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The Effect of Self-Regulated Learning (SRL) on Students' Critical Thinking Skills in Solving Fraction Problems in Grade IV Elementary School

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ABSTRACT

This study aims to determine the differences in elementary students' critical thinking skills based on Self-Regulated Learning (SLR) levels. This quantitative ex post facto study involved 40 elementary students, using questionnaires for SRL and tests for critical thinking. Data analysis included Shapiro-Wilk, Levene's, One-Way ANOVA, and Bonferroni tests. Most students had medium SRL (17), followed by high (13) and low (10), with significant differences (Sig.=0.001<0.05). Bonferroni tests revealed significant differences between high and medium SRL and between high and low SRL groups, but not between medium and low groups. The largest differences occurred in analysis and inference, highlighting SRL's importance in strengthening elementary students' critical thinking through mathematics learning.

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1. Introduction

Education is a process aimed at developing students' potential so they have the ability to think, behave, and act optimally in facing life's various challenges. In 21st-century learning, students are required not only to master knowledge but also to possess higher-order thinking skills (HOTS), one of which is critical thinking (Gunartha, 2024). Critical thinking skills are important for students because they can help them analyze information, evaluate various alternative solutions to problems, and make logical and rational decisions. However, according to the 2022 Program for International Student Assessment (PISA), Indonesian students' mathematical literacy remains relatively low, indicating that

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higher-order thinking skills, including critical thinking, still need improvement (Kemendikbudristek, 2023).

Mathematics is a subject that plays a crucial role in developing students' critical thinking skills. Through mathematics learning, students are trained to understand concepts, analyze problems, connect various pieces of information, and determine solutions based on logical reasoning (Konita et al., 2019). Fractions are a frequently challenging mathematics topic for elementary school students. This topic requires not only numeracy skills but also a deep conceptual understanding to enable students to solve various types of problems involving fractions. In solving fraction problems, students are required to identify known and required information, determine appropriate solution strategies, justify their answers, and draw logical conclusions (Faizah *et al*., 2017). These abilities are part of critical thinking skills that need to be developed in mathematics learning.

However, in reality, many students still experience difficulty solving fraction problems. This difficulty is evident in their poor ability to understand the information contained in the problem, determine the correct steps for solving it, explain the reasons for their chosen answer, and evaluate the accuracy of their results. This situation indicates that students' critical thinking skills in solving fraction problems still need to be improved.

Indications of these problems are also evident from observations of IV grade students' math scores in Nguter District, which indicate that student learning outcomes are still suboptimal. Although math scores do not directly reflect students' critical thinking skills, these results suggest that there are still obstacles in mastering mathematical concepts, reasoning, and problem-solving. This condition indicates that various factors can influence students' ability to solve mathematical problems, including critical thinking skills and factors that support their development.

One internal factor thought to influence students' critical thinking skills is Self-Regulated Learning (SRL). Self-Regulated Learning is a student's ability to manage their learning process independently through planning, monitoring, controlling, and evaluating learning activities to achieve predetermined learning objectives (Mahrufah & Rijanto, 2024). Students who have good Self-Regulated Learning not only act as recipients of information, but are also active in determining learning targets, choosing appropriate strategies, managing learning time, and reflecting on the learning outcomes obtained (Kirana, 2022). This ability enables students to be more responsible for their learning process and outcomes.

In mathematics learning, Self-Regulated Learning has an important role because the process of solving mathematical problems requires logical, analytical and systematic thinking skills (Bangun et al, 2026). When faced with a math problem, students need to understand the problem, determine an appropriate solution strategy, monitor each step taken, and re-evaluate the results. These activities align with the characteristics of students with strong self-regulated learning. Therefore, students who are able to manage their learning process independently are thought to have better abilities in analyzing problems, evaluating information, and drawing logical conclusions, which are indicators of critical thinking skills.

Several previous studies also show that Self-Regulated Learning has a positive relationship with students' critical thinking abilities. The research Rahmawati and Alaydrus (2021) explains that there is a significant difference in

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critical thinking abilities between students who have high Self-Regulated Learning and students who have low Self-Regulated Learning. The higher Self-Regulated Learning you have, the higher your critical thinking ability. In line with this research, Roslinda et al. (2022) stated that students with high and medium Self-Regulated Learning categories have better critical thinking skills than students with low Self-Regulated Learning categories. The research Sholiha et al. (2022) explains that students who have Self-Regulated Learning tend to have self-confidence, perseverance, and the ability to control and evaluate the learning process so that they are able to achieve more optimal learning outcomes.

Although various studies have examined the relationship between Self-Regulated Learning and critical thinking skills, most of the research was conducted at the secondary and tertiary education levels. Research examining the influence of Self-Regulated Learning on critical thinking skills in elementary school students is still relatively limited. Apart from that, there has not been much research that specifically examines critical thinking skills in solving mathematical problems on fractions in fourth grade elementary school students. Some previous research has mainly studied the relationship between Self-Regulated Learning and mathematics learning outcomes in general, while research that places critical thinking skills as the dependent variable in the context of solving fraction problems is still limited. Therefore, research is needed that specifically examines the influence of Self-Regulated Learning on students' critical thinking abilities in solving fraction problems in grade IV elementary school.

Based on the description, this study aims to determine and analyze the effect of Self-Regulated Learning (SRL) on students' critical thinking skills in solving fraction problems in IV grade elementary school. Through this study, it is hoped to obtain an overview of the importance of Self-Regulated Learning in supporting students' critical thinking skills in mathematics learning, especially fraction material in IV grade elementary school.

2. Method

This research is a quantitative study using the ex post facto method. Ex post facto research is used to examine the influence of one variable on another based on data that has already occurred without any manipulation or treatment by the researcher (Wahdah & Malasari, 2022). In this study, the independent variable is Self-Regulated Learning (SRL), while the dependent variable is students' critical thinking skills in solving fraction problems.

The sample in this study was taken using purposive sampling. Therefore, the sample was selected because all students in the group had similar learning conditions, allowing the analysis to focus on the effect of Self-Regulated Learning on critical thinking skills. The sample for this study consisted of 40 fourth-grade elementary school students from three elementary schools, as follows.

Table 1. Research Sample

No.	Elementary Schools	Numbers of Students
1.	SD1	13
2.	SD3	14
3.	SD6	13
	Total	**40**

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The research instruments used consisted of a Self-Regulated Learning (SRL) questionnaire and a critical thinking ability test on fractions. The critical thinking ability test was structured based on four indicators of critical thinking ability: interpretation, analysis, evaluation, and inference. Before being used in the research, the instruments first underwent a content validity test using the Aiken's V index, an empirical validity test using the Pearson Product Moment correlation, and a reliability test. Based on these test results, the Self-Regulated Learning (SRL) questionnaire and the critical thinking ability test were declared valid and reliable, making them suitable for use as research instruments.

Furthermore, the research data were analyzed using one-way analysis of variance (ANOVA) at a significance level of 5% to test differences in students' critical thinking abilities based on the Self-Regulated Learning (SRL) category and to determine the effect of SRL on students' critical thinking abilities in solving fraction problems. Before the analysis was carried out, the SRL questionnaire scores were grouped into high, medium, and low categories. Furthermore, prerequisite tests were carried out which included normality tests and homogeneity of variance tests to ensure that the data met the assumptions of the analysis of variance. This data analysis used SPSS Statistics 25.

3. Results and Discussion

3.1. Results

3.1.1. SRL Questionnaire Data Analysis

Based on Table 2, the average score for students' Self-Regulated Learning (SRL) was 40.73 with a standard deviation of 13.32. Of the 40 students who were the subjects of the study, 13 students were included in the high SRL category, 17 students in the medium SRL category, and 10 students in the low SRL category. The grouping results indicate that the majority of students were in the medium SRL category. This classification was then used to analyze differences in critical thinking skills based on students' SRL levels.

Table 2. Example Table and Description

Student	Average Score	Standard Deviation	Category		
			High	Medium	Low
40	40.73	13.32	13	17	10

Calculations of Table 2,

Standard Deviation = $\sqrt{\frac{\sum(X-\bar{X})^2}{n-1}} = \sqrt{\frac{6918,096}{40-1}} = \sqrt{\frac{6918,096}{39}} = \sqrt{177,3871} = 13,32$

High = $X \geq \bar{x} + 1.\ SD$
= $X \geq 40,73 + 1(13,32)$
= $X \geq 54,04 = X \geq 54$

Medium = $\bar{x} - 1.\ SD \leq X < \bar{x} + 1.\ SD$
= $40,73 - 1(13,32) \leq 40,73 + 1(13,32)$
= $27,41 \leq X < 54,04 = 27 \leq X < 54$

Low = $X < \bar{x} - 1.\ SD$
= $X < 40,73 - 1(13,32)$
= $X < 27,41 = X < 27$

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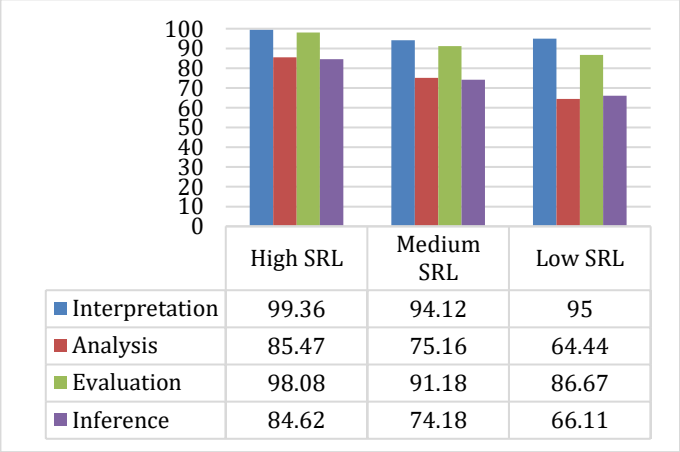
3.1.2. *Analysis of Critical Thinking Skills Based on Indicators*

Based on Figure 1, the interpretation and evaluation indicators achieved relatively high achievement percentages across all SRL categories. Meanwhile, the analysis and inference indicators showed greater differences across SRL categories. Students with high SRL achieved the highest achievement across all indicators, while students with low SRL achieved the lowest achievement, particularly in the analysis and inference indicators.



	High SRL	Medium SRL	Low SRL
Interpretation	99.36	94.12	95
Analysis	85.47	75.16	64.44
Evaluation	98.08	91.18	86.67
Inference	84.62	74.18	66.11

Figure 1. Bar Chart of Critical Thinking Indicators Based on SRL Categories

3.1.3. *Nolmality Test*

Based on Table 3, the results of the normality test using Shapiro-Wilk show that the high SRL group obtained a significance value of 0.115, the medium SRL group 0.532, and the low SRL group 0.360. All significance values are greater than the 0.05 level of significance. Thus, it can be concluded that the critical thinking ability data in the high, medium, and low SRL groups are normally distributed. Therefore, the data meets one of the prerequisites for conducting a One-Way ANOVA analysis of variance.

Table 3. Summary of High, Medium, and Low SRL Normality Test Results

	SRL	Shapiro-Wilk		
		Statistic	Df	Sig.
Results	High	0.895	13	0.115
	Medium	0.955	17	0.532
	Low	0.920	10	0.360

3.1.4. *Homogeneity Test*

Based on Table 4, the homogeneity test using Levene's Test yielded a significance value of 0.849. This value is greater than 0.05, so H_0 is accepted. This indicates that the variance of critical thinking skills in the high, medium, and low SRL groups is homogeneous or has the same variance. Normality and homogeneity assumptions were met, allowing One-Way ANOVA analysis.

Table 4. Results of High, Currently, and Low SRL Normality Test

	Test of Homogeneity of Variance			
	Levene Statistic	df1	df2	Sig.
Result Based on Mean	0.164	2	37	0.849

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3.1.5. *One-Way Analysis of Variance Test*

Based on Table 5, the F value is 8.432 with a significance value of 0.001. Because the significance value is less than 0.05 (0.001 < 0.05), H_0 is rejected. These results indicate that there is a significant difference in critical thinking skills based on students' levels of Self-Regulated Learning. In other words, students' critical thinking skills differ in the high, medium, and low SRL groups.

Table 5. Results of One-Way Analysis of Variance Test

	Results				
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1308.479	2	654.240	8.432	0.001
Within Groups	2870.744	37	77.588		
Total	4179.224	39			

3.1.6. *ANOVA Follow-up Test (Post Hoc Bonferroni)*

Based on Table 6, the results of the Bonferroni further test show that:

1) The high SRL and currently SRL groups had a significant difference with a significance value of 0.042 (<0.05).
2) The high SRL and low SRL groups had a significant difference with a significance value of 0.001 (<0.05).
3) The currently SRL and low SRL groups did not have a significant difference with a significance value of 0.197 (>0.05).

These results indicate that differences in critical thinking skills primarily occur between students with high SRL and those with moderate or low SRL. Meanwhile, the critical thinking skills of students with moderate SRL are relatively insignificant compared to those with low SRL.

Table 6. Results of ANOVA Further Test

Multiple Comparisons **Dependent Variable: Results of Bonferroni**						
(I) SRL	**(J) SRL**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
High	Medium	8.3643*	3.2453	0.042	.226	16.503
	Low	15.0231*	3.7050	0.001	5.732	24.314
Medium	High	-8.3643*	3.2453	0,042	-16.503	-.226
	Low	6.6588	3.5104	0.197	-2.144	15.462
Low	High	-15.0231*	3.7050	0.001	-24.314	-5.732
	Medium	-6.6588	3.5104	0.197	-15.462	2.144

3.2. Discussion

The results of the study showed that the majority of students fell into the moderate category of Self-Regulated Learning (SRL). This finding indicates that students' ability to regulate their learning process has developed, but has not yet reached an optimal level. The dominance of the moderate SRL category may be influenced by the developmental characteristics of elementary school students. At elementary school age, metacognitive abilities and self-control are still developing, so students still need guidance from teachers and parents to regulate their learning process (Akbar, 2026). In addition, mathematics learning in elementary schools is still often dominated by giving examples, practice

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questions, and direct direction from the teacher (Firmansyah et al., 2025). This situation causes students to be more accustomed to following predetermined steps rather than developing independent learning strategies. Other contributing factors include the family environment, home study habits, and the opportunities students have to make decisions about their learning process (Suhartono, 2024). As a result, most students have demonstrated some level of self-regulation skills, but have not yet reached the high category.

The results of the analysis of variance indicate that there are differences in critical thinking skills based on students' SRL levels ($0.001 < 0.05$). This finding indicates that the ability to manage the learning process is related to students' ability to solve mathematical problems critically. In mathematics learning, students are not only required to obtain correct answers, but also to understand the problem, choose the appropriate solution strategy, provide reasons for the steps used, and draw logical conclusions (Normaya, 2015). This process requires good self-regulation skills so that students are able to control and evaluate their thinking processes while solving problems.

The results of the Bonferroni test further showed that there were significant differences in critical thinking skills between students with high and moderate SRL, as well as between students with high and low SRL. Conversely, there were no significant differences between students with moderate and low SRL. These findings indicate that improvements in critical thinking skills do not occur gradually in each SRL category, but are only truly visible when students have high self-regulation skills. Students in the moderate SRL category generally have the motivation and awareness to learn, but have not consistently monitored, evaluated, and reflected on their learning process. As a result, they still experience difficulties when faced with tasks that require high-level reasoning. In contrast, students with high SRL tend to be more active in identifying errors, correcting ineffective strategies, seeking additional information when experiencing difficulties, and evaluating the results obtained. These habits help students develop more systematic and in-depth thinking processes, thus improving their critical thinking skills. This finding is in line with the research results of Jannah (2026) which states that students with good self-regulation skills tend to be better able to set learning goals, manage time, monitor the learning process, and conduct independent self-evaluations. These skills contribute to increased student persistence, activeness, and enthusiasm in participating in the learning process.

The relationship between SRL and critical thinking skills is increasingly evident in the analysis of each critical thinking indicator. In the interpretation indicator, all SRL categories achieved high percentages. These results indicate that the majority of students were able to understand the information contained in the questions and identify relevant facts. Interpretation is a fundamental critical thinking skill that is more closely related to the activity of understanding information, making it relatively easier for elementary school students to master.

A clearer difference was seen in the analysis and inference indicators. The high SRL group achieved 85.47% in analysis and 84.62% in inference, while the low SRL group only achieved 64.44% in analysis and 66.11% in inference. These results indicate that the ability to analyze relationships between information and draw conclusions is the aspect of critical thinking most influenced by students' SRL levels. In the context of mathematics learning, analysis and inference

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indicators require higher-order thinking skills because students must connect various pieces of information, recognize patterns of relationships between concepts, choose appropriate solution strategies, and draw conclusions based on the evidence obtained. This process requires self-monitoring and self-evaluation skills, which are key characteristics of SRL. Therefore, students with high SRL tend to be more successful in both indicators than students with medium or low SRL.

In the evaluation indicators, all groups also demonstrated relatively high achievement. However, students with high SRL still achieved the highest percentage compared to other groups. These results indicate that the ability to evaluate the accuracy of procedures and solutions in solving problems is more developed in students who are accustomed to reflecting on their learning process. Through self-monitoring and self-evaluation activities, students can review the steps they have taken and identify potential errors before determining the final answer.

The findings of this study provide important implications for mathematics learning in elementary schools. Developing critical thinking skills is not only achieved through providing questions that require high-level reasoning, but also requires efforts to improve students' self-regulation skills. Teachers need to provide opportunities for students to set learning goals, plan problem-solving strategies, monitor learning progress, and reflect on the results obtained. Furthermore, the use of problem-based learning, cooperative learning, and reflective activities can be alternatives for developing both SRL and students' critical thinking skills. Thus, mathematics learning is not only oriented towards mastery of concepts and accurate answers, but also towards developing higher-order thinking skills and learning independence that students need to face various problems in the future.

4. Conclusions

The results of the study showed that most students were in the moderate Self-Regulated Learning (SRL) category, indicating that students' ability to regulate their learning process independently had developed but was not yet optimal. The results of the One-Way ANOVA test showed that there were significant differences in critical thinking skills based on students' SRL levels, while the Bonferroni further test showed that these differences occurred between the high SRL group and the medium and low SRL groups. Analysis of critical thinking indicators showed that the most prominent differences were found in the analysis and inference indicators, while the interpretation and evaluation indicators were relatively high across all SRL categories. These findings indicate that the ability to plan, monitor, and evaluate the learning process contributes to students' ability to analyze information and draw logical conclusions. Therefore, developing critical thinking skills in mathematics learning needs to be done not only through providing tasks that require high-level reasoning, but also through systematic efforts to improve students' Self-Regulated Learning through learning that encourages independence, reflection, and active involvement in the problem-solving process.

Author Contributions

The author carried out activities related to data collection, data analysis,

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deduction, and reporting of research results.

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Declaration of Competing Interest
This study belongs to the author. There is no conflict of interest for this study.

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