



## ANALYSIS NUMERACY LITERACY SKILLS OF HIGH SCHOOL STUDENTS IN BIODIVERSITY MATERIAL BASED ON MINIMUM COMPETENCY ASSESSMENT QUESTIONS

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### ABSTRACT

Proficiency in numeracy literacy is indispensable for contemporary individuals, including comprehension of numbers, symbols, and analysis of quantitative data such as graphs, tables, and charts. In this context, students can effectively apply knowledge in practical real-world scenarios with robust numeracy literacy skills. The urgency of numeracy literacy skills needs to be increased by providing a training process through numeracy questions in various subjects including biology. Therefore, this research aimed to analyze numeracy literacy skills of high school students in Biology on biodiversity material adapted to the Minimum Competency Assessment questions using a descriptive and qualitative approach. A convenience sampling technique was used to obtain 80 students from Grade 10 of SHS IT Insan Mulia in Pringsewu, Lampung, Indonesia. The research instrument consisted of 11 multiple-choice Minimum Competency Assessment questions which included numeracy literacy indicators. The result showed that students' numeracy literacy skills were not satisfactory, consisting of 55.3%, 54.4%, and 39.4% on content, cognitive processes, and context, respectively. The analysis reported students' need for practice and improvement in the context dimension.

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Keywords: biodiversity; high school students; minimum competency assessment; numeracy literacy skills

### INTRODUCTION

The importance of literacy and numeracy in senior high schools is a subject of significant research interest over the past decade. In this context, different research show the significance of introducing literacy and numeracy concepts since the skills are considered essential in the 21st century (Rahmadeni, 2022). Early numeracy skills are crucial in predicting academic achievement (Nguyen et al., 2016). Additionally, the readiness and competence of teachers in assessing literacy

and numeracy skills have been reported as essential for student learning outcomes (Rini et al., 2021). Effective planning, implementation, and evaluation of numeracy learning, supported by appropriate resources and infrastructure, are crucial for enhancing numerical education in high schools (Misu et al., 2023).

Research has focused on integrating literacy and numeracy skills in education systems, particularly through thematic learning approaches in elementary and high schools (Perdana & Suswandari, 2021). The influence of the COVID-19 pandemic has been examined, emphasizing the need for innovative strategies to enhance students'

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skills (Yulia et al., 2023). Moreover, assessments of students' literacy and numeracy levels have been conducted to ensure the validity and reliability of educational programs (Susongko, 2021).

The implementation of nationwide assessments for literacy and numeracy, such as NAPLAN in Australia, has influenced school practices and funding allocations, to improve student outcomes (Hardy, 2014; Lewis & Hardy, 2014). Concerns regarding declining literacy and numeracy standards have enhanced teacher quality and training to tackle these challenges (Meeks et al., 2014). Research also explored the correlation between financial literacy and numeracy, showing the interconnectedness of the skills (Jayaraman et al., 2018).

This is the rationale behind the Indonesian Ministry of Education and Culture's emphasis on enhancing numeracy literacy skills of students through the implementation of Minimum Competency Assessment (MCA) as a regulatory measure to improve scores in future TIMSS and PISA assessments. Meanwhile, PISA (Programme for International Student Assessment) survey in 2018 placed Indonesia in 74th out of 79 countries. The reading, mathematics, and science skills of students scored 371, 379, and 396 ranking 74th, 73<sup>rd</sup>, and 71<sup>st</sup>, respectively (Puspendik, 2019). Indonesian students have less experience in tackling contextual problems, which demand reasoning, argumentation, and creativity for resolution (Nuraini & Julianto, 2022).

PISA 2018 test showed that 1 out of 3 students admitted to being given reading assignments with diagrams, graphs, or maps, as well as text based on digital sources only once (Kemdikbud, 2022). Therefore, PISA 2018 questions were very challenging for Indonesian students since the concept was based on a reading containing a world water map. Only 1 out of 30 students could answer that question correctly. Therefore, students need to be familiarized with various types and formats of readings (Kemdikbud, 2022).

MCA assessment is crafted to control achievements based on cognitive learning outcomes. Literacy and numeracy skills can help students learn other fields of knowledge by shaping thinking processes to digest information in written or digital forms. Minimum competency assessments emphasize reasoning skills in literacy and numeracy based on PISA test practices. The goal of the assessment is for students to apply mathematical principles, methods, information, and instruments in appropriate situations to address common challenges.

Through the Indonesian Ministry of Education and Culture, the government is promoting a program called the National Literacy Movement (Gerakan Literasi Nasional or GLN). The Ministry of Education and Culture has launched six essential basic literacies, namely (1) Reading-Writing, (2) Numeracy, (3) Science, (4) Financial, (5) Digital, and (6) Cultural and Civic Literacy, which can enhance the quality of human resources (Kemendikbud, 2017).

In the context of MCA, the government understands students' reasoning skills when learning literacy and numeracy. Therefore, the education output will increase the relevance of education to the needs of the job market, businesses, and industries (*link and match*). Charts, diagrams, data tables, models, and other forms of presentation are often referred to as practical writing in data presentation. Different professions require the skill to read data effectively and numeracy skills need to be taught to students from school days. Many scientists present research results in the form of graphs and tables by organizing and connecting data to express ideas, interpret meanings, explain phenomena, and make predictions (Kozma et al., 2000).

According to Mahmud and Pratiwi (2019), numeracy literacy includes the capacity to reason using mathematical knowledge, numbers, and symbols, while analyzing information. Reasoning is the process of linking arguments to form a logical pattern for conclusions. Numeracy literacy is the skill to 1) Use numbers and symbols related to basic mathematics as solutions to practical problems in daily life, 2) Analyze information in various forms, such as graphs, tables, and charts, and 3) generate concise infographics and numerical information (Han et al., 2017, p. 3). These skills can be used to solve mathematical problems as well as daily life issues by analyzing information and interpreting the analysis to calculate and make decisions (Han et al., 2017, p. 3).

Numeracy literacy skills, as knowledge and competencies closely related to understanding numbers, symbols, and the analysis of quantitative information, are important for the current generation to possess. By possessing good skills, students are proficient in applying mathematical knowledge in real life (Kemdikbud.go.id). Several recent research provide valuable insights into these skills at different levels of education. Novita et al. (2023) examined middle school students' self-efficacy in literacy and numeracy, reporting the importance. Research by Banawi et al. (2022) stated the importance of numeracy skills in ele-

mentary schools, while Iswara et al. (2022) showed the development through a problem-solving method. Validation of the two-factor model in the research of Harris et al. (2018) emphasized early literacy and numeracy skills for academic achievement. Furthermore, Suciwati et al. (2022) assessed elementary school students' skills, providing insights for teachers. Rakhmawati & Mustadi (2021) investigated the necessity of reflective modules for enhancing numeracy literacy skills of primary school students. The results collectively assessed the urgency of practising the skills at various levels of education to ensure academic success and informed decision-making.

Previous research conducted by Ate & Lede (2022) analyzed numeracy literacy skills of 7th-grade students in solving Questions. The results found that 73.3% and 26.7% of students were in the "very insufficient" and "insufficient" categories, respectively. Therefore, students' skills in solving numeracy literacy questions are still low.

The research result of Winata et al. (2021), which analyzed numeracy skills in the development of MCA questions consisting of biology, physics, and chemistry problems for 11th-grade students at MA Darul Ma'wa Plandirejo, Plum-pang District, Tuban Regency, are still low. This is because a total of 61.90% scored below 50 on numeracy skills test. The results from Utami et al. (2020) in solving story problems for 9th-grade students stated that only 20% were able to evaluate solutions, and only 26.67% could formulate real problems. According to Rizki et al. (2022), numeracy literacy skills of students engaged in biology education at SMAN 1 are still insufficient.

Based on the results of the Indonesian education report card for 2023, this year's high school students' literacy skills were 49.26% in the medium category with a category limit of 40-70%. In this context, further improvements still need to be made because the results have decreased from 2022 reaching 53.85%. Meanwhile, this year's numeracy skills were 41.14% in the medium category, with a slight difference from the low category limit of 40%. There is still a requirement for enhancing and refining numeracy skills (Indonesian

Education Report Summary, 2023). Therefore, the urgency of these skills needs to be increased by providing a training process through numeracy questions in various subjects including biology. Mustain (2015) stated that students could not read graphs well and experienced difficulty interpreting graphs and data. Fiangga et al. (2019) reported that the main reason for the inability to solve numeracy-based questions was a lack of familiarization. Based on the previous explanation, this research has 2 questions, namely:

RQ1: How are students' numeracy literacy skills in biodiversity material?

RQ2: Are there students who achieve numeracy literacy skills above average?

Numeracy literacy skills of high school students measured were Biodiversity material adapted to MCA questions. The material is selected because Indonesia is a mega-biodiverse country with the highest biodiversity in the world. This is evident from the ongoing environmental degradation, such as illegal logging, dynamite fishing, wildlife trade, and many other human activities, leading to natural disasters and impacting biodiversity loss (Leksono, 2013).

## METHODS

Quantitative descriptive method was used and the quantitative descriptive research provided an accurate description of the phenomenon measured. This method was used to identify and document the characteristics or properties of a population or sample without manipulation (Creswell, 2017). The training session was attended by 80 students from Grade 10 of SHS IT Insan Mulia in Pringsewu, Lampung, Indonesia, aimed at enhancing students' numeracy and literacy skills. Meanwhile, participants were selected with a convenience sampling method and this research was conducted in May 2023. The instrument used consisted of 11 multiple-choice questions that contained numeracy literacy indicators. Data analysis for the 11 questions used was quantitative using SPSS 25. These questions referred to numeracy indicators used by Han et al. (2017).

**Table 1.** Numeracy Indicators

No.	Indicator
1.	Able to use various numbers or symbols related to basic mathematics to solve everyday life problems.
2.	Capable of analyzing information presented in various forms, such as graphs, tables, charts, and diagrams.
3.	Interpreting the results of this analysis to make predictions and decisions.

Source: Han, et al (2017)

The questions are developed using the components of MCA, which are used to measure and analyze students' numeracy literacy skills. The skills to be measured use three components or indicators, namely content, cognitive processes, and context, under MCA question guidelines (Dewayani et al., 2021).

Content consists of sub-indicators for data and uncertainty, including understanding, interpretation, and data presentation, while cognitive

processes include sub-indicators for understanding facts or data. Context comprises sub-indicators for the scientific field related to understanding issues and activities of the environment. The data results were analyzed using descriptive statistics and interpreted based on the criteria table for levels of numeracy literacy skills according to Arikunto (2010) and the Ministry of Education and Culture education report (2023).

**Table 2.** Criteria for the Level of Student Numeracy Literacy Skills

Value	Criteria
80-100	Very Good
66-79	Good
56-65	Sufficient
40-55	Insufficient
<40	Very Insufficient

Source: Arikunto (2010)

In assessing the level of students' skills, criteria based on Arikunto (2010) in Table 2 can be used, namely Very Good, Good, Sufficient, Insufficient, and Very Insufficient. According to

the Ministry of Education and Culture's education report card, the categories of Good, Intermediate, and Less are used, as outlined in Table 3.

**Table 3.** Category Achievement of Students' Numeracy

Category	Achievement of Students' Numeracy
Good	> 70% students
Intermediate	40% - 70% students
Less	< 40% students

Source: Ministry of Education and Culture education report (2023)

Instrument testing was conducted through validity testing, reliability testing, the level of difficulty, and item discrimination of critical thinking skills questions using SPSS version 25 and Anates test software. This test was conducted on 15 questions given to students with biodiversity material, specifically in Grade 11. In addition, validation testing was carried out by two Biology Education lecturers from the University of Lampung. The validation of questions before testing is a critical step in research and assessment processes to ensure accuracy, relevance, and effectiveness. Subsequently, 11 questions were selected for testing on 80 students from Grade 10 and the data was analyzed quantitatively using SPSS version 25.

## RESULTS AND DISCUSSION

Numeracy literacy skills measured include three indicators, namely content, cognitive processes, and context. According to Arikunto (2012), the levels of students' skills are grouped into five categories, including very good, good, sufficient, insufficient, and very insufficient. Based on the research results, each component of MCA containing question indicators falls into the categories of sufficient, insufficient, and very insufficient. Table 4 shows the comparison of percentages based on each MCA Indicator.

**Table 4.** Percentage of Student Numeracy Literacy Skills Based on Each MCA Indicator

Indicator	Percentages	Category
Content	55,3%	Sufficient
Cognitive processes	54,4%	Insufficient
Context	39,4%	Very Insufficient

Based on Table 4, there are differences in the percentages for each of MCA indicators. The results for numeracy literacy skills in the content and cognitive process, and context indicators fall into the “sufficient”, “insufficient” and “very insufficient” categories with 55.3%, 54.4%, and 39.4%, respectively.

Content refers to the topics or information in the subject matter related to data and uncertainty, including understanding, interpretation, and presentation of data, as well as probabilities. Cognitive processes are related to the thinking skills required in problem-solving or tasks. Meanwhile, context in minimum competency assessment is related to life aspects or situations in the content used. Context indicators for literacy in reading and numeracy are divided into three parts, including personal, sociocultural, and scientific but only the scientific context was used. Numeracy literacy with context indicators has sub-indicators Personal, related to interests, Socio-cultural, related to inter-individual, cultural, and societal issues; and Scientific, including past and futuristic facts. Therefore, the indicator used is the context with the scientific sub-indicator. The reason for using numeracy literacy with a focus on the scientific aspect becomes relevant because the concept allows for a deep understanding of biodiversity issues from a scientific perspective and prospects.

In this research, the indicators with the highest and lowest percentages are content and context, categorized as *sufficient* and *very insufficient*, respectively. Content refers to the information found in print or electronic media, while context refers to sentences or descriptions providing clarity of meaning. Content received a high score because students were able to comprehend the information presented in the questions.

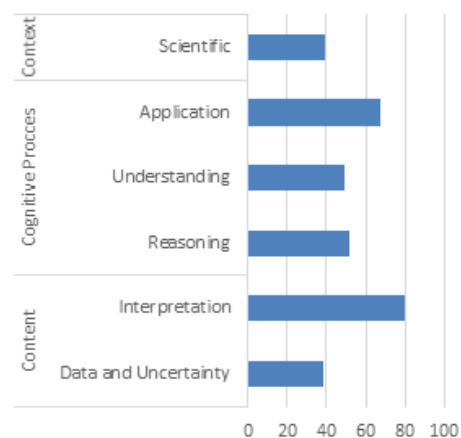
In the context related to numeracy literacy, the concept refers more to aspects of life or situations related to natural or scientific phenomena. The results show that students have not been able to answer context-related questions effectively and require improvement in numeracy literacy skills. This can be achieved through innovative and interactive learning methods, such as using Project-Based Learning (PjBL) models. The outcomes are consistent with research conducted

by Faridah et al. (2022), where the use of PjBL models can influence students in communicating about the construction of outcomes related to experiences in life.

Nisa (2023) showed the effectiveness of Problem-Based Learning (PBL) augmented by Quizizz in enhancing numeracy skills. Meanwhile, Widiastuti & Kurniasih (2021) explored the impact of integrating PBL with Cabri 3D V2 software. Nurjumiati et al. (2022) examined the efficacy of an Inquiry-Based Numeracy Literacy model in advancing mathematical modelling and symbolic language skills in physics. These research showed the effectiveness of various models and methods in enhancing literacy and numeracy skills among high school students, each offering unique benefits and strategies for improving proficiency in critical areas of education.

The learning model promotes students to actively share ideas, represent mathematical situations in the form of tables, graphs, equations, or diagrams, and enhances critical and creative thinking skills (Faridah et al., 2022). PjBL models are more effective than expository learning in improving scientific attitudes. This is because students are actively engaged, providing more opportunities to develop self-concept, scientific attitudes, confidence, and independence (Alawiyah & Sopandi, 2016).

To determine numeracy literacy achievements, students are grouped based on sub-indicators in the following chart.

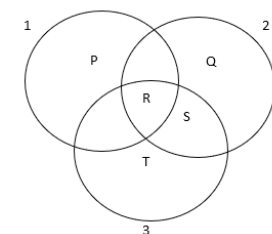
**Figure 1.** Presentation of Student Numeracy Literacy Skills in Each Sub-Indicator

Based on the data from Figure 1 and the Category Achievement of Students' Numeracy from the Ministry of Education and Culture education report (2023), the content indicator is divided into data and uncertainty, as well as interpretation, which scored 39% (less) and 80% (good), respectively. In the cognitive process indicator, the variable is divided into three reasoning, understanding, and application scoring 51%, 49%, and 68%, respectively. In the context indicator, only one sub-indicator is used, which is scientific, scoring 39% (less). Therefore, students with numeracy literacy skills above average only exist in the interpretation sub-indicator at 80% (good), while other sub-indicators need improvement.

Questions containing the content indicator are number 1 with the sub-indicators of data and uncertainty. Students must possess the skills to use numerical values or mathematical symbols to solve problems pertaining to fundamental mathematics. Students are asked to match the data from the photograph to the table. However, many do not understand the concept with only 39% answering correctly. Questions number 4, 6, 9, and 10 use the sub-indicator of interpretation and students are required to interpret data in the graphs. In this section, 80% answered correctly, showing that the skills to read and interpret data or graphs are quite good. In the cognitive process indicator, which is question number 2, students are asked to reason with the concept of mathematical sets and are expected to analyze information presented in the form of set concepts.

2. The following three-set intersection diagram depicts the distribution area of Indonesian fauna. Labels P, Q, R, and S represent the types of organisms that live in Indonesia (1, 2, and 3). Label 1, 2, and 3 shows the division of the region.

If 1 = Western Indonesia Region, T = Tarsier, parts 2, 3, P, R, and S respectively are....



	2	3	P	Q	R	S
A.	Eastern Indonesia Region	Transitional Region	Tiger	Cendrawasih	Elephants	Duyung
B.	Eastern Indonesia Region	Transitional Region	Elephant	Kangaroo	Deer	Cockatoo
C.	Eastern Indonesia Region	Western Indonesia Region	Rhino	Mambruk bird	Orangutan	Horse
D.	Transitional Region	Eastern Indonesia Region	Elephant	Irian porcupine	Butterfly	Cockatoo
E.	Transitional Region	Eastern Indonesia Region	Green peacock	Honey bee	Cassowary bird	Cendrawasih

Figure 2. Question Number 2

The result showed that 51% of students answered correctly, while the remainder felt con-

fused when reading data presented in set form. Meanwhile, questions number 5 and 8 contain the sub-indicator of understanding. Students were asked to comprehend facts by analyzing data presented in the form of tables. The result showed that 49% answered correctly, while the rest were unable to analyze the data accurately.

5. Consider the following table of plant groups (taxa). If the table says 1, it means they exist. If the table says 0, it means they do not exist.

	Taxa A	Taxa B	Taxa C	Taxa D
Chlorophyll	1	1	1	1
Sporophyte generation	1	0	1	1
Sporophyte generation independent of gametophyte	0	0	1	0
Cuticle	1	0	1	1
Gemma Cup	1	0	0	0
Gametophyte shape (0 = callus, 1 = like a leaf, 2 = neither)	0	2	2	1

Notes:

1= available

0 = not available

Based on the table above, The following statement **incorrect** is....

- Taxon A is a Marchantia (Hepaticophyta) because it has gemma
- All taxa except taxon C are pteridophyta (ferns)
- Taxon C is a plant without transport vessels
- Taxon D is a hornwort
- All taxa except pteridophyta belong to the kingdom plantae

Figure 3. Question Number 5

Question number 11 contains the sub-indicator of application. Students are asked to apply the concept of simple mathematics, calculating the number of endangered transitional fauna. The result reported that 68% answered correctly because of knowledge about the animals included in the transitional fauna.

11. The Central Statistics Institute recorded the number of endangered animals in the following table excerpt.

Species of Animals	Number of Threatened Animals		
	2015	2016	2017
Sumatran Tiger	58	71	68
Sumatran Elephant	84	155	362
Rhino	70	19	80
Bull	45	381	270
Gibbon	21	140	492
Orang Utan	143	1153	1890
Proboscis Monkey	455	837	1365
Komodo dragon	6	2919	5954
Bali Starling	7	38	39
Maleo	466	557	1204

How many transitional animals were threatened with extinction in 2017?

- 1234
- 1243
- 4527
- 5993
- 7197

Figure 4. Question Number 11

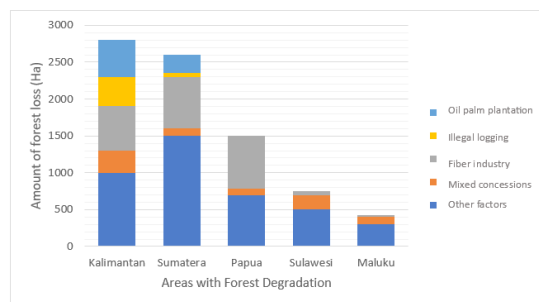
The cognitive process indicators consist of three sub-indicators, namely understanding, reasoning, and application in the category of insufficient. This is attributed to the lack of practice for students in working on questions that require analytical and reasoning skills. An example is Higher-Order Thinking Skills (HOTS) questions that are contextual and associated with using mathematics in daily situations. Questions in the cognitive domains of analysis, evaluation, and creation necessitate more complex solutions (Yuliati et al., 2019).

The results correspond with Surnana (2016), where students' limited cognitive skills are connected to the prevalence of questions emphasizing remembering, understanding, and applying. Meanwhile, questions including higher-level analysis, generalization, synthesis, evaluation, and non-routine problem-solving are rarely used.

Pangesti (2018) explained that in developing numeracy literacy skills, teachers should introduce students to HOTS questions, starting from the easiest to the most challenging. This method enables students to solve HOTS questions and enhances confidence in high-level thinking. HOTS learning in the classroom is reflected in two-way learning between teachers and students. In this context, students have more opportunities to discover problem-solving, as well as measurement activities to prioritize issues in the form of questioning, information retrieval, analysis, evaluation, and decision-making (Sani, 2019, p. 62).

In the context indicator, only the scientific sub-indicator is used since the component is the most relevant for biodiversity material. Questions containing the scientific sub-indicator are numbers 3 and 7, where students are asked to understand issues and activities related to the environment, such as deforestation. The result showed that 39% of students answered correctly. Many misinterpreted the deforestation data presented in the following question.

3. Deforestation is the process of removing natural forests by logging for timber or changing forest land use to non-forest. Increased deforestation activity is one of the causes of biodiversity loss. Consider the following graph of the causes of deforestation on various islands in Indonesia.



The correct conclusion based on the graph is...

- The decline in biodiversity due to oil palm plantation activities is most prevalent on the island of Sumatera.
- The fiber industry contributes to the most deforestation in Maluku Island compared to other factors.
- Illegal logging is the leading cause of deforestation in Maluku Island.
- Palm oil plantations contribute the most to deforestation in Kalimantan Island.
- Deforestation in Sumatera is mainly caused by other factors and the fiber industry.

Figure 5. Question Number 3

The learning process has not adopted a scientific approach through researching materials related to issues, activities, topics, and relevant scientific facts. Students need to be retrained to engage in HOTS problems related to relevant en-

vironmental issues. This perspective is supported by Mahmud and Pratiwi (2019), where students' numeracy literacy in problem-solving and interpreting relevant contextual questions can facilitate the skills to address challenges. Students should also be trained in thinking skills using suitable learning models such as PjBL and inquiry-based learning. This model promotes the active sharing of ideas, represents mathematical situations in the form of tables, graphs, equations, or diagrams, as well as enhances critical and creative thinking skills (Rizki et al., 2022). In contrast, inquiry-based learning model only develops intellectual skills and taps into the full spectrum of potential, including critical thinking and problem-solving skills. The inquiry-based learning model guides students in using an analytical method including all stages of the investigation process (Alberta Education, 2004).

In a research conducted by Nurjumiati et al. (2022), the impact of the Inquiry-Based Numeracy Literacy Model on students' mathematical modelling skills and symbolic language skills in physics learning was explored. This model emphasizes an inquiry method that enhances students' active participation in the learning process to deepen the understanding of numeracy concepts related to physics. The results provide insight into how the integration of numeracy and inquiry literacy methods can improve learning experiences in understanding complex subject matter.

Reyna et al. (2009) examined the effects of low numeracy on individuals' perceptions of risks and benefits, as well as the disruptive nature of risk communication, leading to implications for medical outcomes. Abror et al. (2022) explored the influence of social media on the fundamentals of literacy, emphasizing the importance of literacy skills in understanding accurate information. With challenges such as the spread of misinformation and hoaxes, as well as the increasing complexity of information received every day, improving literacy and numeracy skills has become urgent to enable individuals to critically evaluate information, identify misinformation, and make informed choices.

## CONCLUSION

In conclusion, the proficiency of students in numerical literacy was still unsatisfactory, with percentages of 55.3%, 54.4%, and 39.4% for content, cognitive processes, and context, respectively. Only the interpretation sub-indicator showed students achieving numeracy literacy skills above

the average, scoring at 80% (good). The analysis results emphasized the necessity for students to practice and improve in the context dimension. Numeracy literacy was regularly practiced with the development of challenges such as the spread of misinformation and hoaxes, as well as the increasing complexity of information. This enabled students to possess skills in critically evaluating information, identifying misinformation, and making informed choices. As a recommendation, these skills could be enhanced in mathematical and non-mathematical subjects by providing learning models to train PjBL and inquiry, as well as asking questions and interpreting data.

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