



Determinants and Strategies for Strengthening Junior High Students' Numeracy in the Indonesia–Timor Leste Border Region

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Abstract

The low numeracy skills of students in Indonesia remains a major challenge in many schools, including Junior high school students in the border area of the Republic of Indonesia and the Democratic Republic of Timor Leste. The purpose of this study is to describe the level of students' numeracy skills, identify aspects that still need improvement, explore the factors affecting students' numeracy skills, and examine the efforts made to support numeracy development among junior high school students. This study employs a qualitative research design with a case study approach, conducted at one Junior High School in Kefamenanu City, Indonesia, during the odd semester of the 2024/2025 academic year. The participants were 21 eighth-grade students who completed a written test, followed by interviews with six students, their parents, and the mathematics teacher. Test items and interview guidelines were used to collect data. Results indicate that students' numeracy skills are still relatively low, as reflected in the low average test scores. The numeracy aspects that require the most improvement are application and reasoning. Factors influencing numeracy skills include internal factors-such as interest, motivation, understanding, and attitude-and external factors, including the learning environment, facilities and infrastructure, parental involvement, and teaching strategies. Efforts to enhance numeracy skills include increasing students' interest and motivation, strengthening conceptual understanding, developing application and reasoning skills, and implementing context-based learning strategies.

Keywords: Determinants; mathematics; numeracy skills; strategies for strengthening.

1. INTRODUCTION

Mathematics as a basic science taught at the educational level, starting from elementary, junior high and high school/equivalent, has a very important role in human life. According to Louie (2020), mathematics is a collection of abstract ideas arranged hierarchically. The skills to master mathematics are not only useful for solving problems at school, but also for solving problems in daily life. As emphasized by Kuznetsova, Zhanova and Golovaneva (2021) that mathematics plays an important role in optimizing



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various human activities. Math and numeracy are two slightly different things. However, the two have a very close and complementary relationship.

Numeracy is the skill to apply the concept of numbers and numeracy operations skills in daily life such as at home, work and participation in people's lives as citizens and the skill to interpret quantitative information around us (Tout, 2020). According to Deda, Disnawati and Daniel (2023), numeracy skills is the skill to think by utilizing mathematical concepts, facts, procedures and tools to solve problems in various contexts in each individual as a citizen of Indonesia and the world. Numeracy skills are important to be developed in the world of education, especially at the junior high school level.

The study on the measurement of students' numeracy skills has been carried out by Programme for International Students Assessment (PISA) under the auspices of the Organization for Economic Cooperation and Development (OECD). The OECD is one of the international institutions that measures the quality of education from various participating countries and focuses on literacy skills carried out in students with an age range of around 15 years. Figure 1 represents Indonesia's results in the PISA tests (OECD, 2016; 2019; 2023)

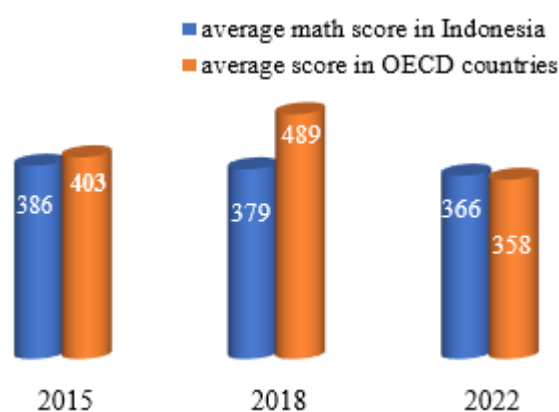


Figure 1. Comparison of PISA mathematics scores between Indonesia and the OECD average

The results of the PISA study show that students' numeracy skills in Indonesia are still low, a reflection of the challenges faced by students in various schools, including in one of the junior high schools in the city of Kefamenanu, Indonesia. The location chosen is one of the favorite schools in the center of Kefamenanu and the results of the research obtained can represent the profile of students' numeracy skills in the urban area of North Central Timor Regency in general. Based on the results of the researcher's interview with one of the teachers of mathematics, students' numeracy skills are relatively moderate. According to the teacher's

statement, students' numeracy skills are assessed from student activities such as practice questions, completing assignments, tests and exams. The assessment is focused on cognitive aspects which include understanding concepts, application of concepts in problem solving and mathematical reasoning.

Based on research conducted by Ratumanan and Salamor (2025), Tout (2020) and Sa'dijah et al. (2023), the numeracy skill of junior high school students is still relatively low. One of the efforts that can be made to improve students' numeracy skills is by applying innovative and creative learning models in mathematics learning (Anggun et al., 2025; Tae et al., 2025). The numeracy skill of junior high school students is also influenced by various factors. The internal factors such as students' interest, motivation and confidence (Romdhiani, Supianto & Triyani, 2025; Tariq & Durrani, 2012), as well as external factors such as learning quality, learning environment and learning facilities have a significant role in influencing students' numeracy skills (Thi et al., 2023).

The findings of these problems show that there is a need for serious handling to find out the problems faced by students that can be used as a basis for improving students' numeracy skills. Although many previous researchers have examined the factors influencing students' numeracy skills, their research was conducted separately between internal and external factors. For example, research by Romdhiani, Supianto and Triyani (2025) and, Tariq and Durrani (2012) focused more on internal factors influencing students' numeracy skills. In contrast, research by Efendi, Pangestu, Hariri and Berlianti (2023) and Widayati, Usodo and Yamtinah (2025) emphasized the influence of external factors such as the learning environment, facilities, family environment and the role of parents. This research is different because

the focus of this research does not look at external and internal factors separately, but as a whole, and focuses more on the local context, especially in the border area of the Republic of Indonesia and the Democratic Republic of Timor-Leste.

Based on the basis of the problem of low numeracy skill of junior high school students, the researcher felt the need to conduct further research on the level of numeracy skill of junior high school students in the city of Kefamenanu, aspects of numeracy skill that still need to be improved, factors that affect students' numeracy skill and efforts that can be made to improve the numeracy skill of junior high school students.

2. METHODS

This is qualitative research with a focus on the case study method. Qualitative research is an effort to deeply understand various events or conditions by exploring the meaning, sense, concept, characteristics, symptoms and symbols contained in them, as well as descriptions of a phenomenon, focus and multimode, natural and holistic, prioritize quality, and presented narratively (Kiely & Hartman, 2023). A case study is part of a qualitative method that aims to investigate a particular case in more detail by involving a collection of various sources (Priya, 2021). The research method used is flexible so that researchers can adjust the questions. If something interesting is found in the test results, the researcher can dig deeper into it during the interview.

This study was conducted among eighth-grade students at a junior high school in Kefamenanu, located on the border between the Republic of Indonesia and the Democratic Republic of Timor-Leste. The participants of this study were 21 grade students who took a randomly selected written test. Then for the interview 6 students with different numeracy skills were selected based on the test results to examine internal factors that affect students' numeracy skill, as well as parents of the six students and one of the mathematics subject teachers to find out the external factors that affect the skill to Student Numerals. The teacher chosen as the subject is the mathematics teacher who teaches the class and is closer to the students so that it is easy to know the students' skills. Meanwhile, for the parents to be selected, it is enough to represent a variety of different backgrounds.

The selection of subjects, namely students, teachers and parents, was carried out to provide a triangulating perspective on the factors that affect students' numeracy skills. All participation is voluntary with the consent of the relevant parties. The data collection techniques in this study can be seen in the Figure 2.

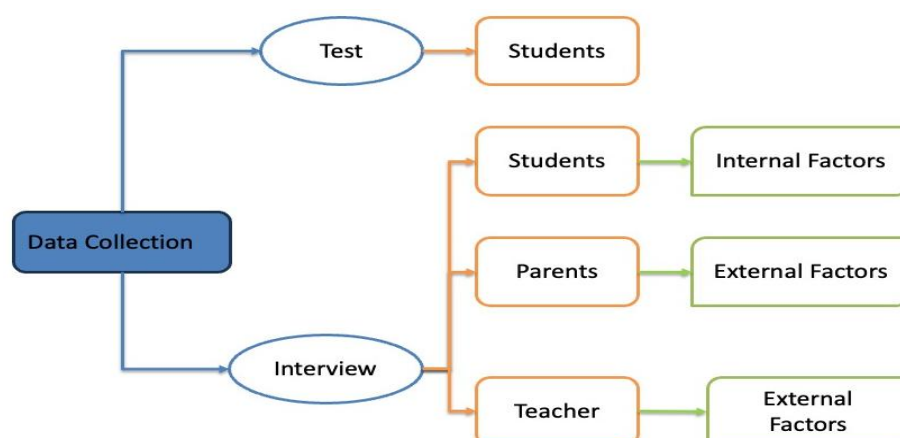


Figure 2. The data collection techniques

A test is a series of questions given to students to elicit oral and written responses. Test results tend to be objective, and assessments are based on predetermined criteria. Meanwhile, an interview is a data collection technique through a one-way question-and-answer process. Interviews allow researchers to dig deeper into information, including respondents' opinions, feelings, and personal experiences. The instruments used are test questions and interview guidelines.

Data analysis in this study employed the data analysis techniques proposed by Miles, Huberman and Saldaña (2020), which consist of three stages: data reduction, data display, and conclusion drawing. Data reduction was carried out by eliminating information that was not relevant to the objectives of the study. In the data display stage, the information collected from the research findings was systematically organized and presented in the form of descriptive narratives. In the final stage, the researcher drew conclusions or performed verification based on the data findings.

3. RESULTS AND DISCUSSION

Based on the results of the students' numeracy test, there were 3 students with scores that reached a high level of numeracy, 4 students who reached a medium level of numeracy, and 14 students were classified as having a low level of numeracy with an overall average score of 39.81. The results of the analysis of the scores obtained by the students showed that their numeracy was low as evidenced by the overall average score of the students in that interval, so the researcher selected 6 students along with their parents and mathematics teachers to be interviewed. Subjects were selected based on the students' numeracy levels, namely high, medium, and low.

Description of Students' Numeracy Skills

The aspects of numeracy skills explained in this section include aspects of understanding, application, and reasoning. Although there were 21 students in this study, in this section, only the work of 3 students was photographed and described, which represents the students' work as a whole.

Aspects of Understanding

Figure 3 describes the results of students' work on the understanding aspect.

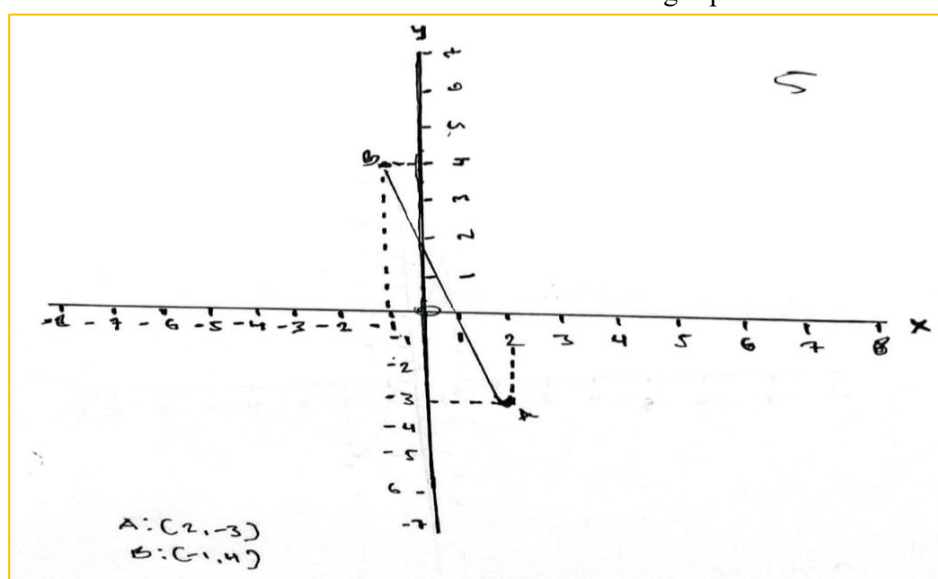


Figure 3. Students' work on the understanding aspect

In the understanding aspect, the subject is able to understand the facts in the problem, namely the location of points A (2, -3) and point B (-1,4) which are described in the cartesian plane correctly and the solving process is also in accordance with the problem asked in the question, which is to connect the two points using a line.

Aspects of Application

Figure 4 describes the results of students' work on the application aspect of the question.

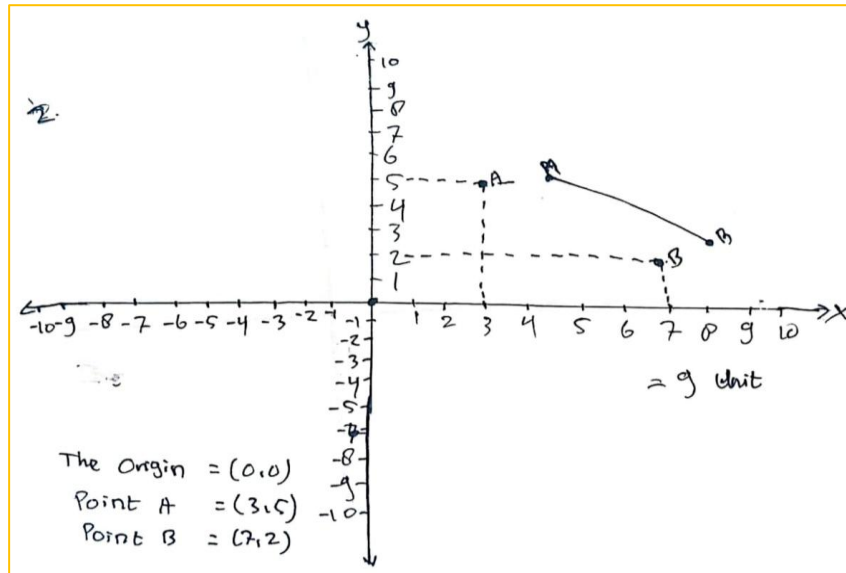


Figure 4. students' work on the application aspect

In the application question, the subject is able to understand the concept used, namely the concept of distance. However, in the process of solving the problem, the subject has not been able to apply the distance formula so that the subject's answer is only limited to describing the cartesian plane and determining the known points in the problem.

Aspects of Reasoning

Figure 5 describes the results of students' work on reasoning questions.

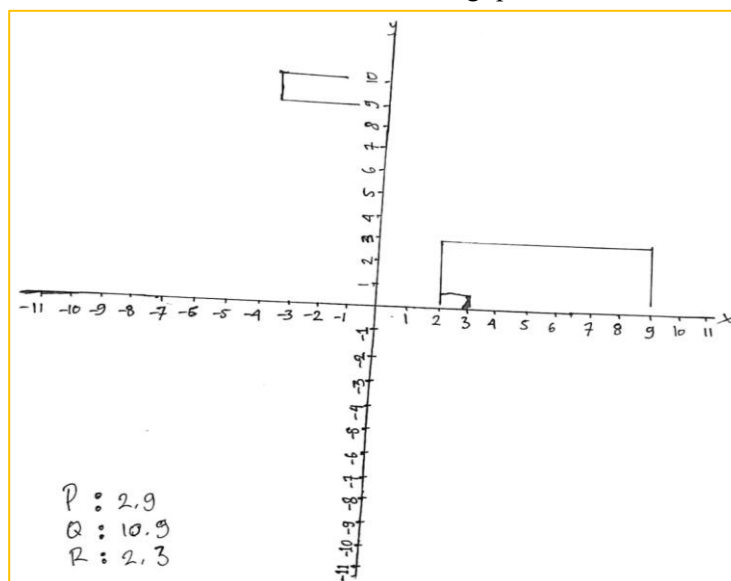


Figure 5. Students' work on reasoning questions

In the reasoning problem, the subject has not been able to reason well in the process of solving the problem, that is, he has not been able to determine the coordinate point that is not yet known and use the rectangular formula to solve the problem in the problem.

The test administered to 21 eighth-grade students at the school under study revealed that students' numeracy skills remained relatively low. Numeracy skills were assessed based on cognitive levels, namely understanding, application, and reasoning. Among the students, three achieved a high level of numeracy proficiency, accounting for 14.28%, four students reached a moderate level, accounting for 66.67%, and the overall average score obtained was 39.81.

This study demonstrates that students' numeracy skills are predominantly at a low level, as indicated by the overall average score falling within the low category range of $0 < X \leq 40$. These findings are consistent with the study by Xu, Burr and LeFevre (2023), which showed that students' numeracy skills are largely concentrated at the low level. The results are further supported by Ratumanan and Salamor (2025), who found that students' mathematical numeracy skills remain low, evidenced by a significant number of students scoring below the average. The issue of low numeracy skills among students is a significant concern that requires serious attention and collaborative efforts from various stakeholders to enhance these skills. This need for improvement was also emphasized by Megawati and Sutarto (2021) who reported that students displayed low performance in solving numeracy literacy problems.

Based on students' scores in the numeracy tests assessing the cognitive aspects of understanding, application, and reasoning, it was found that many students performed better in tasks measuring understanding, whereas in tasks measuring application and reasoning, a significant number of students struggled to achieve the expected scores. This aligns with the findings of Isnani and Handoko (2023), who noted that students with high numeracy literacy scores could fulfill two to three indicators, while students with low scores typically met only one indicator.

An analysis of students' test responses revealed that in the understanding tasks, students across high, moderate, and low numeracy proficiency levels were able to comprehend and complete the tasks successfully. However, in the application tasks, many students were unable to complete the problems. Only those with a high level of numeracy proficiency were able to correctly solve the application-based questions, while students with moderate and low proficiency mostly produced sketches of the Cartesian plane without proceeding to apply formulas for calculating distances between points, indicating a difficulty in applying mathematical concepts to real-life problem-solving contexts.

Meanwhile, in the reasoning tasks, students with high numeracy proficiency demonstrated strong reasoning skills, enabling them to connect multiple concepts and successfully solve the problems. Jannati, Utama, Setyaningsih and Adnan (2025) found that students with high numeracy proficiency exhibited better critical thinking skills compared to students with lower proficiency. In contrast, students with moderate and low numeracy proficiency struggled to reason effectively and could not establish connections between different mathematical concepts within a single problem. These findings are consistent with Pratiwi, Peni and Prabowo (2024), who reported that students with high numeracy proficiency displayed strong cognitive skills across understanding, application, and reasoning; students with moderate proficiency were proficient in understanding and application; and students with low proficiency only achieved at the understanding level. Therefore, in this study, the aspects of numeracy that require further development are application and reasoning.

The results of interviews with students were also presented to explore information related to internal factors that affect students' numeracy skills which include interests, motivations, understanding and attitudes towards mathematics and the results of interviews with parents of students and subject teachers to explore information about external factors that affect students' numeracy skills which include the learning environment, facilities and infrastructure, the role of parents and learning strategies used by teachers, as well as efforts that can be made to support students' numeracy skills. The following is a

description of the results of interviews with students related to their interests, motivations, understanding and attitudes towards mathematics.

I : Do you enjoy learning mathematics?

S : I do not particularly enjoy it.

I : What makes you dislike learning mathematics?

S : Because there is too much note-taking

Note: (Interviewer (I) and Student (S))

Based on the interview excerpt regarding interest, the student expressed a lack of enthusiasm for mathematics, primarily due to the frequent note-taking required during lessons. The researcher further explored factors that motivate students in learning mathematics.

I : What motivates you to study mathematics?

S : The desire to achieve good grades.

I : Is there any reward or recognition that further motivates you to study mathematics?

S : Yes, it is.

According to the interview excerpt regarding motivation, the student is motivated by the prospect of obtaining good grades and fulfilling parental expectations. In addition to motivational factors, it is also important to assess students' level of understanding. Therefore, the researcher continued by exploring students' understanding of mathematical concepts.

I : Can you explain in your own words what Cartesian coordinates are?

S : Cartesian coordinates are related to the position of points on the Cartesian plane.

I : Which part of Cartesian coordinates do you find easiest to understand?

S : Determining the location of points on the Cartesian plane.

I : Which part of Cartesian coordinates do you find most difficult to understand?

S : Connecting mathematical concepts to the problems.

I : Do you encounter difficulties in understanding mathematical concepts?

S : Yes, I do.

Based on the interview excerpt regarding understanding, the student reported difficulties in grasping mathematical concepts, particularly abstract concepts and solving word problems. The final internal factor observed was students' attitudes toward mathematics.

I : How do you feel when learning mathematics?

S : I am not really happy.

I : Do you feel confident when solving mathematical problems?

S : I do not feel very confident on it.

I : Do you often experience anxiety when facing quizzes or mathematics exams?

S : Yes, I often feel anxious.

Based on the interview excerpt regarding attitude, the student indicated feelings of discomfort, low self-confidence, and anxiety when participating in mathematics learning. After examining internal factors, the researcher proceeded to interview students' parents to investigate external factors that influence students' numeracy skills. The following section presents excerpts from the interviews conducted with the parents. The following presents a description of the interview results with students' parents regarding external factors that influence students' numeracy skills.

I : Does your child often study mathematics at home?

P : They study, but spend more time playing on their phone.

I : Are there any facilities at home that support your child in learning mathematics?

P : There are mathematics textbooks and a phone, but they rarely open the book and spend more time playing games.

I : Do you regularly supervise and assist your child in studying mathematics at home?

P : We rarely supervise during study time, but we try to pay attention whenever we have free time.

Note: **(Interviewer (I) and Parent (P))**

Based on the interview excerpt regarding the home learning environment, it can be concluded that while students have access to adequate learning facilities, these resources are underutilized. In addition, parental supervision of the child's study activities is not optimal. Besides exploring the home environment, the researcher further investigated the active role of parents in supporting their child's mathematics learning process.

I : What do you usually do to motivate your child to study mathematics more diligently?

P : I usually give extra pocket money to encourage them to study.

I : How do you respond when your child experiences difficulties in learning mathematics and asks for help?

P : Most of the time, I ask them to study independently or search for answers on the internet.

I : Are there any regular activities you do at home together with your child to support their learning in mathematics?

P : No specific activities. They mostly play games when we are not at home.

Based on the interview excerpt regarding parental involvement, it was found that parents rely more on external motivation, such as rewards, rather than providing direct support or guidance to their child's learning process.

To complete the overview of external factors influencing numeracy skills, the researcher sought additional information from the school by interviewing the mathematics teacher regarding the availability of facilities and infrastructure that support mathematics learning. The following are excerpts from the teacher interview.

I : Are the facilities and infrastructure at the school adequate to support mathematics learning?

MT : The facilities and infrastructure are sufficient.

I : Do students frequently use these facilities and infrastructure during learning activities?

MT : Yes, they are often used.

I : Are there any obstacles related to facilities and infrastructure that hinder the mathematics learning process?

MT : Sometimes, the lack of textbooks hinders the learning process.

Note: **(Interviewer (I) and Mathematics Teacher (MT))**

Based on the interview excerpt regarding facilities and infrastructure, it can be concluded that, in general, the existing facilities and infrastructure are adequate to support mathematics learning. However, the limited availability of textbooks still poses a challenge to the learning process. To complement the information regarding the support of learning facilities, the researcher further explored the learning strategies

I : What teaching strategies do you frequently implement to support students' numeracy skills?

MT : The strategies I usually implement are adjusted to the material being taught.

I : Have you ever tried different teaching methods to help students develop their numeracy skills?

MT : Yes, for example, at the beginning of the semester with newly assigned classes, I usually start with the lecture method. However, when observing students' learning progress, if there is no significant improvement, I incorporate group discussion sessions to make students more active with their peers and not solely dependent on my explanations at the front of the class.

I : Do you use any specific indicators to measure students' numeracy skills?

MT : Not yet.

Based on the interview excerpt with the mathematics teacher regarding teaching strategies, it can be concluded that the teacher has applied various teaching strategies but has not yet established specific indicators to measure students' numeracy skills. In addition to the teaching strategies applied, the school learning environment also influences the development of students' numeracy skills. The following are excerpts from the interview regarding the learning environment at school.

I : How would you describe the learning environment at school in terms of its influence on students' numeracy skills?

MT : There are various factors, sometimes depending on the weather.

I : How do you create a positive and supportive learning environment for all students?

MT : I often incorporate games into the learning process to prevent students from getting bored with the material being delivered.

Based on the interview excerpt with the mathematics teacher regarding the learning environment, it can be concluded that while the learning environment does influence students' numeracy skills, the teacher has made efforts to create a positive and supportive environment through various approaches.

The factors influencing students' numeracy skills are generally categorized into internal and external factors. Internal factors are intrinsic to the students, including interest, motivation, understanding, and attitudes toward mathematics. These findings align with Ramdhani and Khadafie (2025), who found that students' numeracy literacy skills are significantly impacted by internal factors such as interest, motivation, and understanding. Students with high numeracy proficiency generally exhibit strong interest, motivation, positive attitudes, and good understanding of mathematical concepts. Conversely, students with moderate proficiency demonstrate interest and motivation but show weaknesses in attitude and understanding, particularly struggling with abstract mathematical concepts and lacking confidence in problem-solving.

Students with low numeracy proficiency display insufficient interest, motivation, negative attitudes toward mathematics, and below-average understanding, resulting in significant challenges in completing mathematical tasks. This is supported by Riyanto (2024), who stated that students' interest and motivation are crucial to their numeracy understanding; high interest and motivation correlate with stronger numeracy skills, while low interest and motivation lead to weaker skills. Additionally, a positive learning attitude promotes greater engagement compared to a negative one (Ferrer et al., 2022).

External factors also significantly impact students' numeracy skills. Factors contributing to low numeracy proficiency include lack of parental support, low student autonomy, environmental challenges, insufficient access to learning facilities, limited school resources, and a weak academic ethos (Emelda, Mubemba & Thelma, 2024). Based on interviews with parents and the mathematics teacher at the research site, the identified external factors include the learning environment, facilities and infrastructure, parental involvement, and teaching strategies. A poor learning environment—both at home and at school—can hinder the development of numeracy skills. Disruptive classroom environments and a lack of support from parents at home can distract students from concentrating on mathematics learning. Furthermore, inadequate facilities such as incomplete textbooks and limited mathematical teaching aids can obstruct effective learning. These findings are consistent with Thi et al. (2023), who indicated that external factors influencing low numeracy proficiency include the learning environment, inadequate facilities, peer influence, and the teaching methods employed by teachers.

Parental involvement is crucial in supporting students' numeracy development. Active parental engagement through motivation, support, and creating a positive home learning environment can enhance students' numeracy skills. However, in reality, many parents are not actively involved, resulting in students lacking necessary support. Alfred et al. (2023) similarly emphasized that limited parental involvement contributes to students' neglect of their academic responsibilities. Additionally, teaching strategies play a crucial role; methods not suited to the material or student needs can hinder students'

comprehension of mathematical concepts. Therefore, it is important for teachers to adopt varied and innovative teaching methods tailored to students' needs.

The findings of this study highlight the urgent need to improve students' numeracy skills by addressing both internal and external influencing factors. Several strategies can be employed, including organizing engaging activities relevant to real-life contexts, providing positive feedback, and building students' confidence to foster interest and motivation. Implementing active learning methods, such as group discussions and problem-based learning, and offering varied practice exercises can strengthen students' conceptual understanding. This approach aligns with Ramdhani and Khadafie (2025), who found that practice exercises enhance students' mathematical thinking and skill to formulate, apply, and understand mathematics in diverse contexts. Further efforts include developing students' application and reasoning skills by encouraging real-life application of mathematical concepts, fostering critical thinking, and providing problem-solving training. Creating a conducive learning environment both at school and at home, improving learning facilities, and involving parents in the learning process are also essential (Niklas, Cohrsen & Tayler, 2016; Melhuish et al., 2008). Finally, enhancing teacher professionalism through training and professional development, particularly in innovative and effective teaching methods, is crucial. Anggun, et al. (2025) emphasized that the application of innovative and creative teaching models can significantly enhance students' numeracy skills.

4. CONCLUSION

The results of this study indicate that students' numeracy skills are still relatively low. This is evidenced by the fact that the majority of students, 66.67%, are categorized as having low numeracy skills, while only a small proportion (14.28%) achieved high numeracy skills, and the remaining 19.04% were at medium numeracy skills (19.04%). The overall average student score of 39.81 also falls within the low proficiency range.

Numeracy skills were assessed based on three cognitive aspects: understanding, application, and reasoning. Overall, students demonstrated a satisfactory level of understanding across all numeracy ability groups-high, medium, and low. However, in the application and reasoning aspects, only students with high numeracy skills were able to meet the expected standards. Students with medium and low numeracy skills were unable to perform adequately in these aspects. Therefore, the aspects that require special attention and improvement are application and reasoning.

Student numeracy skills are influenced by two main factors: internal and external factors. Internal factors, originating from within the students themselves, include interest, motivation, understanding, and attitudes toward mathematics. Students with high numeracy skills demonstrate strong interest, motivation, positive attitudes, and conceptual understanding of mathematics. Conversely, students with low numeracy skills demonstrate low interest and motivation, negative attitudes, and below-average conceptual understanding. External factors, originating from outside the students, include the learning environment, the availability of learning facilities and infrastructure, parental involvement, and teaching strategies used by teachers. A supportive learning environment both at home and at school, adequate facilities and infrastructure, strong parental support, and effective teaching strategies contribute significantly to improving students' numeracy skills.

Several efforts can be made to address these challenges, including increasing students' interest and motivation, strengthening their conceptual understanding, developing their application and reasoning skills, improving the quality of the learning environment both at home and at school, enhancing teacher professionalism through professional development and training, and encouraging teachers to implement a variety of teaching strategies tailored to the material and the needs of their students.

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