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Analysis of Students' Mathematical Literacy in Solving Problem-Solving Questions Based on Self-Regulated Learning

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Abstrak

Sangat penting bagi siswa untuk mengembangkan kemampuan literasi matematika sehingga mereka dapat memanfaatkan matematika untuk memecahkan masalah dalam kehidupan sehari-hari dan tidak hanya memahami materi pelajaran. Tujuan dari penelitian ini adalah untuk mengevaluasi seberapa baik siswa menggunakan literasi matematika untuk memecahkan masalah yang telah ditinjau dari SRL. Penelitian ini menggunakan metodologi kualitatif deskriptif. Tiga anak dari kelas IX MTsN 3 Banda Aceh mereka yang memiliki kemampuan SRL tinggi, sedang, dan rendah menjadi subjek penelitian. Peneliti, soal tes untuk literasi matematika, kuesioner SRL, dan protokol wawancara berfungsi sebagai instrumen penelitian. pengumpulan data melalui wawancara dan penilaian tertulis. Tiga langkah prosedur analisis data adalah reduksi data, penyajian data, dan penarikan kesimpulan. Dengan memberikan STKLM-1 dan STKLM-2 pada berbagai waktu, teknik pemeriksaan validitas data menggunakan triangulasi waktu. Temuan penelitian menunjukkan bahwa peserta dengan SRL tinggi memenuhi ketiga kriteria literasi matematika: merumuskan, menggunakan, dan menafsirkan. Hanya dua indikator literasi merumuskan dan menggunakan yang dipenuhi oleh subjek dengan SRL menengah; mereka tetap tidak mampu memahami hasil mengingat tingkat kesulitannya. Hanya indikator merumuskan yaitu, mengartikulasikan masalah matematika yang dapat dipenuhi oleh subjek dengan SRL rendah; mereka tetap tidak mampu memenuhi indikator menggunakan dan menginterpretasi.
Kata Kunci: Analisis; Kemampuan Literasi Matematis; Self-Regulated.

Abstract

It is crucial that students develop mathematical literacy abilities so that they can utilize mathematics to solve problems in their daily lives and not just understand the subject matter. The purpose of this study is to evaluate how well students use mathematical literacy to solve problems that have been reviewed from SRL. This study employs a descriptive qualitative methodology. Three kids from class IX MTsN 3 Banda Aceh those with high, medium, and low SRL abilities were the study's subjects. Researchers, test questions for mathematical literacy, SRL questionnaires, and interview protocols served as the study's instruments. collecting data through interviews and written assessments. The three steps of data analysis procedures are data reduction, data presentation, and conclusion drawing. By administering STKLM-1 and STKLM-2 at various times, the data validity checking technique employs time triangulation. The study's findings demonstrated that participants with high SRL satisfied all three criteria for mathematical literacy: formulate, employ, and interpret. Only two literacy indicators formulate and employ were met by subjects with intermediate SRL; they were nevertheless unable to understand the results in light of the difficulty. Only the formulate indikator that is, articulating mathematical problems could be met by subjects with low SRL; they were nevertheless unable to fulfill the employ and interpret indicators.
Keywords: Analysis; Mathematical Literacy Ability; Self-Regulated.

I. INTRODUCTION

Mathematical literacy is just one of many essential skills that students need to comprehend mathematics in the 21st century. According to Ojose, mathematical literacy is the ability to understand and use fundamental mathematical concepts to solve various real-world problems (Izzatin et al., 2022). A person with a high level of mathematical literacy will be sensitive to the relevance of mathematical ideas to the problems or events they face. Based on this awareness, mathematical concepts are utilized to solve problems (Waridah, 2022).

The results of PISA (Programme for International Student Assessment), an international test conducted every three years by the Organization for Economic Cooperation and Development (OECD), are used to measure the mathematical literacy of Indonesian students. Findings from PISA studies clearly indicate that Indonesian students exhibit poor mathematical literacy skills. According to the first study, only five out of twenty-five eighth-grade students at MTsN 3 Banda Aceh could answer contextual problem-solving questions, while the rest still struggled (Maisarah, 2025). Further research is needed to assess students' mathematical literacy skills, particularly in solving mathematical problems.

A person with strong mathematical literacy can contribute to their life, community, and society by applying logical mathematical reasoning. Individuals with mathematical literacy can base their decisions on sound mathematical reasoning (Muslimah & Pujiastuti, 2022).

Besides understanding mathematical concepts, mathematical literacy also equips individuals to solve real-life problems. Unfortunately, the emphasis on mathematics education in schools is often limited to tasks such as computation, memorization, recall, and comprehension (Anggoro, 2021). Providing a detailed description of curricula that support mathematical literacy and identifying the necessary mathematical skills are part of the effort to assist students in building their mathematical literacy (Putri et al., 2024). By understanding students' mathematical literacy skills, teachers can address areas where students struggle and consider appropriate teaching strategies and evaluation tools (Abidin et al., 2021). Therefore, to describe students' mathematical literacy skills and enable teachers to take necessary steps to enhance students' mathematical proficiency, a deeper analysis is needed to examine how students' mathematical literacy skills are expressed in each indicator of mathematical literacy ability: (1) Formulating, which refers to the ability to mathematically formulate problems; (2) Employing, which involves the ability to design and apply strategies and use mathematical concepts to solve problems; and (3) Interpreting, which is the ability to reinterpret results within the context of the problem (Sari et al., 2021).

Mathematical problem-solving is directly related to literacy, and developing mathematical problem-solving skills is a fundamental goal of mathematics education. This type of problem-solving goes beyond answering standard mathematical questions; it involves addressing real-world problems that require logical reasoning. Problem-solving

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entails efforts to figure out how to overcome obstacles and achieve long-term goals (Haqqul & Saraswati, 2023). Students with problem-solving skills recognize that there are multiple approaches to tackling different challenges. Hence, problem-solving ability is an essential skill that every student must develop (Septhiani, 2022).

Students' reading skills play a crucial role in developing their reasoning abilities. Self-Regulated Learning (SRL) is a significant aspect of learning and teaching. SRL refers to an individual's ability to regulate, motivate, and manage their own learning. Students with strong SRL skills can manage their learning effectively to meet their learning goals, reducing difficulties or stress during learning activities. SRL influences students' performance in solving mathematical problems (Hudaifah, 2020: 76). Problem-solving is one of the key abilities required for mathematical literacy. Students who receive high-quality SRL instruction will be better equipped to handle literacy-related challenges.

Self-regulated learning is characterized by several key indicators:

1. Learning initiative – students engage in learning independently because they understand the value of learning and recognize the need for continuous study at home to grasp difficult concepts.
2. Diagnosing learning needs – students can identify their own learning needs.
3. Setting learning goals – students establish goals they aim to achieve.
4. Facing challenges as opportunities – students do not hesitate to tackle obstacles while learning or solving problems.
5. Utilizing and identifying relevant resources – students actively seek out and use appropriate learning materials.
6. Selecting and practicing learning strategies – students choose and apply effective learning strategies.
7. Evaluating the learning process and outcomes – students review what they have learned in class and correct mistakes made in problem-solving.
8. Self-efficacy (self-control) – students believe in their ability to complete assigned tasks (Hidayat, Agil Maulana Akhdiyat, & Wahyu, 2018).

One of the critical issues in mathematics education is the low level of mathematical literacy among Indonesian students, as reflected in the PISA test results. Understanding mathematical concepts is only one aspect of mathematical literacy; another essential aspect is the ability to solve real-world problems. A primary goal of mathematics education is to enable students to tackle contextual problem-solving challenges, which is the focus of this study. Additionally, an essential factor influencing students' mathematical literacy is their Self-Regulated Learning (SRL) ability. This study is unique because it connects SRL with mathematical literacy and explores how SRL factors can assist students in developing their problem-solving skills. Furthermore, this research provides new perspectives on mathematical literacy skills, such as formulating, employing, and interpreting,

which are rarely considered in relation to SRL in Indonesia.

The objective of this study is to characterize students' mathematical literacy skills in problem-solving, considering the background information mentioned earlier, through the lens of Self-Regulated Learning (SRL) levels.

II. METHOD

The objective of this study is to determine the characteristics of students' mathematical literacy skills. To achieve this objective, the researcher employed a qualitative strategy with a descriptive research design. This study was conducted at MTsN 3 Banda Aceh in July 2023. The research subjects were ninth-grade students at MTsN 3 Banda Aceh. The students' levels of Self-Regulated Learning (SRL) were considered in selecting research participants.

Tests and interviews, each conducted in two stages, were used in this study. First, students completed an SRL questionnaire to map their SRL levels before proceeding with the literacy skills assessment. Subsequently, three students were selected, each representing a different SRL level: one with low SRL, one with moderate SRL, and one with high SRL. In the first stage, test questions and interviews with the three selected students were administered. The second stage of testing and interviews was conducted to assess the consistency of the subjects' responses.

The SRL questionnaire sheets, test question sheets, and interview guidelines served as supporting research instruments, while the researcher acted as the primary instrument. Data collection methods included interviews, mathematical literacy test questions, and SRL questionnaires. The SRL questionnaire was designed based on students' Hard Skills and Mathematical Problem-Solving Skills (Sintya & Sari, 2024). The test questions were adapted from Pusmenjar (Indonesian Center for Educational Assessment) and had been validated. Additionally, the interview questions were designed to align with the indicators of mathematical literacy skills.

According to Miles and Huberman (as cited in Sugiyono, 2012: 247-252), qualitative data analysis involves interactive and continuous tasks performed until data saturation is reached. The analysis consists of data reduction, data presentation, and conclusion drawing. Data validity was tested using triangulation. This study employed time triangulation, as described by Sugiyono (2019: 274), which was conducted in two stages. Data from the second round of testing and interviews were compared with the results from the first round. The data were considered valid if the results remained consistent. If the results from the first and second stages differed for any student, a third stage—consisting of additional testing and interviews—was conducted to verify the findings.

III. RESULT AND DISCUSSION

A. Results

Students' Self-Regulated Learning (SRL) skills were used as the basis for selecting research participants. In addition, three students were chosen as research subjects based on their SRL levels: one with low SRL (referred to by the initials NS), one with moderate SRL (AS), and one with high SRL

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(HU). The researcher presents the initials of the selected subjects as follows:

Table 1.
Initial Subject

No	Initial	Self-Regulated Learning (SRL) Score	Self-Regulated Learning (SRL)	Mathematical Literacy Ability
1	HU	89	High	High
2	AS	67	Moderate	Moderate
3	NS	45	Low	Low

Source: Subject Selection from Research Findings

The researcher then administered a mathematical literacy test to each participant. The following are the students' mathematical literacy test scores based on the given test.

Table 2.
Students' Mathematical Literacy Test Scores

No	Subject	Stage Test	Question Number	*Scores of Mathematical Literacy Skill Aspects*			*Score Total*	*Percentage Score*
				Formulate	*Employ*	*Interpret*		
1.	HU	1	1	3	3	3	32	88,8%
			2	3	3	3		
			3	3	2	2		
			4	2	3	2		
		2	1	2	3	3	35	97,2%
			2	3	3	3		
			3	3	3	3		
			4	3	3	3		
2.	AS	1	1	3	3	1	22	61,1%
			2	2	2	1		
			3	2	2	1		
			4	2	2	1		
		2	1	3	3	1	23	63,8%
			2	2	2	1		
			3	2	3	1		
			4	2	2	1		
3.	NS	1	1	2	0	0	12	33,3%
			2	2	0	0		
			3	2	2	0		
			4	2	1	1		
		2	1	2	0	0	12	33,3%
			2	2	1	0		
			3	2	1	0		
			4	2	1	1		

In the mathematical literacy test questions STKLM 1 and STKLM 2, the subject with high SRL (HU) achieved excellent scores. To make the problems easier to analyze mathematically, HU was able to formulate the problem mathematically by identifying what is known, what is asked, and what needs to be answered. The utilization indicator shows that HU was able to develop and implement a plan, as well as solve the problem using mathematical ideas, facts, and techniques. However, in the interpretation indicator, HU misinterpreted

the solution results when placing them in the context of the problem.

For the subject with moderate SRL (AS), obtaining high scores in STKLM 1 and STKLM 2 was challenging. The formulation indicator suggests that AS was able to mathematically formulate the problem based on the provided information, questions, and known mathematical models, making it easier to answer. The utilization indicator shows that AS was able to develop and apply strategies, as well as solve problems using mathematical facts, concepts, and procedures. However, AS was unable to reinterpret the results in the context of the problem when using the interpretation indicator.

For the subject with low SRL (NS), achieving high scores in STKLM 1 and STKLM 2 was not possible. The formulation indicator suggests that NS was able to construct mathematical problems based on the given information, questions, and known mathematical models, making them easier to answer. However, according to the utilization indicator, NS was unable to develop and execute problem-solving strategies or apply mathematical facts, concepts, and methods to solve the problems. Additionally, in the interpretation indicator, NS was unable to reinterpret the results within the context of the given problems.

B. Discussion

Mathematical Literacy Ability of MTsN 3 Banda Aceh Students in Terms of Self-Regulated Learning (SRL)

Based on the test results and interviews conducted, the researcher gathered information regarding the mathematical literacy skills of MTsN 3 Banda Aceh students in solving mathematical literacy problems, viewed from the perspective of Self-Regulated Learning (SRL).

1) Students with High SRL (HU)

In the formulation indicator, HU is capable of mathematically formulating problems, writing problems based on the given and asked situations, and creating mathematical models appropriate to the presented problem. HU can also identify relevant information and simplify problems for easier analysis.

In the utilization indicator, HU demonstrates the ability to apply principles, facts, and mathematical methods to solve problems. HU is also able to develop and implement problem-solving strategies based on relevant mathematical concepts and procedures.

In the interpretation indicator, HU can draw conclusions, reinterpret results within the context of the problem, and assess the reasonableness of the results in real-world situations.

These findings indicate that students with high SRL also exhibit high mathematical literacy. This aligns with the study by Anggraeni et al. (2021), which states that students with high SRL also possess strong mathematical literacy skills and can fulfill all three processes: formulating, employing, and interpreting mathematical problems. Additionally, the research by Syafitri et al. (2024) supports that students with good SRL tend to achieve better academic performance due to their ability to plan, regulate, and evaluate their own learning processes.

2) Students with Moderate SRL (AS)

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In the formulation indicator, AS is capable of mathematically formulating problems, writing problems based on the given situations, and creating mathematical models to address the posed problems. Additionally, AS can recognize key information and simplify the problem.

In the utilization indicator, AS is able to use concepts, facts, and mathematical procedures to solve problems and can develop and implement solution-seeking strategies.

However, in the interpretation indicator, AS has not yet developed the ability to write conclusions, reinterpret results within the context of the problem, or assess whether the obtained results are reasonable in real-world situations.

These findings suggest that students with moderate SRL exhibit moderate mathematical literacy levels, as observed in the study by Juniansyah et al. (2023). Their research indicates that students with moderate SRL can perform two literacy processes—applying concepts and formulating problems in mathematical language—but struggle with interpreting their learning outcomes.

This result is also in line with the findings of Khishaaluhussaniyyati et al. (2023), which highlight that higher SRL is associated with students' ability to overcome learning challenges, including solving mathematical problems. Their research confirms that mathematical literacy is not solely based on conceptual understanding but also on the ability to effectively apply these concepts in more complex situations.

3) Students with Low SRL (NS)

In the formulation indicator, NS is still able to mathematically formulate problems, construct mathematical models based on the given difficulties, and rewrite problems in simplified mathematical language.

However, in the utilization indicator, NS struggles to apply appropriate mathematical models for problem-solving. Many problems remain unsolved due to NS's limited ability to develop and implement problem-solving strategies. Some problems were answered by NS, but without sufficient explanation.

In the interpretation indicator, NS fails to write conclusions, reinterpret results within the context of the problem, and assess their reasonableness in real-world scenarios. Additionally, several items in this indicator were left unanswered.

Based on these findings, it is evident that students with low SRL also exhibit low mathematical literacy levels. This is consistent with the findings of Kholifasari et al. (2020), who state that students with low SRL are only capable of formulating mathematical ideas but struggle to apply or evaluate their findings.

This study also aligns with the research by Faruq & Daliman (2021), which states that students trained to become more independent in their learning—by developing effective SRL strategies—are more successful in achieving their academic goals. Their findings support the notion that enhanced SRL skills contribute to improving students' mathematical literacy, particularly in the areas of problem

formulation, concept application, and result interpretation.

4) Implications for Learning

Teachers play a crucial role in assisting students in developing mathematical literacy skills. Therefore, educators must identify students' initial abilities in mathematical literacy and integrate them with self-regulated learning strategies.

As educators, teachers must design lesson plans that consider students' prior knowledge, select appropriate instructional methods, and help students overcome difficulties in understanding mathematical concepts. This aligns with the view of Estari (2020), who asserts that without teachers' awareness of students' initial skills, students' learning growth will be hindered.

Thus, effective instructional strategies based on SRL can assist students in developing mathematical literacy, enhancing conceptual understanding, and fostering independent learning skills.

IV. CONCLUSION

The research findings indicate that students in the high SRL (HU) group exhibit strong mathematical literacy, as they are able to meet all mathematical literacy criteria. In addition to formulating problems based on given situations, students can also develop mathematical models derived from the problems presented. They effectively utilize mathematical concepts, facts, and methods to find solutions (apply) and can design and implement appropriate problem-solving techniques. Furthermore, they are able to draw conclusions, reinterpret their findings within the context of the problem, and evaluate the reasonableness of their results in real-world scenarios (interpretation).

The level of mathematical literacy among students in the moderate SRL (AS) category is considered average, as they can fulfill two out of the three mathematical literacy criteria. While they are capable of formulating problems and developing mathematical models based on given situations, their ability to apply mathematical concepts, facts, and methods in identifying solutions is also evident. Additionally, they can create and implement problem-solving strategies. However, they have not yet developed the ability to draw conclusions, reinterpret their findings within the context of the problem, or assess the reasonableness of their results in real-world situations (interpretation).

Students in the low SRL (NS) category exhibit weak mathematical literacy, as they can only fulfill one criterion: formulation. Their literacy skills remain limited to using appropriate representations to formulate situations in mathematical form or models. However, they struggle with utilizing mathematical ideas, information, and methods to solve general problems and analyzing or explaining solutions. These students have not yet met the two other literacy indicators, namely application (employ) and interpretation (interpret).

This study suggests that teachers should focus on developing students' Self-Regulated Learning (SRL) to enhance their mathematical literacy, particularly in problem-solving tasks. Contextual and problem-based learning methods can also be implemented to strengthen students'

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abilities in formulation, concept application, and interpretation.

This research provides insight into the relationship between SRL and mathematical literacy, while also identifying strategies for improving students' literacy skills through SRL development. The findings offer valuable guidance for educators in designing more effective teaching and learning strategies to support students in achieving higher mathematical literacy levels.

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