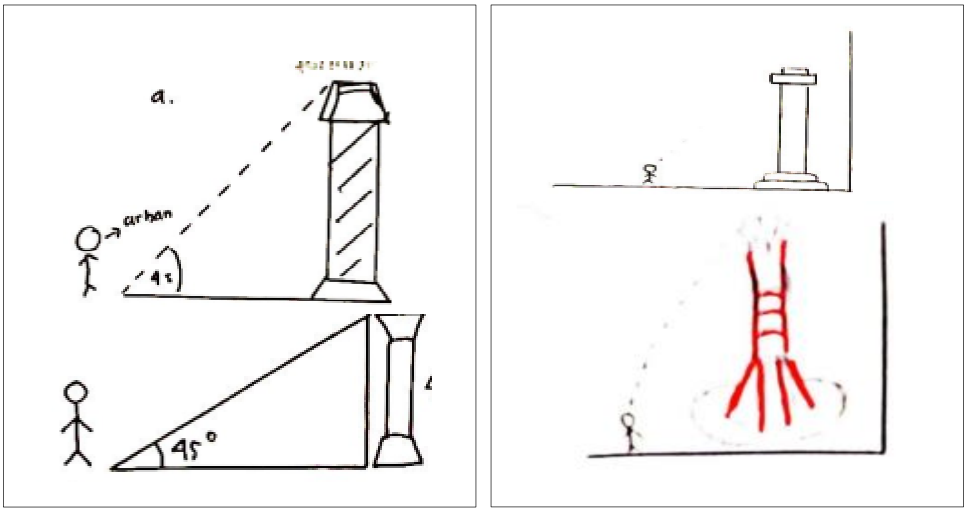
Figure 2. Example of correct student answers at the analysis stage of problem 1

At the visualization stage of Problem 1, students demonstrated their ability to present a rectangle shape and identify its diagonal. This finding suggests that their visualization skills for this problem were well-developed. At this stage, students were primarily required to recognize the rectangle described in the problem. Several students successfully illustrated the shape as a rectangle, fulfilling the requirements of the task. However, the accuracy of the dimensions in each drawing was not evaluated at this stage.

The visualization stage is a critical foundational step in solving geometric problems, as it reflects the students' ability to recognize and understand the geometric shape being referenced in the problem. Their capacity to visualize the shape accurately indicates mastery of this initial level. Furthermore, students were able to represent the diagonal of the rectangle in their drawings.

An interesting observation was made in the response of one student (Student 3), who depicted not only the park as a whole but also included a smaller rectangle within it, representing the playground. This approach was still deemed correct, as the primary requirement of accurately illustrating a rectangle with a diagonal was fulfilled. The smaller rectangle accurately addressed the problem, while the larger rectangle represented the entire park. This response demonstrates the student's accurate visualization ability and understanding of the problem context.

The analysis of these responses confirms that students were able to visualize the problem effectively and use their understanding to construct accurate illustrations. Next, students' numeracy skills at the visualization stage for Problem 2 were examined. According to the research findings, only 86.67% of students were able to respond correctly at this level. Figure 3 presents examples of both correct and incorrect responses for Problem 2.



(a) (b)

Figure 3. Example of the analysis stage for problem 2 a) correct student response, (b) incorrect student response

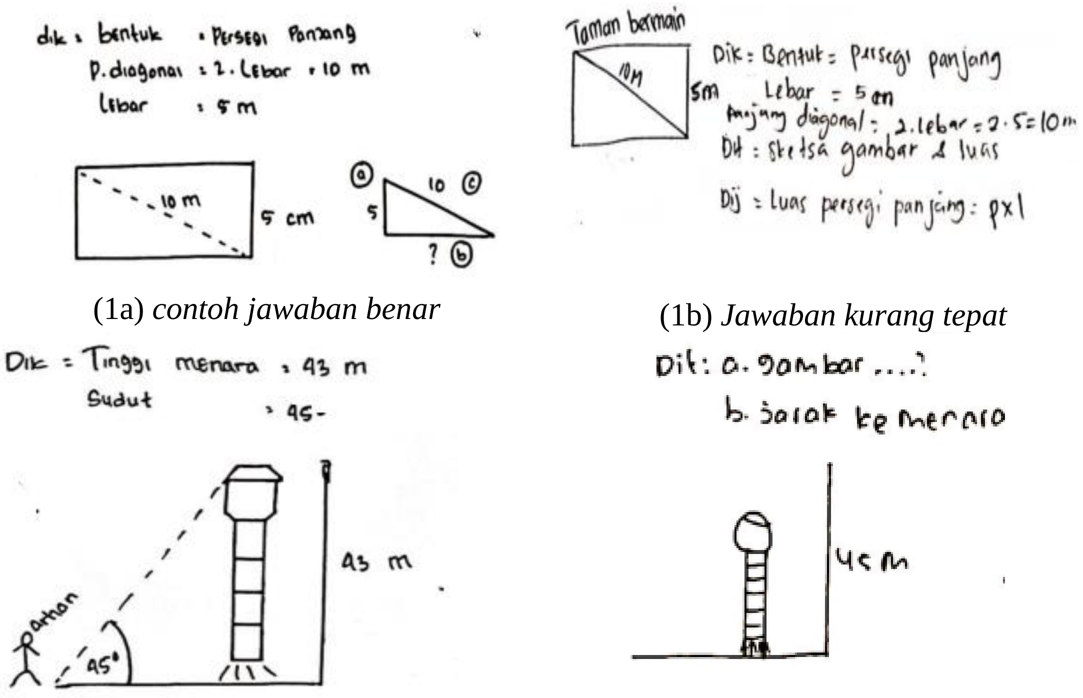
The analysis of student responses to Problem 2 reveals that students who provided correct answers were able to visualize the problem effectively, representing it as a triangle illustration (Figure a). Conversely, some students failed to construct an accurate geometric representation of the problem (Figure b). The ability to visualize geometric problems in this context involved applying trigonometry to right-angled triangles.

The findings indicate that students generally demonstrated strong visualization skills. This ability, often developed informally, is supported by students' exposure to visual objects in their environment that resemble geometric shapes (Mulyadi & Muhtadi, 2019). These results align with the conclusions of Purwanto (2014), who found that the thinking characteristics of most junior high school students (grades VII and VIII) are at level 0 (visualization) according to the van Hiele model. Visualization skills also play a critical role in fostering students' interest in mathematics (Sholihah & Afriansyah, 2017).

Analysis Level Competency

Numeracy competency at the analysis level involves students' ability to comprehend concepts and properties of geometric shapes. At this stage, students demonstrate their understanding by describing the attributes of shapes, accurately measuring geometric elements, and explaining the relationships among these properties. The analysis focuses on students' ability to articulate the known components of geometric shapes, such as identifying the parts of a rectangle, exploring the relationships between sides, and analyzing the diagonal properties of a rectangle.

In Problem 2, students' responses were evaluated based on their ability to utilize trigonometric ratios and determine angles accurately. Their ability to articulate and represent these relationships in geometric constructions was a key indicator of success at this level. The following sections present examples of student responses at the analysis stage in solving numeracy problems within the geometric domain.



(1a) *contoh jawaban benar*

(1b) *Jawaban kurang tepat*

(2a) *contoh jawaban benar*

(2b) *Jawaban kurang tepat*

Figure 4. Example of the analysis stage, (a) problem 1, (b) problem 2

The figure above illustrates students' responses at the analysis stage for both Problem 1 and Problem 2. In the case of Problem 1 (Figure 4a), students were able to accurately write and illustrate the geometric concepts, including the length, width, and diagonal measurements. These values were correctly recorded and represented in their diagrams. In contrast, the response shown in Figure 4b reveals that the student incorrectly documented the elements of the rectangle. For Problem 2, students with strong analytical skills demonstrated their ability to accurately conceptualize the problem, starting with the correct placement of the angle of elevation and the height of the tower. Constructing geometric shapes and identifying known components requires robust analytical skills to ensure that the written concepts align with the problem's requirements. However, the response shown in Figure 4b illustrates a student who could only visualize the image but did not write or construct the intended geometric concept (in the form of a triangle).

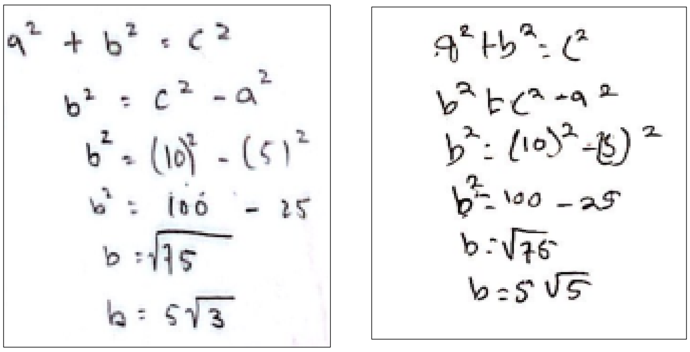
To further validate these observations, several students were selected for interviews to confirm the data. Below, we present an excerpt from the interview with Student AG, who demonstrated errors at the analysis level for Problem 2.

Researcher:	*"Please take another look at the problem and reread the information."*
Student:	*"Yes, ma'am."*
Researcher:	*"In the problem, where is Arkan positioned? Why isn't this reflected in your drawing?"*
Student:	*"On the left side, ma'am."*
Researcher:	*"The 45-degree angle in the problem should be placed where? And how does the triangle form?" (Researcher shows the correct answer)*
Student:	*"Yes, ma'am..."*

Deduction Level Competency

At the deduction level, competency is evaluated based on how students understand the relationships between the properties of geometric shapes. Geometric relations, such as the equal length of opposite sides in a rectangle, the diagonal of a rectangle being the square root of the sum of the squares of its length and width, and the ability to write area formulas and perform accurate calculations, are examined.

For Problem 2, the focus was on how students articulated the relationships between trigonometric ratios in a right-angled triangle. Below, we present one student's response at the deduction level of competency.



(a) (b)

Figure 5. Example of the deduction stage, (a) correct student, (b) incorrect student response

The figure above illustrates how students applied the Pythagorean theorem to determine one side of the rectangle (the length). The use of this formula was appropriate, as students correctly identified the hypotenuse based on the Pythagorean theorem in a right-angled triangle. This choice of formula was also informed by students' understanding that one of the angles formed by the diagonal of a rectangle is 90 degrees.

The ability of students to connect these concepts to determine the length of a side of the rectangle demonstrates well-developed deductive reasoning skills. In Figure 5, the student made a calculation error but correctly applied the concept to find the length of the rectangle from its diagonal.

To confirm whether this error stemmed from a misunderstanding of the square root concept or was simply a calculation mistake, an interview was conducted with Student RA based on their answer sheet. The transcript is as follows:

Researcher: *"Please review your answer again."*
Student: *"Yes, ma'am."*
Researcher: *"What is the result of √75? Is it correct that it's 5√5? Try finding the value of √8; what times what gives that result?"*
Student: *(attempts calculation) "It's the square root of 4 times the square root of 2, ma'am, so it's 2√2."*
Researcher: *"How about the square root of 75? Is your answer correct?"*
Student: *"5√3, I made a calculation mistake."*

The transcript reveals that the student's error was purely a calculation mistake. However, in this context, the student's deductive ability was sound, as they accurately applied the Pythagorean theorem and square root concepts. This indicates that, overall, students' deductive skills in numeracy are well-developed.

This research demonstrates that the most prevalent abilities among the students were in the areas of visualization and analysis. These skills represent the foundational geometric competencies of the students. The study reveals that, as the geometric ability level increases, fewer students are able to reach higher levels. In geometry, many students tend to focus on the overall shape rather than its properties (Utami et al., 2016). This suggests that many students master the visualization level but have not yet developed the analytical skills required to examine geometric properties. The Bengkulu context in the problems in the questions also supports this ability. Using context in mathematics learning will make it easier for students to understand (Zulkardi & Kohar, 2018). Likewise, traditional game objects and local contexts (Jannah & Putri, 2019), make it easier for students to understand. This is one of the factors that can make it easier for students to visualize geometric problems in questions.

To improve students' numeracy skills in geometry, conceptual understanding is necessary so that students can effectively apply their abilities in problem-solving, particularly visualization skills (Pertiwi & Sudihartinih, 2020). This is critical because the foundational step in problem-solving requires students to understand the geometric concepts involved. Furthermore, we observed that students' abilities at the deduction level were lower. This is likely because, in geometry education, students often memorize formulas without fully understanding how to use them to solve problems. Therefore, the role of the teacher in the classroom is essential for facilitating the gradual development of students' geometric skills.

▪ CONCLUSION

Based on the findings presented in this study, it can be concluded that the numeracy abilities of the students were distributed as follows: 4 students (13.33%) demonstrated low-level numeracy skills, 24 students (80.00%) exhibited medium-level numeracy skills, and 2 students (6.67%) achieved high-level numeracy skills. Regarding students' numeracy abilities according to geometric levels, the average percentage for visualization was 81.66%, for analysis it was 66.67%, and for deduction it was only 40.00%. The results of this study highlight the influence of culturally-based numeracy problems on students' abilities. These findings carry important implications for classroom instruction, emphasizing the need for a focus on numeracy problems that assess students' skills through practice exercises. Additionally, incorporating local contexts in mathematical problems can serve as a valuable tool for supporting students in developing their mathematical skills.

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