Journal of General Education and Humanities
Vol. 4, No. 4, November 2025, pp. 1433 - 1444, https://doi.org/10.58421/gehu.v4i4.338
ISSN 2963-7147

Numeration Literacy Capability Based on The Assimilation and Accommodation Framework Reviewed from Students' Cognitive Style

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Article Info

Article history:

Received 2024-12-12
Revised 2025-08-29
Accepted 2025-08-29

Keywords:

Accommodation
Assimilation
Impulsive cognitive style
Numeracy literacy
Reflective cognitive style

ABSTRACT

Numeracy literacy is one of the essential skills developed in mathematics learning, as it supports critical thinking and problem-solving abilities in daily contexts. However, many students still struggle to apply mathematical symbols and strategies effectively. This study aims to analyse students' numeracy literacy skills in solving systems of linear equations in two variables (SPLDV) by considering reflective and impulsive cognitive styles through the assimilation and accommodation framework. This research employed a qualitative descriptive approach with eighth-grade students at MTsN 2 Batang Hari as participants. Subjects were selected using the Matching Familiar Figures Test (MFFT) to identify reflective and impulsive cognitive styles. Data were collected through numeracy literacy test questions, think-aloud protocols, and semi-structured interviews. Students' responses were analysed based on indicators of numeracy literacy and their cognitive processes of assimilation and accommodation. The findings indicate that reflective students (R1 and R2) could analyse information accurately, employ mathematical symbols appropriately, construct SPLDV models, and conclude solutions logically. They predominantly demonstrated assimilation processes, showing careful and systematic reasoning. In contrast, impulsive students (I1 and I2) could identify information but struggled to use symbols and formal methods, often relying on guessing strategies. Their responses reflected accommodation processes, with lower accuracy and incomplete reasoning. In conclusion, reflective students achieved proficient numeracy and literacy skills, while impulsive students remained at a basic level. These results highlight the importance of tailoring instructional strategies to students' cognitive styles to strengthen numeracy literacy competencies.

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https://doi.org/10.58421/gehu.v4i4.338

1. INTRODUCTION

Numeracy literacy skills are necessary in mathematics, because mathematics is not only always related to formulas, but also requires students' reasoning power or critical thinking patterns in answering each problem presented. The National Literacy Movement Team revealed that numeracy literacy helps support 21st century skills for mastering basic literacy and can help solve daily problems related to numbers, data, and mathematical symbols, training someone as a critical thinker who is rational and systematic in solving problems and make a decision on a problem [1]. Mastery of numeracy literacy must be balanced with developing critical thinking skills in problem solving, creativity, communication, and collaboration [2]. Numeracy literacy ability is a person's ability to use reasoning to understand and analyse a statement, through activities in contextually manipulating mathematical symbols or language, and being able to express the statement in writing or orally [3]. Thus, numeracy literacy is positioned not only as a mathematical competence, but also as a key competency that supports lifelong learning and problem-solving in everyday life [4], [5].

Based on the 2022 PISA results for numeracy literacy, it is among the lowest, equivalent to the results obtained in 2003, and shows a decline of 12-13 points compared to 2018. Research conducted by Khoirunnisa revealed that students' ability to solve numeracy literacy problems is still low, especially when using symbols and mathematical variables to solve everyday problems [6]. A preliminary study conducted at MTs N 2 Batang Hari shows that students' numeracy literacy skills in SPLDV material are still low. If viewed from the indicators of numeracy literacy skills, this is because students do not understand the use of mathematical symbols or variables, they do not provide the right representation in finding the price of two notebooks and one pen, and they do not use the right methods and calculations in answering questions. These findings indicate a significant gap between the expected numeracy literacy competencies and the actual abilities demonstrated by students in the field.

In achieving numeracy literacy, students have different ways of thinking when responding to problems. This way of thinking arises because of the differences in cognitive styles each student possesses [7], [8]. Cognitive style describes how students tend to acquire knowledge and information that is processed by students [9], [10], [11]. Cognitive style is a bridge between a person's personality and intelligence. Students use different ways of processing, using, and processing information to solve problems [12]. Thus, because the processing of student data is different, there is a tempo in solving problems accurately, so the cognitive style used in this research is included in the conceptual tempo category, namely, reflective and impulsive. Students have different cognitive styles and ways of solving problems, which will also trigger differences in their numeracy literacy abilities [13]. Therefore, understanding the role of cognitive style is crucial to explaining why some students excel in numeracy literacy while others struggle.

Numeracy literacy skills require deeper analytical thinking to complete them. In this case, it means that numeracy literacy abilities are closely related to activities to build and form knowledge. So you need the ability to construct a scheme based on your basic

knowledge, using your own words and making connections with new knowledge. This is related to the theory of constructivism according to Piaget's perspective which states that the knowledge a person acquires is the result of constructing the initial knowledge they already have with newly acquired knowledge, meaning that the learning process as an effort to give meaning by students to their experiences through the process of assimilation and accommodation, will form a construction of knowledge that leads to cognitive abilities [14]. Consequently, the assimilation and accommodation framework provides a strong theoretical foundation for analysing how students develop numeracy literacy through cognitive processes.

Based on the problems that have been explained regarding the importance of achieving student numeracy literacy, which cannot be separated from cognitive style and the process of assimilation and accommodation, it is necessary to carry out research by analysing students' numeracy literacy abilities based on an analysis of assimilation and accommodation thinking in terms of the conceptual tempo cognitive style. Therefore, this research will analyse students' numeracy literacy skills based on this problem. So the theme of this research is: Analysis of Students' Numeracy Literacy Abilities Based on the Assimilation and Accommodation Framework Viewed from Reflective and Impulsive Cognitive Styles. This research will provide theoretical contributions to studying cognitive styles in mathematics education and practical implications for teachers in designing more adaptive learning strategies.

2. METHOD

This research uses a qualitative approach with descriptive analysis methods to analyse and describe numeracy literacy abilities based on students' assimilation and accommodation thinking processes regarding reflective and impulsive cognitive styles on SPLDV at junior high school/equivalent level. This research was conducted at MTs Negeri 2 Batang Hari, class VIII. This research's subjects were four out of 25 students in the class. The selection of subjects in this research was carried out by administering the MFFT (Mathing Figure Familiar Test) test developed by Warli to select students with a reflective cognitive style (R1 and R2) and an impulsive cognitive style (I1 and I2) [15]. The level of student proficiency in numeracy literacy skills is presented in Table 1 [16]. The study design is thus exploratory, focusing on the depth of analysis rather than generalisation to a wider population.

Table 1. Level of proficiency in literacy skills

Proficiency Level	Descriptor
Need Special Intervention	Students only have limited mathematical knowledge. Students only show partial mastery of concepts and limited calculation skills.
Base	Students have basic mathematics skills such as basic calculations, basic concepts, and solving simple routine mathematics problems.
Capable	Students can apply their mathematical knowledge to various contexts.
Adept	Students can use reasoning to solve complex problems based on the mathematical concepts that students have.

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The data collected in this research are in qualitative form. The instruments used were the MFFT test, numeracy literacy test questions in the form of SPLDV essay questions, and semi-structured interviews conducted with research subjects. The data collection technique in this research is through questions that measure students' numeracy literacy abilities, along with the results of their work based on predetermined indicators, and interviews that aim to find out and reveal in more depth the research subjects' numeracy literacy abilities and their thought processes in solving questions based on the assimilation framework and accommodation. In order to ensure that the instruments were aligned with the research objectives, all items were designed to capture the three indicators of numeracy literacy ability. In order to determine the level of student proficiency in the abilities in this study, indicators were used, as presented in Table 2 [17].

Table 2. Indicators of numeracy literacy abilities

Indicator	Descriptor
Using numbers and symbols related to basic mathematics in solving daily life problems	Students can write down what they know, ask questions, and make examples using variables or mathematical symbols.
Analyse information displayed in various forms (graphs, tables, diagrams, etc.)	Students can change the information from the problem into a simpler mathematical model, understand problems and plan problem solutions, and choose the appropriate method or operation to solve the problem.
Interpret analysis results to predict and make decisions	Students can use appropriate procedures and operations to solve problems and write logical arguments to make conclusions.

In this research, the data credibility test was carried out by source triangulation, which was carried out by comparing interview data with test result data. The stages and techniques of data analysis in this research, referring to Creswell, include: 1) examining student work results based on established indicators, 2) conducting interviews and analysing research subject interview results, and 3) describing numeracy literacy skills based on assimilation and accommodation thinking processes by creating narratives [18]. Furthermore, data reduction, data display, and conclusion drawing were systematically conducted to strengthen the validity of findings. This stepwise process ensured that the analysis remained consistent with the theoretical framework and research objectives.

3. RESULTS AND DISCUSSION

Below are presented the research results of four research subjects: two with a reflective cognitive style and two with an impulsive cognitive style, which is based on assimilation and accommodation thinking processes on SPLDV questions on their numeracy literacy abilities.

3.1. Results

3.1. Exposure to Subject Data with a Reflective Cognitive Style

R1 worked on the questions for 25 minutes and 10 seconds. The results of R1's answers in completing the numeracy literacy test questions on SPLDV material are presented in Figure 1.

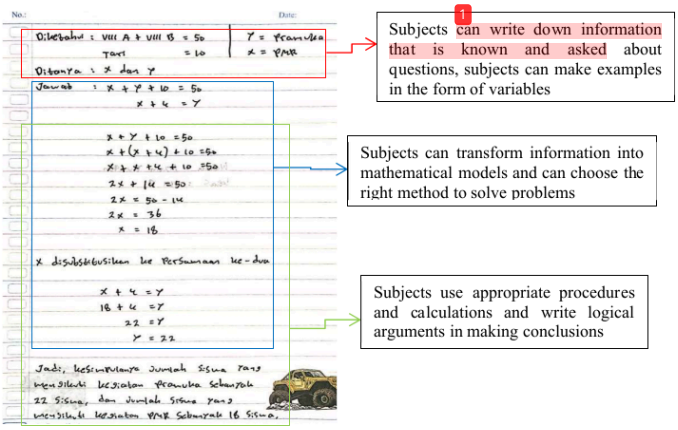

Figure 1. R1's answer to the numeracy literacy test question

Based on R1's answer in Figure 1, it can be seen that subject R1 can write down the information that is known and asked in the question correctly, and R1 can change the information from the question into an example in the form of x and y variables. R1 can also convert information from the problem into a mathematical model in SPLDV, namely $x + y + 10 = 50$ and $x + 4 = y$. A review of the numeracy literacy indicators shows that R1 can fulfil indicator 1 of numeracy literacy.

The next step, R1, determines the method or strategy used to solve the problem. R1 starts working on the problem by using the substitution method to find the x and y values. Judging from the results of R1's answer in Figure 1, R1 solved the problem using the method he used and carried out the correct calculations. This means that R1 meets indicator 2 of numeracy literacy.

Based on the interview results, R1 was confident with the answers he had worked on. R1 confirmed that the answer he had worked on was correct, and R1 provided a conclusion at the end of the answer. Apart from that, R1 is also confident in the answer he has worked on. This shows that R1 can fulfil indicator 3 of numeracy literacy. The R1 assimilation and accommodation framework is illustrated in Figure 2 below [19].

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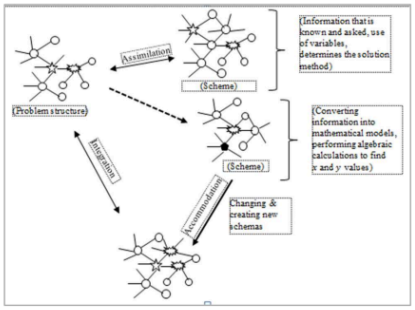
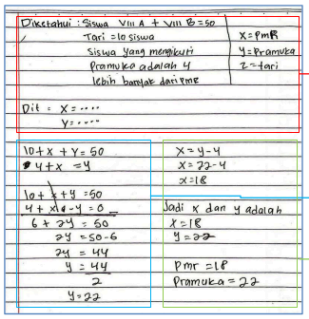


Figure 2. R1's thinking structure is based on the assimilation and accommodation framework of the problem
◄——► State the suitability between the problem structure and the thinking structure (scheme)
----------► Stating the discrepancy between the problem structure and the thinking structure (scheme)

Next, the answers from R2 are presented in Figure 3. R2 worked on the questions in 25 minutes and 30 seconds.



Subjects can write down the information that is known and asked about questions, subjects can make examples in the form of variables.

Subjects can transform informations into mathematical models and can choose the right method to solve problems

Subjects use appropriate procedures and calculations and write logical arguments in making conclusions

Figure 3. R2's answer to the numeracy literacy test question

Based on the results of R2's answer in Figure 3, it can be seen that R2 can understand the information in the question in the form of information that is known and asked about in the question. If viewed from the numeracy literacy indicator, this shows that R2 can fulfil indicator 1 of numeracy literacy. R2 can also make examples in the form of variables x and y and create a mathematical model in the form of SPLDV, and R2 can determine the method or strategy used to solve the problem. R2 uses a combined method, namely elimination and substitution. R2 uses the elimination method to find the y value and the substitution method to find the x value. This shows that R2 meets indicator 2 of numeracy literacy.

Based on the interview results, R2 was confident with the answers he had worked on. R2 has confirmed that the answer is correct, and R2 has also provided a conclusion at the end of the answer. The R2 assimilation and accommodation framework is illustrated in Figure 4 below.

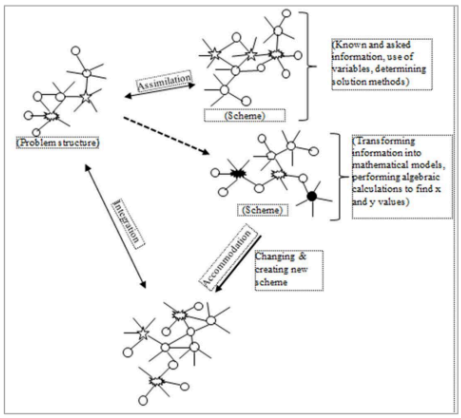


Figure 4. R2 thinking structure based on the assimilation and accommodation framework in the problem

3.2. Exposure to Subject Data with an Impulsive Cognitive Style

I1 did the problem in 21 minutes 24 seconds. The results of I1's answer in solving the SPLDV questions are presented in Figure 5.

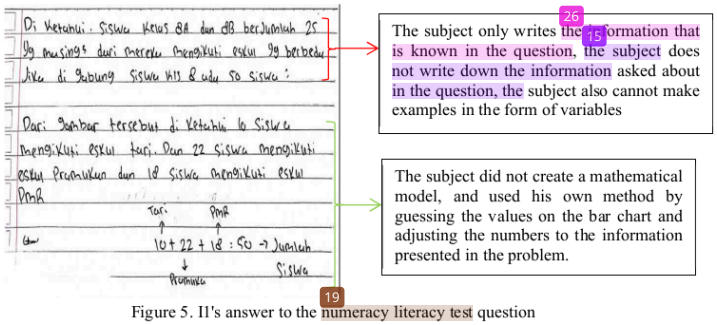


Figure 5. I1's answer to the numeracy literacy test question

Based on the data in Figure 5, I1 can find out what information is known from the question and write it on the answer sheet correctly. However, I1 did not write down what was asked in the question and did not change the information into simpler variables. If viewed from the numeracy literacy indicator I1, it does not meet indicator 1 of numeracy literacy.

I1 can analyse the information in the bar diagram presented in the question. However, I1 did not answer the questions using the SPLDV solution method. Based on the interview results, I1 was confused about solving the questions. Then I1 decided to use his own method by looking at the data in the bar chart presented in the question and then guessing the answer. Even though I1's answer was correct, the method he used was not correct, and

https://doi.org/10.58421/gehu.v4i4.338

I1 was not sure about the answer he had given. I1 also did not write the conclusion of his answer. This means I1 does not meet indicators 3 and 3 of numeracy literacy. The I1 assimilation and accommodation framework is illustrated in Figure 6 below.

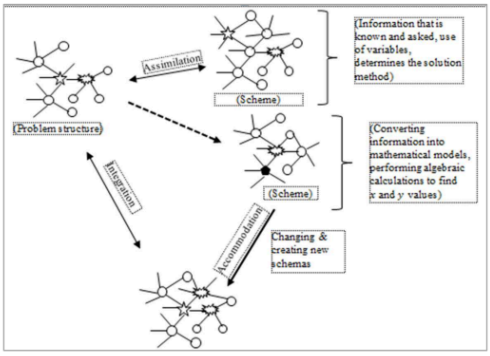


Figure 6. I1 thinking structure based on the assimilation and accommodation framework in the problem

Next, the results of I2's answers in solving the questions are presented in Figure 7. I2 worked on the questions in 19 minutes.

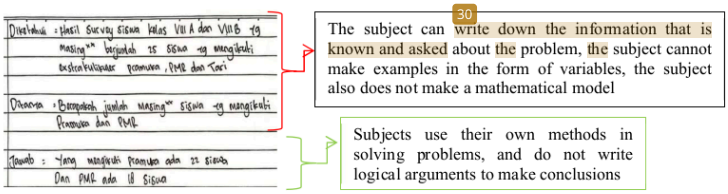


Figure 7. I2's answer to the numeracy literacy test question

In Figure 7, it can be seen that I2 can write down the information that is known and asked about in the question. However, I2 did not use symbols or variables in answering questions. If viewed from the numeracy literacy indicators, I2 does not meet indicator 1 of numeracy literacy.

Then I2 can analyse the information in the bar diagram presented in the question by writing that there are 22 Scouts and 18 students in PMR. This means that I2 meets indicator 2 of numeracy literacy. However, I2 did not use the SPLDV solution method in answering the questions; instead, he used his own method by looking at the data in the bar chart presented in the questions and then guessing the results. Judging from the results of the interview, I2 was also not sure about the answers he had worked on, so I2 did not make any conclusions about the results of his answers. Even though the answer is correct, the method used is not correct. If viewed from the numeracy literacy indicators, I2 does not

meet indicator 3 of numeracy literacy. The I2 assimilation and accommodation framework is illustrated in Figure 8 below.

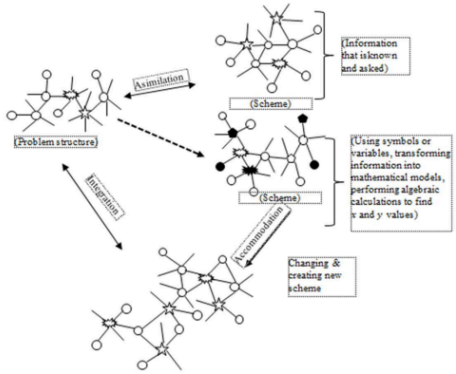


Figure 8. I2 thinking structure based on the assimilation and accommodation framework in the problem

3.2. Discussion

Indicators Using Numbers and Symbols Related to Basic Mathematics in Solving Contextual Problems

Findings on indicators of using numbers and symbols related to basic mathematics in solving contextual problems in this research reveal that students with a reflective cognitive style can use numbers and symbols and make examples in the form of variables. At this stage, students with a reflective cognitive style experience an assimilation process, demonstrated by adapting the information in the questions to previous learning. This is in line with Junarti et al. [20], who say that assimilation occurs in students, namely that students adapt the new experiences they obtain to the structures that exist within them. In contrast to students with an impulsive cognitive style, they only write down information that is known and asked about, but do not write examples in the form of symbols or variables. Students with an impulsive cognitive style experience an accommodation process at this stage. This difference highlights that reflective students can formalise abstract concepts, while impulsive students remain at a surface level of information representation.

Indicators Analyse Information Displayed in Various Forms (Graphs, Tables, Charts, etc.)

Subjects with a reflective and impulsive cognitive style can understand the meaning of questions through stories or diagrams. At this stage, students experience an assimilation process. Junarti et al (in Putri [21]) stated that the students' assimilation indicators are the same or almost the same experience as the instructions given. Nevertheless, reflective students tended to transform the information into structured mathematical models, while impulsive students often relied on intuition or direct observation without deeper

abstraction. This finding suggests that although both groups can assimilate visual data, the quality of their analytical strategies differs.

Indicators Interpret t-Analysis Results to Predict and Make Decisions.

The ability of students with a reflective cognitive style to describe the methods used and carry out calculation operations correctly to produce correct answers, as well as write logical arguments and draw conclusions from the results obtained. At this stage, R1 and R2 experience an accommodation process that reaches equilibrium. This is in line with Suparno's [22] statement, which states that accommodation can occur through modifying the existing schema to match the stimulus and the adjustment process of assimilation and accommodation that reaches equilibrium will produce the correct answer. In contrast to students with an Impulsive cognitive style, they use their own methods, so that even though the answer is correct, the subject experiences errors in the processing steps. At this stage, subjects with an impulsive cognitive style experience an accommodation process. This is in line with Junarti et al [20], who said that the indicator of accommodation in students is that students cannot solve questions correctly because they cannot adapt the new scheme to the scheme that already exists within them.

Based on this explanation, it can be described that students who have a reflective cognitive style have literacy skills at the "Advanced" proficiency level because they have met all the indicators of numeracy literacy. This is in accordance with Asrijanty's [23] statement, which states that a student's level of numeracy literacy achievement is proficient if the student can use reasoning to solve complex problems based on the mathematical concepts they have. Students with a reflective cognitive style are more careful when working on questions, so there is very little chance of making mistakes when working on questions. This is in line with the opinion of Rozencwajg & Corroyer [24] who explain that students with a reflective cognitive style are characterised by being slow in answering problems, but careful/thorough, so that answers tend to be correct.

Students with an impulsive cognitive style have numeracy literacy skills at the "Basic" proficiency level because some do not meet the indicators of numeracy literacy. This is in accordance with Asrijanty's (2020) statement, which states that a student's level of numeracy literacy achievement is said to be basic if the student has basic mathematics skills, such as basic calculations, basic concepts, and solving simple routine mathematics problems. This is because students who have an impulsive cognitive style are less careful in answering, so they make mistakes in the process. This aligns with the results of research conducted by Fridanianti et al. [25], which states that students with an impulsive cognitive style are less thorough or inaccurate in answering questions.

4. CONCLUSION

Based on the research results, it can be concluded that students with an impulsive cognitive style are more likely to experience accommodation at each stage of numeracy literacy and remain at the basic proficiency level. They generally fulfil only one indicator, namely the ability to analyse information presented in various forms (graphs, tables, charts), but struggle to use mathematical symbols and variables or to determine appropriate

solution methods. In contrast, students with a reflective cognitive style tend to experience assimilation at each stage of numeracy literacy and achieve proficiency. They successfully fulfil all indicators of numeracy literacy: (1) using numbers and symbols in solving contextual problems, (2) analysing information in different representations, and (3) interpreting analysis results to make predictions and logical decisions.

In line with these findings, it is recommended that teachers design learning models and approaches that accommodate differences in students' cognitive styles. Reflective students may be given more complex and open-ended problems to challenge their reasoning, while impulsive students require structured guidance and scaffolding to strengthen their accuracy in mathematical symbols and strategies. Moreover, developing assessment instruments that specifically measure numeracy literacy across indicators is essential to effectively support students' competencies.

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