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The Students' Numeracy Literacy Profile through Visual, Auditory and Kinesthetic Learning Styles

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Abstract

This study aimed to describe students' numeracy literacy ability reviewed from visual, auditory, and kinesthetic learning styles. The method used is a qualitative approach with a case study method. The subjects in this study consisted of 73 eighth-grade students at a junior high school in Kelapa Dua, Indonesia, who were selected intentionally based on variations in learning styles and levels of numeracy literacy skills. Data collection was carried out through test numeracy literacy, a questionnaire-style study, and semi-structured interviews. Data were analyzed in a descriptive qualitative way with a triangulation technique to increase the validity of findings. Research results show that students with visual learning tend to achieve higher literacy more numeracy tall compared to students stylish Study auditory and kinesthetic way. Visual students appear more capable of understanding mathematics and developing solution strategies to questions in a way. On the other hand, students are auditory and kinesthetic; many are in the low category, especially because lack of verbal support and concrete activities in the learning process. Research This concludes that the style of Study is influential to the method of student processing and implementing draft numeracy. Findings. This gives important implications in designing learning strategies for adaptive mathematics to suit the needs of students, to improve the quality of numeracy literacy in schools.

Keywords: Numeracy Literacy, Learning Styles, Junior High School Students

INTRODUCTION

The quality of human resources (HR) plays a crucial role in determining a country's progress, including in the education sector. However, according to the UNDP's *2025 Human Development Report*, 2023 data places Indonesia's HDI score at 0.728 (ranked 113th out of 193 countries), still in the *high category*. Although better than before, it indicates that the education sector and other basic services have not yet - optimally contributed to improving human resource quality (UNDP, 2022). One indicator of the education sector's weak contribution is reflected in the still low levels of literacy and numeracy among students at various levels of education. Low literacy and numeracy skills indicate that students are not yet fully able to understand, analyze, and use number-based information in the context of everyday life, which are basic competencies in developing superior human resources in the modern era (OECD, 2023a). The skills required of students in mathematics are not limited to numeracy skills, but also include the ability to reason logically and think critically in solving problems. The problems in question are not only routine questions, but also problems that arise in everyday life; this ability is understood to be a numeracy literacy ability (Muslimah & Pujiastuti, 2020).

One of the main issues of concern in the world of education is the still low literacy and numeracy achievements of students. Data from *the Programme for International Student Assessment* (PISA) (OECD, 2022b) shows that the numeracy skills of Indonesian students are still below the average of OECD countries. Numeracy literacy is one of the things that is no less important in everyday life. Many social activities, such as planning shopping, starting a business, or providing information, require numeracy literacy. This shows that students' numeracy literacy skills are crucial because they enable them to understand and apply mathematical concepts in real-world contexts, as conveyed by Pujiastuti & Haryadi (2023) regarding the importance of utilizing mathematics to solve everyday problems. This finding emphasizes the urgency of improvements in the learning process, especially in strengthening numeracy literacy as a basic competency that is essential for solving contextual problems in everyday life.

The low numeracy literacy skills of students can be influenced by various aspects, one of which is the mismatch between the learning approach and the characteristics of students' learning styles. In a study by Subagja & Rubini (2023), it was stated that recognizing students' learning styles helps teachers design more effective media and strategies in learning. Furthermore, Pujiastuti et al. (2014) revealed that the ongoing learning process has not fully developed students' higher-order thinking skills. This is closely related to numeracy literacy, as this skill encompasses not only the ability to calculate but also involves the ability to think critically, solve problems, and draw conclusions based on complex quantitative information. As explained by Rahim et al. (2023), numeracy literacy is an integral part of 21st-century skills that require students to think reflectively and logically in making data-based decisions.

DePorter & Hernacki (2011) explain that individual learning styles are divided into three, namely visual, auditory, and kinesthetic. The success of the learning process is largely determined by the suitability of the teaching strategy to the dominant learning style possessed by students. If the learning approach is not aligned with the student's dominant learning style, then understanding of the subject matter, including the numeracy aspect, will be less than optimal (Faidah et al., 2021). Therefore, it is important to assess students' numeracy literacy abilities based on their learning style preferences. This study aims to describe students' numeracy literacy abilities in terms of differences in learning styles, specifically visual, auditory, and kinesthetic styles. The results of this study are expected to provide a complete picture of learning styles and numeracy literacy abilities, as well as serve as a basis for designing more adaptive and effective learning strategies to improve the quality of mathematics education in schools.

METHOD

This study used a qualitative approach with a case study method, a way to deeply profile of ability literacy and numeracy abilities of students based on a variation style study. Focus mainly on studies. This is to understand how style Study student, especially visual, auditory, and kinesthetic, correlates with their ability they finish the question numeracy that measures skills to think logically, understanding concepts, as well as solving problems in contextual research implemented at a junior high school. Selection techniques used in a *purposive sampling* consider diversity style learning and level ability literacy numeracy, which are classified into categories low, medium, and high (Sugiyono, 2021).

Data collection was carried out through three instrument main : (1) test literacy numeracy based indicator Assessment Minimum Competency from Ministry of Education, Culture, Research and Technology; (2) questionnaire style adopted learning from (DePorter & Hernacki, 2011) which has customized with context junior high school students; and (3) semi- structured interviews aimed at for explore thinking strategies student in finish question numeracy in accordance style Study dominant. Test literacy given numeracy in the form of question description, as many as 5 questions with the domain of *Algebra,* and includes three AKM literacy context numeracy, namely personal, social culture, and *scientific.* The algebra domain was chosen in measuring numeracy literacy because algebra has an important role in supporting the understanding of advanced mathematical concepts and applications in various fields such as science and technology (Ario & Suhendra, 2025). The questions were made based on grid literacy numeracy, referring to indicators (De Bruin et al., 2023) presented in Table 1.

Table 1. Indicators Numeracy Literacy

No	Indicator
1	Applying various types of symbols and numbers related to basic mathematics to solve problems in everyday life
2	Analyze information presented in the form of charts, graphs, tables, etc.
3	Interpret analysis results to make predictions and make decisions.

(De Bruin et al., 2023)

After preparing the numeracy literacy test grid, the next step is to design the test questions and the assessment rubric. At this stage, students are given five questions to measure their numeracy literacy skills. Next, students' answers are evaluated using the numeracy literacy assessment rubric according to Polya. Later scores obtained were converted to get mark literacy numeracy, after that, literacy numeracy students were classified based on the value intervals presented in Table 2.

Table 2. Numeracy Literacy Categories

Value Interval	Category
≤ 40	Low
$41 - 70$	Medium High
≥ 70	High

(Yustinaningrum, 2021)

After the numeracy literacy ability data were obtained through a test, a learning style questionnaire instrument was given to students to identify their learning style type based on the DePorter & Hernacki (2011) model, which includes three main categories: visual, auditory, and kinesthetic. This was developed and validated by experts before being used. The test and questionnaire results were analyzed to determine the pattern of relationship between the type of student learning style and the level of numeracy literacy skills, to obtain a comprehensive picture of the student's learning profile. Data analysis uses technique analysis, a descriptive qualitative analysis process covering data reduction, data presentation, and data extraction conclusion analysis from Miles Huberman.

In ensuring data validity, the technique triangulation sources and methods, with comparison of results, tests, questionnaires, and interviews. These techniques aim to increase the reliability and credibility of the data obtained in the study (Creswell & Poth, 2016) .

RESULTS AND DISCUSSION

This study aims to identify students' numeracy literacy skills based on their learning styles: visual, auditory, and kinesthetic. To obtain this data, a numeracy literacy test was initially administered to 73 students, followed by a learning style questionnaire. This questionnaire was developed based on the *Quantum Learning approach* by DePorter & Hernacki (2011), which divides learning styles into three main categories: visual, auditory, and kinesthetic.

The results of the numeracy literacy test showed that the majority of students were in the low category, namely 43 students (59%). A total of 28 students (38%) were in the medium category, and only 2 students (3%) were classified as having high numeracy literacy skills. Furthermore, filling out the learning style questionnaire showed that the visual learning style was the most dominant, owned by 53 students (73%). Auditory learning styles were found in 13 students (18%), while kinesthetic learning styles were owned by 7 students (10%). Figure 1 is shown in a bar graph that illustrates the distribution of students' numeracy literacy skills based on learning styles.

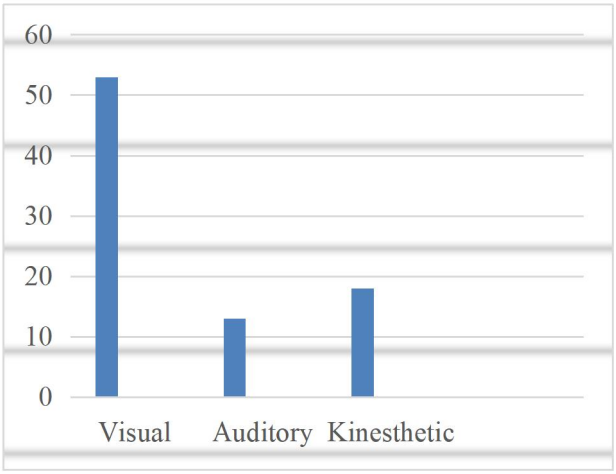

Figure 1. Frequency Distribution of Numeracy Literacy Based on Learning Style

This suggests that while visual learning is a dominant learning style, it doesn't necessarily automatically correlate with high numeracy skills. Visual learners appear to be more prevalent across all ability levels than other learning styles. This finding aligns with Wahyuni's (2022) research, which showed that visual learners respond more quickly to numeracy problems, especially those based on images or visual contexts. Meanwhile, students with style Study auditory, totaling 13 people. A total of 10 students are in the category low, and only 3 students are classified as moderate. There is none. Student auditory that reaches category high. This result in harmony with the findings of Kirani et al. (2023), who found that students with style of Study auditory tend to need explicit and frequent verbal support for difficulty if the material is served visually or symbolically without a strong verbal explanation.

Learning style kinesthetic is owned by 7 students, with 4 students is in the category low and 3 in the category moderate. Similarly with auditory, no student found kinesthetic in the category of high ability. This condition strengthens findings DePorter & Hernacki (2011) that students with Study kinesthetic learning style will more maximum If get learning based activities, movements, and simulations directly. In the context of question abstract and symbolic numeracy, they tend to experience difficulties. Findings This is also reinforced by Widayanti (2013), who stated that students kinesthetic more easier to absorb material through direct practice compared to exposure theory.

Visual Learning Style with High Numeracy Literacy

Students with a visual learning style who have high numeracy literacy skills demonstrate systematic problem-solving patterns and can link contextual information with symbolic representations. This is evident in the following answer from student V1 can be seen in Figure 2. The problem-solving process of student V1 with high numeracy literacy is illustrated in Figure 2. The student begins by writing down what is known, identifies the

appropriate formula, and then substitutes the values into the equation until the solution is obtained

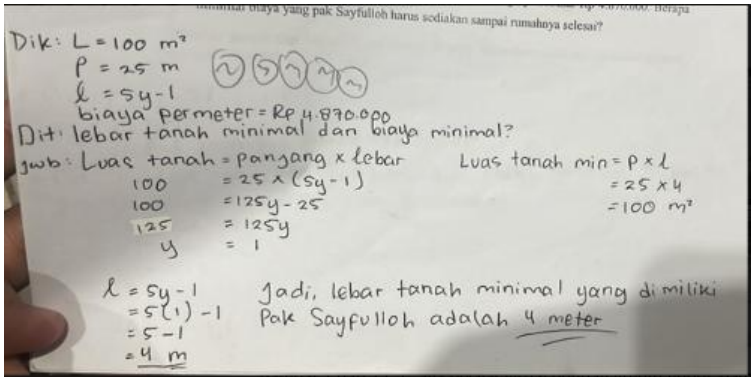

Figure 2. Visual with High Numeracy Literacy(V1)

Figure 3 also presents the results of an interview with V1 "*I immediately look for information in the problem and the picture, then I try to write down what is known and asked, then think of a formula that can be used. After that, I calculate y and substitute it later. So the minimum width is 4.*" (Student V1 - Visual, High). This statement shows that the student is able to understand the context of the problem and use appropriate problem-solving strategies. This is in accordance with the indicators of representation and reasoning abilities in numeracy literacy (Ermiana et al., 2021).

Visual Learning Style with Moderate Numeracy Literacy

The problem-solving approach of student V2 with medium numeracy literacy is illustrated in Figure 3. The student recognizes the relationship between the given area and length, then divides to obtain the width, and continues the process by multiplying by the price per meter.

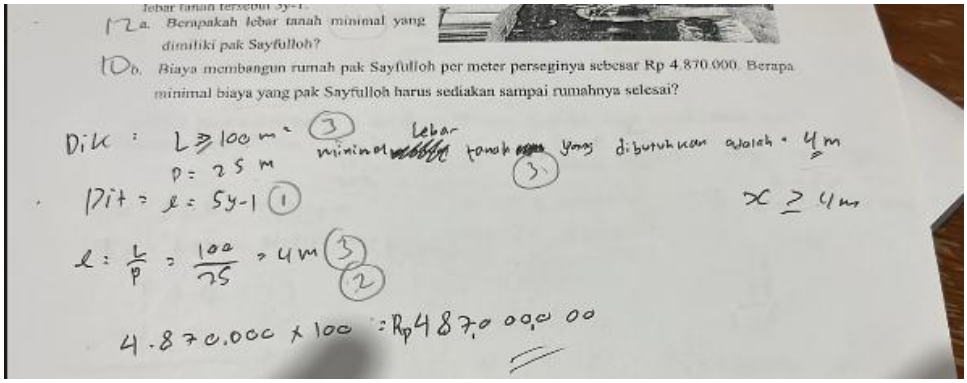

Figure 3. Visual with Medium Numeracy Literacy (V2)

Researcher: "*You answered that the land is 4 meters wide and calculated the total cost. How did you determine that*?"

Student V2: "*Because you said the area is 100 and the length is 25, so I just divided it by one hundred and twenty-five. Then I just multiplied it by the price per meter. I think that's the easiest way.*"

V2 students' skills in recognizing and using basic numerical information are evident, but they do not yet demonstrate in-depth reasoning processes or the use of alternative strategies. This reflects the characteristics of moderate numeracy literacy, namely the ability to understand problems and apply simple algorithms, but is still limited in terms of flexibility of thinking and elaboration (OECD, 2022b).

This finding is in accordance with the statement Kirani et al. (2023) that students with moderate numeracy literacy tend to need additional scaffolding to develop stronger mathematical arguments.

Visual Learning Style with Low Numeracy Literacy

Shown in Figure 4, student V3 with low numeracy literacy immediately uses the numerical value provided in the problem without engaging in deeper reasoning. The solution only focuses on multiplying the given numbers directly.

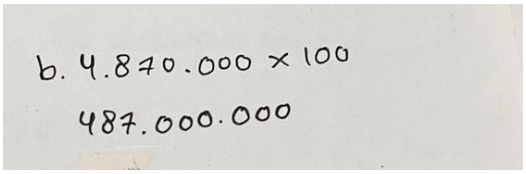

Figure 4. Visual with Low Numeracy Literacy (V3)

Researcher: "*Earlier, you immediately wrote 4,870,000 times 100, why is that?*"

Student V3: "*Because you asked how much money. Then there was the number 100 above, so I just multiplied it. I think that's what it meant...*"

These answers reflect students attempting to respond to the problem superficially, using the seemingly dominant numerical information without engaging in contextual analysis. This aligns with findings from (Ariyanti & Astuti, 2024) that students with low numeracy literacy often solve problems by simply guessing or copying the numbers that appear, without understanding the meaning or interrelationships between the data.

Overall, these data confirm that the relationship between learning styles and numeracy literacy skills is complex. Visual learners tend to be more adaptive in solving numeracy problems, while auditory and kinesthetic learners require a more contextual and multisensory learning approach to improve numeracy achievement. This is in line with a study by Rahim et al. (2023) , which found that selecting a learning style that suits a student's characteristics will have a positive impact on mathematical literacy, particularly in context-based problem-solving skills.

Auditory Learning Style with Moderate Numeracy Literacy

The response of student A1 with an auditory learning style and medium numeracy literacy is presented in Figure 5. Although the student's answer lacks a written mathematical explanation, it still demonstrates a basic understanding of the problem structure.

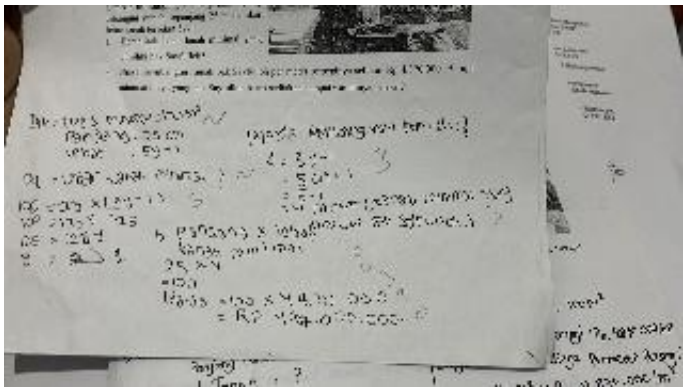

Figure 5. Auditory with Medium Numeracy Literacy (A1)

The student's answer appears coherent but lacks a written mathematical explanation. However, the solution structure demonstrates a basic understanding of broad concepts within the context of the problem. This reflects moderate numeracy literacy skills, relying on solution patterns from previous explanations. This characteristic aligns with an auditory learning style, which tends to understand problems through verbal explanations and memorize the sequence of steps provided by the teacher or discussions.

Researcher*:* "*Where did you start working on this problem?*"

Student A1*:* "*I remember when the teacher explained it, she used the formula of length times width. So I first found the known value, then I calculated the width. After that, I just multiplied it by the cost.*"

This statement indicates that students rely on memory of previous verbal explanations, which is consistent with the characteristics of auditory learners. They tend to follow the sequence of solutions previously presented and feel more confident when working on problems with a context or structure similar to those discussed in class. Research from Pinchot & Paullet (2014) also emphasized that auditory learners are more effective at absorbing information delivered verbally than in the form of long texts.

Auditory Learning Style with Low Numeracy Literacy

The answer provided by student A2, who represents an auditory learning style with low numeracy literacy, can be seen in Figure 6. The student tends to directly copy the given numbers without deeper reasoning, which reflects the limited analytical process characteristic of this group.

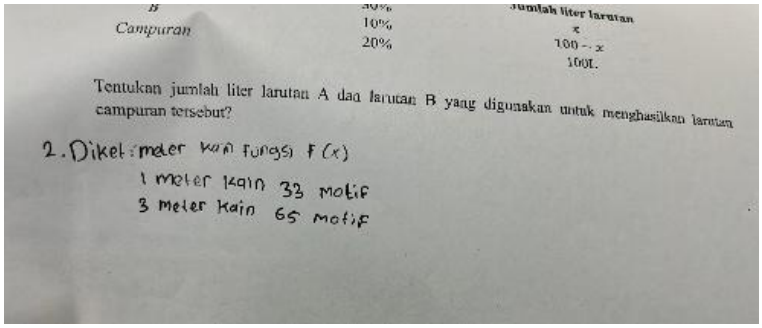

Figure 6. Auditory with Low Numeracy Literacy (A2)

The difficulty auditory learners with low numeracy skills face in solving problems independently is supported by the theory of DePorter & Hernacki (2011), who stated that auditory learners require explicit verbal explanations. This is reinforced by PISA data (OECD, 2022b), which shows that students with low numeracy literacy tend to simply copy numbers from problems without understanding their context.

Kinesthetic Learning Style with Moderate Numeracy Literacy

Solution strategy of student K1 with a kinesthetic learning style and moderate numeracy literacy is illustrated in Figure 7. The student begins by recording the known information, constructs the mathematical model, and proceeds step by step to reach the result systematically**.**

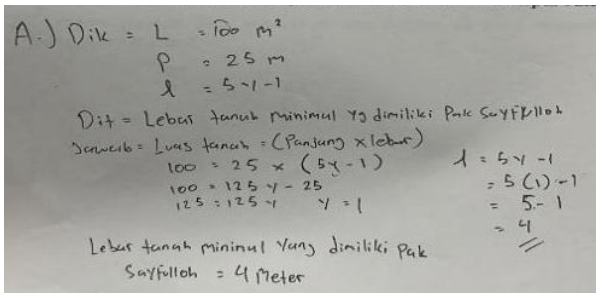

Figure 7. Kinesthetic with Medium Numeracy Literacy (K1)

Students start workmanship by taking notes on information from the question, then constructing mathematical models using the formula area L= p×l and manipulating it in a way algebra to find mark width. The calculation process is sufficiently systematic and achieves exact results. However, in the section on calculation fees, students see no consistency. This shows that students with style Study kinesthetic learning styles and abilities in numeracy currently have their own understanding to draft basic, but still not thorough enough, and not yet fully complete in linking information. Students bravely try to compile the step alone, but need strengthening in testing repeated results.

Kinesthetic Learning Style with Low Numeracy Literacy

As shown in Figure 8, student K2 with a kinesthetic learning style and low numeracy literacy demonstrates a direct computational approach by merely substituting the given

numbers. This response highlights a tendency to prioritize calculation over conceptual reasoning.

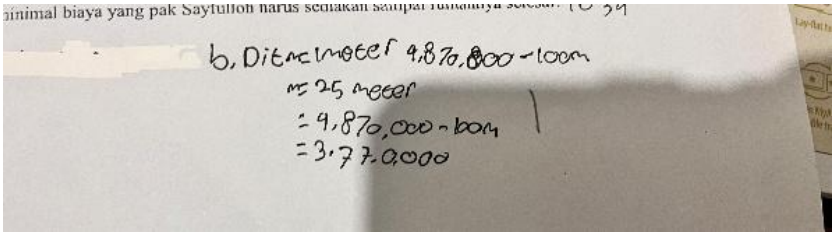

Figure 8. Kinesthetic with Low Numeracy Literacy (K2)

Students only copy numbers from questions (for example Rp. 4,870,000 and 100), then multiply directly without a mathematical modeling process or checking context. The final result is wrong, which shows that the student has not yet understood the relatedness between information and only manipulates numbers in a random way. Answer: This reflects low ability literacy and numeracy, where students are not yet capable of interpreting context, modeling problems, or verifying results. This is in line with the findings of Rasmitadila et al. (2020) and Siska & Hanif (2024), which state that kinesthetic learners require concrete media and gradual guidance to be able to understand abstract concepts in mathematics.

Different results in the ability to numeracy literacy in each category style. Study student No appears in a way coincidental, but rather influenced by a number of related factors with characteristics of style learning, ability to understand context questions, as well as the cognitive strategies used by students. Literacy and numeracy as part of skills think level high (*higher order thinking skills*) demands students to not only calculate, but also interpret, model, and evaluate information mathematically in various real-life contexts life real (OECD, 2017). Students with visual learning tend to have more capabilities and superior characteristics because they in accordance with form presentation questions based on text and visuals. DePorter & Hernacki (2011) explain that more visual learners easily understand information through pictures, symbols, diagrams, and notes written. On the other hand, students with a style of Study auditory and kinesthetic, experience difficulty when context questions are not supported by verbal explanations or learning media-based activity. This is reinforced by the findings of Wahyuni (2022), who stated that students' auditory tend to experience confusion if not get directions directly or discuss orally before doing a question.

In addition, the low ability numeracy literacy in students' Auditory and kinesthetic skills is also affected by a lack of metacognitive strategies, such as the ability to plan steps, evaluate answers, and connect concepts. According to Rahim et al. (2023), students with non-visual learning tend to rely more on stimulus from outside to understand problems and experience difficulty in building connections between information in an independent way. Environment-

dominant learning, lecture and text-oriented written also becomes a factor, external factors that contribute to the results mentioned, as mentioned by Siska & Hanif (2024), that students kinesthetic will be left behind if no given approach concrete and experiential direct in studying mathematics.

Study excels in its use of a qualitative approach with data triangulation (tests, questionnaires, and interviews), allowing for in-depth analysis of the relationship between learning styles and numeracy literacy. The use of the DePorter & Hernacki (2011) model also strengthens the relevance of the analysis in the school context. However, limitations of the study lie in the uneven distribution of subjects and the limited scope of the study to a single school, so the results cannot be broadly generalized.

The results of this study align with the findings of Wahyuni (2022) and Rahim et al. (2023), which show that students with visual learning styles tend to have better numeracy literacy performance than auditory and kinesthetic learners. This finding also strengthens the theory that an appropriate learning style can support information processing in a numeracy context. However, unlike the study by Rahim et al. (2023), which found that auditory learners can excel when material is presented interactively and verbally, in this study, auditory learners tended to experience difficulties due to the more visual and contextual approach to the questions. As an alternative strategy to improve numeracy literacy skills, educators need to integrate learning models that align with students' learning styles. Selecting the right learning model can not only increase student engagement in the learning process but also enable students to understand numeracy literacy concepts more deeply according to their learning preferences. For example, the application of activity-based learning models such as *problem-based learning* or *problem-based instruction* (Buyung et al., 2024).

CONCLUSION

This study concludes that there is a connection between style and students ' literacy and numeracy. Students with visual learning tend to show higher achievements in literacy more numeracy compared to students stylish Study auditorily and kinesthetic. Findings This indicates that style studies play an important role in method students process information, choose a resolution strategy for problems, and understand context question numeracy. Visual students are more capable of interpreting mathematics and thinking systematically, while students with auditory and kinesthetic need to approach more learning in accordance with their learning styles to reach optimal results.

Based on the results mentioned, it is recommended that teachers design learning adaptive mathematics to diverse style study students, by combining visual media, verbal

explanations, and concrete activities. Research furthermore expected can furthermore expand coverage subject from various levels of different classes and schools, as well as study more in other factors that influence literacy and numeracy, such as motivation for learning, family environment, or support technology in learning. Thus, the development of more effective learning strategies, inclusive and contextual, can be done sustainably.

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