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The Relationship Between Self-Directed Learning and Mathematical Literacy Skills Among Grade XI Students: A Correlational Study

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ABSTRACT

This scholarly investigation examines the relationship between self-directed learning and proficiency in mathematical literacy among students. The methodology employed in this study is quantitative, utilizing a correlational approach. The sampling technique adopted was convenience sampling, encompassing 143 high school students from Jakarta. The instruments employed for data collection comprised a self-directed learning questionnaire alongside a mathematical literacy assessment. The questionnaire was meticulously crafted to evaluate the degree to which students exhibit initiative, responsibility, and self-directed learning capabilities. Conversely, the mathematical literacy assessment was designed to gauge students' proficiency in comprehending, interpreting, and resolving contextualized mathematical challenges. The data analysis incorporated a correlation test to determine the relationship between the two variables. The results revealed a statistically significant correlation between self-directed learning and students' mathematical literacy competencies, with a significance value of 0.035 below the threshold of $\alpha = 0.05$, alongside a Pearson correlation coefficient of $r = 0.176$. Consequently, it can be inferred that an increase often follows an increase in the level of students self-directed learning in mathematical literacy. However, because the correlation value is very low, the effect of self-directed learning on mathematical literacy is considered small, suggesting that other factors may also play a role in influencing students' mathematical literacy skills.

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1. INTRODUCTION

Mathematical literacy is one of the fundamental skills students must possess to face challenges in the global environment. This skill not only improves understanding of mathematical concepts but also allows students to use this knowledge in various situations in everyday life [1]. In everyday life, students often face challenges that require thinking

skills, social interaction, and decision-making individually and in groups, which are directly or indirectly related to mathematics [2]. Therefore, mathematical literacy is an ability that cannot be ignored in education.

Various studies have been conducted to identify factors that influence mathematical literacy. One study by Trisnaningtyas and Khotimah [3] found that students with an auditory learning style have the most comprehensive mathematical literacy skills, while those with a kinesthetic learning style tend to face challenges in meeting reasoning and problem-solving criteria. Additionally, another study by Rodhi [4] emphasizes the importance of students' interest in learning: students with a high interest in mathematics demonstrate good mathematical literacy skills, while those with little interest struggle to achieve several key indicators.

Mathematical literacy includes the ability to understand and utilize mathematics in various scenarios for problem-solving and the proficiency to teach others how to apply mathematical concepts [5]. This is in line with Farida et al. [6], which says that mathematical literacy has three aspects, namely: 1) Mathematical processes and basic math skills, 2) Knowledge of mathematical content, and 3) The context that students face when dealing with mathematics.

Mathematical literacy can be explained as a person's ability to formulate, apply, and analyze mathematical principles in a variety of contexts, including mathematical reasoning and the use of mathematical constructions, methodologies, verifiable information, and instruments to explain, clarify, and estimate events [7], [8]. However, these competencies have not been comprehensively realized in the academic achievements of Indonesian students. According to the Program for International Student Assessment (PISA) findings conducted in 2022, Indonesian students' average mathematical literacy score is 366 points, which is far below the average of OECD countries, which is 489 points. Furthermore, the percentage of Indonesian students capable of attaining the requisite minimum standard is also beneath the OECD average [9].

This shows that the mathematical literacy skills of Indonesian students are still relatively low, and the PISA results are an important indicator to describe the situation objectively [10]. The following is a shortcoming that shows the student's level of mathematical literacy is still low. This can be seen from the following mathematical literacy initial ability test results:

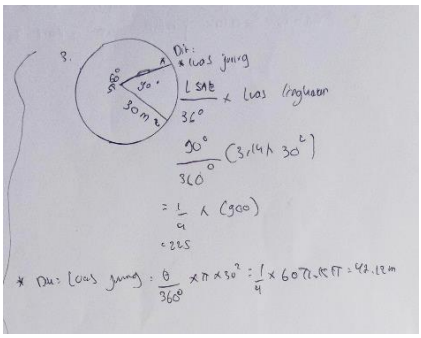

Figure 1 . Preliminary Study of Students' Mathematical Literacy

According to the findings presented, it is evident that students have not exhibited adequate proficiency in accurately resolving the assigned problems, interpreting data, or articulating logical justifications for their computations. This observation reflects insufficient mathematical literacy competencies and a lack of adeptness in applying theoretical concepts within practical, real-world scenarios.

A potential contributing factor to the observed deficiencies in mathematical literacy may be attributed to self-directed learning approaches. To date, pedagogical practices have predominantly emphasized results rather than fostering students' cognitive processes, which impedes comprehensive conceptual understanding. Furthermore, the deficiency in literacy practice coupled with a lack of intrinsic motivation for autonomous learning aggravates this predicament.

Self-directed learning refers to students' attitudes and actions that reflect initiative in learning, setting goals, organizing strategies, and evaluating their learning process self-directedly without the help of others [11]. The level of self-directing learning is generally correlated with math learning outcomes, where students with high independence tend to show better results [12]. Students' lack of self-directed learning can cause various problems, such as low academic grades, decreased motivation to learn, difficulty making decisions, and challenges in social interaction [11].

Several factors influence student self-directed learning: 1) Internal factors that affect students' self-directed learning from within include discipline, self-confidence, motivation, and a sense of responsibility. 2) External factors, which are aspects that affect student self-directed learning from outside, including culture, social environment, and natural conditions [13]. Increasing self-directed learning to support learning success is important, especially in mathematical literacy. Learning attitudes that reflect independence will encourage students to actively explore their interests, develop learning plans, and implement and evaluate strategies [14].

Although many studies on mathematical literacy have been conducted, most still focus on mastering mathematical concepts without considering the factor of self-directed learning as an important aspect of the learning process. As in the previous journal articles [7], low mathematical literacy among students is caused by various difficulties, such as understanding problems, identifying important information, and converting problems into mathematical forms. This reflects a lack of independence and active participation in learning.

This investigation seeks to bridge the deficiencies identified in prior scholarly work by analyzing how self-directed learning significantly correlates with mathematical literacy in practical contexts. This research aims to explore the interplay between self-directed learning and mathematical literacy. Therefore, this study concentrates on scrutinizing the substantial relationship between the levels of self-directed learning among students and their proficiency in mathematical literacy while also assessing the degree to which self-directed learning impacts the attainment of mathematical literacy.

2. METHOD

This research applies a quantitative approach with a focus on correlational research. The quantitative approach was chosen because it allows researchers to objectively,

systematically, and measurably understand and analyze the relationship between various variables. The correlational research type was chosen to explore whether there is a significant relationship between student self-directed learning and mathematical literacy skills in students in grade XI.

The investigator utilized a convenience sampling methodology, selecting subjects predicated on their accessibility and the feasibility of their involvement in the research. This methodology was adopted due to limitations in temporal factors and available resources, facilitating more direct and efficient engagement with the student demographic. Although convenience sampling enabled practical access to participants, this method may limit the generalizability of the findings. Future studies should consider using random sampling for more robust results.

The data was gathered through surveys, combining questionnaire forms and written tests. The questionnaire focused on identifying how independently students manage their learning, while the written tasks were used to evaluate their skills in mathematical literacy. Specifically, the questionnaire aimed to capture how students perceive and carry out self-directed learning, covering how they plan, apply, and reflect on their learning processes on their own. The self-directed learning instrument was adapted from the journal [15], [16], [17], which consists of 19 statement items. By using 4 Likert scales, namely Strongly Agree (SS), agree (S), Disagree (TS), and Strongly Disagree (STS) [18]. The self-directed learning questionnaire instrument will aim to measure the level of student independence in completing tasks. On the other hand, the mathematical literacy test is a description question consisting of 6 questions, which are assessed based on indicators adapted from [19], as in Table 1.

Table 1 . Indicators of Mathematical Literacy Skills

Indicator of Mathematical Literacy Skills	Description
Knowing	The capacity of learners to comprehend factual information, procedural methodologies, and conceptual frameworks.
Apply	Learners must proficiently employ mathematical skills and expertise in authentic contexts to resolve prevailing challenges.
Reasoning	The capability of students to assess, infer conclusions, and enhance their comprehension across diverse contexts with precision.

To ensure the quality of the instrument, its validity and reliability were evaluated using the Rasch model approach through Winsteps software [20]. Before being analyzed using the Rasch Model, the instruments were reviewed by two mathematics education experts to ensure that they could accurately measure the research variables and were consistent with the research objectives. Following the analysis, six items related to mathematical literacy and nineteen valid items from the self-directed learning questionnaire were determined to be appropriate, signifying that both instruments remain valid for application in this research.

The Rasch model was chosen for its efficacy in evaluating item validity through model fit, detecting items that do not function as anticipated (misfitting items), and yielding unbiased estimations of respondent ability and item difficulty. The analysis demonstrated that all items within the self-directed learning questionnaire and all mathematical literacy items exhibited outfit and infit mean square values within the acceptable threshold of 0.5 to 1.5. This finding signifies a favorable alignment with the Rasch model. Furthermore, the reliability coefficients for respondents and items were elevated (> 0.80), indicating robust internal consistency and affirming the appropriateness of the measurement instruments for this investigation.

The gathered data will initially undergo an evaluation for normality employing the Kolmogorov-Smirnov test. In order to evaluate the uniformity of variances among groups, Levene's test for homogeneity will also be implemented. A thorough statistical analysis will be executed, concentrating on Pearson's product-moment correlation to investigate the association between self-directed learning and mathematical literacy competencies. This analysis will be conducted utilizing SPSS software to guarantee the precision and dependability of the findings following the study's objectives.

3. RESULTS AND DISCUSSION

RESULTS

This study aims to assess two primary variables: self-directed learning (X) and proficiency in mathematical literacy (Y). The instruments comprised a questionnaire designed to evaluate self-directed learning, encompassing self-management, initiative, and accountability in the learning process, and a mathematical literacy assessment measuring students' abilities to comprehend, analyze, and resolve mathematical problems encountered in real-life contexts.

Based on findings from a survey on self-directed learning conducted among 11th-grade students at a secondary school in Jakarta, the students were grouped into three categories: high, medium, and low. The purpose of this categorization is to assist in examining the connection between students' self-directed learning abilities and their proficiency in mathematics literacy skills. As presented in Figure 2.

Wright's Map below illustrates the range of logit values between 8 and -4; the left side illustrates the distribution of respondents' ability to explain the level of student self-directing learning. Higher ratings for students indicate greater self-directing learning and vice versa. On the right side is a distribution of statement items that reflect the difficulty level of each item. Highly ranked items indicate greater difficulty for respondents to agree with. The findings show that one hundred and thirty-two students belonged to the high self-directing learning category, but only eleven students topped the Map. One of the students, coded (113), showed positive tendencies and ease in agreeing with all statement items. In contrast, three students fell into the low self-directing learning category. One was the student coded (111), who showed a negative reaction and had difficulty agreeing to each item compared to the other students.

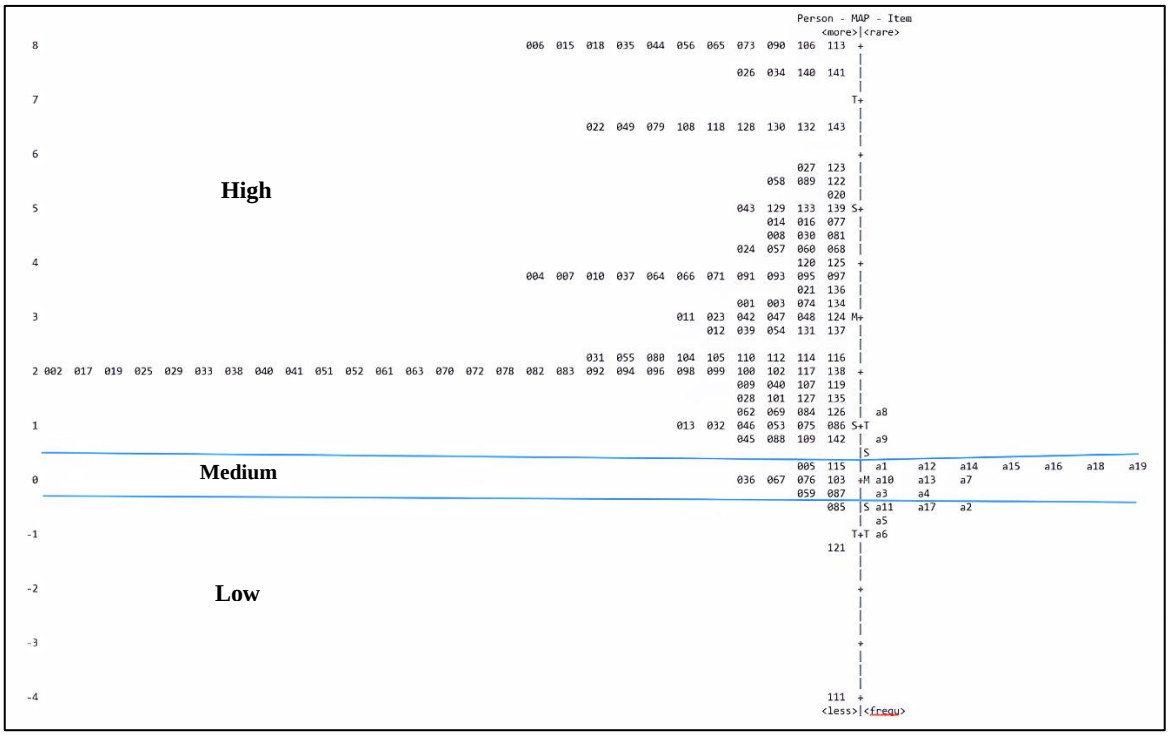

Figure 2. Wright's Map of self-directing learning

Based on data analysis conducted using Wright's Map, the level of self-directed learning of class XI students was obtained through questionnaires distributed directly. From the results of the analysis, it was found that most students were in the high self-directed learning category, which amounted to 92%. Meanwhile, 6% were categorized as moderate, and the remaining 2% were in the low category. This illustrates that many students have shown good self-directed learning, which can contribute to improving mathematical literacy skills.

The following descriptive analysis results are presented to provide a clearer picture of the data distribution on the self-directing learning and mathematical literacy variables, including each variable's mean value, highest score, lowest score, and standard deviation. The results of the descriptive evaluation of the survey on self-directed learning and mathematics assessment for grade XI are shown in Table 2.

Table 2. Descriptive Data

Variables	Average	Score Highest	Lowest Score	Standard Deviation
Self-Directing Learning	61.398	76	30	8.616
Mathematical Literacy Skills	26.398	30	20	2.241

The analysis of the dataset indicated that the scores pertaining to the self-directed learning construct exhibited a range from a minimum of 30 to a maximum of 76, with a

calculated mean score of approximately 61.398 and a standard deviation of 8.616. In relation to the mathematical literacy construct, the scores exhibited variation between 20 and 30, resulting in a mean of approximately 26.398 and a standard deviation of 2.241.

The normality test results indicated that each variable had a significance value of 0.200 for both variables, indicating that the data were normally distributed. Following this, Levene's test was employed to examine whether the variances across the variables were consistent. The test yielded a significance value of 0.170, implying that the variances are statistically similar. This means that the data distribution between groups remained uniform. After verifying these two criteria, Pearson's correlation analysis could be applied. The results of this examination can be seen in Table 3.

Table 3. Pearson Correlation Test

		Self-Directing Learning	Mathematical Literacy Skills
Self-Directing Learning	Pearson Correlation	1	.176*
	Sig.(2-tailed)		.035
	N	143	143
Mathematical Literacy Skills	Pearson Correlation	.176*	
	Sig.(2-tailed)	.035	
	N	143	143

*Correlation is significant at the 0.05 level (2-tailed)

The table above shows the correlation test results between self-directed learning and mathematical literacy. Based on the $sig.$ the value obtained from testing the correlation between the two variables, the result is $sig.\ (2{-}tailed)$ = 0.035 indicates a correlation between self-directed learning and mathematical literacy skills. The relationship between self-regulated learning and learning motivation is weakly correlated when viewed from the Pearson Correlation value.

DISCUSSION

This study aims to determine whether self-directed learning ability is related to mathematical literacy skills among eleventh-grade students at a public high school in Jakarta. The data obtained from this study involved 143 students. The data were obtained from questionnaires and tests as research instruments.

Based on the statistical data obtained, the hypothesis proposed in this study is "there is a significant relationship between the level of self-directed learning (X) and mathematical literacy skills (Y)." The relationship between self-directed learning and mathematical literacy shows a positive correlation.

Then, statistical hypothesis testing was conducted to prove the existence or absence of a relationship between self-directed learning ability and mathematical literacy ability using a correlation test assisted by IBM SPSS Statistics 26 software. The results of the data tested using Pearson's correlation test stated that the value of $sig.\ (2-tailed)$ = 0.035, which

means that there is a correlation between self-directed learning and mathematical literacy skills. When viewed from the Pearson Correlation value, it means a correlation exists between self-directed learning and mathematical literacy skills. The conclusion from the hypothesis test results shows that there is a positive relationship between self-directed learning and mathematical literacy ability.

Although the correlation produced shows a significant positive result, it is quite weak, at around r = 0.176. This indicates that while more independent students may perform slightly better, this trait does not explain most variation. It only contributes a small portion of the variation. Other factors, such as teaching quality, prior mathematical experience, or even self-confidence, may play a role here. Therefore, while self-directed learning is relevant, it is not the only factor that needs to be considered in this study.

In line with Kholifasari et al. [21], students with high levels of self-directed learning typically have better mathematical literacy skills. On the other hand, students with low learning abilities also have low levels of mathematical literacy. However, not all students with high independence automatically demonstrate high levels of mathematical literacy, indicating the possibility of other external factors playing a significant role in the learning process [22].

For example, Pokhrel and Sharma [23] state that students with low levels of self-directed learning are not yet fully capable of self-directed learning, so students still need significant help from teachers when learning. This dependence affects the ability of individuals to understand, apply, and interpret mathematical ideas independently [24].

Furthermore, Inayah et al. [25]. argues that teaching methods that emphasize final results rather than students' thinking processes can hinder meaningful growth in mathematical literacy. In this case, the weak relationship between self-directed learning and mathematical literacy can be explained by teaching methods that do not fully support self-directed learning practices. Thus, even though students have a high level of independence, they do not always receive support from an educational environment that allows them to develop their mathematical literacy potential optimally. Additionally, difficulties in managing their learning experiences contribute to low motivation, self-regulation, discipline, and the cognitive strategies needed to understand and process information effectively.

Even when students demonstrate high levels of learning independence, they do not always benefit from an educational environment that supports the full development of their mathematical literacy. Challenges in managing their learning often result in decreased motivation, weak self-regulation, and inadequate strategies to understand and process information effectively. Although the relationship between self-directed learning and mathematical literacy is statistically significant, its influence appears limited. Improvements in self-directed learning, on its own, only contribute moderately to students' abilities in this area.

This suggests that promoting self-directed learning alone is insufficient to improve mathematical literacy significantly. A broader and more holistic approach is needed to encompass and create better classroom interactions, present problems rooted in real-life situations, and promote reflective and metacognitive thinking. Teachers can support this process by combining various teaching strategies, such as project-based tasks, real-world

applications, and dedicated time for student reflection, to help students build stronger mathematical understanding over time.

4. CONCLUSION

This investigation established that autonomous learning positively correlates with students' proficiency in mathematical literacy, albeit the intensity of this correlation is relatively modest. In other terms, individuals who engage in self-directed learning typically display enhanced mathematical literacy, yet the correlation lacks sufficient strength to be regarded as the exclusive determinant. This suggests the existence of additional variables that may exert a more substantial impact on the attainment of mathematical literacy.

Nonetheless, these results yield significant implications for educators and curriculum designers. Initiatives that foster learning autonomy, such as motivating students to articulate their educational objectives, engaging in reflective practices regarding the learning process, and addressing open-ended inquiries, ought to be integral to the pedagogical framework. However, these approaches must be integrated with other strategies that may prove more efficacious in enhancing students' mathematical literacy.

Subsequent investigations should delve into alternative factors anticipated to exert a more pronounced influence, such as problem-solving abilities, emotional intelligence, or support from the educational environment. Longitudinal studies are also crucial for examining the evolution of the relationship between learning autonomy and mathematical literacy over time and elucidating how the interplay between these variables influences students' comprehensive learning outcomes.

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