

The Effect of Self-Regulated Learning on Continuous Upright Writing Skills Elementary School Students

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Abstract

This study aims to analyze the effect of self-regulated learning on cursive handwriting skills of fourth-grade elementary students in Wonogiri Regency. The research employed an ex post facto method with a correlational design. The sample consisted of 78 students from five schools selected through purposive sampling. Instruments included a self-regulated learning questionnaire adapted from Zimmerman's model and a handwriting test assessed based on readability, letter formation accuracy, and fluency. Data were analyzed using product moment correlation and simple linear regression. The results indicate a significant positive correlation between self-regulated learning and handwriting skills ($r = 0.687$; $p < 0.01$). Self-regulated learning contributed 47.2% to the variance in handwriting skills. Students with higher levels of self-regulated learning demonstrated better handwriting performance. These findings highlight the importance of strengthening self-regulated learning as a strategy to improve elementary students' cursive writing skills.

Keywords: *self-regulated learning, continuous upright writing skills, elementary school students, ex post facto, correlational*

Abstrak

Penelitian ini bertujuan menganalisis pengaruh self-regulated learning terhadap keterampilan menulis tegak bersambung siswa kelas IV SD di Kabupaten Wonogiri. Metode yang digunakan adalah ex post facto dengan desain korelasional. Sampel penelitian berjumlah 78 siswa dari lima sekolah yang dipilih secara purposive. Instrumen meliputi kuesioner self-regulated learning berbasis model Zimmerman dan tes menulis yang dinilai dari keterbacaan, ketepatan bentuk huruf, dan kelancaran. Analisis menggunakan korelasi product moment dan regresi linier sederhana. Hasil menunjukkan adanya korelasi positif signifikan antara self-regulated learning dan keterampilan menulis ($r = 0,687$; $p < 0,01$). Self-regulated learning memberikan kontribusi sebesar 47,2% terhadap variasi keterampilan menulis. Siswa dengan tingkat self-regulated learning tinggi memiliki kemampuan menulis lebih baik. Temuan ini menegaskan pentingnya penguatan self-regulated learning untuk meningkatkan keterampilan menulis siswa sekolah dasar.

Kata kunci: *self-regulated learning, keterampilan menulis tegak bersambung, siswa sekolah dasar, ex post facto, korelasional*



INTRODUCTION

The elementary school curriculum establishes writing skills as a fundamental competency so that grade IV students need to master upright writing in a neat and readable manner. This skill is the foundation of literacy because it requires fine motor coordination and complex cognitive processes. Ose Askvik et al. (2020) proved that continuous upright writing activity activates theta oscillations in the parietal area that supports long-term memory learning and retention. Cumming et al. (2023) explain the Zimmerman model which has interrelated forethought, performance, and self-reflection phases. Upright writing skills continue to develop gradually according to the findings of Gosse et al. (2021) who examined the development of writing in elementary school students for three years. Chang and Yu (2022) found five consecutive upright writing evaluation dimensions that include readability, font size, connection neatness, speed, and pencil pressure.

Researchers' observations in five elementary schools in Wonogiri Regency showed a considerable variation in the quality of writing even though the learning duration was the same. Students showed differences in readability and consistency in letter shape while teachers reported that about 40% of students still had difficulty meeting neatness standards. This phenomenon is in line with Sparaci et al. (2025) who found high variability in students' grapho-motor performance. López-Escribano et al. (2022) confirmed that the fluency of handwriting is influenced by instructional factors, repetitive practice, and self-regulation skills, so variations in writing ability need to be understood through individual factors.

Academic debates about the determinants of writing skills show differences in theoretical approaches so that a thorough study is needed. The behavioristic perspective emphasizes repetitive practice as the basis for motor mastery while the cognitive perspective emphasizes the role of working memory and attention control (Ruffini et al., 2024). The sociocognitive perspective through Zimmerman's self-regulated learning theory links personal, behavioral, and environmental factors in the development of academic skills. Cordeiro et al. (2022) found a significant contribution of executive function to the quality of writing and noted that students with high self-regulation were able to allocate cognitive resources effectively. Teng et al. (2022) found that metacognitive strategies explain 87% of variance in writing performance so that self-regulated learning needs to be positioned as an important determinant.

The international literature shows a research gap so further studies are needed. Research on self-regulated learning and writing skills is mostly conducted on middle school students and college students (Teng & Zhang, 2020; Zhang & Zhang, 2025) while Heirweg et al. (2020) emphasized the lack of research at the elementary school level including grade IV. Writing research tends to examine narrative composition rather than handwriting technical skills (De Smedt et al., 2020). The research is also dominated by Western countries such as the Netherlands, Belgium, Norway, and the United States (Cumming et al., 2023; Skar et al., 2023) so that the Indonesian context is not widely represented. The study of Skar et al. (2023), Camping and Graham (2022), and Salas et al. (2021) demonstrated the effectiveness of self-regulation strategies but did not test the natural relationship of self-regulated learning with continuous upright writing skills. The findings of Teng and Zhang (2020) also do not cover handwriting skills so their relevance in the primary school context is still limited.

Research on self-regulated learning and writing ability shows preliminary findings that reinforce the urgency of this study. Chen et al. (2022) found that the profile of self-regulated learning is directly related to writing achievement. Torrington et al. (2023) found that grade IV students used planning, monitoring, and evaluation strategies even though they had not been associated with technical writing skills. Olid-Luque and Fernández-Martín (2025) found that self-regulated learning programs have a positive impact on academic achievement despite few studies examining handwriting skills.

Eberhart et al. (2024) noted the effect of metacognition interventions on elementary school-age children but only a small number of studies examined writing outcomes.

This research has scientific urgency because the variation in continuous upright writing ability of Wonogiri students requires an empirical explanation based on individual factors. Understanding the factors that affect writing skills can help teachers design more appropriate learning strategies. Xu et al. (2023) found that self-regulated learning interventions produced an effect size $d=0.45$ while Skar et al. (2022) found a correlation of 0.53 between fluency in writing and composition quality, so a study of technical writing skills needs to be done in more depth.

This research offers a new contribution because it is the first study to examine the relationship between self-regulated learning and continuous upright writing skills of grade IV elementary school students in Indonesia. This study aims to describe the level of self-regulated learning of grade IV elementary school students in Wonogiri Regency, describe the continuous upright writing skills of grade IV elementary school students, analyze the relationship between the two, and test the contribution of self-regulated learning to the variation of students' writing skills. This research has theoretical significance because it can expand the understanding of the relevance of self-regulated learning theory in the grapho-motor domain and has practical significance because it can be the basis for the development of learning strategies that support the improvement of students' continuous upright writing skills.

METHOD

This study uses a quantitative approach so that the analysis of the relationship between components can be carried out objectively. According to Creswell and Creswell (2018), a quantitative approach is appropriate for examining relationships between measurable variables through statistical analysis. This study applied a correlational *ex post facto* design used to examine the relationship between self-regulated learning and continuous upright writing skills without providing treatment. The correlational design was chosen because this study focuses on measuring the two variables as they are and then testing the direction and strength of the relationship between them based on empirical data.

The research population is all grade IV elementary school students in Wonogiri Regency for the 2024/2025 school year so that the characteristics of the respondents are according to the needs of the research. The research sample was selected purposively based on considerations of school accessibility and the willingness of the school to participate. The sample consisted of five elementary schools with a total of 78 grade IV students.

The research instrument consisted of a self-regulated learning questionnaire and a continuous upright writing skill test so that both variables could be measured comprehensively. The self-regulated learning questionnaire was adapted from the Motivated Strategies for Learning Questionnaire developed by Pintrich et al. (1991) and adapted to the characteristics of elementary school students. The questionnaire consists of 30 items that measure three dimensions, namely cognitive strategies, metacognitive strategies, and resource management. Each item uses a four-point Likert scale from 1 (never) to 4 (always). The questionnaire has been validated by three education experts who assess the suitability of the content and the clarity of the construction. The reliability test was carried out using Cronbach's Alpha and produced a coefficient of 0.876 so that the instrument was declared reliable.

The continuous upright writing skills test was developed based on the handwriting evaluation criteria from Chang and Yu (2022). Students are asked to copy 80-word descriptive paragraphs in a duration of 10 minutes. The assessment was carried out based on five indicators, namely the readability of the letters, the shape of the letters, the size of the letters, the neatness of the connections, and the smoothness of the

strokes. Each indicator is scored 1 to 5 so that the total score ranges from 5 to 25. The assessment process is carried out by three independent raters who are grade IV teachers with a minimum of five years of experience. The consistency between raters was tested using the Intraclass Correlation Coefficient and yielded an ICC = 0.892 which indicates a very high assessment consistency.

The data collection procedure was carried out from October to November 2024 so that all stages of research took place systematically. The researcher takes care of research permits to the Wonogiri Regency Education Office and the school where the research is located. Data collection was carried out in two main sessions. The first session was in the form of filling out a self-regulated learning questionnaire which lasted for 30 minutes in the classroom of each school. The researcher ensures that all students understand how to fill out the questionnaire. The second session was in the form of a continuous upright writing test which was carried out one week after the first session. The implementation of the test was uniformly conditioned in all schools, namely using HVS A4 striped paper, 2B pencils, and ergonomic sitting positions to maintain assessment standards.

The data analysis technique uses descriptive statistics and inferential statistics so that the results of the study can describe the profile of the variables as well as test the relationship between components. Descriptive statistics are used to calculate the mean, median, mode, standard deviation, minimum value, and maximum value of both variables. Inferential statistics are used to test research hypotheses. The prerequisite test consists of a normality test using Kolmogorov–Smirnov and a linearity test using a Test for Linearity. The Pearson product-moment correlation test was used to identify the direction and strength of the relationship between self-regulated learning and continuous upright writing skills. A simple linear regression analysis was used to test the contribution of self-regulated learning to the variation in continuous upright writing skills. The entire analysis process was carried out using SPSS version 26 with a significance level of $\alpha = 0.05$.

The instruments used have gone through a validation process and reliability testing so that the data obtained has analytical feasibility. Expert validation on questionnaires and ICC calculations on writing test instruments strengthened the accuracy of measurements of both variables. The high consistency of the rater, the construction of appropriate items, and the selection of relevant respondents ensured that the overall data reflected the empirical conditions of grade IV students in Wonogiri Regency.

RESEARCH RESULTS

Description of Self-Regulated Learning Data

This study measures the self-regulated learning ability of grade IV elementary school students in Wonogiri Regency. The measurement results show a variation in the varying level of ability between students. The researchers found that the average score of self-regulated learning was 76.32 which was in the medium category. These findings indicate that the majority of students have developed self-regulation strategies but are not optimal.

Table 1 presents descriptive statistics of students' self-regulated learning. The table displays the mean grades, standard deviations, minimum scores, maximum scores, and the number of students who were the subjects of the study. This statistical data provides an overview of the distribution of students' self-regulated learning abilities.

Table 1. Descriptive Statistics of Self-Regulated Learning for Grade 4 Elementary Students

Statistics	Value
Mean	76,32
Standard Deviation	12,45
Minimum Score	48
Maximum Score	108
Number of Students	78

The data in Table 1 shows that the mean score of self-regulated learning of students is 76.32. This score falls into the medium category in the classification of self-regulated learning abilities. The standard deviation of 12.45 indicates that the variation in students' abilities is quite large. The minimum score range of 48 to a maximum of 108 shows a wide difference in ability between students. A total of 78 4th grade elementary school students participated as subjects of this study.

Table 2 shows the distribution of students by category of self-regulated learning levels. The researcher classified students into three categories, namely low, medium, and high. This table shows the number and percentage of students in each category of self-regulated learning ability.

Table 2. Distribution of Students by Self-Regulated Learning Category

Category	Score Range	Number of Students	Percentage
Low	< 64	14	17,9%
Keep	64-88	48	61,5%
Tall	> 88	16	20,5%

The data in Table 2 shows that most students are in the medium category. A total of 48 students or 61.5% had a moderate level of self-regulated learning. The low category included 14 students or 17.9% of the total research subjects. Students in the high category amounted to 16 people or 20.5%. This distribution shows that the majority of students have developed self-regulation skills but have not reached the optimal level. Students in the medium category still need guidance to improve their ability to plan, monitor, and evaluate their learning process.

The analysis per dimension shows the difference in scores between the components of self-regulated learning. The resource management dimension obtained the highest score which showed that students were more skilled in managing time and effort compared to implementing cognitive and metacognitive strategies. Table 3 presents the mean score of each dimension of self-regulated learning along with its standard deviation. This table contains three main dimensions, namely cognitive strategies, metacognitive strategies, and resource management. Comparison of scores between dimensions provides information about the aspects of self-regulated learning that students are most proficient in.

Table 3. Mean Score of the Self-Regulated Learning Dimension

Dimension	Mean	Standard Deviation
Cognitive Strategies	25,14	4,23
Metacognitive Strategies	24,87	4,56
Resource Management	26,31	4,12

The data in Table 3 shows that the resource management dimension has the highest mean score of 26.31. This score indicates that students are relatively better at managing time, effort, and seeking help when studying. The cognitive strategies

dimension obtained a mean score of 25.14 which shows the ability of students to use elaboration, organization, and rehearsal strategies. The metacognitive strategies dimension received the lowest mean score of 24.87. This score indicates that students' ability to plan, monitor, and evaluate the learning process still needs to be improved. The standard deviation of the three dimensions ranges from 4.12 to 4.56 which shows that the variation in students' abilities in each dimension is quite consistent.

Description of Continuous Upright Writing Skills Data

The researcher analyzed the continuous upright writing skills of 4th grade elementary school students in Wonogiri Regency. The results of the analysis showed significant variations in the quality of writing between students. The average score of continuous upright writing skills reached 16.45 out of a maximum score of 25. Table 4 shows the descriptive statistics of students' continuous upright writing skills. The table contains the mean grade, standard deviation, minimum score, maximum score, and number of students. This data illustrates the overall level of continuous upright writing skills of students.

Table 4. Descriptive Statistics of Continuous Upright Writing Skills

Statistics	Value
Mean	16,45
Standard Deviation	3,87
Minimum Score	8
Maximum Score	24
Number of Students	78

The data in Table 4 shows the mean score of students' continuous upright writing skills of 16.45. This score is in the medium category from the score range of 5 to 25. The standard deviation of 3.87 indicates that the variation in writing skills between students is quite large. A minimum score of 8 and a maximum of 24 show a wide difference in the quality of writing between students. A total of 78 4th grade elementary school students were the subjects of continuous upright writing skills measurement. The average score shows that students' ability to write upright in a row still needs further coaching to achieve a high skill level.

Table 5 illustrates the distribution of students by consecutive upright writing skill categories. The researcher grouped students into three categories, namely low, medium, and high. This table shows the number and percentage of students in each category of writing skills.

Table 5. Distribution of Students Based on Continuous Upright Writing Skill Categories

Category	Score Range	Number of Students	Percentage
Low	5-13	18	23,1%
Keep	14-19	43	55,1%
Tall	20-25	17	21,8%

The data in Table 5 shows that the majority of students are in the medium category. A total of 43 students or 55.1% have moderate continuous upright writing skills. The low category included 18 students or 23.1% of the total research subjects. Students in the high category amounted to 17 people or 21.8%. This distribution shows that more than half of the students have basic writing skills in continuous upright but

have not yet reached the proficient level. Students in the medium and low categories still need intensive practice to improve readability, font accuracy, size consistency, neatness of connections, and fluency in their writing strokes.

Table 6 presents the mean score of each aspect of the assessment of upright writing skills in a row. The table contains five aspects of assessment, namely the readability of the letters, the accuracy of the letter shape, the consistency of the letter size, the neatness of the connections, and the smoothness of strokes. Each aspect is graded on a scale of 1-5 to measure the quality of students' writing.

Table 6. Mean Score of Continuous Upright Writing Skills Assessment Aspect

Assessment Aspects	Mean	Standard Deviation
Letter Readability	3,42	0,89
Letter Shape Accuracy	3,18	0,94
Font Size Consistency	3,35	0,82
Connection Neatness	3,28	0,91
Smoothness of Scratches	3,22	0,88

The data in Table 6 shows that the literacy aspect of letters has the highest mean score of 3.42. This score indicates that students are relatively capable of making letters that others can read. The aspect of font size consistency obtained a mean score of 3.35 which shows that students are quite capable of maintaining uniform font sizes. The neatness of the connection received a mean score of 3.28 which indicates that the students' ability to connect letters still needs improvement. The aspect of smooth strokes obtained a mean score of 3.22 which shows that students still have difficulty in making smooth and continuous strokes. The aspect of letter shape accuracy has the lowest mean score of 3.18. This score indicates that students often make mistakes in forming letters according to the standard of continuous upright writing. The standard deviation of the five aspects ranged from 0.82 to 0.94 which showed the variation in students' abilities in each aspect was relatively consistent.

Analysis Prerequisites Test

The researcher conducts prerequisite tests before the main analysis. The normality test using the Kolmogorov-Smirnov yields values that meet the assumption of normal distribution. The linearity test shows a linear relationship between the two research variables.

Table 7 shows the results of the normality test of the research data. The table contains the Kolmogorov-Smirnov D value, the p value, and the normality status description for both variables. A p-value greater than 0.05 indicates a normally distributed data so that it qualifies for parametric analysis.

Table 7. Data Normality Test Results

Variable	D Value	Value p	Information
Self-Regulated Learning	0,078	0,200	Usual
Continuous Upright Writing Skills	0,084	0,156	Usual

The data in Table 7 show that both research variables have normal distributions. The self-regulated learning variable obtained a D value of 0.078 with a value of p = 0.200. A p-value greater than 0.05 indicates normally distributed self-regulated learning data. The variable of continuous upright writing skills obtained a D value of 0.084 with a value of p = 0.156. A p-value greater than 0.05 indicates that the data on continuous

upright writing skills is also normally distributed. The results of this normality test meet the assumptions of parametric analysis so that the researcher can continue the correlation and regression analysis.

Table 8 presents the results of the linearity test of the relationship between self-regulated learning and continuous upright writing skills. The table shows the significant F value of linearity and the value of F deviation from linearity that is not significant. These results confirm the linear relationship between the two study variables.

Table 8. Results of the Linearity Test

Component	F Value	Value p	Information
Linearity	67,543	< 0.001	Significant
Deviation from Linearity	1,234	0,245	Insignificant

The data in Table 8 show a linear relationship between self-regulated learning and continuous upright writing skills. The linearity component obtained an F value of 67.543 with a p value of < 0.001. A p-value of less than 0.05 indicates a linear relationship between the two statistically significant variables. The deviation from linearity component obtained an F value of 1.234 with a p value = 0.245. A p-value greater than 0.05 indicates no significant deviation from the linear pattern. The results of this linearity test confirm that the linearity assumption is fulfilled so that a simple linear regression analysis can be performed.

Correlation Hypothesis Test

Pearson's product moment correlation analysis yielded a significant positive correlation coefficient. Correlation values show a unidirectional relationship between self-regulated learning and continuous upright writing skills. Students who have high self-regulated learning tend to have high upright writing skills as well.

Table 9 shows the results of the correlation analysis between self-regulated learning and continuous upright writing skills. The table contains the Pearson correlation coefficient, significance value, and correlation strength categories based on Cohen's (1988) interpretation. The value of the coefficient $r = 0.687$ indicates a strong relationship between the two variables.

Table 9. Results of Correlation Analysis of Self-Regulated Learning and Continuous Upright Writing Skills

Correlation	R coefficient	Value p	Category
Pearson Correlation	0,687	< 0.01	Strong

The data in Table 9 show a strong positive relationship between self-regulated learning and continuous upright writing skills. The Pearson correlation coefficient obtained a value of r of 0.687. This value belongs to the category of strong correlation based on the interpretation of Cohen (1988) who classifies $r = 0.50-0.69$ as a strong correlation. The significance value of $p < 0.01$ indicates that the relationship is significant at the 99% confidence level. Positive correlation shows a unidirectional relationship between the two variables. Students who have high self-regulated learning tend to have high upright writing skills as well. These results confirm the research hypothesis that there is a significant positive relationship between self-regulated learning and continuous upright writing skills of 4th grade elementary school students.

Table 10 presents the correlation between each dimension of self-regulated learning and continuous upright writing skills. The table shows the three dimensions of self-regulated learning, namely metacognitive strategies, cognitive strategies, and

resource management along with their respective correlation values. This data provides information about the dimensions that play the most role in writing skills.

Table 10. Correlation of Dimensions of Self-Regulated Learning and Continuous Upright Writing Skills

Dimension	R coefficient	Value p
Metacognitive Strategies	0,654	< 0.01
Cognitive Strategies	0,612	< 0.01
Resource Management	0,589	< 0.01

The data in Table 10 show that all dimensions of self-regulated learning are positively correlated significantly with continuous upright writing skills. The metacognitive strategies dimension had the highest correlation, namely $r = 0.654$. This value indicates that metacognitive strategies such as planning, monitoring, and regulating have the most important role in mastering continuous upright writing skills. The cognitive strategies dimension obtained a correlation value of $r = 0.612$ which shows that cognitive strategies such as rehearsal, elaboration, and organization also affect writing skills. The resource management dimension received a correlation value of $r = 0.589$ which indicates the ability to manage time, effort, and seek help plays a role in improving students' writing skills. All three dimensions had a $p < 0.01$ which showed a significant correlation at the 99% confidence level. These findings reinforce the importance of developing all dimensions of self-regulated learning to improve students' continuous upright writing skills.

Simple Linear Regression Analysis

The researcher conducted a simple linear regression analysis to determine the contribution of self-regulated learning to continuous upright writing skills. The analysis yielded a regression equation $Y = 2.145 + 0.188X$. This equation shows that every 1-point increase in the self-regulated learning score will increase the continuous upright writing skill score by 0.188 points.

Table 11 shows the results of a simple linear regression analysis. The table contains the constant value, regression coefficient, R^2 determination coefficient, F-value, and Durbin-Watson value. The R^2 determination coefficient indicates the large contribution of self-regulated learning to the variation of continuous upright writing skills.

Table 11. Results of Simple Linear Regression Analysis

Parameters	Value	Information
Constant	2,145	-
Regression Coefficient (b)	0,188	-
R^2	0,472	47,2%
F	67,543	$p < 0.001$
Durbin-Watson	1,987	No autocorrelation

The data in Table 11 show a significant regression model and can be used to predict continuous upright writing skills. The constant value of 2.145 is the predictive value of writing skills when self-regulated learning is zero. The regression coefficient of 0.188 indicates that every 1-point increase in the self-regulated learning score will increase the continuous upright writing skill score by 0.188 points. The R^2 determination coefficient of 0.472 indicates that 47.2% variation in continuous upright writing skills can be explained by self-regulated learning. The remaining 52.8% were influenced by other factors that were not researched such as motivation, teacher support, and learning environment. An F value of 67.543 with $p < 0.001$ indicates a

statistically significant regression model. The Durbin-Watson value of 1.987 is close to 2 which indicates no autocorrelation in residuals. The contribution of 47.2% included a substantial category that showed self-regulated learning was an important predictor of students' continuous upright writing skills.

Comparison of groups based on levels of self-regulated learning

The researchers conducted additional analyses to compare continuous upright writing skills between groups of students. The single-path ANOVA test showed significant differences between groups based on the level of self-regulated learning. The group of students had significant differences in writing skills according to their level of self-regulated learning.

Table 12 shows the results of a one-track ANOVA test to compare writing skills between groups. The table contains the value of F, significance value, and a description of the results of the statistical test. A value of $F = 42.315$ with a $p < 0.001$ shows significant differences between groups of students based on the level of self-regulated learning.

Table 12. One-Lane ANOVA Test Results

Source of Variation	F	Value p	Information
Intergroup	42,315	< 0.001	Significant

The data in Table 12 show significant differences in continuous upright writing skills between groups of students. An F value of 42.315 with $p < 0.001$ indicates a statistically significant difference in mean writing skills between groups at a confidence level of 99.9%. These results show that students' self-regulated learning levels affect their continuous upright writing skills. Students in different self-regulated learning groups have different writing qualities.

Table 13 presents the mean continuous upright writing skills for each group based on the level of self-regulated learning. The table shows the groups of students with high, medium, and low self-regulated learning along with the mean, standard deviation, and number of students in each group. This data provides an overview of the differences in writing skills between groups of students.

Table 13. Average Continuous Upright Writing Skills Based on Self-Regulated Learning Level

Group	Mean	Standard Deviation	Number of Students
Self-Regulated Higher Learning	20,56	2,34	16
Self-Regulated Learning Is Being	16,42	2,89	48
Low Self-Regulated Learning	11,71	2,56	14

The data in Table 13 shows the difference in mean continuous upright writing skills between groups of students. The high-quality self-regulated learning group obtained a mean writing skill of 20.56. This score is in the high category that indicates that students are able to produce good quality upright writing. The self-regulated learning group obtained a mean of 16.42. This score is a medium category that shows that students have basic writing skills that are upright in a row but are not optimal. The low self-regulated learning group obtained a mean of 11.71. This score is included in

the low category that indicates that students have difficulty in writing upright in a row. The mean difference between the high and low groups reached 8.85 points. This difference is a significant practical difference that shows the huge impact of self-regulated learning on writing skills. The post hoc test of Tukey HSD confirmed significant differences between all group pairs. These findings reinforce the results of correlation and regression analysis that show self-regulated learning plays an important role in the mastery of continuous upright writing skills. Students who have the ability to plan, monitor, and evaluate their learning process tend to produce upright continuous writing that is more neat, readable, and quality.

DISCUSSION

The results showed a significant positive correlation between self-regulated learning and continuous upright writing skills of 4th grade elementary school students ($r = 0.687$, $p < 0.01$). These findings are consistent with the theoretical framework of self-regulated learning put forward by Zimmerman (2002) which states that students with self-regulatory abilities are better able to regulate their cognitive processes, motivations, and behaviors to achieve learning goals. In the context of continuous upright writing, students with high self-regulated learning are better able to set specific goals for the quality of their writing, monitor the performance of hand movements when writing, and self-correct when the shape of the letter does not meet the standard. Cumming et al. (2023) explain that the forethought phase in the Zimmerman model includes goal setting that helps students focus attention on important aspects of writing skills such as letter shape accuracy and continuity of connections. The performance phase includes self-monitoring that allows students to realize letter errors in real-time and make adjustments. The self-reflection phase includes evaluating the results of the writing and identifying areas that need improvement for the next exercise.

The correlation strength of $r = 0.687$ which belongs to the strong category indicates that self-regulated learning is a substantial predictor of continuous upright writing skills. These findings are in line with the research of Skar et al. (2023) who found that self-efficacy for writing self-regulation predicted the writing quality of grade 2 students ($N=2,124$). The study showed students who believed in their ability to regulate the writing process showed higher persistence in writing practice and produced better quality writing. Chen et al. (2022) used latent profile analysis to identify students with highly self-regulated profiles showing the highest writing achievement compared to moderately self-regulated and low self-regulated groups. The research emphasizes the importance of the pattern of using integrated self-regulation strategies not only in one aspect. The findings of this study reinforce empirical evidence that self-regulated learning is not only important for composition writing skills but also for handwriting technical skills such as continuous upright writing that requires fine motor coordination.

Analysis by dimension showed that the dimension of metacognitive strategies had the highest correlation with writing skills ($r = 0.654$, $p < 0.01$). These findings are consistent with the research of Teng et al. (2022) which identified 87% variance in writing performance can be explained by students' metacognitive strategies. Metacognitive strategies include planning, namely the ability to plan the sequence of writing movements and the target quality of writing, monitoring, which is the ability to monitor the implementation of hand movements and writing results in real-time, and regulation, which is the ability to make corrections and adjustments when deviations from the target occur. Ruffini et al. (2024) in a systematic review of the relationship between executive function and writing in children explained that monitoring and cognitive flexibility are important predictors of writing quality. Students who are able to monitor their writing process can detect errors faster and make corrections before mistakes become the habit. Eberhart et al. (2024) in a meta-analysis of 67 studies found that metacognition interventions in kindergarten and elementary school children

had an effect size of $g=0.48$ which indicated a moderate to large impact on various learning outcomes, including writing skills.

The contribution of self-regulated learning of 47.2% to the variation in continuous upright writing skills indicates that there is still a 52.8% variance explained by other factors. Cordeiro et al. (2022) in a longitudinal study on 4th and 5th grade students found that other factors that contribute to writing skills include handwriting automaticity (20.3%), working memory capacity (15.7%), and inhibitory control (12.4%). Handwriting automation refers to the level of automation of writing movements that frees up the cognitive capacity to focus on other aspects such as the content and organization of the writing. Gosse et al. (2021) in a 3-year study found that the automation of graphomotor skills develops gradually and reaches a mature level by the end of elementary school. Working memory capacity is important for storing the representation of the target letter shape while coordinating hand movements to realize the shape. Inhibitory control is important to suppress irrelevant hand movements or incorrect writing habits.

Significant differences in continuous upright writing skills between groups based on levels of self-regulated learning ($F = 42.315$, $p < 0.001$) provide additional empirical evidence of the importance of self-regulated learning. Students with high self-regulated learning had a mean writing skill of 20.56 which almost reached a maximum score of 25 while the low group only had a mean of 11.71. The difference of 8.85 points is a practically significant difference in the context of learning to write in elementary school. Heirweg et al. (2020) examined 104 upper-class elementary school students who found high achievers in writing to show a more strategic and adaptive self-regulation approach than low achievers. High achievers often do planning before writing, monitoring during the writing process, and evaluation after finishing writing. Low achievers tend to write without planning, rarely monitor the quality of their writing, and do not evaluate for improvement. Salas et al. (2021) found that self-regulated strategy development (SRSD) interventions were effective in improving the writing quality of 2nd and 4th grade students from various socioeconomic backgrounds. The intervention teaches students to set specific goals, use self-instruction, and conduct self-evaluations which are core components of self-regulated learning.

The finding that the metacognitive strategies dimension has the highest correlation with writing skills has important practical implications for learning in primary schools. Camping and Graham (2022) examined self-regulated strategy development instruction in grade 1 students found that explicit teaching of planning, monitoring, and evaluating strategies improved the quality of students' writing and self-regulation knowledge. The instruction uses a think-aloud model that allows students to see how expert writers use metacognitive strategies during the writing process. Olid-Luque and Fernández-Martín (2025) in a systematic review of self-regulated learning programs in primary education recommend the integration of self-regulation strategy teaching in the regular curriculum rather than just as a separate program. Teachers can integrate the teaching of metacognitive strategies in each continuous upright writing practice session such as asking students to set writing quality targets before starting, monitoring the performance of hand movements during writing, and evaluating writing results using clear criteria.

This study found that 4th grade elementary school students in Wonogiri had a mean self-regulated learning of 76.32 which is in the medium category. These findings indicate that the majority of students have developed some self-regulation strategies but are not optimal. Torrington et al. (2023) identified elementary school students using various self-regulation strategies but the use of these strategies has not been consistent and has not been integrated. Xu et al. (2023) in a meta-analysis found that self-regulated learning interventions were effective in improving the academic achievement of K-12 students with an effect size $d=0.45$. These findings suggest the need for a systematic and sustainable self-regulated learning development program in

primary schools. The program can include explicit teaching of self-regulation strategies, modeling by teachers, guided practice, and gradual independent practice. López-Escribano et al. (2022) in a meta-analysis of handwriting fluency interventions found that a combination of explicit instruction, guided practice, and specific feedback resulted in an effect size $d=0.64$ that ranged from moderate to large.

The limitations of this study need to be considered in the interpretation of the results. First, the design of the correlational *ex post facto* cannot prove a definitive causal relationship between self-regulated learning and continuous upright writing skills. There may be a third variable that affects both variables or a bidirectional relationship where good writing skills can also improve students' self-regulated learning. Experimental or longitudinal research is required to confirm the direction of causality. Second, the research sample was limited to 5 elementary schools in Wonogiri which may not be representative of the overall population of Indonesian elementary school students. Generalization of findings to other geographical and cultural contexts needs to be done carefully. Third, self-regulated learning measures using self-report questionnaires are susceptible to social desirability bias where students may report more positively than their actual behavior. Direct observation of students' self-regulation behavior during the writing learning process can provide more valid data. Fourth, the continuous upright writing skill assessment is only carried out once, which may not reflect the consistent ability of the student. Multiple sample assessments can provide a more accurate estimate of a student's skills.

CONCLUSION

This study concludes that self-regulated learning has a significant positive effect on the continuous upright writing skills of grade IV elementary school students. The correlation between the two variables was in the strong category ($r = 0.687$, $p < 0.01$) so that students with high self-regulated learning tended to produce neater, consistent, and readable writing. Self-regulated learning contributed 47.2% to the variation in writing skills which shows the substantial role of this variable as a predictor. The metacognitive strategies dimension has the highest relationship ($r = 0.654$) so that planning, monitoring, and regulating skills are the main keys in mastering continuous upright writing. Comparisons between groups showed that students with high self-regulated learning had a better writing score of 20.56 than the medium and low groups. The findings emphasized the need to strengthen self-regulation strategies such as goal setting, self-monitoring, and self-evaluation in writing learning in elementary schools.

Further research can use experimental designs to test causal relationships, longitudinal studies to monitor student development, as well as replication in different regions to test generalizability. A qualitative approach can be used to understand the mechanism of using self-regulation strategies in the continuous upright writing process in elementary schools.

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