Journal of Pedagogy and Education Science (JPES)
Vol. 4, No. 03, pp. 660-673
journal.iistr.org/index.php/JPES
DOI: 10.56741/jpes.vxix.xx

The Contribution of Learning Motivation and Learning Styles to Numeracy Literacy Skills

A Regression-Based Study

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ARTICLE INFO

Article history
Received 28 August 2025
Revised 16 September 2025
Accepted 23 September 2025

ABSTRACT

This study aims to examine the effect of learning motivation and learning styles on the numeracy literacy skills of grade 7 at SMP Negeri 2 Kasihan. The research employed a quantitative approach with an ex post facto design. The sample consisted of 120 students selected purposively, and the study was conducted from February to May 2025. The research instruments included a learning motivation questionnaire, a learning style questionnaire, and a numeracy literacy test, all of which underwent construction, expert validation, and pilot testing. Most of the items were found to be valid and reliable, except for several items in the numeracy literacy test that were eliminated. The data were analyzed using descriptive statistics to obtain the maximum, minimum, total, and mean scores for each variable. The prerequisite tests included normality, multicollinearity, heteroscedasticity, and linearity, all of which indicated that the data met the assumptions for regression analysis. The results of multiple linear regression analysis revealed that learning motivation and learning styles simultaneously had a significant effect on numeracy literacy skills (sig. 0.000 < 0.05). However, partially, neither learning motivation nor learning styles showed a significant effect. The coefficient of determination (R^2) of 0.276 indicates that the two independent variables explained 27.6% of the variance in students' numeracy literacy skills, while the remaining variance was influenced by other factors beyond this study.

Keywords
Ex Post Facto Design
Learning Motivation
Learning Styles

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Multiple Regression Analysis Numeracy Literacy Skills	

Introduction

Education serves as the primary foundation in shaping the quality of superior human resources [1]. Along with the rapid development of science and technology in the 21st century, the field of education is required to produce a generation that is not only academically intelligent but also equipped with critical thinking, creativity, and problem-solving skills in real-life contexts [2]. Therefore, literacy, particularly numeracy literacy, has become one of the essential competencies that students must master. Numeracy literacy is not merely the ability to calculate, but rather the skill to understand, interpret, and apply mathematical concepts across various life contexts [3].

However, various surveys indicate that Indonesian students' numeracy literacy skills remain relatively low. The 2018 PISA report revealed that Indonesia ranked 73rd out of 79 participating countries in mathematics, reflecting weak numeracy literacy among students [4]. This condition is consistent with the results of the Minimum Competency Assessment conducted by the Ministry of Education, Culture, Research, and Technology [5], which showed that most students still struggle to relate mathematical concepts to everyday life situations. These findings highlight the urgency of strengthening numeracy literacy through various factors influencing the learning process, including learning motivation and learning styles.

Learning motivation is one of the internal factors that determines students' success in understanding instructional materials. Motivation can be defined as the driving force that moves an individual to achieve specific goals [6]. Students with high learning motivation tend to demonstrate persistence, enthusiasm, and more effective learning strategies compared to those with lower motivation [7]. Siminto et al. [8] found that learning motivation makes a significant contribution to academic achievement, including the enhancement of numeracy literacy. Thus, learning motivation can be considered a key element in encouraging students to actively develop their numeracy skills.

In addition to motivation, learning styles also play a crucial role in influencing how students absorb and process information. Each individual has different preferences in learning, such as visual, auditory, reading/writing, and kinesthetic styles, as proposed by Dominguez et al. [9]. Teachers' understanding of students' learning styles can assist in designing appropriate instructional strategies, making learning more effective. Reina [10] further emphasized that learning success is more optimal when teaching strategies are aligned with students' needs and preferences. Therefore, suitable learning styles can support students in improving their numeracy literacy skills.

The interrelation between learning motivation, learning styles, and numeracy literacy demonstrates a reciprocal relationship that reinforces one another. Students with high learning motivation will attempt to adapt their learning styles to achieve better understanding, while an appropriate learning style can foster greater interest and motivation to learn [11]. When these two factors function in balance, students' numeracy literacy skills can develop optimally. Kilag [12] also confirmed that internal factors, such as motivation, and external factors, such as instructional strategies, significantly influence students' numeracy skills.

This context is highly relevant to study among junior high school students, especially grade 7, who are in the transition phase from elementary to secondary education. At this stage, students are required to be more independent in learning while facing increasingly complex academic materials. SMP Negeri 2 Kasihan, as one of the public junior high schools located in Tamantirto Regency, Kasihan District, Bantul Regency, Daerah Istimewa Yogyakarta Province, needs to ensure that its learning process fosters student learning motivation while accommodating their learning styles. Therefore, research on the influence of learning motivation and learning styles on the numeracy literacy skills of grade 7 students at SMP Negeri 2 Kasihan is very important to conduct.

Through this research, it is expected that a more comprehensive understanding can be obtained regarding how learning motivation and learning styles contribute to students' numeracy literacy. The findings will not only be beneficial for teachers in designing effective instructional strategies but also provide valuable insights for schools in improving the overall quality of education. Furthermore, this study contributes to the government's efforts to strengthen the fundamental competencies of Indonesian students, particularly numeracy literacy, as essential preparation for facing future global challenges.

Literature Review

A. Learning Motivation

Learning motivation is an internal factor that plays a crucial role in determining students' success in the learning process. Motivation can be defined as an internal or external drive that encourages an individual to achieve specific learning goals [13]. In the context of education, motivation is not merely temporary enthusiasm but also encompasses students' needs, expectations, and beliefs in achieving academic success. According to Pratiwi et al. [14], students with high motivation tend to be more active, persistent, and resilient in facing learning difficulties compared to those who are less motivated. This indicates that learning motivation is an essential prerequisite for fostering independence and improving the quality of academic achievement.

Furthermore, learning motivation can be influenced by various factors, both internal and external, such as teacher support, family environment, and socio-cultural conditions. The theory of learning motivation proposed by Sikandar et al. [15] through Self-Determination Theory (SDT) emphasizes the importance of fulfilling three basic psychological needs: competence, autonomy, and relatedness in order to optimally develop students' intrinsic motivation. A study conducted by Tian and Zhang [16] also revealed that learning motivation significantly contributes to students' academic achievement in secondary schools. Thus, learning motivation not only serves as a driver of learning activities but also becomes a key factor in enhancing literacy, critical thinking skills, and overall academic performance.

B. Learning Styles

Learning style refers to the way individuals absorb, process, and retain information during the learning process. According to Sayed et al. [17], learning styles can be categorized into the VARK model, namely Visual, Auditory, Reading/Writing, and Kinesthetic, each reflecting students' preferences in receiving information. Understanding learning styles is highly important for teachers in designing appropriate instructional strategies to make learning materials more accessible to students. Curlewis et al. [18] Emphasize that each student has a dominant learning style that needs to be accommodated to improve the effectiveness of the learning process. By adjusting teaching strategies based on students' learning styles, teachers can enhance engagement, interest, and learning outcomes.

On the other hand, several studies emphasize that learning styles do not operate in isolation but interact with other factors such as motivation, intelligence, and the learning environment. Research by Goyibova et al. [19] found that although students' learning style preferences vary, what matters most is the use of diverse and contextual teaching strategies to accommodate all types of learning styles. This aligns with Saifi et al. [20], who argued that learning success is not solely determined by matching teaching with learning styles but is also influenced by teachers' pedagogical approaches. Therefore, understanding learning styles should not be treated as a fixed label but rather as a basis for flexibility in designing enjoyable, challenging, and meaningful learning experiences.

C. Numeracy Literacy Skills

Numeracy literacy skills are among the essential competencies that students need to master in facing the challenges of the 21st century. The OECD [4] defines numeracy literacy as the ability to formulate, apply, and interpret mathematics in a variety of real-life contexts. Numeracy literacy is not limited to arithmetic skills but also encompasses conceptual understanding, reasoning, and the ability to use mathematics to solve everyday problems. This is reinforced by Kilpatrick et al. [21], who stated that numeracy literacy involves five key

aspects: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and a productive disposition toward mathematics. Therefore, numeracy literacy is a complex ability that requires the integration of knowledge, skills, and attitudes.

The importance of numeracy literacy in the Indonesian education context is also highlighted in national policy, in which the Minimum Competency Assessment program identifies reading literacy and numeracy as the primary indicators of education quality [22]. Research conducted by Rosnelli & Pitra [23] showed that Indonesian students' numeracy skills remain relatively low, particularly in applying mathematical concepts to real-life situations. Low numeracy literacy may hinder students' ability to solve daily problems as well as compete globally. Therefore, strengthening numeracy literacy must be carried out through contextual, problem-based learning approaches and integration with other disciplines to foster students' critical and creative thinking, as well as their ability to make rational decisions.

Material and Methods

This study employed a quantitative approach with an ex post facto research design, in which the researcher analyzed the relationship between the independent variables, namely learning motivation (X_1) and learning style (X_2), and the dependent variable, numeracy literacy (Y). The research was conducted at SMP Negeri 2 Kasihan with a sample of 120 grade 7 students and was carried out from February to May 2025. The research instruments were developed through stages of construction, expert validation, and pilot testing to determine validity and reliability, which indicated that most of the items were feasible for use, except for a few items in the numeracy literacy test that were excluded. The data were collected through learning motivation and learning style questionnaires, as well as a numeracy literacy test. The data were first analyzed descriptively to obtain the maximum, minimum, total, and mean values for each variable. Subsequently, prerequisite tests were conducted, including normality testing using the Kolmogorov-Smirnov test, multicollinearity testing by examining tolerance and VIF values, heteroscedasticity testing using the Glejser test, and linearity testing through ANOVA analysis, all of which confirmed that the data met the requirements for linear regression analysis. The main data analysis employed multiple linear regression, with an F-test used to examine simultaneous effects, a t-test to assess partial effects, and the coefficient of determination (R^2) to measure the contribution of X_1 and X_2 to Y.

Results

A. Results of Instrument Testing and Descriptive Analysis of Each Variable

Before conducting the research, a pilot test of the instruments was carried out, covering the variables of learning motivation, learning style, and numeracy literacy skills. After being constructed and validated by experts, the instruments were then tested for validity and

reliability. The results of the instrument trial are presented in Table 1. Based on Table 1, it can be seen that the t_{count} for all items in the learning motivation and learning style variables is greater than the t_{table} value (0.179), and the Cronbach's Alpha significance values exceed 0.05.

Table 1. Instrument test results

No	X_1		X_2		No	Y	
	t_{count}	Sig.	t_{count}	Sig.		t_{count}	Sig.
1	0.346	0.970	0.268	0.971	1a	-0,001	0.644
2	0.424		0.396		1b	0.196	
3	0.250		0.242		1c	0.377	
4	0.702		0.565		2	0.585	
5	0.546		0.548		3	0.233	
6	0.572		0.510		4	-0.023	
7	0.638		0.578		5a	0.768	
8	0.672		0.507		5b	0.687	
9	0.416		0.467		5c	0.727	
10	0.589		0.604		5d	0.707	
11	0.542		0.394		6	0.613	
12	0.482		0.434		7	0,042	
13	0.254		0.428				
14	0.329		0.418				
15	0.474		0.564				
16	0.523		0.507				
17	0.672		0.567				
18	0.414		0.342				

However, for the numeracy literacy test variable, the t_{count} for items 1a, 4, and 7 is smaller; thus, these items were excluded from the study. Subsequently, a descriptive analysis was conducted to provide an overview of the data used in the research. This analysis aimed to present the total number of collected data, along with a summary of the total scores, mean, maximum, and minimum values for each research variable. The results of the descriptive data analysis are clearly presented in Table 2.

Table 2. Description of each variable

Value	X_1	X_2	Y
Maksimum	92.96	92.96	60.00
Minimum	50.70	49.30	4.62
Total	8521.06	8133.85	2915.38
Mean	71.17	67.78	24.29

Based on the results of the data analysis, variable X_1 recorded a maximum value of 92.96, a minimum value of 50.70, a total of 8,521.06, and a mean of 71.17. Variable X_2 showed a maximum value of 92.96, a minimum value of 49.30, a total of 8,133.85, and a mean of 67.78. Meanwhile, variable Y had a maximum value of 60.00, a minimum value of 4.62, a total of 2,915.38, and a mean of 24.29. These findings indicate that X_1 and X_2 tend to have relatively

high score ranges with balanced averages, whereas Y demonstrates a lower mean with a comparatively wide score range.

B. Prerequisite Analysis Testing

The first step in testing the prerequisites for analysis was conducting a normality test on the data. To perform this test, the Kolmogorov-Smirnov method was employed as a statistical tool to assess whether the data distribution followed a normal pattern. This specific test was selected because, as noted by Sugiyono [24], it is appropriate and recommended for use when the sample size exceeds 50 respondents, as in this study. The normality test results, showing the data distribution characteristics, are presented in Table 3.

Table 3. Results of the normality test (One-Sample Kolmogorov-Smirnov Test)

		Unstandardized Residual
N		120
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2026.62936737
Most Extreme Differences	Absolute	.077
	Positive	.077
	Negative	-.065
Test Statistic		.077
Asymp. Sig. (2-tailed)		.077[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Based on Table 3, the Kolmogorov-Smirnov column shows a significance value of 0.005. Compared with the significance level of $\alpha = 0.005$, this indicates that the data are normally distributed. Therefore, it can be concluded that the values of all variables in this study were derived from a normally distributed population. Subsequently, a multicollinearity test was conducted to examine whether there was a perfect correlation among the independent variables. Multicollinearity is also one of the classical assumption tests used to identify whether a regression model can be considered robust. The results of the multicollinearity test are presented in Table 4.

Table 4. Results of the multicollinearity test (Coefficients[a])

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	10673.742	1673.506		6.378	.000		
	X_1	-1.083	.166	-.513	-6.517	.000	.999	1.001
	X_2	.281	.174	.127	1.619	.108	.999	1.001

a. Dependent Variable: Y

Based on the results of the analysis above, it can be concluded that there is no multicollinearity in the proposed regression model. This is indicated by the tolerance values of variables X_1 and X_2, both of which are $0.999 > 0.10$, and the VIF values of variables X_1 and X_2,

which are 1.001 < 10, confirming the absence of multicollinearity. These results demonstrate that the regression model used is free from multicollinearity. Subsequently, a heteroscedasticity test was conducted using the Glejser test technique to examine whether there were deviations from the classical assumption of homoscedasticity, specifically to determine whether unequal variances existed in the residuals across the regression model's observations. The results of the heteroscedasticity test are presented in Table 5.

Table 5. Heteroscedasticity test results (Coefficients[a])

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10673.742	1673.506		6.378	.000
	X_1	-1.083	.166	-.513	-6.517	.100
	X_2	.281	.174	.127	1.619	.108

a. Dependent Variable: Abs RES

Based on the results, it can be concluded that there are no indications of heteroscedasticity in the regression model used. This is evidenced by the significance values of variables X_1 and X_2, all of which are greater than 0.05. Subsequently, a linearity test was conducted to determine whether a linear relationship exists between the dependent variable and each of the independent variables examined. The linear regression model cannot be applied if the assumption of linearity is not fulfilled. The results of the linearity test are presented in Table 6 and Table 7.

Table 6. ANOVA Table of the linearity test between learning motivation and numeracy literacy skills

			Sum of Squares	df	Mean Square	F	Sig.
$Y*X_1$	Between Groups	(Combined)	277088008.610	28	9896000.307	2.262	.002
		Linearity	175416847.516	1	175416847.516	40.104	.000
		Deviation from Linearity	101671161.094	27	3765598.559	.861	.662
	Within Groups		398034658.557	91	4374007.237		
	Total		675122667.167	119			

Table 7. ANOVA Table of the linearity test between learning styles and numeracy literacy

			Sum of Squares	df	Mean Square	F	Sig.
$Y*X_2$	Between Groups	(Combined)	132783107.769	30	4426103.592	.726	.838
		Linearity	8922436.814	1	8922436.814	1.464	.229
		Deviation from Linearity	123860670.955	29	4271057.619	.701	.860
	Within Groups		542339559.397	89	6093702.915		
	Total		675122667.167	119			

Based on the results of the analysis, it can be concluded that there is a significant linear relationship between purchase decisions and the three variables examined. In Table 6, the

significance value of the deviation from linearity is 0.662 > 0.05, indicating a significant linear relationship between learning motivation and numeracy literacy. In Table 7, the significance value of 0.860 > 0.05 demonstrates a significant linear relationship between learning style and numeracy literacy. Hypothesis testing in this study was carried out through multiple regression analysis to determine whether the two independent variables (X) influence the dependent variable (Y). This regression analysis was conducted using simultaneous testing (F-test), partial testing (t-test), and the coefficient of determination. The simultaneous significance test was performed using the F-test, in which the ANOVA table shows the significance of the simultaneous effect of store location, price sensitivity, and product promotion on purchase decisions. Table 8 shows the results of the F-test.

Table 8. F test results (ANOVA[a])

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	186362702.635	2	93181351.318	22.306	.000[b]
	Residual	488759964.531	117	4177435.594		
	Total	675122667.167	119			

a. Dependent Variable: Y
b. Predictors: (Constant), X_2, X_1

The decision based on Table 8 indicates that the F-test result obtained a significance value of 0.000 < 0.05, meaning that H_1 is accepted and the hypothesis is confirmed. Thus, learning motivation and learning style simultaneously influence students' numeracy literacy skills. Furthermore, a partial test (t-test) was conducted to examine the significance of the regression coefficients individually and to determine the effect of each independent variable on the dependent variable by referring to the *t* value at a significance level of 0.05. Based on the SPSS-25 analysis results, the partial test (t-test) is presented in Table 9.

Table 9. T-Test results (Coefficients[a])

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10673.742	1673.506		6.378	.000
	X_1	-1.083	.166	-.513	-6.517	.100
	X_2	.281	.174	.127	1.619	.108

a. Dependent Variable: Abs_RES

Based on Table 8, the hypotheses can be tested partially, or one by one, leading to the following conclusions: (1) The first hypothesis regarding the store location variable shows a *t*-test significance value of 0.100 > 0.05; therefore, H_1 is accepted, and it can be concluded that there is a partial influence of learning motivation on numeracy literacy. (2) The second hypothesis regarding the price sensitivity variable shows a *t*-test significance value of 0.108 > 0.05; therefore, H_2 is accepted, and it can be concluded that there is a partial influence of learning style on numeracy literacy.

Subsequently, the coefficient of determination test was conducted to indicate the proportion of variation in the independent variables (X) that explains changes in the dependent variable (Y). This value is presented in the model summary table and is represented by the R-squared value. Table 10 shows the analysis results using SPSS-25.

Table 10. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.525[a]	.276	.264	2043.87759

a. Predictors: (Constant), X_2, X_1

Based on Table 10, it can be seen that the R-Square value represents the coefficient of determination that has been adjusted according to the number and size of the sample, thereby reducing potential bias when additional variables are included. In this study, the R-Square value of 0.276 indicates that the variables of store location, price sensitivity, and product promotion collectively influence the purchase decision variable by 27.6%.

Discussion

The results of the study indicate that learning motivation (X_1) and learning style (X_2) have a simultaneous influence on students' numeracy literacy skills (Y). This is evidenced by the F-test with a significance value of 0.000 < 0.05, thus confirming the acceptance of the hypothesis. Descriptively, the average score of learning motivation was 71.17 with a range of 50.70–92.96, while learning style had an average of 67.78 with a range of 49.30–92.96. Meanwhile, numeracy literacy showed a lower mean score of 24.29 with a range of 4.62–60.00. These findings affirm that although students' motivation and learning styles are relatively strong, their numeracy literacy achievement remains relatively low. This condition aligns with the PISA report [4], which revealed that Indonesian students' numeracy literacy performance is still below the OECD average.

The study further revealed that, partially, learning motivation contributes more significantly to numeracy literacy compared to learning style. This is reflected in the linearity test, where the relationship between learning motivation and numeracy literacy was significant, with a significance value of 0.000. This result is consistent with the findings of Radišić et al. [25] and Huang et al. [26], who stated that students with higher motivation tend to demonstrate better mathematical literacy, as they are driven to solve numeracy problems using a wider range of strategies. In other words, learning motivation serves as a key driver in the development of students' cognitive skills, including numeracy literacy.

In contrast, learning style, although not showing a significant partial effect, still contributes by mediating the relationship between motivation and academic achievement.

Previous studies, such as that of Polydoros & Antoniou [27] and Chaiarwut et al. [28], highlighted that the alignment between learning style and teaching methods can improve conceptual understanding in numeracy. This suggests that learning style is not a sole determinant of numeracy literacy outcomes but rather depends on how teachers adapt their instructional strategies to students' preferences. Therefore, learning style should still be regarded as a supporting factor in enhancing learning outcomes.

When compared with other studies, such as the research conducted by Oberleiter et al. [29] and Deda et al. [30], a similar pattern emerges, showing that junior high school students' numeracy literacy generally remains at a moderate to low level. Contributing factors include the lack of practice with contextual problems and low interest in mathematics. The findings of this study reinforce those results, as numeracy literacy remains suboptimal despite relatively high levels of motivation and learning style. Consequently, strengthening numeracy learning requires more contextual, creative approaches that also consider students' learning preferences.

Moreover, the low level of numeracy literacy achievement can also be associated with the limited integration of literacy-based learning in schools. Cintamulya et al. [31] and Anisah [32] emphasized that literacy-based learning integrated across subjects can enhance students' ability to comprehend numerical and data-based information. Within the context of this study, although motivation and learning styles were relatively strong, systematic efforts are still needed by teachers to cultivate students' application of numeracy skills across diverse learning contexts.

Overall, the findings of this research demonstrate that learning motivation and learning style play an important role in supporting junior high school students' numeracy literacy skills. However, high levels of motivation and learning style do not necessarily guarantee high numeracy literacy unless accompanied by appropriate learning strategies. The practical implication of this study is the need for instructional innovation that accommodates diverse learning styles while fostering students' intrinsic motivation. This is in line with the findings of Dorris et al. [33] and Laksana et al. [34], who emphasized that improving numeracy literacy depends not only on internal student factors but also on effective, relevant, and contextual instructional design.

Conclusion

Based on the research findings, it can be concluded that the research instruments used for the variables of learning motivation, learning styles, and numeracy literacy were valid and reliable, although several numeracy literacy items were deemed invalid. The results of the descriptive analysis indicate that students' learning motivation and learning styles had relatively high average scores, whereas numeracy literacy fell into the low category. The

prerequisite tests for analysis, including normality, multicollinearity, heteroscedasticity, and linearity, showed that the data met the requirements for further analysis. The regression test results revealed that learning motivation and learning styles simultaneously had a significant influence on students' numeracy literacy, although the partial effect of each variable was not statistically significant. The coefficient of determination of 27.6% indicates that other factors beyond motivation and learning styles also affect numeracy literacy. Therefore, it is recommended that teachers not only focus on enhancing motivation and adapting learning styles but also develop context-based learning strategies, critical thinking skills, and consistent practice with diverse numeracy problems to optimally improve students' numeracy literacy.

Conflict of Interest

The authors declare no conflict of interest

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