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Mathematical Literacy through PBL-Team Teaching with Educaplay: A Case Study Based on Students' Learning Styles

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Abstract

This study aims to describe the mathematical literacy skills of junior high school students on the geometry of tubes and cones by applying the Problem-Based Learning (PBL) model with a team teaching strategy assisted by Educaplay digital media in terms of student learning styles. This study employed a descriptive qualitative approach with a case study design. The research subjects consisted of 30 eighth-grade students, with an in-depth analysis focused on three students, each representing a dominant learning style: visual, auditory, and kinesthetic. The research instruments included a learning style questionnaire, a mathematics literacy test based on local cultural contexts, and semi-structured interviews. The results indicated that visual learners tended to excel in interpreting visual contexts but struggled with abstract mathematical formulation. Auditory learners demonstrated understanding through verbal explanations but showed weaknesses in procedural aspects, while kinesthetic learners exhibited strong spatial reasoning through hands-on experiences. This study reveals that implementing the PBL model, integrated with team teaching strategies and the interactive media Educaplay, positively impacts the development of students' mathematical literacy, taking into account differences in learning styles and their connection to local cultural contexts.

Keywords: Educaplay, Learning Styles, Mathematical Literacy, Problem-Based Learning, Team Teaching

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INTRODUCTION

Mathematical literacy is a critical competency that students must develop to navigate the challenges of the 21st century. It encompasses computational skills and the ability to formulate contextual problems into mathematical form, apply mathematical concepts and procedures, and interpret results in various real-world situations (Afni & Hartono, 2020; Poernomo et al., 2021). In this context, mathematical literacy is understood as the ability to understand, use, and evaluate mathematics in diverse life contexts, enabling students to recognize the role of mathematics in everyday life (Almarashdi & Jarrah, 2023). Despite its importance, numerous national and international studies, including findings from the Programme for International Student Assessment (PISA), indicate that Indonesian students' mathematical literacy remains below the global average (Harisman et al., 2023). This condition highlights a gap between students' expected ideal and actual competencies (Kusmaryono & Kusumaningsih, 2023). One of the main factors contributing to the low level of mathematical literacy is the learning approach, which remains procedure-oriented and lacks connections between mathematical concepts and relevant real-life contextual problems (Ichda et al., 2023).

Therefore, mathematics instruction needs to focus on developing critical, logical, and creative thinking skills so that students can integrate mathematical concepts in solving real contextual problems (Sundawan et al., 2019). The Problem-Based Learning (PBL) model is a relevant approach for enhancing mathematical literacy because it emphasizes solving real-world problems presented in contexts that are meaningful to students (Khairunnisah & Rasyidah, 2024). PBL has been proven to increase student engagement and strengthen conceptual understanding (Smith et al., 2022), as well as encourage students to develop higher-order thinking skills through problem-solving activities grounded in everyday life situations (Suastra et al., 2019). To optimize the implementation of the PBL model, a team teaching strategy can be applied as a form of teacher collaboration to enhance the effectiveness of instruction in meeting the diverse needs of students (Maharani et al., 2019). In the digital era, integrating technology into learning also plays a crucial role in increasing student motivation and participation. One effective form of educational technology innovation is the use of digital-based educational games such as Educaplay, which offers engaging activities such as puzzles, quizzes, matching tasks, and contextual simulations (Purbawati et al., 2024).

The use of interactive educational games not only makes learning more enjoyable but also fosters meaningful learning experiences aligned with the characteristics of 21st-century education (Pramuditya et al., 2018). The implementation of digital-based Problem-Based Learning (PBL) has shown significant potential in improving mathematics learning outcomes across various cultural contexts, especially when contextualized locally (Nityasanti et al., 2025; Pratama & Yelken, 2024). However, learning effectiveness is not solely determined by the instructional model and media used; it is also greatly influenced by students' characteristics, one of which is learning style. Learning style is a key factor that affects how students optimally receive and process information (Delima et al., 2019). Each student has a different learning tendency, which is generally categorized into three main types: visual, auditory, and kinesthetic (Ishartono et al., 2021).

Nevertheless, the learning approach based on learning styles remains debated in academia. A systematic review by (Pashler et al., 2008) There is no convincing empirical evidence that matching individual students' learning styles with specific teaching strategies consistently improves learning outcomes. This finding is reinforced by (Delima et al., 2019; El-Sabagh, 2021) Who showed that tailoring instruction according to learning style preferences has not significantly impacted students' academic achievement. Therefore, implementing this approach must be conducted critically and flexibly, emphasizing adapting teaching strategies to students' needs. In addition to considering students' characteristics, relating mathematics content to local cultural contexts is also believed to enhance meaning and connectedness in learning (Suprayo et al., 2019). In geometry topics such as cylinders and cones, contextualization can be carried out through cultural objects such as the Tifa musical instrument from Papua, which has a cylindrical shape; the Mbaru Niang traditional house from Wae Rebo, which has a conical shape; and the Honai traditional house from Papua, which is a combination of cylindrical and conical forms. This culturally based learning approach has the potential to help students build knowledge more creatively and relevantly, while integrating cultural values into the learning process (Noto et al., 2018).

Although several previous studies have examined separately the effectiveness of Problem-Based Learning (PBL), the use of digital media, learning styles, and local cultural contexts in mathematics instruction, research integrating all four aspects within a single learning framework remains very limited. Specifically, this study investigates the influence of dominant learning styles (visual, auditory, kinesthetic) on students' mathematical literacy skills in the context of geometry contextualized culturally. The novelty of this research lies in the integrated application of the PBL learning model, team teaching strategies, and the digital media Educaplay within a local cultural context, with a particular focus on differences in learning styles in culturally based geometry learning. Thus, the objective of this study is to describe the mathematical literacy of junior high school students on geometry topics (cylinders and cones) through the implementation of the Problem-Based Learning (PBL) model combined with team teaching strategies supported by Educaplay digital media, viewed from students' differing learning styles.

METHOD

Research Design

This study employed a descriptive qualitative approach with a case study design, as described by (Assyakurrohim et al., 2022; Houghton et al., 2017), focusing on an in-depth exploration of a phenomenon within a real-life context. The study aimed to describe and analyze students' mathematical literacy skills based on their learning styles after participating in instruction using the Problem-Based Learning (PBL) model combined with a team teaching strategy supported by the interactive media Educaplay. The research was conducted over approximately one week, from April 14 to April 17, 2025, at a junior high school (SMP) in Cirebon. The research subjects consisted of 30 eighth-grade students who had undergone mathematics learning on cylinders and cones using a local cultural contextual approach, including the Tifa musical instrument, the Mbaru Niang traditional house, and the Honai traditional house. However, the in-depth analysis focused on three students representing each dominant learning style: visual, auditory, and kinesthetic. The subjects were selected based on the results of a learning style questionnaire completed by all students before the test administration. The three students with the highest scores in each learning style category were chosen as the primary subjects to explicitly represent different learning style tendencies.

Instrument and Procedure

The instruments used in this study consisted of: (1) a questionnaire to identify learning styles, (2) a mathematical literacy test adapted to the local cultural context, and (3) a semi-structured interview guide. The learning style questionnaire comprised 30 statements divided into three sections, each containing 10 statements. Examples of statements in the questionnaire include: for the visual learning style, "I understand lessons better when using pictures or diagrams"; for the auditory learning style, "I comprehend lessons well when explained verbally"; and for the kinesthetic learning style, "I understand faster when I can directly practice the material." The items in the questionnaire were designed to accurately identify students' dominant learning style tendencies across the three styles, using a four-point Likert scale, as detailed in Table 1.

Table 1. Likert Scale for the Learning Style Questionnaire

Score	Criteria
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Based on Table 1, the final score for each learning style category is calculated by summing the scores from 10 statements in each category. Students with the highest score in a particular category are considered to have a dominant learning style. Two expert lecturers in mathematics education validated the questionnaire to ensure content appropriateness, readability, and relevance to the characteristics of junior high school students. Four open-ended questions based on local cultural contexts were developed to assess mathematical literacy skills, referring to the PISA framework (OECD, 2019). Each question was designed to represent one mathematical literacy indicator, as shown in Table 2.

Table 2. Questions and Mathematical Literacy Indicators

<table>
<tr><th>Mathematical Problems</th><th>Indicator/Deskription</th></tr>
<tr><td>Read about the Traditional Musical Instrument Tifa!

Making the Tifa Instrument. Source: https://images.app.goo.gl/vMtXawfrtgAXuMbi9
In a village in Papua, there is a traditional musical instrument craftsman named Mr. Budi. He is an expert in making the Tifa, a traditional Papua drum-shaped instrument used in various cultural ceremonies and art performances. Mr. Budi wants to teach the village youth how to make the Tifa to preserve the local culture. In the making process, Mr. Budi selects high-quality wood and carves it into a cylindrical shape. The top of the cylinder is covered with stretched animal skin to produce a resonant sound. To ensure the Tifa produces a good sound, Mr. Budi must consider the wood's diameter, height, and thickness to optimise the sound resonance. After the Tifa is completed, the youth try to play it in an art performance. They realise that Tifa's size affects the sound's pitch and volume. Therefore, Mr. Budi invites them to understand the mathematical aspects of making the Tifa to create a high-quality musical instrument.
1. Mr. Budi wants to make the Tifa produce a louder sound without changing the diameter of the cylinder. What factors can be adjusted to achieve this goal? Explain mathematically how these changes will affect the sound resonance!</td><td>Formulate: Identifying and formulating situations into mathematical terms.</td></tr>
<tr><td>
Traditional House Mbaru Niang, East Nusa Tenggara.
Source: https://images.app.goo.gl/KVsvm5x2YEqpNt5N9
2. The traditional house Mbaru Niang has a circular base with a diameter of 14 meters. If the home is constructed in the shape of a cone, determine the area of the cone's base. Then, calculate the amount of materials needed to cover the house's base, considering that every square</td><td>Employ: Using mathematical concepts, procedures, and facts in problem-solving.</td></tr>
</table>

	Mathematical Problems	Indicator/Deskription
	meter requires five bamboo sheets. Is the estimated amount of bamboo sufficient to cover the entire base of the house?	
3.	The Honai traditional house is designed to reduce the impact of extreme weather in Papua. How does the conical roof of the Honai help channel rainwater efficiently? Analyse and provide a simple mathematical calculation to support your answer.	**Interpret:** Interpreting mathematical results and relating them to the original context.
4.	If an artisan wants to send 5 Tifa drums out of town in a rectangular box measuring 16 cm × 9 cm × 10 cm, can all the Tifas fit inside the box?	**Evaluate:** Evaluating and reflecting on the solution and the problem-solving process.

In addition to written tests, data were also collected through in-depth interviews using a semi-structured interview guide. After completing the test, the questions posed to the three main subjects included: “What helped you understand this problem?” and “Can you explain your answer in another way?” These interviews aimed to gain deeper insights into the students’ thinking processes, problem-solving strategies, and the influence of learning styles in understanding and solving mathematics problems based on real-world contexts. Research data were obtained from the learning style questionnaire, written tests, and in-depth interviews with the three main subjects.

The collected data were analyzed using the Miles and Huberman model, which involves three main stages: (1) data reduction, the process of identifying and grouping data to find thematic focuses; (2) data display, organizing data in the form of narratives, tables, and direct quotations to facilitate interpretation; and (3) drawing conclusions, the stage of analyzing patterns of relationships between students’ learning styles and their mathematical literacy abilities. The analysis focused on the written test results and interview transcripts to identify students’ response patterns, their relation to mathematical literacy indicators, and the relationship between dominant learning styles and mathematical literacy skills.

The data categorization process was conducted inductively through open coding techniques applied to the interview transcripts. Examples of initial categories used included: “using images to understand concepts” (visual), “requiring verbal explanation” (auditory), and “involving direct physical activity” (kinesthetic). These categories were then classified into main categories referring to the indicators of mathematical literacy, namely formulating, applying, interpreting, and evaluating solutions in real-world contexts.

Two researchers independently conducted the categorization process to enhance data validity and subsequently discussed the results until reaching a consensus (interrater reliability). Triangulation was performed by analyzing the consistency of data obtained from the questionnaire, tests, and interviews to strengthen the credibility of the research findings. The overall research flow is illustrated in Figure 1.

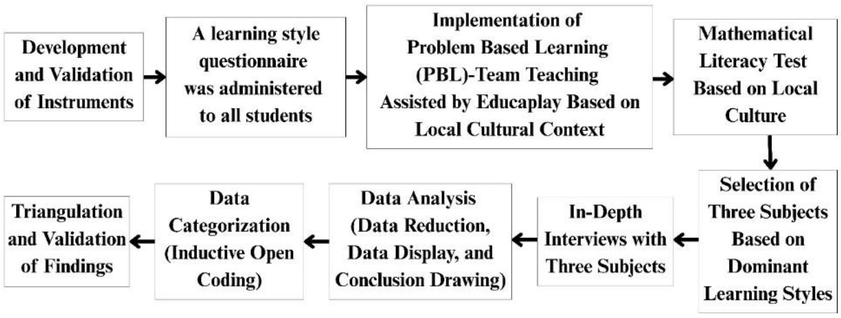

Figure 1. Research Flowchart

Figure 1 depicts the systematic stages of the research process, spanning from initial planning to the conclusion.

RESULTS AND DISCUSSION

The analysis results of the learning styles questionnaire completed by 30 eighth-grade students are presented in Figure 2.

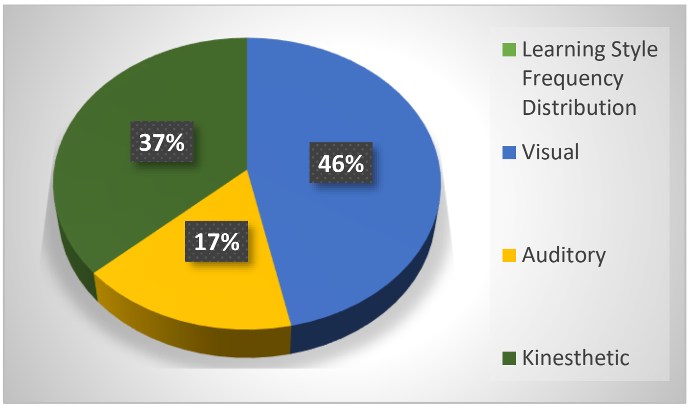

Figure 2. Percentage of Learning Styles Questionnaire Results

Figure 2 presents the distribution of students' learning styles as follows: 14 students (46%) demonstrated a dominant visual learning style, five students (17%) were auditory learners, and 11 students (37%) showed a kinesthetic learning preference. These findings reflect the diversity of students' learning styles, in line with the study by (Magdalena & Amanda, 2020), which asserts that each student possesses a unique approach to receiving and processing information. The predominance of visual learners suggests the importance of visually delivering instructional content, such as through images and diagrams, to enhance students' comprehension of mathematical concepts. This aligns with the study's outcomes (Sheromova et al., 2020)Visual learners achieve better learning outcomes when engaging with visualisation-based media. Additionally, (Cimermanová, 2018) Emphasised that selecting instructional models and media should consider students' dominant learning styles to maximise learning effectiveness. This variation necessitates a flexible and differentiated instructional approach, which is accommodated through integrating the Problem-Based Learning (PBL) model with a team teaching strategy supported by Educaplay media. This approach fosters interactive and contextually meaningful learning experiences.

Following the classification of students' learning styles, a mathematical literacy test was administered to assess their abilities to formulate, employ, and interpret mathematical concepts related to cylinders and cones. The test, given to 30 students, revealed variations in performance aligned with their respective learning styles. For an in-depth analysis, three representative students were selected: S1 (visual learner), S2 (auditory learner), and S3 (kinesthetic learner). The data from the mathematics test and follow-up interviews are summarised as follows.

Mathematical Literacy Ability of Student with Visual Learning Style (S1)

After administering the learning style questionnaire, one student with the highest score in the visual learning style category was selected from 14 students identified as visual learners. This student was chosen as a subject for further analysis of their responses to the mathematics literacy test. The student's answers, representing the mathematical literacy ability of a visual learner, are presented in Figure 3.

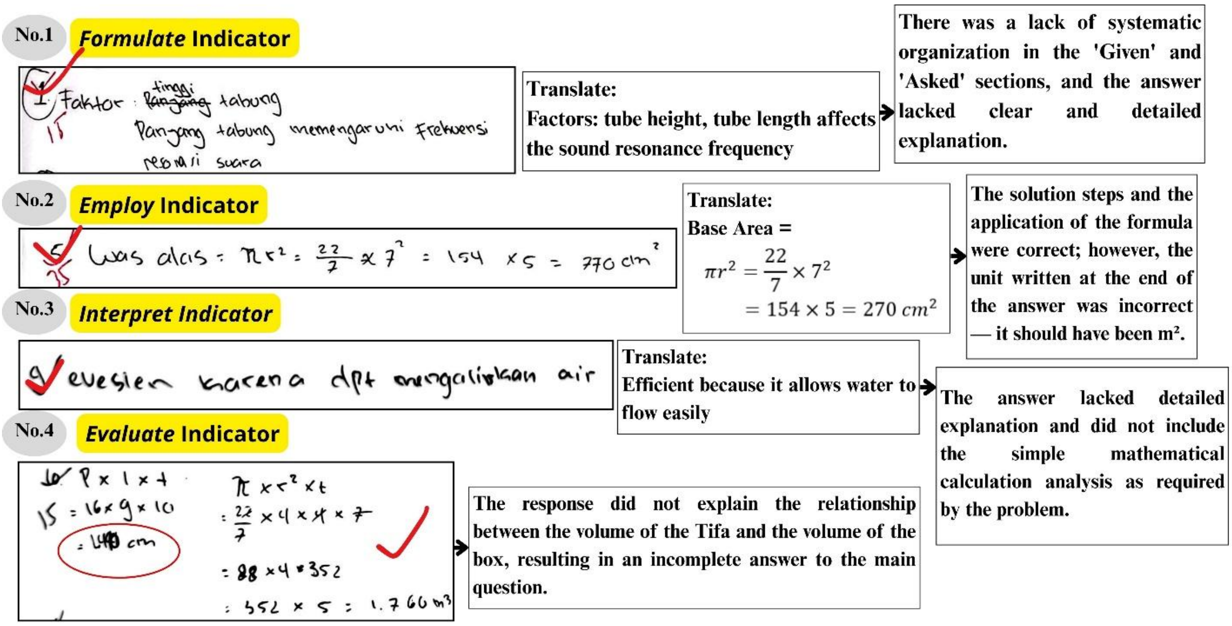

Figure 3. Results of Written Tests: Students with Visual Learning Style

Figure 3 shows that students with a visual learning style solved all problems using mathematical literacy indicators. The following section provides a detailed analysis of each problem.

Problem 1 (Formulate)

Student S1 demonstrated the ability to identify the relationship between the length of the cylindrical part of the Tifa musical instrument and the frequency of the sound produced. This ability reflects an initial conceptual understanding based on the visualization of the context. However, the student had not yet explicitly integrated mathematical representations, such as resonance formulas or systematic calculation steps. This indicates that the student's understanding remains conceptual, based on visual observation, and has not yet developed into the stage of abstraction in the form of a formal mathematical model. These findings are consistent with (Montenegro et al., 2018), who stated that students with a visual learning style need additional visual support to connect concrete situations with formal mathematical representations. An excerpt from the interview with Student 1 (S1) is presented below:

Interviewer : Mr. Budi wants to make a Tifa that produces a louder sound without changing the diameter of the tube. What factor can be adjusted?

Student (S1) : The length of the tube. If it is shorter, the sound becomes higher and louder. I saw in the picture that the sound waves become more compact.

Interviewer : What helped you understand this question?

Student (S1) : The illustration or image. If it were only a formula, I would be confused, but with the image, I understood it right away.

Problem 2 (Employ)

Student S1 successfully calculated the base area of the conical traditional house *Mbaru Niang* using the formula $L = \pi r^2$ multiply it by the number of bamboo pieces needed. Although there was an error in unit conversion, the procedure demonstrated a fundamental mastery in applying mathematical formulas within a cultural context. This ability reflects how students with a visual learning style operate calculations based on visual observation and pattern recognition of geometric shapes through pictorial representations. This finding aligns with (Mainali, 2021), who highlighted the critical role of visual media in facilitating the understanding of spatial concepts.

Problem 3 (Interpret)

Student S1 explained that the conical roof shape of the Honai house "facilitates water flow" without providing mathematical analysis, such as the inclined plane's slope angle or surface area. This indicates an initial contextual conceptual understanding but has not yet developed into an analytical mathematical interpretation. It shows that visual learners can associate shape with function but require additional media support to construct the mathematical meaning of the phenomenon. This finding is consistent with (Mailani et al., 2024), who emphasize the importance of geometric visualization in supporting mathematical interpretation. An excerpt from the interview with Student 1 (S1) is presented below:

Interviewer : How does the conical roof of the Honai house help rainwater flow efficiently?
Student (S1) : The sloped roof in all directions helps the water run off quickly.
Interviewer : Can you explain that mathematically, with a simple calculation?
Student (S1) : Formulas can be challenging to explain. It is easier for me to understand if there is a picture to help visualise the concept.

Problem 4 (Evaluate)

Student S1 could accurately calculate the total volume of five Tifa musical instruments and their box. However, the student did not consider the arrangement of the objects inside the box, so a comprehensive evaluation of the feasibility of storage was not conducted. This finding indicates that although the student has good procedural understanding, support in spatial representations, such as three-dimensional diagrams or visual simulations, is still needed to assist the evaluation process in realistic contexts. This is consistent with the findings of (Alfianti & Nalurita, 2025), who highlighted the role of visual media in strengthening students' spatial reasoning. The following is an excerpt from the interview with the subject:

Interviewer : A craftsman wants to send 5 Tifa drums in a box measuring $16\ cm\ \times\ 9\ cm\ \times 10\ cm$. Do you think all the Tifa can fit inside the box?
Student (S1) : I calculated the volume to be enough. But I'm still unsure how to arrange them so they fit, and I'm not confident they will all fit.

Mathematical Literacy Ability of Students with Auditory Learning Style (S2)

From the five students identified as having an auditory learning style through the administered questionnaire, one student (S2) was selected for in-depth analysis based on obtaining the highest score in this category. According to the written assessment results, S2 was able to correctly solve two out of the four problems, specifically those aligned with the interpret (Problem 3) and evaluate (Problem 4) indicators, as presented in Figure 4.

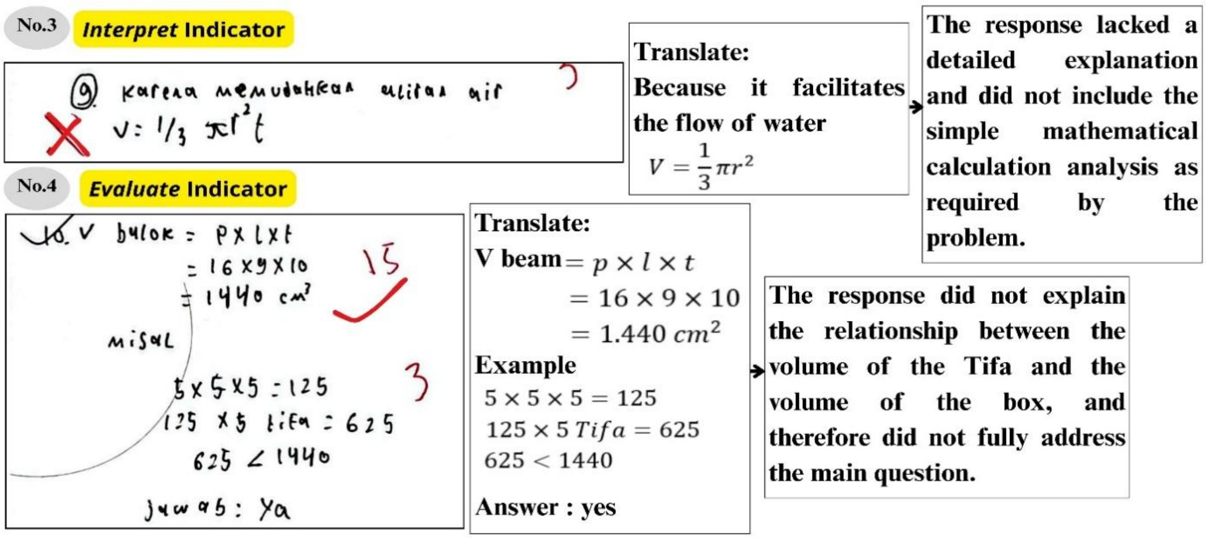

Figure 4. Results of Written Tests: Students with Auditory Learning Style

Based on Figure 4, the following is the analysis for each problem.

Problem 3 (Interpret)

S2 stated that the conical roof shape of the Honai house facilitates rainwater flow, but did not relate this to geometric concepts such as slope angle or the surface area of the inclined plane. The understanding demonstrated was based on verbal explanation, reflecting the characteristics of auditory learners who benefit more from oral explanations in grasping abstract concepts. This finding aligns with (Wulandari & Wardhani, 2024), who reported that students with an auditory learning style better comprehend material through sequential and structured verbal explanations as a bridge to conceptual understanding. Below is an excerpt from the interview with S2:

Interviewer : How does the Honai house’s conical roof help channel rainwater?
Student (S2) : The water flows immediately without pooling because it is pointed and sloped.
Interviewer : How do you find it easier to understand questions like this?
Student (S2) : Through verbal explanations. If it is only pictures or formulas, I often get confused.

Problem 4 (Evaluate)

S2 correctly calculated the volume of the box and five Tifa instruments, but did not conclude on the storage feasibility. The lack of spatial evaluation reflects a limitation in contextual information, consistent with (Setiana & Purwoko, 2020), who emphasized that auditory learners require repeated verbal guidance to independently develop evaluative skills. The following excerpt is from the interview with S2:

Interviewer : Can five Tifas fit into a $16 \times 9 \times 10\ cm$ Box?
Student (S2) : My calculations show they fit, but I am not confident. I need repeated verbal explanations to fully understand.

Mathematical Literacy Ability of Students with Kinesthetic Learning Style (S3)

Following the administration of the learning style questionnaire, one student was selected from a group of 11 identified as having a kinesthetic learning style to serve as the subject of further analysis. This student’s responses to the mathematical literacy test were examined in detail. Based on the study, the kinesthetic learner (S3) successfully solved Problem 3, corresponding to the interpret indicator, and Problem 4, corresponding to the evaluate indicator. The results of this student’s mathematical literacy test responses are presented in Figure 5 below.

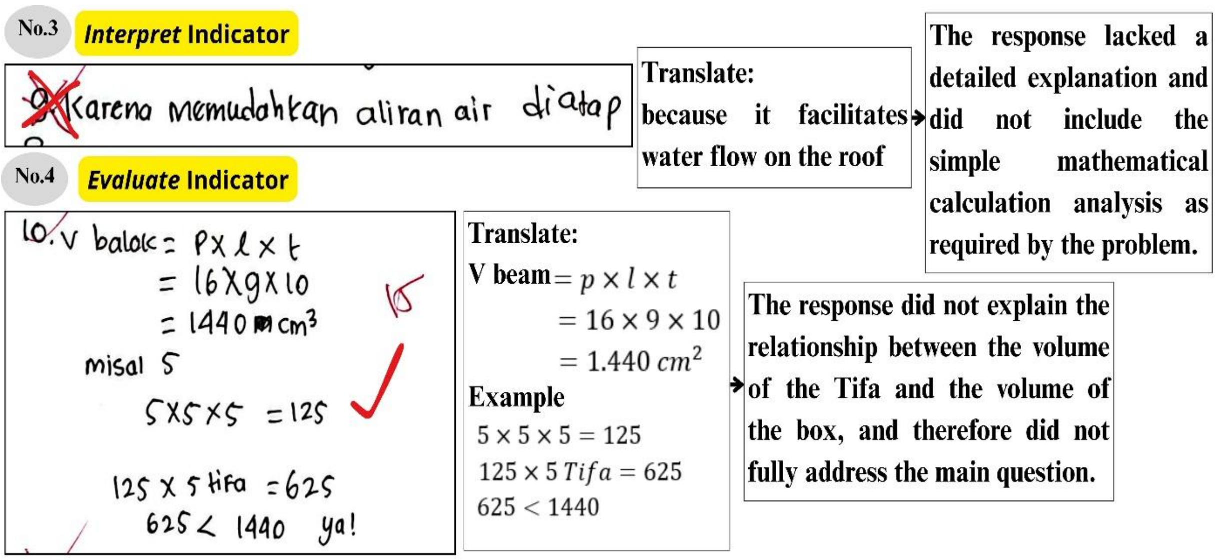

Figure 5. Results of Written Tests: Students with Kinesthetic Learning Style

Based on Figure 5, the following is an analysis of each problem.

Problem 3 (Interpret)

S3 explained the function of the Honai house roof in facilitating rainwater runoff accurately and contextually, although it did not include formal mathematical analysis such as slope angle or surface area. This understanding is based on real experience using a physical model, highlighting the strength of kinesthetic learners in linking physical form to practical function. This finding aligns with (Alfianti & Nalurita, 2025), who stated that physical representations can enhance the spatial understanding of kinesthetic students. Presented below is an excerpt from the interview:

Interviewer : How does the conical roof of the Honai house help rainwater flow efficiently?
Student (S3) : When I hold the model and pour water on it, it flows right down. Because it is pointed and sloped in all directions, water does not pool.
Interviewer : How do you find it easier to understand this problem?
Student (S3) : I understand better through hands-on practice.

Problem 4 (Evaluate)

S3 accurately calculated the volume of the box and five Tifa instruments, and also considered strategies for arranging their positions so that all Tifa could fit inside the box. The student demonstrated precision in volume calculations and logical evaluation regarding the arrangement of the Tifa, based on concrete hands-on experience. This finding aligns with the research by (Magdalena & Amanda, 2020), which highlights the advantage of kinesthetic learners in performing contextual evaluations through direct interaction with physical objects. Presented below is an excerpt from the interview:

Interviewer : How did you think about arranging the Tifa drums so they would fit in the box?
Student (S3) : I imagined that the Tifa drums should be neatly arranged, maybe standing upright or tilted to fit. I once tried arranging objects similar to Tifa in a small box during practice, so I know the importance of positioning so that everything fits.

After presenting each student's mathematical literacy abilities based on their dominant learning styles (visual, auditory, and kinesthetic), Table 3 compares the three representative subjects (S1, S2, and S3) across the four mathematical literacy indicators.

Table 3 shows that students with a visual learning style tend to understand context more effectively through illustrations and visual representations. However, these students still experience difficulties in transferring contextual information into abstract mathematical models. This finding is supported by (Rif'at, 2018; Yilmaz & Argun, 2018), who state that visual learners require extended visual support to develop more abstract mathematical modeling. Meanwhile, students with an auditory learning style demonstrate strong understanding through verbal explanations, especially in interpretation and evaluation. Nonetheless, they still require guidance in developing mathematical models. This aligns with the findings of (Hakim & Mulyono, 2020; Joswick et al., 2023), who argue that auditory learners need reinforcement through repeated verbal explanations to build stronger procedural understanding. On the other hand, students with a kinesthetic learning style demonstrate comprehensive understanding through concrete activities, particularly in connecting mathematical calculations with meaningful spatial representations. This is consistent with the views of (Oladele, 2024; Simamora et al., 2025) Those who emphasize the importance of hands-on experience and physical representation in deepening students' spatial understanding.

Table 3. Comparison of Students' Mathematical Literacy Abilities Based on Learning Styles

Mathematical Literacy Indicators	Visual (S1)	Auditory (S2)	Kinesthetic (S3)
Formulate	Understands the context through visualization; has not yet formed a formal mathematical model.	Did not answer	Did not answer
Employ	Correct steps and formulas; incorrect unit conversion.	Did not answer	Did not answer
Interpret	Reasonable visual interpretation; lacks mathematical analysis.	Contextual understanding relies on verbal explanations.	Interpretation based on concrete experience (hands-on model).
Evaluate	Accurate calculation; incomplete evaluation.	Accurate calculation; incomplete evaluation.	Accurate calculation and spatial assessment.

This study demonstrates that implementing the Problem-Based Learning (PBL) model combined with a team teaching strategy supported by the interactive media Educaplay positively impacts the development of students' mathematical literacy, considering differences in learning styles and their connection to local cultural contexts. This implementation fosters more adaptive learning, as also emphasized by (Kriswanto & Wahyuningsih, 2024; Siswanto et al., 2024), who state that culture-based and media-supported PBL models can enhance student engagement and contextual relevance. Nevertheless, students' mathematical literacy achievements still show variation influenced by their learning styles—namely, visual, auditory, and kinesthetic. These findings directly support the research objective, which is to describe students' mathematical literacy abilities based on learning styles in the context of applying the Problem-Based Learning (PBL) model integrated with a team teaching strategy and Educaplay media. Integrating instructional models, interactive media, and student learning style characteristics demonstrates potential in creating learning experiences that are more meaningful, adaptive, and relevant to everyday life. These results align with the findings of (Saputra et al., 2024), who highlight the effectiveness of contextual inquiry-based learning in improving science literacy. Furthermore, an international study by (Smith et al., 2022) shows that applying PBL contextualized in collaborative and multicultural learning environments can significantly promote students' conceptual understanding and active participation.

These findings underscore the importance of a Problem-Based Learning (PBL) approach responsive to cultural contexts and students' diverse needs. The three studies consistently highlight that connecting learning to students' real-life contexts and designing instruction considering individual learner characteristics are key factors in fostering relevant and meaningful mathematical literacy. Accordingly, this research provides empirical contributions to developing culturally based mathematical literacy.

CONCLUSION

This study demonstrates that students' mathematical literacy abilities in geometry learning based on local cultural contexts are influenced by individual learning styles. Through implementing a Problem-Based Learning (PBL) model combined with team teaching strategies supported by the interactive Educaplay media, each learning style—visual, auditory, and kinesthetic—exhibits its strengths and weaknesses across mathematical literacy indicators. An adaptive instructional approach that accommodates diverse learning styles holds potential for developing mathematical literacy that is contextual, meaningful, and relevant to students' cultural contexts.

RECOMMENDATION

Based on the findings of this study, it is recommended that future research designs explicitly consider the diversity of students' learning styles. The selection of digital media, such as Educaplay, should be tailored to the preferences of visual, auditory, and kinesthetic learners to provide optimal learning support for each student. Furthermore, lesson plans should incorporate collaborative activities within team teaching strategies to facilitate culturally based problem-solving through diverse and complementary pedagogical approaches. For future studies, developing digital instruments more responsive to variations in learning styles is suggested, along with expanding research subjects across different cultural contexts and regions to strengthen the generalizability of results. The primary limitation of this study lies in its relatively small sample size and single-context setting; therefore, further studies with methodological designs that include cross-validation across contexts and subjects are necessary to test the consistency of findings in a broader and more representative manner.

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