Riemann: *Research of Mathematics and Mathematics Education*
Volume 7, Issue 3, 252-261, December 2025
e-ISSN: 2721-8848 | p-ISSN: 2721-883X
https://journal.sanagustin.ac.id/index.php/reimann

The Influence of Learning Independence and Intelligence Quotient on Students' Mathematical Creative Thinking Skills

Ervina Setianingrum[1], Kintoko[1*], Deny Hadi Siswanto[2]

[1]PGRI Yogyakarta University, Indonesia
[2]Muhammadiyah Mlati High School, Indonesia
kintoko@upy.ac.id
*Corresponding author

Received: September, 2025 | Revised: Oktober, 2025| Accepted: November, 2025| Published: December, 2025

***Abstract*:**
This study aims to examine the influence of learning independence and Intelligence Quotient (IQ) on students' mathematical creative thinking skills. The research employed a quantitative approach with an ex post facto design and was conducted at SMPN 5 Purworejo during the odd semester of the 2024/2025 academic year. The population comprised seventh-grade students, from whom 32 participants were selected through purposive sampling based on the availability of official IQ test results from a professional psychological institution. The research instruments included an essay test measuring creative thinking skills based on four indicators, namely fluency, flexibility, elaboration, and originality; a learning independence questionnaire covering six assessment aspects; and documentation of students' IQ scores. Data analysis consisted of descriptive statistics, prerequisite testing, and multiple linear regression analysis using SPSS version 25. The results showed that learning independence and IQ significantly affected students' mathematical creative thinking skills, both partially and simultaneously. Learning independence had a more dominant effect than IQ. Together, both variables explained 92.5% of the variance in students' mathematical creative thinking skills.

Keywords: Learning Independence, Intelligence Quotient (IQ), Mathematical Creative Thinking

Introduction

Mathematics education in the era of globalization does not merely emphasize computational skills, but also requires students to develop higher-order thinking skills, including creative thinking (Yuniara et al., 2023). Mathematical creative thinking skills are among the essential competencies of the 21st century that students must possess, as creativity enables them to discover various alternative solutions to problems and generate original ideas (Martín-Cudero et al., 2024). However, in reality, many students still struggle when faced with non-routine problems, such as solving word problems that demand flexible and elaborative thinking. This condition indicates that students' mathematical creativity needs to be developed more systematically by understanding the factors that influence it.

One of the key internal factors is learning independence. This refers to a student's ability to regulate their own learning. It includes setting goals, selecting strategies, and evaluating learning outcomes (Syarqia et al., 2024). Students with high learning independence are more active and disciplined. They also depend less on teachers when understanding mathematical concepts. Ardana et al. (2021) and Limori et al. (2025) noted a positive relationship between learning independence and mathematical creative thinking skills. Independent learners are more willing to take initiative in exploring new ideas and solving problems in different ways.

In addition to learning independence Intellectual intelligence, or IQ, is another factor influencing creative thinking (Kornilova et al., 2025). IQ reflects a person's cognitive capacity to understand, remember, analyze, and integrate information (Kathirisetty et al., 2022). Mulyani & Lubis (2024) found that higher IQ levels relate to better mathematics achievement and conceptual understanding. Yet, a high IQ does not always align with high creativity, so how IQ supports mathematical creative thinking requires further study.

Yulia et al. (2024) ound that students with higher learning independence generate more flexible mathematical ideas. In a similar vein, Daskova et al. (2020) howed that IQ is an important predictor of students' capacity to solve mathematical problems. Nevertheless, few studies explore the influence of both learning independence and IQ on mathematical creative thinking at the same time, highlighting a gap that needs further research.

SMPN 5 Purworejo is a formal secondary education institution. It faces challenges in optimizing the quality of mathematics learning. In particular, the school aims to enhance students' creativity. Preliminary observations showed varied levels of learning independence, with most students in the moderate category. IQ test documentation from a professional psychological institution revealed a wide range of intellectual capacities among students, from below average to high. This situation is serious to investigate. The variations in learning independence and IQ likely contribute significantly to students' mathematical creative thinking skills at the school.

Research Methods

This research used a quantitative method with an ex post facto design, meaning the variables had already happened and were not changed by the researcher. The goal was to see how learning independence (X_1) and IQ (X_2) affect the mathematical creative thinking skills (Y) of seventh-grade students at SMPN 5 Purworejo. The study took place during the first semester of the 2024/2025 school year for three months. It included all seventh-grade students, with a sample of 32 chosen based on available IQ test results from a professional testing service. The tools used were: (1) an essay test to measure math creative thinking, based on four points from Torrance (1974) : fluency, flexibility, elaboration, and originality; (2) a learning independence survey with six points from Zimmerman (2002) : strategy, initiative, goal-setting, evaluation, preparation, and learning behavior; and (3) past IQ test records. Data was collected

with tests, surveys, and document review. Data analysis included descriptive statistics for each variable, checks for basic statistical assumptions, and multiple linear regression with SPSS-25 to study both individual and joint effects of the independent variables, as well as the strength of their relationships (Naufal et al., 2025).

Results and Discussions

Mathematical creative thinking skills were analyzed using four aspects from Torrance (1974) : fluency, flexibility, elaboration, and originality. Each was assessed using set scoring guidelines. Essay test data were analyzed to determine students' tendencies in these skills. Results showed variation in each aspect, highlighting students' ability to generate ideas quickly, view problems from multiple perspectives, elaborate on details, and find unique solutions. Average scores for each aspect appear in Figure 1.

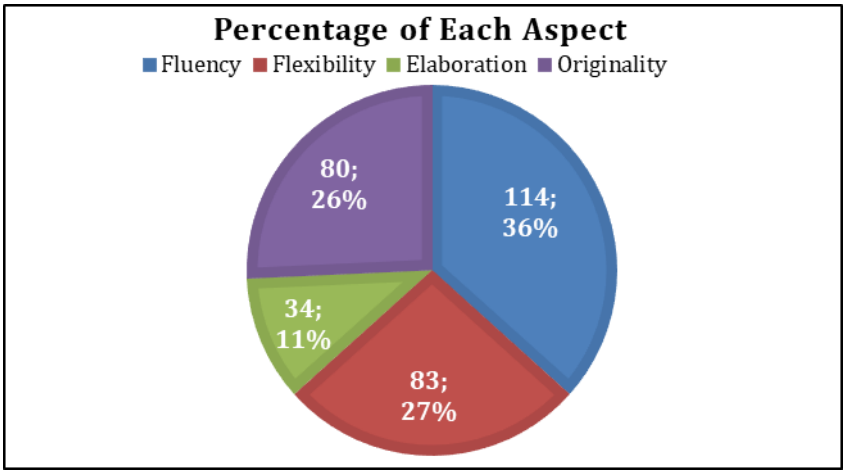

Figure 1. Percentage of Each Aspect of Mathematical Creative Thinking Skills
Source: Results of Analysis of Each Aspect of Mathematical Creative Thinking Skills (2025)

The data show that fluency ranks highest at 36%. Flexibility follows at 27%, originality at 26%, and elaboration is the lowest at 11%. Junior high students generate many ideas, try multiple solutions, and offer original answers. However, they struggle to develop ideas in detail, structure them, and present them comprehensively. This imbalance indicates that their mathematical creative thinking favors producing ideas over thoroughly explaining and refining solutions.

Learning habits and teaching practices contribute to low elaboration. Junior high mathematics often emphasizes getting the correct answer, not offering detailed reasoning. Students rarely explain their reasoning or practice written mathematical communication. As a result, they struggle to expand and clarify ideas. Students usually stop after finding a correct solution, without elaborating further. Teachers need to adopt strategies that emphasize reflective thinking, detailed explanation, and systematic reasoning to improve elaboration skills.

We used a questionnaire to measure learning independence across six main aspects: learning strategies, initiative, goals, evaluation, preparation, and learning

behavior. We analyzed the data to identify how students engage in independent learning. Results varied by aspect. These findings show how students develop responsibility, manage time, seek resources, and assess their own academic progress. Table 1 presents the mean scores for each aspect.

Table 1. Percentage of Each Aspect of Learning Independence

Aspect	Total Score	Mean	Percentage
Learning strategies	488	81,33	16,6%
Learning initiatives	525	75	15,3%
Learning objectives	539	77	15,7%
Learning evaluation	155	77,50	15,8%
Learning preparation	95	95	19,4%
Behavior (self-confidence, responsibility, problem-solving)	590	84,29	17,2%

Source: Results of Analysis of Learning Independence Aspects (2025)

The table data reveals that learning preparation stands out, achieving the highest mean score (95) and a strong 19.4% contribution. This shows students are reliably proactive in readying their tools before activities. However, learning initiative lags, posting the lowest mean (75) and just 15.3%, signaling that students hesitate to seek resources or ask unprompted questions. The remaining aspects—learning strategies, goals, evaluation, and behavior—cluster in the medium range, with means from 77 to 84.29. Altogether, the total mean of 490.12 places learning independence in the medium-to-high range, but initiative clearly needs extra focus. These findings serve as a basis for further analysis using additional data sources.

In addition to test and questionnaire data, this study also utilized documentation of IQ test results previously conducted by a professional psychological institution. Building on the earlier analysis, these data are considered important as they provide an overview of students' cognitive capacity, which is assumed to play a role in the process of mathematical creative thinking. The distribution of students' IQ categories is presented in Table 2.

Table 2. Percentage of Students' IQ Categories

IQ Categories	Total of Students	Percentage
Above Average/Smart	4	12,5%
Below Average/Average	28	87,5%

Source: IQ Test Documentation (2024)

The data in the table above show that most students (87.5%) are in the lower-average/average category. Only 12.5% are in the upper-average/intelligent category. Most students, therefore, have intelligence in the lower-average to average range, with a small group in the upper-average/intelligent range. This distribution is important for the study, as differences in IQ levels may affect students' mathematical creative thinking skills.

Before regression analysis, classical assumption tests were used to check if the model was feasible. Three tests were conducted: a normality test, a multicollinearity test, and a heteroscedasticity test. The normality test checked if residuals were normally distributed. The multicollinearity test detected correlations among independent variables. The heteroscedasticity test confirmed whether residual variance was homogeneous (Affandi et al., 2024; Tarso et al., 2025). Table 3 summarizes the results.

Table 3. Results of Prerequisite Analysis Tests

Test Types	Test Results	Description
Normality (Shapiro-Wilk)	Sig. > 0,05	Residual data is normally distributed
Multicollinearity (Tolerance & VIF)	Tolerance > 0,10; VIF < 10	No multicollinearity
Heteroscedasticity (Glejser)	Sig. > 0,05	No heteroscedasticity

Source: SPSS-25 Data Processing Results (2025)

After we satisfied the prerequisite tests using the results of the classical assumption tests, we performed multiple linear regression analysis. We carried out the regression calculations with the assistance of SPSS-25. The analysis generated several output tables, including the Coefficients table, which provides the multiple linear regression equation along with the t-values and their significance levels; the ANOVA table, which presents the F-value and its significance level; and the Model Summary table, which reports the correlation coefficient (R) and the coefficient of determination (R^2). The following table presents the results of the multiple linear regression analysis and the t-test.

Table 4. Results of Multiple Linear Regression Analysis and t-Test

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-56.819	16.961		-3.350	.002
	Learning Independence (X1)	.804	.043	.978	18.878	.000
	IQ (X2)	.610	.171	.185	3.578	.001

a. Dependent Variable: Mathematical Creative Thinking Skills

Source: SPSS-25 Data Processing Results (2025)

Based on the table above, the multiple linear regression equation obtained is $Y = -56.819 + 0.804X_1 + 0.610X_2$, indicating that the coefficient of X_1 (learning independence) is greater than that of X_2 (IQ). This suggests that an increase in learning independence has a stronger influence on mathematical creative thinking skills than IQ. The constant value of Y (-56.819) means that if both learning independence and IQ are equal to zero, students' mathematical creative thinking skills would be -56.819. This constant value is a statistical extrapolation value, and the main focus is on the positive directional

coefficients (gradients) of X_1 and X2 The coefficient of learning independence (0.804) implies that for every 1-point increase in learning independence, while holding IQ constant, mathematical creative thinking skills increase by 0.804 (80.4%), and vice versa. Similarly, the IQ coefficient (0.610) indicates that for every 1-point increase in IQ, while holding learning independence constant, mathematical creative thinking skills increase by 0.610 (61%), and vice versa.

The results of the partial test (t-test) further reinforce this finding. The variable of learning independence yielded a significance value of 0.000 ($\alpha < 0.05$) with a t-value of 18.878 > t-table 2.04523, while the IQ variable yielded a significance value of 0.001 ($\alpha < 0.05$) with a t-value of 3.578 > t-table 2.04523. Thus, it can be concluded that both learning independence and IQ have a positive and significant partial effect on students' mathematical creative thinking skills. Subsequently, an F-test was conducted to determine the simultaneous effect of learning independence and IQ on mathematical creative thinking skills, as shown below.

Table 5. Results of the F-Test

ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9914.683	2	4957.342	178.200	.000b
	Residual	806.752	29	27.819		
	Total	10721.436	31			

a. Dependent Variable: Mathematical Creative Thinking Skills

b. Predictors: (Constant), IQ, Learning Independence

Source: SPSS-25 Data Processing Results (2025)

Based on Table 7, the sign value is 0.000 ($\alpha < 0.05$) and the calculated f value is 178.200 > ftable 3.33; thus, it is concluded that the independent variables simultaneously or jointly influence the dependent variable. The results of the correlation coefficient and the coefficient of determination can be seen in the following table.

Table 6. Results of the Correlation Coefficient and the Coefficient of Determination

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.962[a]	.925	.920	5.274

a. Predictors: (Constant), IQ, Learning Independence

Source: SPSS-25 Data Processing Results (2025

Based on Table 8, the results of the correlation coefficient with an R value of 0.962 are included in the very high category, so it can be concluded that the independent variables together have a very strong influence on the dependent variable. In addition, the results of the determination coefficient are shown by the R Square (R^2) value of 0.925 or 92.5%, which means that learning independence and IQ simultaneously

contribute 92.5% to students' mathematical creative thinking skills, while the remaining 7.5% is influenced by other variables outside this study.

The findings of this study reveal an uneven distribution across the four aspects of mathematical creative thinking skills, with fluency emerging as the dominant aspect, followed by flexibility and originality, while elaboration remains notably low. This pattern aligns with Torrance's (1974) framework, which emphasizes that creative thinking does not merely involve generating ideas, but also refining and expanding them in meaningful ways. The relatively high fluency score indicates that students are able to produce multiple ideas or responses when faced with mathematical problems. However, the significantly low elaboration score suggests that students struggle to develop these ideas into well-structured and detailed solutions. Similar trends have been reported in previous studies, which found that students often demonstrate surface-level creativity but lack depth in mathematical reasoning and explanation (Molita & Masriyah, 2023; Siswanto et al., 2024). This finding underscores a persistent issue in mathematics education, particularly at the junior high school level, where students are accustomed to procedural problem-solving rather than reflective and elaborative thinking.

The notably low elaboration scores are mainly a result of instructional practices favoring correct answers over reasoning. Teacher-centered instruction and closed-ended questions restrict students' opportunities for deeper expression, as they are rewarded for speed rather than explanation. This study identifies a need for explicit strategies that promote elaboration, such as open-ended tasks and reflective questioning, to foster mathematical communication and metacognitive reflection.

In terms of learning independence, the results indicate that students generally fall into the medium-to-high category, with learning preparation as the strongest aspect and learning initiative as the weakest. This finding is consistent with Zimmerman's (2002) theory of self-regulated learning, which emphasizes that independent learners actively plan, monitor, and evaluate their learning processes. The high score in learning preparation suggests that students are capable of organizing learning tools and meeting basic academic requirements. However, the low initiative score indicates that students are still dependent on teacher direction and lack intrinsic motivation to explore learning resources independently. Previous studies often reported learning independence as a single construct influencing academic achievement, without examining its internal dimensions (Maba et al., 2025; Yulia et al., 2024). By contrast, this study provides a more nuanced understanding of how specific aspects of learning independence relate to creative thinking outcomes.

The analysis reveals that learning independence influences mathematical creative thinking skills more than IQ. This challenges traditional assumptions and highlights that self-regulatory behaviors can drive creativity, even if cognitive ability is only average. The main takeaway is that learning independence is the stronger contributor.

Learning independence and IQ together explain 92.5% of the variance in creative thinking skills, demonstrating a strong combined impact. By integrating both cognitive and non-cognitive factors, this study provides a comprehensive explanation absent in previous single-variable analyses.

The main contribution of this research is its integrated perspective: it analyzes both learning independence and IQ, revealing that independence is dominant even when cognitive ability is controlled. This approach provides new empirical evidence and practical guidance for supporting mathematical creativity, especially regarding the elaboration skill gap.

Conclusions and Suggestions

Based on the results of this study, it can be concluded that learning independence and Intelligence Quotient (IQ) significantly influence students' mathematical creative thinking skills. Learning independence has a more dominant influence than IQ. Together, both factors contribute 92.5% to mathematical creative thinking skills. This shows that students with higher learning independence tend to develop better mathematical creativity, supported by their cognitive capacity. Therefore, it is recommended that mathematics teachers design learning activities that strengthen intellectual skills and encourage learning independence. For example, use project-based assignments, problem-solving activities, and reflective evaluations. Through these efforts, students can optimally improve both their independence and their mathematical creative thinking skills.

Acknowledgement

We would like to thank all reviewers for their valuable comments and suggestions.

References

Affandi, G. R., Hadi, C., Fardana, N. A., Megawati, F., Laili, N., & Rohman, N. M. (2024). Joyful Learning & Media Pembelajaran: Teori dan Penerapannya pada Konteks Pendidikan. Sidoarjo: UMSIDA PRESS.

Ardana, I. M., Ariawan, I. P. W., & Sugiharni, G. A. D. (2021). The expansion of sociocultural theory-oriented mathematical learning model. Cypriot Journal of Educational Sciences, 16(6), 3016–3032. https://doi.org/10.18844/cjes.v16i6.6493

Borup, J., Graham, C. R., West, R. E., Archambault, L., & Spring, K. J. (2020). Academic Communities of Engagement: an expansive lens for examining support structures in blended and online learning. Educational Technology Research and Development, 68(2), 807–832. https://doi.org/https://doi.org/10.1007/s11423-020-09744-x

Daskova, Y. V., Poliakova, I. V., Vasilenko, S. A., Goltseva, O. S., Belyakova, T. E., Shevalie, K. N., & Vasilenko, E. V. (2020). Development of Creative Independence of Design Students in Course of Higher Education. Propósitos y Representaciones, 8(2), 1–12. https://doi.org/10.20511/pyr2020.v8nspe2.637

Goyibova, N., Muslimov, N., Sabirova, G., Kadirova, N., & Samatova, B. (2025). Differentiation approach in education: Tailoring instruction for diverse learner needs. MethodsX, 14(January), 103163. https://doi.org/10.1016/j.mex.2025.103163

Kathirisetty, N., Jadeja, R., Garg, D., & Thakkar, H. K. (2022). On the Design of Student Assessment Model Based on Intelligence Quotient Using Machine Learning. IEEE Access, 10, 48733–48746. https://doi.org/10.1109/ACCESS.2022.3171807

Kholisoh, L., Lismawati, L., Sutarsana, S., Kharismawan, D., & Herliana, E. (2023). The Effect Of The Activist Teacher Education Program On Improving The Quality Of Teacher Education. Proceeding Of International Conference On Education, Society And Humanity, 1(1), 244–255.

Kornilova, T. V., Chumakova, M. A., & Maksarova, L. B. (2025). Intelligence Types Predict Diff erent Domains of Emotional Creativity Th rough Self-Assessed Creativity and Intelligence Tatiana. Psychology in Russia: State of the Art, 18(1), 60–82. https://doi.org/10.11621/pir.2025.0104

Limori, M., Siswanto, D. H., Shigematsu, T., & Astiwi, W. (2025). Integrating STEAM in Teaching Integrals: An Interactive Media Needs Analysis to Enhance Creative Thinking. RUKASI: Jurnal Ilmiah Perkembangan Penedidikan Dan Pembelajaran, 02(05), 220–233. https://doi.org/10.70294/59c2b980

Maba, M. M. A., Siswanto, D. H., & Caesaria, N. Z. (2025). Ethnomathematical Exploration of the Apem Wonolelo Tradition in Sleman Regency. Jurnal Padamu Negeri, 2(4), 161–171. https://doi.org/10.69714/x4xp7f07

Martín-Cudero, D., Cid-Cid, A. I., & Guede-Cid, R. (2024). Analysis of Mathematics Education from a Steam Approach at Secondary and Pre-Universitary Educational Levels: A Systematic Review. Journal of Technology and Science Education, 14(2), 507–528. https://doi.org/10.3926/jotse.2349

Molita, A., & Masriyah, M. (2023). Junior High School Students Creative Thinking Ability In Solving Open Ended Problems On Straight-Line Equations From Gender. Edumaspul: Jurnal Pendidikan, 7(1), 822–832. https://doi.org/10.33487/edumaspul.v7i1.5660

Mulyani, R., & Lubis, R. S. (2024). The Effect of Intellectual Intelligence (IQ) and Emotional Intelligence (EQ) on Student Mathematics Learning Outcomes. Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram, 12(2), 354. https://doi.org/10.33394/j-ps.v12i2.11225

Musullulu, H. (2025). Evaluating attention deficit and hyperactivity disorder (ADHD): a review of current methods and issues. Frontiers in Psychology, 16(February), 1–21. https://doi.org/10.3389/fpsyg.2025.1466088

Naufal, N., Apriani, F., Fajriana, Nurdin, Nurdin, K., & Siswanto, D. H. (2025). Analisis Multivariat. Padang: Literasi Langsung Terbit.

Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. Zentralblatt Für Didaktik Der Mathematik, 29(3), 75–80. https://doi.org/10.1007/s11858-997-0003-x

Siswanto, D. H., Alghiffari, E. K., & Andriyani. (2024). Development of Creative Thinking Evaluation Tool Utilizing Microsoft Sway Application in the Context of Pythagorean Theorem Material. Al Khawarizmi, 8(1), 33–48. https://doi.org/10.22373/jppm.v8i1.23059

Syarqia, L., Suyatna, A., & Suana, W. (2024). Implementing Differentiated Learning Using the Problem-Based Learning Model to Stimulate Students' Problem-Solving Skills. Asian Journal of Science Education, 6(1), 145–154. https://doi.org/10.24815/ajse.v6i1.36928

Tarso, Kasanah, H. U., Purwanto, E., Siswanto, D. H., & Khasanah, N. R. (2025). An empirical study on teacher performance: The effects of commitment, professionalism, and school principal Supervision in Sleman Regency. JUPERAN: Jurnal Penedidikan Dan Pembelajaran, 04(02), 750–759.

Torrance, P. E. (1974). Torrance Test of Creative Thinking: Norm Technical Manual. Bensenville: Scholastic Testing Inc.

Yulia, Y., Kustati, M., & Afriadi, J. (2024). Analyze of students' mathematical disposition and learning independence through blended learning: A study in West Sumatra, Indonesia. Al-Jabar: Jurnal Pendidikan Matematika, 15(1), 145–157. https://doi.org/10.24042/ajpm.v15i1.21209

Yuniara, R., Saminan, S., Abidin, Z., & Johar, R. (2023). Students' Mathematical Problem Solving Ability Based on The Steps of Ideal Problem Solving Viewed From Adversity Quotient (AQ). Al Khawarizmi: Jurnal Pendidikan Dan Pembelajaran Matematika, 7(1), 36–47. https://doi.org/10.22373/jppm.v7i1.18211

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. Theory Into Practice, 41(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2