EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

THE EFFECT OF GAMES IN THE GASING METHOD ON MATHEMATICAL CREATIVE THINKING ABILITY OF JUNIOR HIGH SCHOOL STUDENTS

Abu Moh. Rasyid Ridho[1], Al Jupri[2*], Sumanang Muhtar Gozali[3]
Department of Mathematics Education, Universitas Pendidikan Indonesia
Email: aljupri@upi.edu

Diterima: *29/09/2026*; Direvisi: *08/10/2026*; Diterbitkan: *21/10/2026*

ABSTRAK

Kemampuan berpikir kreatif matematis penting dikembangkan karena siswa tidak hanya dituntut memperoleh jawaban, tetapi juga menghasilkan beragam strategi dan representasi dalam menyelesaikan masalah. Penelitian ini bertujuan menganalisis pengaruh permainan dalam metode GASING terhadap kemampuan berpikir kreatif matematis siswa SMP pada materi perkalian bilangan bulat serta mendeskripsikan profil kemampuan berdasarkan indikator kreativitas. Penelitian menggunakan *mixed methods* dengan desain *sequential explanatory*, melibatkan 49 siswa kelas VII dari dua SMP negeri di Kabupaten Lembata, Nusa Tenggara Timur, yang terdiri atas 24 siswa kelas eksperimen dan 25 siswa kelas kontrol. Data dikumpulkan melalui tes berpikir kreatif matematis, wawancara semiterstruktur, dan observasi. Instrumen tes divalidasi oleh empat ahli dengan skor rata-rata 3,54 dari 4,00 dan reliabilitas Cronbach's alpha 0,907. Hasil menunjukkan perbedaan signifikan antara kelas eksperimen dan kontrol ($t(44{,}373) = 2{,}476$; $p = 0{,}017$; $d = 0{,}71$), dengan *N-gain* masing-masing 0,35 dan 0,23. Profil kreativitas menunjukkan originality 54,17%, fluency 45,83%, elaboration 40,63%, dan flexibility 33,33%. Dengan demikian, permainan dalam metode GASING menunjukkan potensi sebagai pendekatan pembelajaran yang mendukung perkembangan berpikir kreatif matematis siswa.

Kata kunci: *berpikir kreatif matematis*; *GASING*; permainan matematika; perkalian bilangan bulat; siswa SMP.

ABSTRACT

Mathematical creative thinking is important because students need not only to obtain correct answers but also to generate varied strategies and representations when solving problems. This study aimed to examine the effect of games integrated into the GASING method on junior high school students' mathematical creative thinking ability in integer multiplication and to describe their creative thinking profiles across indicators. A *mixed methods* approach with a *sequential explanatory* design was employed with 49 Grade VII students from two public junior high schools in Lembata Regency, East Nusa Tenggara, comprising 24 students in the experimental class and 25 in the control class. Data were collected through a mathematical creative thinking test, semi-structured interviews, and classroom observation. The test was validated by four experts, obtaining a mean score of 3.54 out of 4.00 and a Cronbach's alpha reliability coefficient of 0.907. The results showed a significant difference between the groups ($t(44.373) = 2.476$, $p = .017$, $d = 0.71$), with *N*-gains of 0.35 and 0.23, respectively. The creative thinking profile showed originality (54.17%), fluency (45.83%), elaboration (40.63%), and flexibility (33.33%). Thus, games integrated into the GASING method show potential for supporting students' mathematical creative thinking.

Keywords: mathematical games; GASING method; mathematical creative thinking; integer multiplication; mixed methods; 3T education

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

INTRODUCTION

Mathematical creative thinking is an important component of mathematics education because students need to do more than obtain correct answers; they also need to generate different strategies, representations, and approaches when solving problems. Creative thinking in mathematics is associated with students' ability to produce ideas and solutions that are varied and appropriate to a given problem. Previous studies have shown that mathematical learning can support creativity when students are provided with opportunities to explore, construct, and communicate mathematical ideas (Faiziyah et al., 2020; Sahliawati & Nurlaelah, 2020). More recent research also indicates that students' creative thinking is influenced by factors such as creative self-efficacy, attitudes, and learning environments that provide opportunities for creative engagement (Suherman & Vidákovich, 2025). Therefore, mathematics instruction should provide learning experiences that encourage students to explore alternative solutions rather than rely primarily on routine procedures.

The need to strengthen students' mathematical thinking is particularly relevant in the Indonesian context. The PISA 2022 results reported that Indonesian students obtained a mathematics score of 366, which remained below the OECD average and reflected persistent challenges in mathematical literacy (OECD, 2023). Previous research has also identified difficulties among Indonesian students in dealing with mathematical problems that require reasoning and the application of mathematical concepts in unfamiliar situations (Masfufah & Afriansyah, 2021). These conditions indicate the need for learning approaches that move beyond procedural practice and provide students with opportunities to explore mathematical ideas in meaningful and challenging situations. Such opportunities are especially important for students in geographically disadvantaged areas, where access to learning resources and instructional innovations may be more limited.

One potential approach is game-based learning. Games can create learning situations that encourage students to actively engage with mathematical problems, receive immediate feedback, and attempt different strategies. A meta-analysis by Byun and Joung (2018) found positive contributions of digital game-based learning to K–12 mathematics education, while a systematic review by Hussein et al. (2022) showed that game-based learning has been increasingly applied to support mathematical learning across different educational levels. Game-based learning has also been associated with cognitive and affective outcomes, including students' engagement and learning motivation (Hui & Mahmud, 2023). In addition, educational game design can provide opportunities for students to generate and develop creative ideas (Bulut et al., 2022; Huang et al., 2025). These findings suggest that games may provide an appropriate learning environment for developing mathematical creative thinking when the game activities are deliberately connected to mathematical objectives.

The potential of games is also evident in mathematics learning activities involving direct interaction with mathematical concepts. For example, Liu and Cheung Tse (2023) reported that a mathematical game could support students' calculation abilities, while Vitoria et al. (2020) demonstrated the use of a snakes-and-ladders game to support students' understanding of angle measurement. Furthermore, game-based learning has been shown to support higher-order thinking processes. Mao et al. (2022), through a meta-analysis, found that game-based learning can contribute to students' critical thinking development. However, the effectiveness of games depends not only on their entertaining characteristics but also on how game activities are designed and connected to learning objectives. Games that provide opportunities for students to explore different solutions and make decisions may offer greater potential for developing creative mathematical thinking.

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

In this context, the GASING method provides a complementary instructional framework because it emphasizes meaningful mathematical experiences through a progression from concrete activities toward more abstract mathematical understanding. Integrating games into the GASING method can provide students with opportunities to practice mathematical concepts in an active and enjoyable setting while maintaining a structured progression of learning activities. This integration is potentially relevant to integer multiplication, a topic that requires students to understand positive and negative quantities as well as relationships among different sign combinations. Rather than presenting integer multiplication only through symbolic procedures, game activities can provide contextual situations in which students repeatedly apply and interpret these operations.

Although previous studies have examined game-based learning in mathematics and its relationship with students' cognitive and creative outcomes, limited attention has been given to the integration of games within the GASING method to develop mathematical creative thinking. In particular, evidence from geographically, remotely, and disadvantaged areas remains limited. Existing studies have also tended to emphasize quantitative learning outcomes, while students' performance on specific dimensions of mathematical creativity and their actual responses during learning activities have received less attention. This creates a research gap concerning how an integrated game-and-GASING approach may influence mathematical creative thinking and how students demonstrate different creative thinking indicators during the learning process.

Therefore, this study aimed to examine the difference in mathematical creative thinking ability between students who learned integer multiplication through games integrated into the GASING method and those who received conventional instruction. The study also aimed to describe students' mathematical creative thinking profiles based on four indicators: fluency, flexibility, originality, and elaboration. A sequential explanatory mixed-methods design was employed to combine quantitative evidence of learning outcomes with qualitative information from students' written responses, interviews, and classroom observations. The study is expected to provide empirical evidence concerning the use of game-integrated GASING instruction for developing mathematical creative thinking, particularly in a 3T educational context.

METHODS

This study employed a mixed-methods approach using a sequential explanatory design, in which quantitative data were collected and analyzed first and subsequently complemented by qualitative data to provide a deeper explanation of the quantitative findings (Creswell & Plano Clark, 2018). The quantitative phase used a quasi-experimental design with a nonequivalent control-group structure involving pretests, instructional treatment, and posttests. The study was conducted at two public junior high schools in Lembata Regency, East Nusa Tenggara. The participants were 49 Grade VII students, consisting of 24 students in the experimental group and 25 students in the control group. The classes were selected purposively based on the equivalence of the classes and accessibility of the schools. The learning intervention was conducted in four instructional sessions, with each session incorporating a different mathematical game related to integer multiplication.

The experimental group received learning through games integrated into the GASING method. The games were designed to address different combinations of integer multiplication. The first session used a hand-gesture game to represent positive multiplied by positive numbers. The second session used mathematical puzzles to represent positive multiplied by negative numbers. The third session used a mathematical snakes-and-ladders game to address negative

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

multiplied by positive and negative multiplied by negative numbers. The fourth session used mathematical ludo to integrate all sign combinations. The control group learned the same mathematical content through conventional instruction without the game-integrated GASING activities. The qualitative phase involved analysis of written responses from all 24 students in the experimental group and semi-structured interviews with three students representing high, moderate, and low posttest performance. Classroom observations and an interview with the teacher were also used to provide additional information about students' learning processes. The study was conducted with the permission of the participating schools, and informed consent was obtained from the participants.

The main instrument was a mathematical creative thinking test consisting of four open-ended constructed-response items. Each item was designed to assess one creative thinking indicator: fluency, flexibility, originality, or elaboration. The items were contextualized through situations involving integer operations, including changes in elevation, temperature, game scores, and the construction of a tower. Additional instruments consisted of a semi-structured interview guide and a classroom observation checklist. The test was reviewed by four experts, comprising two mathematics education lecturers and two experienced junior high school mathematics teachers. The expert validation produced a mean score of 3.54 out of 4.00. The items met the required validity criteria, with the calculated correlation coefficients exceeding the critical value of 0.456, and the items demonstrated acceptable difficulty and discrimination levels. The reliability analysis produced a Cronbach's alpha coefficient of 0.907, indicating high internal consistency.

Quantitative data were analyzed using descriptive and inferential statistics. The analysis began with descriptive statistics to identify students' pretest and posttest performance. Normality was examined using the Shapiro–Wilk test, while homogeneity of variance was assessed using Levene's test. Because the data did not fully satisfy the normality assumption and the group variances were unequal, the Welch independent-samples *t*-test was used to examine the difference between the experimental and control groups at a significance level of 0.05. Cohen's *d* was calculated to estimate the magnitude of the difference between groups. Learning improvement was also examined using normalized gain (N-gain). Qualitative data were analyzed through data reduction, data display, and conclusion drawing following Miles and Huberman (1994). The quantitative findings were subsequently interpreted together with students' written responses, interview data, and classroom observations to provide a more comprehensive explanation of the students' mathematical creative thinking.

RESULTS AND DISCUSSION

Results

Students' Mathematical Creative Thinking Ability

The quantitative analysis first examined the students' mathematical creative thinking performance before and after the instructional intervention. Pretest and posttest scores were compared to identify changes in the experimental and control groups. Table 1 presents the descriptive statistics for both groups.

Table 1. Descriptive Statistics of Mathematical Creative Thinking Scores

Group	n	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Posttest Min	Posttest Max
Experimental	24	13.02	14.50	43.49	18.93	18.75	81.25
Control	25	10.50	11.93	31.25	15.42	12.50	93.75

The results show that both groups improved after instruction, but the increase was greater in the experimental group. The experimental group increased from a mean pretest score

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

of 13.02 to 43.49, representing an increase of 30.47 points. In comparison, the control group increased from 10.50 to 31.25, representing an increase of 20.75 points. To provide a more comparable description of improvement, the normalized gain was calculated for each group. The results are presented in Table 2.

Table 2. Normalized Gain of Mathematical Creative Thinking

Group	Pretest Mean	Posttest Mean	N-gain	Interpretation
Experimental	13.02	43.49	0.35	Moderate
Control	10.50	31.25	0.23	Low

The experimental group obtained an N-gain of 0.35, which was categorized as moderate, whereas the control group obtained an N-gain of 0.23, categorized as low. The difference indicates that students receiving game-integrated GASING instruction showed greater improvement in mathematical creative thinking than students receiving conventional instruction. However, the magnitude of improvement remained moderate, indicating that the four instructional sessions did not produce a high level of normalized gain.

Difference Between the Experimental and Control Groups

An inferential analysis was conducted to determine whether the difference in posttest mathematical creative thinking performance between the two groups was statistically significant. Preliminary assumption testing showed that the experimental group had a Shapiro–Wilk significance value of .025 and the control group had a value below .001, indicating that the data did not fully meet the normality assumption. Levene's test also produced a significance value of .028, indicating unequal variances; therefore, the Welch *t*-test was used.

Table 3. Welch *t*-Test of Posttest Mathematical Creative Thinking

Statistic	Value
t	2.476
df	44.373
p	.017
Cohen's *d*	0.71
Effect size	Large

The Welch *t*-test produced a value of $t(44.373) = 2.476$ with $p = .017$. Because the significance value was below .05, the posttest performance differed significantly between the experimental and control groups. The Cohen's *d* value of 0.71 indicates a large standardized difference between the groups.

Mathematical Creative Thinking by Indicator

The analysis was further conducted to identify the achievement of the four mathematical creative thinking indicators among students in the experimental group. This analysis was intended to determine whether students demonstrated similar levels of performance across fluency, flexibility, originality, and elaboration. Table 4 presents the achievement of each indicator.

Table 4. Achievement of Mathematical Creative Thinking Indicators

Indicator	Total Score	Maximum Score	Achievement (%)	Category
Fluency	44	96	45.83	Moderate
Flexibility	32	96	33.33	Low
Originality	52	96	54.17	Moderate
Elaboration	39	96	40.63	Low

The highest achievement was found in originality, with 54.17%, followed by fluency at 45.83%. Elaboration reached 40.63%, while flexibility had the lowest achievement at 33.33%. These findings indicate that students demonstrated greater ability to produce relatively original

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

responses and multiple responses than to shift between solution approaches or develop solutions in greater detail.

The distribution of students' scores for each indicator was then examined to provide a more detailed description of their performance. Table 5 shows the distribution of students according to the scores obtained for each indicator.

Table 5. Distribution of Students' Scores on Creative Thinking Indicators

Indicator	Score 0	Score 1	Score 2	Score 3	Score 4
Fluency	1	9	8	5	1
Flexibility	0	17	6	1	0
Originality	0	10	3	8	3
Elaboration	0	13	7	4	0

The distribution shows that flexibility had the largest concentration of students at score 1, with 17 students obtaining this score. Originality showed a more varied distribution, including three students who reached the highest score of 4. Fluency and elaboration were concentrated primarily at the lower and middle score levels, indicating that most students had begun to demonstrate these abilities but had not yet consistently produced highly developed responses.

Students' Fluency Responses

The quantitative results were complemented by an analysis of students' written responses to examine how creative thinking was expressed during problem solving. The first qualitative analysis focused on fluency, particularly students' ability to produce and communicate mathematically relevant responses. A representative response is presented in Table 6.

Table 6. Representative Student Response for the Fluency Indicator

Item	Representative Response	Analysis
Mountaineer problem	The student identified the multiplication operation and attempted to calculate the total vertical distance traveled during the five-hour descent.	The student demonstrated an appropriate solution strategy and recognized the relationship between rate and time, although an arithmetic error occurred in the final calculation.

The response indicates that the student was able to identify an appropriate mathematical operation for the situation. However, the final computation was inaccurate because the student calculated 120 × 5 as 700 instead of 600. This suggests that the student's mathematical reasoning was present, but computational accuracy remained an issue in expressing the solution completely.

Students' Flexibility Responses

The flexibility indicator was examined through students' responses to a temperature-change problem that required them to consider different changes over time. The task was intended to provide an opportunity for students to move beyond a single direct procedure. A representative response is presented in Table 7.

Table 7. Representative Student Response for the Flexibility Indicator

Item	Representative Response	Analysis
Temperature-change problem	The student separated the temperature decrease and increase during the specified hours but did not provide another solution approach.	The response showed partial understanding of the changes in the situation, but the student did not demonstrate sufficient variation in mathematical strategies.

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

The response shows that the student could distinguish between decreasing and increasing temperature changes. Nevertheless, the solution remained limited to one approach and contained an error in determining the sequence of hourly changes. The finding is consistent with the relatively low overall achievement of the flexibility indicator.

Students' Originality Responses

Originality was analyzed through students' responses to a game-score problem involving positive points for successful catches and negative points for unsuccessful attempts. The task allowed students to interpret the scoring situation and construct a mathematical solution. A representative response is shown in Table 8.

Table 8. Representative Student Response for the Originality Indicator

Item	Representative Response	Analysis
Fishing-game problem	The student calculated the score as $(7 \times 9) + (6 \times -3) = 45$ and provided one solution.	The student correctly represented the positive and negative scores but did not provide an alternative or more distinctive solution.

The response demonstrates that the student understood how positive and negative values were involved in the scoring system. However, only one solution strategy was provided, limiting the extent to which the response demonstrated originality. Among the 24 experimental students, three students obtained the highest originality score, representing 12.5% of the group.

Students' Elaboration Responses

The elaboration indicator was examined through a tower-building problem requiring students to account for both increases and decreases in height over time. The task required students to explain the sequence of changes rather than only calculate a final value. A representative response is presented in Table 9.

Table 9. Representative Student Response for the Elaboration Indicator

Item	Representative Response	Analysis
Tower-building problem	The student calculated the increase as $4 \times 5 = 20$ but did not incorporate the 1 cm reduction caused by a falling block.	The response captured part of the mathematical process but did not fully elaborate the sequence of changes required by the problem.

The response indicates that the student recognized the repeated increase in height but overlooked the decrease caused by the falling block. In the interview, the student was able to explain the sequence orally, including the changes from 15 to 14 cm and from 19 to 18 cm. This difference indicates that some mathematical understanding was expressed more clearly through oral explanation than through written responses.

Teacher's Observation of Students' Learning

The teacher interview and classroom observations provided additional information about students' responses during the game-integrated GASING instruction. The teacher reported that students attempted several approaches, including using number lines, tables, and direct calculations when solving integer multiplication problems. The teacher also observed that the snakes-and-ladders and ludo activities encouraged students to participate more actively, while some previously quiet students became more willing to respond during the games.

Overall, the qualitative findings support the quantitative results while showing that the development of mathematical creative thinking was not uniform across indicators. Students demonstrated relatively stronger performance in originality and fluency than in flexibility and elaboration. The qualitative responses also revealed that some students possessed partial

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

mathematical understanding but experienced difficulties in computational accuracy, producing alternative strategies, and communicating detailed reasoning in written form.

Discussion

The findings demonstrate that games integrated into the GASING method were associated with better mathematical creative thinking performance than conventional instruction. The experimental group increased its mean score from 13.02 to 43.49, while the control group increased from 10.50 to 31.25. The N-gain was also higher in the experimental group (0.35) than in the control group (0.23), indicating a greater improvement in mathematical creative thinking among students who experienced the game-integrated learning activities. This difference was statistically significant, with Welch's $t(44.373) = 2.476$ and $p = .017$, while the effect size ($d = 0.71$) indicated a substantial difference between the groups. These findings suggest that the combination of structured mathematical learning and game activities can provide a more supportive learning environment for developing creative responses than conventional instruction alone.

The result is consistent with previous research showing that games can contribute to students' cognitive and creative development when they are designed as part of the learning process. Byun and Joung (2018) reported positive effects of digital game-based learning in K–12 mathematics education, while Hussein et al. (2022) found that game-based learning has been widely used to support mathematical learning and engagement. Bulut et al. (2022) further showed that the educational game design process can contribute to the development of creativity. More recent evidence indicates that specific game-design characteristics, particularly challenge and autonomy, can support creative performance through students' engagement and creative self-efficacy (Huang et al., 2025). Thus, the improvement observed in the present study is not simply attributable to the presence of games, but can be understood in relation to the opportunity provided by the games for students to actively engage with mathematical situations, make decisions, and repeatedly apply mathematical concepts.

The use of several games across the four instructional sessions also appears to be important. The experimental treatment did not rely on a single game but employed hand gestures, mathematical puzzles, snakes and ladders, and mathematical ludo to address different combinations of integer multiplication. Such variation allowed students to encounter the same mathematical concept through different activity structures. This is relevant because game-based learning can support mathematics learning when game mechanics are connected to specific learning objectives rather than used only as entertainment (Hussein et al., 2022; Hui & Mahmud, 2023). The present findings therefore strengthen the argument that instructional games should be designed around the mathematical content and expected learning outcomes. The games in this study provided repeated opportunities for students to work with positive and negative numbers while simultaneously engaging in an active learning environment.

The improvement in the experimental group was also accompanied by differences across the four creative thinking indicators. Originality obtained the highest achievement (54.17%), followed by fluency (45.83%), elaboration (40.63%), and flexibility (33.33%). This pattern indicates that the intervention was more successful in encouraging students to produce responses and recognize possible ideas than in requiring them to shift systematically between different strategies or elaborate their solutions in detail. This finding is important because mathematical creativity is multidimensional and should not be represented only by the number of correct answers. Vale and Barbosa (2024) emphasized that rich and challenging mathematical tasks can provide opportunities for students to demonstrate dimensions of

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

creativity, including fluency, flexibility, and originality. Therefore, the relatively different achievement across indicators suggests that the mathematical tasks embedded in the games may have provided stronger stimulation for some dimensions of creativity than for others.

The relatively high originality score can be related to the characteristics of the game activities used in the experimental class. Games such as mathematical puzzles, snakes and ladders, and ludo required students to respond to changing situations and apply integer operations within different contexts. These conditions may have encouraged students to generate responses that were not limited to a single routine procedure. Bulut et al. (2022) showed that the design of educational games is relevant to students' creative development, while Huang et al. (2025) demonstrated that game features such as challenge and autonomy can enhance creative performance. In the present study, the opportunity to make decisions during game activities may therefore have contributed to students' relatively stronger originality performance.

Fluency also reached a moderate level, although the qualitative findings show that fluency was not always accompanied by computational accuracy. One student, for example, identified the appropriate multiplication strategy in the mountaineer problem but incorrectly calculated 120×5 as 700. This finding indicates that students may be able to identify an appropriate mathematical relationship without being able to communicate a fully accurate solution. Consequently, the presence of an appropriate strategy should not automatically be interpreted as complete mastery of mathematical creative thinking. The learning activities need to provide opportunities for students to generate ideas and subsequently verify the accuracy and mathematical consistency of those ideas.

In contrast, flexibility and elaboration remained relatively weak. Flexibility reached only 33.33%, with 17 of the 24 experimental students obtaining a score of 1, while elaboration reached 40.63%. The qualitative responses showed that students often relied on a single approach and did not sufficiently develop the details of their reasoning. This finding suggests that game activities alone are not sufficient to develop all dimensions of mathematical creativity. Rich mathematical tasks must explicitly require students to compare strategies, construct alternative solutions, explain their reasoning, and extend an initial solution. Vale and Barbosa (2024) similarly highlighted the importance of rich and challenging mathematical tasks in creating opportunities for different dimensions of creative thinking. Therefore, future implementation of game-integrated GASING learning should incorporate explicit prompts for alternative strategies and detailed mathematical explanations rather than focusing primarily on obtaining answers during gameplay.

The qualitative findings also reveal an important difference between students' oral and written mathematical communication. In the elaboration task, for example, the student's written response did not fully account for the decrease in tower height, whereas the interview response showed that the student could explain part of the sequence orally. This finding suggests that students' mathematical understanding may not always be completely represented by written responses alone. The result is consistent with the importance of providing appropriate learning support and scaffolding for creativity development. Maksić and Jošić (2021) found that students recognize the importance of educational support, particularly cognitive scaffolding, in developing creative thinking. In the present study, teacher guidance during the games may therefore have supported students' emerging understanding, while the written test placed an additional demand on students to organize and communicate their reasoning independently.

The findings also reinforce the importance of designing learning environments that support creativity rather than assuming that an enjoyable learning activity will automatically

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

produce creative thinking. Hui and Mahmud (2023) emphasized that game-based learning in mathematics can influence both cognitive and affective aspects of learning, while Mao et al. (2022) found positive effects of game-based learning on higher-order thinking. However, the present study shows that the development of specific creative thinking indicators requires more targeted instructional design. The games successfully created active mathematical experiences, but flexibility and elaboration required stronger and more explicit cognitive demands. Thus, the main contribution of the present study is not merely demonstrating that games can be used in mathematics learning, but showing that integrating games with a structured mathematical approach can improve overall creative thinking while still leaving particular creative dimensions in need of further instructional support.

The context of the study is also important. The intervention was implemented in two public junior high schools in Lembata Regency, an area characterized by limitations in educational accessibility. Within this context, the use of relatively simple games that did not depend heavily on digital infrastructure provided a practical alternative for creating more active mathematical learning experiences. The results indicate that instructional innovation does not necessarily require sophisticated technological resources. What is more important is the alignment between the game structure, mathematical content, and intended cognitive outcomes. This finding is particularly relevant for schools where access to digital learning resources remains constrained.

Nevertheless, the results should be interpreted within the boundaries of the study. The intervention consisted of only four instructional sessions and focused on integer multiplication among Grade VII students. The experimental and control groups were also selected without random assignment, and their initial mean scores were not identical. Therefore, the significant posttest difference should be interpreted as evidence of a difference under the conditions of this study rather than as definitive proof that the game-integrated GASING approach alone caused all observed improvement. Longer interventions, broader mathematical topics, larger samples, and stronger experimental controls are needed to establish the consistency and generalizability of the findings.

Overall, the study indicates that integrating games into the GASING method can provide a meaningful learning environment for supporting mathematical creative thinking among junior high school students. The strongest development was observed in originality and fluency, whereas flexibility and elaboration remained comparatively limited. The findings imply that future game-integrated mathematics instruction should retain the active and engaging characteristics of games while adding explicit tasks that require students to generate multiple strategies, compare different approaches, and elaborate mathematical reasoning. In this way, games can function not only as motivational activities but also as structured learning tools for developing broader dimensions of mathematical creativity.

CONCLUSION

The study concludes that integrating games into the GASING method provided a more supportive learning experience for developing students' mathematical creative thinking than conventional instruction. The students who participated in game-integrated GASING learning demonstrated greater improvement in solving integer multiplication problems and showed more active engagement in generating mathematical responses. The findings indicate that games can function not merely as an enjoyable learning activity but also as a meaningful context for practicing mathematical concepts and encouraging students to explore different ways of thinking.

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
Vol. 6, No. 4, Oktober-Desember 2026
e-ISSN : 2807-8659 | p-ISSN : 2807-8829
Online Journal System : https://jurnalp4i.com/index.php/educator

The development of mathematical creative thinking, however, was not equal across all indicators. Students showed stronger performance in originality and fluency, while flexibility and elaboration remained less developed. This finding indicates that game-based activities need to be accompanied by learning tasks that explicitly encourage students to produce alternative strategies, compare different solutions, and explain their mathematical reasoning in greater detail. Therefore, the integration of games with the GASING method has potential as an instructional approach for supporting mathematical creative thinking, particularly when game activities are deliberately designed to address broader dimensions of creativity.

REFERENCES

Bulut, D., Samur, Y., & Cömert, Z. (2022). The effect of educational game design process on students' creativity. *Smart Learning Environments, 9*(1), Article 8. https://doi.org/10.1186/s40561-022-00188-9

Byun, J., & Joung, E. (2018). Digital game-based learning for K–12 mathematics education: A meta-analysis. *School Science and Mathematics, 118*(3–4), 113–126. https://doi.org/10.1111/ssm.12271

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Thousand Oaks, CA: SAGE Publications.

Faiziyah, N., Sholihah, I., Wulandari, S., & Yudha, D. A. (2020). Enhancing creativity through ethnomathematics. *Universal Journal of Educational Research, 8*(8), 3704–3710. https://doi.org/10.13189/ujer.2020.080850

Huang, S., Qian, M., & Gao, Q. (2025). The effects of game design on students' creative performance in video game environments. *Thinking Skills and Creativity, 59*, Article 102009. https://doi.org/10.1016/j.tsc.2025.102009

Hui, H. B., & Mahmud, M. S. (2023). Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review. *Frontiers in Psychology, 14*, Article 1105806. https://doi.org/10.3389/fpsyg.2023.1105806

Hussein, M. H., Ow, S. H., Elaish, M. M., & Jensen, E. O. (2022). Digital game-based learning in K–12 mathematics education: A systematic literature review. *Education and Information Technologies, 27*(2), 2859–2891. https://doi.org/10.1007/s10639-021-10721-x

Kholid, M. N., Mahmudah, M. H., Ishartono, N., Putra, F. G., & Forthmann, B. (2024). Classification of students' creative thinking for non-routine mathematical problems. *Cogent Education, 11*(1), Article 2394738. https://doi.org/10.1080/2331186X.2024.2394738

Liu, Y., & Cheung Tse, A. W. (2023). The influence of digital game-based learning with a mathematical game on calculation abilities of Grade 3–4 students: A case study. *2023 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)*, 1–8. https://doi.org/10.1109/TALE56641.2023.10398294

Maksić, S., & Jošić, S. (2021). Scaffolding the development of creativity from the students' perspective. *Thinking Skills and Creativity, 41*, Article 100835. https://doi.org/10.1016/j.tsc.2021.100835

Mao, W., Cui, Y., Chiu, M. M., & Lei, H. (2022). Effects of game-based learning on students' critical thinking: A meta-analysis. *Journal of Educational Computing Research, 59*(8), 1682–1708. https://doi.org/10.1177/07356331211007098

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122

Masfufah, R., & Afriansyah, E. A. (2021). Analisis kemampuan literasi matematis siswa melalui soal PISA [Analysis of students' mathematical literacy ability through PISA items]. *Mosharafa: Jurnal Pendidikan Matematika, 10*(2), 291–300. https://doi.org/10.31980/mosharafa.v10i2.662

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). SAGE Publications.

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing. https://doi.org/10.1787/53f23881-en

Presidential Regulation No. 63 of 2020 on the designation of underdeveloped regions 2020–2024. (2020). Secretariat of State of the Republic of Indonesia.

Romaito, P., Safitri, I., Sarida, H., Nisah, H., Apriani, D., Afsari, S., Dwichanda, O., & Lucky, Y. (2021). The mathematics learning using GeoGebra software to improve students' creative thinking ability. *Journal of Physics: Conference Series, 1819*(1), Article 012008. https://doi.org/10.1088/1742-6596/1819/1/012008

Sugiyono. (2017). Metode penelitian kuantitatif, kualitatif, dan R&D [Quantitative, qualitative, and R&D research methods]. Bandung: CV. Alfabeta.

Sahliawati, M., & Nurlaelah, E. (2020). Mathematical creative thinking ability in middle school students. *Journal of Physics: Conference Series, 1469*(1), Article 012145. https://doi.org/10.1088/1742-6596/1469/1/012145

Suherman, S., & Vidákovich, T. (2025). Creative self-efficacy, attitudes, creative style, and environmental literacy: Promoting mathematical creative thinking. *Journal of Educational Research, 118*(5), 475–485. https://doi.org/10.1080/00220671.2025.2495329

Vale, I., & Barbosa, A. (2024). Exploring the creative potential of mathematical tasks in teacher education. *International Electronic Journal of Mathematics Education, 19*(4), Article em0790. https://doi.org/10.29333/iejme/15075

Vitoria, L., Ariska, R., Farha, & Fauzi. (2020). Teaching mathematics using snakes and ladders game to help students understand angle measurement. *Journal of Physics: Conference Series, 1460*(1), Article 012005. https://doi.org/10.1088/1742-6596/1460/1/012005

Copyright (c) 2026 EDUCATOR : Jurnal Inovasi Tenaga Pendidik dan Kependidikan
https://doi.org/10.51878/educator.v6i4.16122