

THE EFFECT OF THE SELF-REGULATED LEARNING ON STUDENTS' MATHEMATICAL LITERACY: CASE ON LINEAR EQUATION SYSTEM.

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ABSTRACT

This study aims to examine the influence of Self-Regulated Learning (SRL) on students' mathematical literacy skills in the topic of Three-Variable Linear Equation Systems (SPLTV). Mathematical literacy is understood as the ability to formulate, employ, and interpret mathematical concepts in solving contextual problems. The background of this research arises from the low mathematical literacy skills of students at SMK TRIDARMA, as observed through initial observations and the 2024 education report. Many students struggled to identify essential information, apply mathematical procedures correctly, and interpret their solution results logically. Self-regulated learning was implemented to help students take greater responsibility for their learning process through the phases of planning, monitoring, evaluation, and reflection. This study employed a quasi-experimental method with a Pretest-Posttest Control Group Design. The research sample consisted of two eleventh-grade classes: the experimental class, which was taught using the self-regulated learning model, and the control class, which received direct instruction. Data on students' mathematical literacy skills were collected through essay tests that had been validated by experts. The data were analyzed using ANCOVA to determine the effect of the treatment after controlling for students' initial abilities. The results showed a significant difference between the two groups. The obtained F_{count} of 97.02083 exceeded the F_{table} value of 4.105, indicating that self-regulated learning had a positive and significant effect on students' mathematical literacy skills. Students in the experimental class demonstrated greater improvement compared to those in the control class. Thus, it can be concluded that Self-Regulated Learning is effective in enhancing students' mathematical literacy skills on SPLTV material.

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INTRODUCTION

Mathematics is the fundamental knowledge of the universe. This science is essential for uncovering specific laws governing the phenomena around humanity, and it plays a significant

role in the development of production, science, and technology (Do'stov & Xolmirzayev, 2023). As a result, Mathematics is one of the important subjects that students must study in school. This makes it one of the subjects taught in schools with the highest percentage of instructional hours compared to other subjects (Usman et al., 2022). Mathematics learning demands the active participation of students in constructing their knowledge to fully and comprehensively understand mathematical concepts so that they can solve mathematical problems accurately (Napui et al., 2023). Furthermore, the role of mathematics is closely intertwined with the development of science and technology (Taha et al., 2022). Moreover, the process of reasoning and logic are essential elements that students must possess to understand and relate concepts to successfully and correctly solve mathematical problems (Takaendengan et al., 2022). The objective of mathematics learning comprises five competencies: mathematical problem-solving, mathematical communication, mathematical reasoning, mathematical connection, and mathematical representation (I. Safitri, 2021). The ability that encompasses these five competencies is mathematical literacy.

Research conducted by (Nurwahid & Ashar, 2022) states that mathematical literacy is an individual's ability to formulate, use, and interpret mathematical concepts in various real-life contexts. This ability includes reasoning, designing, applying, and effectively interpreting mathematical concepts to solve real-world problems. Mathematical literacy is defined as a person's ability to formulate, apply or use, and interpret mathematics in daily life, involving reasoning and the use of mathematical concepts, procedures, facts, and tools to describe, explain, and relate them to everyday situations (I. Safitri, 2021). According to (Santia, 2018), mathematical literacy is the ability to combine information, draw conclusions, and apply one's knowledge to various situations in daily life. To support mathematical literacy skills, it is necessary to first understand its indicators. (Abidin, 2018) explains in his book that there are three indicators of mathematical literacy: formulating, applying, and understanding mathematics. Meanwhile (N. Safitri, 2023) argues that mathematical literacy is not merely the ability to calculate or use formulas, but includes analytical abilities, reasoning, problem-solving, idea communication, and other essential 21st-century skills. Furthermore, research conducted by (Rambe et al., 2023) states that mathematical literacy is a key 21st-century competence that plays a role in developing mathematical connection skills and the factors that influence mathematical literacy outcomes.

However, mathematical literacy skills in the world, and particularly in Indonesia, are often not given sufficient attention. According to the research conducted by PISA (Programme for International Student Assessment) in 2018 (Development, 2019), the PISA report explains the levels of mathematical literacy achievement across countries, patterns of students' difficulties in contextual problems, and implications for educational policy. The PISA report also shows that Indonesia obtained a score of 379, placing the country 73rd out of 78 participating nations, with the international average score being 489. Furthermore, the study by (Melissa et al., 2025) found that although 71% of teachers are familiar with the concept of mathematical literacy, around 39% of them are still uncertain or do not fully understand it. Many teachers struggle to classify aspects of mathematical literacy, indicating that there are obstacles in teachers' awareness and comprehension of mathematical literacy. Based on observations and interviews conducted at SMK TRIDARMA, it was found that many students still have low mathematical literacy, with a significant number performing poorly in this area. The average literacy achievement score in 2024 was around 50%. This can be seen from the 2024 SMK TRIDARMA report card data as follows:

A.2.1	Kompetensi pada domain Bilangan Nilai rerata peserta didik dalam berpikir menggunakan konsep, prosedur, fakta, dan alat matematika pada konten bilangan untuk menyelesaikan masalah sehari-hari	47,66		Turun 1,19	48,85
A.2.2	Kompetensi pada domain Aljabar Nilai rerata peserta didik dalam berpikir menggunakan konsep, prosedur, fakta, dan alat matematika pada konten aljabar untuk menyelesaikan masalah sehari-hari	56,64		Naik 7,32	49,32
A.2.3	Kompetensi pada domain Geometri Nilai rerata peserta didik dalam berpikir menggunakan konsep, prosedur, fakta, dan alat matematika pada konten geometri untuk menyelesaikan masalah sehari-hari	58,05		Naik 10,15	47,9
A.2.4	Kompetensi pada domain Data dan Ketidakpastian Nilai rerata peserta didik dalam berpikir menggunakan konsep, prosedur, fakta, dan alat matematika pada konten data dan ketidakpastian untuk menyelesaikan masalah sehari-hari	56,93		Naik 9,43	47,5

Figure 1. 2024 Education Report Card Results for SMK TRIDARMA Gorontalo

To address this problem, one possible solution is to implement strategies that can enhance mathematical literacy skills in the learning process. Self-Regulated Learning is one of the alternatives that can help overcome this issue. According to (Rizqa et al., 2023), Self-Regulated Learning is an important internal factor within students that influences the learning process, and it can be defined as the way students demonstrate responsibility in managing and disciplining themselves, as well as developing their learning abilities independently. Furthermore, research conducted by (Gabriel & Buckley, 2020) states that self-regulated learning is a factor that directly contributes to students' mathematical literacy achievement.

METHOD

This research was conducted at SMK TRIDARMA. The data collection process began on Monday, April 21, 2025, and ended on Friday, May 23, 2025, using two classes as research subjects. One class was assigned as the experimental group using the Self-Regulated Learning model, while the other class served as the control group using the direct instruction learning model.

The research design used in this study was the Pretest–Posttest Group Design. In this design, the first group is given a treatment (X), while the other group is not. The group that receives the treatment is referred to as the experimental group, and the group that does not receive the treatment is referred to as the control group. Afterward, both groups are given a final test (Posttest) to determine the final condition of students' mathematical literacy skills between the experimental and control groups. The research design is presented in Table 1.

Table 1. Research Design

Class	Pretest	Treatment	Posttest
Experimental	O_1	X_1	O_2
Control	O_1	X_2	O_2

Explanation:

X_1 = Learning using the Self-Regulated Learning

X_2 = Learning using the Direct Instruction model

O_1 = Pretest for the experimental class and the control class

O_2 = Posttest for the experimental class and the control class

The independent variables in this study are students' responses during learning using the Self-Regulated Learning model and the Direct Instruction model on the topic of *Three-Variable*

Linear Equation Systems (SPLTV). The dependent variable in this research is Mathematical Literacy Ability, while the covariate variable is students' initial ability, which is indicated by their scores prior to the learning process (Pretest). The population of this study consists of all eleventh-grade students at SMK TRIDARMA, totaling 39 students across two classes. The sample was selected using a simple random sampling technique, with the experimental group being the eleventh-grade Nursing class and the control group being the eleventh-grade Pharmacy class. The data collection technique in this study involved an essay-type test instrument consisting of a Pretest and Posttest, which included indicators of mathematical literacy ability. The collected data were then analyzed using ANACOVA.

RESULTS AND DISCUSSION

Results

The data on students' mathematical literacy ability were collected after administering the pretest and posttest, which were in the form of essay tests, to both the experimental and control classes. The data from both groups were analyzed using descriptive analysis and inferential analysis.

Descriptive Analysis

To differentiate the average scores of students' mathematical literacy ability on the pretest and posttest from both groups. The results are presented in the table below.

Table 2. Description of Pretest and Posttest Data

Data	Class	N	Mini Score	Max Score	Mean	Median	Mode	Standard Deviation	Variance
Pre-test	E	20	4	12	6,9	6,6	6,16	2,210025	4,8842
	C	19	4	11	6,368	6,125	5,78	1,9406	3,766
Post-test	E	20	7	14	10,1	9,5	8,7	2,39297	5,726
	C	19	4	11	7,184	8,92	8,5	2,1359	4,5621

Based on the results of the descriptive analysis, the pretest scores of both classes were relatively equivalent. This indicates that the initial mathematical literacy ability of students in the experimental and control classes was at nearly the same level. Meanwhile, the posttest results showed an improvement in mathematical literacy ability in both classes. However, the improvement observed in the experimental class was higher than that of the control class. This demonstrates that the use of self-regulated learning contributed to enhancing students' understanding in solving mathematical literacy problems. The descriptive analysis data will then be further examined using inferential analysis through ANACOVA.

Inferential Analysis

Before testing the research hypothesis with the ANACOVA test, prerequisite tests were first conducted, namely the normality test and the homogeneity test.

Data Normality Test

The result of the data normality calculation, which consists of pretest and posttest data for both the experimental and control classes with a significance level of $\alpha = 5\%$, shows that the L_{count} value for all four data sets is smaller than L_{table} . Consequently, H_0 is accepted, meaning that all four data sets come from a normally distributed population.

Data Homogeneity Test

The result of the variance homogeneity test with a significance level of $\alpha = 5\%$ shows that the F_{count} value for the pretest and posttest data in both the experimental and control classes, which served as samples in this study, have homogeneous variances.

Based on the results of the prerequisite tests that met the testing criteria, where the data obtained are normally distributed and homogeneous, the analysis can be continued with the hypothesis test using ANCOVA.

Analysis of Covariance (ANCOVA) Test

1) Determining the Regression Model

Experimental Class Regression Model: $\hat{Y} = 3,2449 + 0,979X$

Control Class Regression Model: $\hat{Y} = 0,7442 + 1,0071X$

2) Test for the Independence of X on Y / Test for the Significance of the X Coefficient in the Regression Model

- Experimental Class

Briefly, the calculation results of the analysis of variance for the experimental class are presented in Table 3.

Table 3. Analysis of Variance for the Independence Test of the Experimental Class Regression Coefficient

Source of Variation	df	SS	MS	F
Regression	1	86.23608	86.23608	158.9781
Residual	18	9.76392	0.54244	
Total	19	96		

From the calculation results, the $F_{count} = 158,9781$. Meanwhile, the value from the $F_{(0,05;1;18)}$ distribution table, $F_{(0,05;1;18)} = 4,41378$. This can be interpreted as $F^* > F$, leading to the rejection of H_0 . This means that the Self-Regulated Learning has a significant influence on students' mathematical literacy ability.

- Control Class

Briefly, the calculation results of the analysis of variance for the control class are presented in Table 4.

Table 4. Analysis of Variance for the Independence Test of the Control Class Regression Coefficient

Source Of Variation	df	SS	MS	F
Regression	1	67.3718	67.3718	125.1099
Residual	17	9.154517	0.538501	
Total	18	76.52632		

From the calculation results, the $F_{count} = 125,1099$. Meanwhile, the value from the distribution table, $F_{(0,05;1;17)} = 4,41378$. This can be interpreted as $F^* > F$, leading to the rejection of H_0 . This means that the direct instruction model has a significant influence on students' mathematical literacy ability.

3) Test for the Linearity of the Regression Model

- Experimental Class

The results of the linearity test of the experimental class regression model are presented in Table 5.

Table 5. Linearity Test of the Experimental Class Regression Model

Source Of Variation	SS	Df	MS	F*
Error	11,8335	18		2,47
Lack Of Fit	6,0001	6	1,2000	
Pure Error	5,8334	12	0,4861	

From the calculation results, the value of $F^* = 2,47$, and the value from the distribution table, $F_{(0,05;6;12)} = 3,106$. This can be interpreted as $F^* < F$, leading to the acceptance of H_0 . This means that the pretest results (before using Self-Regulated Learning) in the experimental class have a linear relationship with the posttest results (after using Self-Regulated Learning).

- Control Class

The results of the linearity test of the control class regression model are presented in Table 6.

Table 6. Linearity Test of the Control Class Regression Model

Source of Variation	SS	Df	MS	F*
Error	7,9168	17		0,2023
Lack Of Fit	0,5001333	5	0,12503	
Pure Error	7,44167	12	0,61086	

From the calculation results, the $F^* = 2,47$, and the value from the distribution table, $F_{(0,05;6;12)} = 3,106$. This can be interpreted as $F^* < F$, leading to the acceptance of H_0 . This means that the pretest results (before using Direct Instruction) in the control class have a linear relationship with the posttest results (after using Direct Instruction).

4) Test for the Equality of Two Regression Models

Based on the calculation results, the value of $F^* = 45,073895964008$ and $F_{table} = 3,26$, with a significance level of $\alpha = 5\%$. The comparison obtained is $F^* = 45,073895964008 > F_{table} = 3,26$, which in this case means that H_0 is rejected. This demonstrates that the regression models for the experimental class and the control class are not the same or are significantly different.

5) Test for the Parallelism of Two Regression Models

The calculation results of the test for the parallelism of two regression models are briefly presented in Table 7.

Table 7. Linearity Test of Two Regression Models

Grup	Sum Of Squares		Sum Of Product	Adjusted Sum Of Squares for x
	X	Y	XY	
Experiment	89,8	96	86	13,63919821826
Control	66,44	76,5275	66,89	9,184452137266
Total	156,24	172,5275	152,89	22,82365035552

From the calculation results, $F^* = 0,1411 < F_{table} = 4,12$. Consequently, H_0 is accepted, meaning that the two regression models are parallel. Therefore, it can be stated that there is a difference in the mathematical literacy ability of the experimental class students and the control class students.

Based on the calculation results of the Analysis of Covariance (ANCOVA), the value of $F^* = 97,02083$ and $F_{table} = F_{(0,05;1;37)} = 4,105$. Upon comparison, $F^* = 97,02083 > F_{table} = F_{(0,05;1;37)} = 4,105$, leading to the rejection of H_0 . This means that the mathematical literacy ability of students taught with the Self-Regulated Learning is better than the mathematical literacy ability of students taught with the direct instruction model.

Discussions

Based on the results of the normality and homogeneity tests, the data were found to be normally distributed and to have homogeneous population variances. Subsequently, the ANCOVA test steps were performed. The result of the inferential analysis of the simple regression model for the experimental class (taught using the Self-Regulated Learning model) stated the relationship between initial ability (pretest) and mathematical literacy ability (posttest) as $\hat{Y} = 3,2449 + 0,979X$. For the control class (taught using the direct instruction model), the simple regression model stated the relationship between initial ability (pretest) and mathematical literacy ability (posttest) as $\hat{Y} = 0,744057 + 1,0071X$. From this analysis, the difference between the experimental class (taught with the Self-Regulated Learning model) and the control class (taught with the direct instruction model) can be observed. The experimental class has a larger regression model constant compared to the regression model constant in the control class.

Observing the regression models present in both the experimental class and the control class, it can be concluded that there is an influence on the mathematical literacy ability of Class XI students at TRIDARMA Vocational High School (SMK TRIDARMA) who were taught using the Self-Regulated Learning model compared to those taught using the direct instruction model.

This finding is due to the different treatments applied in the two classes. During the teaching and learning process, the class taught using the Self-Regulated Learning (SRL) model appeared more motivated and focused because the learning process centered on each individual student in identifying the strengths and weaknesses of their understanding during the learning session, with the assistance of the teacher guiding students who seemed to be struggling. A different situation occurred in the class taught with the direct instruction model, where students appeared less conducive to learning, were less courageous or still shy to express opinions, and also failed to complete the assigned tasks properly and on time.

This is substantiated by previous research conducted by (Latipah, 2010), which showed that the Self-Regulated Learning (SRL) model significantly influences the increase in students' academic achievement, where students who are able to regulate their own learning process have higher learning outcomes compared to those who do not. Furthermore, research conducted by (Rahmawati & Muchtarom, 2023) demonstrated that the application of SRL in online learning helps students manage study time effectively and enhances their metacognitive skills. Meanwhile, the results of a study by (Ulya et al., 2022) revealed that the implementation of the SRL model is capable of improving students' mathematics learning outcomes through the strengthening of planning, monitoring, and self-evaluation components in the learning process. (Kusumawati, 2024) found that students who are able to manage their own learning process (Self-Regulated Learning) feel more motivated and better prepared to face academic challenges. The study conducted by (Nurvicalesi & Ratnasari, 2023) states that self-regulated learning has a positive impact on an individual's learning outcomes; the higher the level of self-regulated learning, the better the learning results. Thus, the Self-Regulated Learning model has been proven effective in improving learning outcomes, motivation, and student autonomy across various learning contexts.

CONCLUSION

Based on the results of the research conducted at TRIDARMA Vocational High School (SMK TRIDARMA) regarding students' mathematical literacy ability on the topic of the Three-Variable Linear Equation System (SPLTV), it can be concluded that the mathematical literacy ability of students taught using the Self-Regulated Learning (SRL) model is significantly higher compared to the mathematical literacy ability of students taught using the direct instruction model. This is evidenced by the results of the Analysis of Covariance (ANCOVA), where $F^* = 97,02083 > F_{tabel} = 4,105$, which leads to the rejection of H_0 .

It is recommended for teachers to use the Self-Regulated Learning (SRL) model to enhance students' mathematical literacy ability. For future researchers, it is suggested that a different material approach be used.

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