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Development of Mathematical Creative Thinking Skills in Elementary School Students through the GASING Method

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A B S T R A C T

The demand for higher-order thinking skills is increasing, and mathematical creativity must be developed systematically from the elementary level. This study aims to examine the development of students' mathematical creative thinking through the GASING method (Fun, Easy, and Enjoyable Learning). This study used a quantitative quasi-experimental design with a pretest-posttest approach on a selected group. The limitation of this study lies in the small sample size (20 students) and the use of purposive sampling limits the generalizability of the findings; therefore, further studies with larger samples are needed to validate the results. The instrument was a mathematical creative thinking test covering fluency, flexibility, originality, and elaboration. Data were analyzed using descriptive statistics and the N-Gain test. The results show that the average score improved from 30.95 (pre-test) to 64.95 (post-test), with an N-Gain of 0.4827 (48.27%), categorized as moderate. The highest improvement occurred in fluency (29 to 84), followed by originality (25 to 63), elaboration (31 to 67), and flexibility (26 to 60). While gains in originality and elaboration suggest that the concrete-to-abstract approach deepens students' creativity, overall, these findings indicate that the GASING method is effective in improving elementary students' mathematical creative thinking skills.

1. Introduction

In the context of 21st-century education, mathematical creativity occupies a crucial position as a competency that must be developed from the elementary school level (Boaler, 2016; OECD, 2019). This ability is not only related to the mastery of concepts, but also encompasses students' capacity to generate new ideas, discover various alternatives and solutions, and develop flexible and innovative thinking in solving mathematical problems (Beghetto & Kaufman, 2017; Munandar, 2012). Therefore, mathematics learning in elementary school must be designed in a

meaningful, enjoyable manner that is capable of encouraging active student engagement so that their creative potential can develop optimally (Partnership for 21st Century Learning, 2019; Van de Walle et al., 2019).

However, the reality in the field shows that mathematics learning is still often perceived as difficult and stressful by students (Boaler, 2016; OECD, 2023). The learning process, which tends to be teacher-centered and insufficiently attentive to students' cognitive developmental characteristics, leads to low learning motivation and limited opportunities for students to develop creative thinking skills (Leikin, 2018; Van de Walle et al., 2019). According to recent studies on cognitive development in elementary school students, children at this stage tend to think concretely and understand concepts more effectively through real and contextual learning experiences. Therefore, learning activities should begin with concrete objects and contextual situations to support optimal conceptual understanding (Yanti et al., 2024).

One alternative approach that directly addresses these challenges is the GASING method, originally developed by physicist and educator Yohanes Surya. The name GASING stands for *Gampang, Asyik, dan Menyenangkan*, loosely translated as Easy, Enjoyable, and Fun. The method is grounded in a learner-centered philosophy that progresses systematically from tangible, real-world representations toward increasingly abstract mathematical reasoning (Surya, 2025). Key features of GASING include hands-on use of concrete materials, sequentially structured content delivery, and a supportive classroom climate designed to reduce mathematics anxiety and build learner confidence (Armianti et al., 2018; Kusuma et al., 2019). Furthermore, learning with the GASING method is designed to actively engage students through various engaging activities that integrate cognitive and affective elements in the learning process, thereby stimulating optimal brain function in both the left and right hemispheres. These activities have an impact on improving students' concentration, speed of thinking, and creativity in understanding mathematical concepts (Jensen, 2019; Gou et al., 2024; Sousa, 2017). According to Pratiwi et al. (2026), the GASING method has transformative potential when implemented in a dialogic and reflective manner within a critical pedagogy framework to support sustainable mathematics learning.

Several studies have examined the impact of GASING on elementary mathematics learning, consistently documenting positive outcomes. The study conducted by Mahendra & Dewi (2026) shows that the implementation of the GASING method integrated with the traditional game Megowak-gowakan can reduce students' mathematics anxiety levels. Kusuma et al. (2019) reported notable gains in mathematics achievement among Grade III students taught using the GASING approach. Devi (2024) explored an integration of GASING with traditional games and noted improvements in conceptual understanding and numeracy performance. Adam et al. (2026) found that the GASING method can enhance students' understanding of basic mathematical concepts and create a more interactive and enjoyable learning environment. Manurung et al. (2025) documented step-by-step improvements in Grade III learning mastery related to geometric perimeters. Lestari & Hardini (2022) compared GASING with conventional instruction and concluded

that GASING yielded stronger learning gains, while Situmorang et al. (2024) observed enhanced academic outcomes for Grade II students. Maharudin et al. (2026) found that the GASING method, which emphasizes learning through the concrete representational abstract progression as well as mental calculation in an easy and enjoyable manner, is more effective than direct instruction in improving elementary school students' addition skills. More recent contributions by Soraya & Ningtias (2025) and Romadona et al. (2025) further confirm that GASING supports growth in mathematical communication skills and arithmetic proficiency, respectively.

Nevertheless, research that specifically examines the development of mathematical creative thinking skills among elementary school students through the implementation of the GASING method remains limited. According to Kharisma (2022), creative thinking ability is an important aspect of modern education that demands students not only to think critically, but also to be innovative and adaptive in facing various problems. Mathematical creative thinking encompasses the ability to generate new ideas, view problems from multiple perspectives, and develop original and detailed solutions competencies that are increasingly recognized as the core of 21st-century mathematics learning (Leikin, 2018; Silver, 1997). This limitation reveals a research gap that needs to be filled through deeper empirical investigation.

Based on the above description, there is a research gap that needs to be addressed, namely the absence of empirical studies that specifically measure the development of each indicator of mathematical creative thinking skills (fluency, flexibility, originality, and elaboration) through the implementation of the GASING method at the elementary school level. Therefore, this study aims to analyze the development of mathematical creative thinking skills among elementary school students through the implementation of the GASING method, with the expectation of providing more detailed empirical contributions regarding the effectiveness of this method across each dimension of mathematical creativity. The findings of this study are expected to provide theoretical contributions by enriching the study of mathematics learning oriented toward the development of creativity and higher-order thinking skills, as well as practical contributions for teachers in designing and implementing innovative and effective learning strategies that are appropriate for the characteristics of elementary school students.

2. Methodology

This study adopts a pretest-posttest design on a selected group, a quasi-experimental approach that enables structured measurement of changes in creative thinking skills before and after the treatment through the implementation of the GASING method via a systematic, gradual, concrete, and enjoyable learning approach, while facilitating active student engagement, the use of games, and the integration of music media (GASING songs and movement activities) in the mathematics learning process. Rizky et al. (2026) also measured creative thinking

skills based on the same four indicators, namely fluency, originality, flexibility, and elaboration.

Fluency refers to students' ability to generate a wide range of ideas or answers to a given problem, as well as to demonstrate variation in the solution strategies they employ. Flexibility denotes the ability of students to view a problem from different perspectives. This indicator is reflected in students' capacity to consider diverse alternative solutions and to shift approaches when facing different situations or problem contexts. Thus, students are not confined to a single pattern of thinking but are able to adapt to various problem-solving strategies. Originality is associated with the ability to produce ideas that are new, unique, and not commonly generated by others. In the learning context, students who demonstrate originality are capable of developing uncommon solution methods and combining various elements of information into novel and original ideas or solutions. Meanwhile, elaboration refers to the ability to develop an idea in greater detail and depth.

The study employed the N-Gain (Normalized Gain) as the measure of learning progress to quantify learning gains. This index expresses the proportion of the possible improvement actually achieved by each student, relative to the gap between the pre-test score and the maximum possible score. The calculation follows: N-Gain = (Post-test Score – Pre-test Score) / (Maximum Score – Pre-test Score). Following the widely adopted classification proposed by Hake (1999), values of 0.70 or above reflect high gain, values between 0.30 and 0.70 reflect moderate gain, and values below 0.30 reflect low gain.

Data were collected from a sample of 20 Grade IV elementary school students selected through purposive sampling from a single school. Before the intervention, students completed a pre-test to measure their initial mathematical creative thinking ability. The GASING method was then implemented over several learning sessions on the topic of whole numbers up to 10,000, integrating concrete materials, games, GASING songs, and movement activities. Upon completion of the treatment, students completed a post-test using the same instrument to measure changes in their creative thinking ability.

2. Results and Discussion

Before the implementation of the GASING method, the Grade IV students exhibited a limited ability to think creatively in mathematics. Based on initial observations, most students appeared passive, hesitant to express ideas, and heavily reliant on a single procedure when solving problems. Mathematics was frequently perceived as a difficult and anxiety-inducing subject, which constrained students' willingness to explore solutions beyond rote methods. These conditions indicated the need for a learning approach that could build confidence, stimulate curiosity, and open up structured yet enjoyable opportunities for creative thinking to develop.

The GASING method was then implemented across several learning sessions on the topic of whole numbers up to 10,000. In the classroom, each session began by

introducing concepts through concrete objects, colored cards representing place values (white for units, black for tens, blue for hundreds, red for thousands, and yellow for ten-thousands), as well as sticks, candies, and straws, allowing students to physically manipulate materials before moving to pictorial and then abstract representations. Students engaged in group activities, games, and GASING songs with movements to reinforce concepts in an enjoyable manner. The teacher progressively guided students from concrete understanding toward abstract mathematical notation, in accordance with the concrete-pictorial-abstract (CPA) principle recommended in primary mathematics education (Bruner, 1966; Van de Walle et al., 2019). This approach created a classroom atmosphere that was active, low-anxiety, and supportive of idea exploration, enabling students to build conceptual understanding at their own pace (Surya, 2025; Armianti et al., 2018). According to Zahara (2018), enjoyable learning that is consistently filled with joy is capable of supporting brain growth, and the integration of songs, movements, and mathematical concepts in GASING stimulates both the left and right hemispheres of the brain simultaneously, producing positive effects on students' cognitive skills and creativity.

The development of students' mathematical creative thinking through the GASING method can be explained through several theoretical mechanisms. First, GASING fosters active interaction between students and educators, resonating with Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), in which learners make their greatest cognitive gains when guided by a knowledgeable instructor within a psychologically supportive setting (Boaler, 2016; Kusuma et al., 2019). Second, the method's sequential, stage-based structure, progressing from easy to more complex concepts, aligns with Piaget's (1970) cognitive development theory and NCTM (2000) principles, allowing teachers to tailor instruction to students' thinking levels and promote deeper understanding. Third, GASING increases intrinsic motivation by creating a pressure-free, enjoyable learning environment, consistent with Ryan & Deci's self-determination theory (2000, as cited in Van de Walle et al., 2019), which affirms that autonomy-supportive environments are a primary prerequisite for optimal creativity development. Finally, the use of games, repetition, and collaborative activities helps students connect mathematical content to real-world contexts, as emphasized by Dewey (1933, as cited in Van de Walle et al., 2019), encouraging reflective and creative problem-solving (Lestari & Hardini, 2022; Beghetto & Kaufman, 2017; Situmorang et al., 2024).

Compared to conventional teacher-centered instruction, which tends to limit students' space for exploration and creative thought (Boaler, 2016; OECD, 2023), the GASING method is inherently designed to simultaneously build confidence, curiosity, and creativity through meaningful and enjoyable learning experiences (Surya, 2025). Based on field observations, mathematics learning with the GASING method successfully created an enjoyable atmosphere free from pressure, reduced stress, and boosted students' self-confidence. Students were actively involved in interactions with their teacher and peers, and the use of games connected mathematical content to their daily lives (Devi, 2024; Kusuma et al., 2019; Gou et al., 2024). As a result, students became more willing to generate ideas, try

unconventional strategies, and develop their thinking independently, all of which are hallmarks of mathematical creative thinking. This is consistent with the view of Guilford (1967, as cited in Munandar, 2012) that creativity is an ability that can be developed through stimulation from a conducive and challenging learning environment, a view reinforced by modern research on creativity (Beghetto & Kaufman, 2017; Runco & Jaeger, 2012). The effectiveness of GASING in supporting creative thinking is further confirmed by the consistency of findings from multiple studies across various elementary school contexts (Lestari & Hardini, 2022; Situmorang et al., 2024; Soraya & Ningtias, 2025; Romadona et al., 2025; Khairunisa et al., 2025).

There are three stages in mathematics learning using the GASING method, as follows:

1. The concrete stage, which involves the use of real objects such as sticks, candies, marbles, and so on to explain the concepts of addition, multiplication, and subtraction. One example for introducing place values of whole numbers namely units, tens, hundreds, thousands, and ten-thousands is the use of concrete colored cards to help students visualize. Specifically, the units card is white, tens is black, hundreds is blue, thousands is red, and ten-thousands is yellow.

Figure 1. GASING Card Props

Concrete objects subsequently used as learning media include sticks, boxes, candies, and straws, as shown in Figure 2.

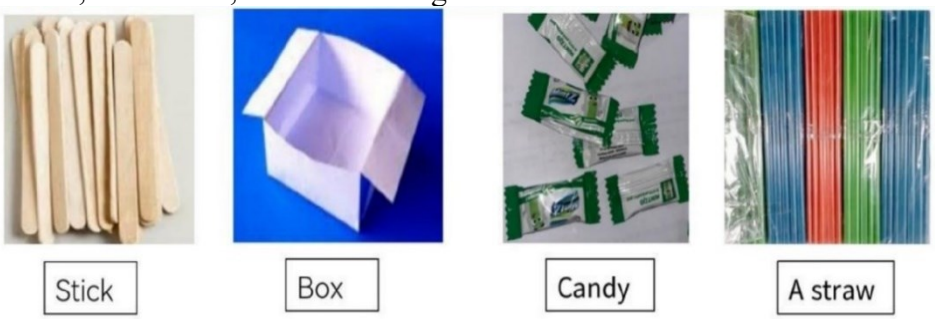

Figure 2. Learning Media

2. The abstract stage involves writing mathematical symbols and equations derived from previously learned concrete concepts. For example, before writing the absract form of addition, the concret representation is shown in Figure 3.

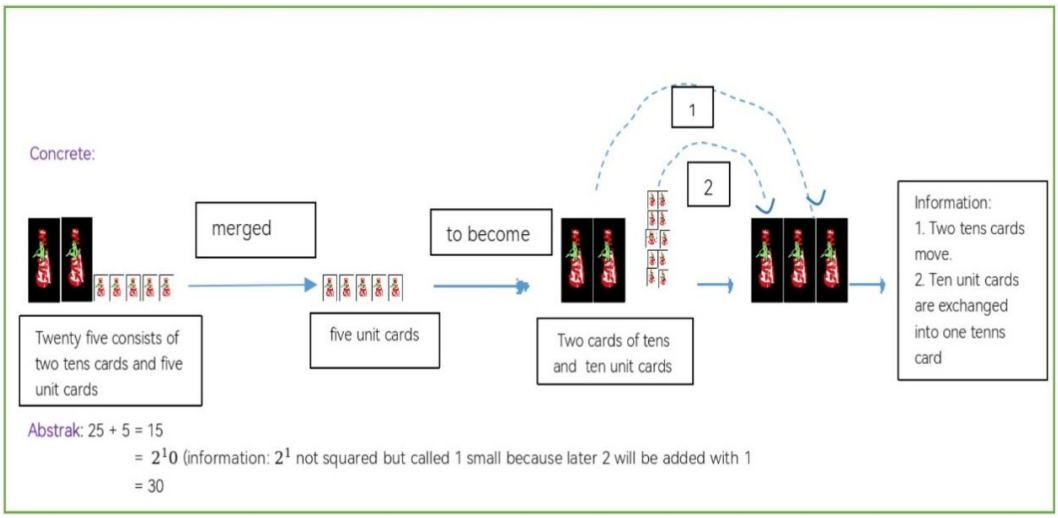

Figure 3. Concrete Stages of Abstraction

The following Figure 4 illustrates the implementation process of the GASING method, in which learning is conducted progressively from concrete concepts toward abstract concepts through explanations provided by the teacher.

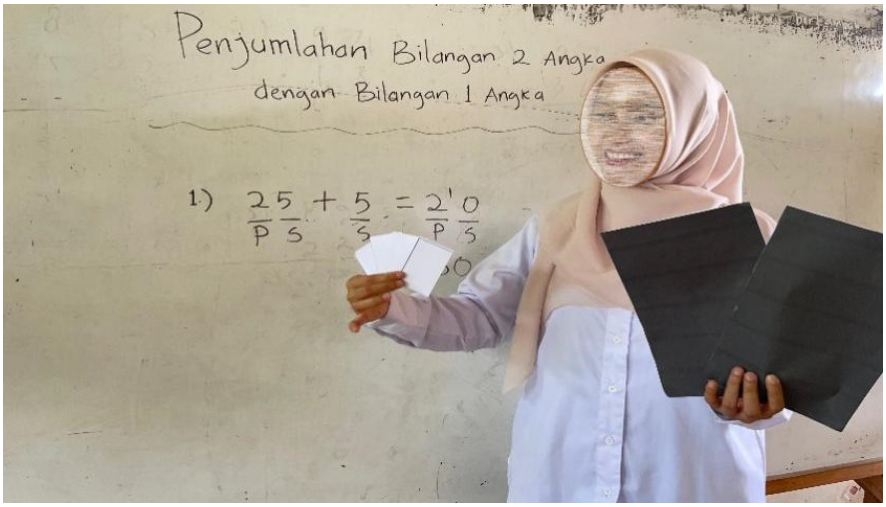

Figure 4. The Teacher Implementing the GASING Method

The initial analysis was conducted by examining the scores of pre-test and post-test students. Based on the descriptive statistical analysis of 20 students, the pre-test scores showed a score range of 27, a minimum value of 25, and a maximum value of 52, with a mean of 30.95 and a standard deviation of 7.222. These results indicate that the students' initial abilities were at a relatively similar level. After the learning treatment was administered, the post-test scores in the experimental group showed an increase. The post-test score range reached 52, with a minimum value of 39 and a maximum value of 91. The mean score increased to 64.95 with a standard

deviation of 11.888. This improvement indicates a development in students' creative thinking ability outcomes following the implementation of the GASING method. The results of the pre-test and post-test obtained by students are presented in Table 1.

Table 1. Data pre-test and post-test

Group	N	Range	Minimum	Maximum	Mean	Std. Deviation
Pre-Test	20	27	25	52	30.95	7.222
Post-Test	20	52	39	91	64.95	11.888

Based on the analysis of average indicator scores of students' creative thinking skills at the stage before (pre-test) and after (post-test) learning using the GASING method, covering four indicators namely fluency, flexibility, originality, and elaboration. In general, all indicators showed a clear improvement after the GASING method was implemented.

For the fluency indicator, the average score increased from 29 on the pre-test to 84 on the post-test, with an increase of 55 points. This improvement demonstrates that students' ability to generate many ideas or answers developed significantly. According to recent studies on creative thinking, fluency is one of the core components of divergent thinking, referring to the ability to generate a large number of relevant ideas or responses to a given stimulus (Alabbasi et al., 2022). The high improvement in fluency in this study is consistent with the key characteristics of the GASING method, which encourages students to actively explore various problem-solving approaches through games and repetition, thereby training students to generate many ideas without fear of making mistakes (Boaler, 2016; Kusuma et al., 2019).

For the flexibility indicator, the average score increased from 26 to 60, representing an improvement of 34 points. Flexibility is the ability to shift perspectives or strategies when facing a problem, and it is an indicator that takes longer to develop because it demands higher cognitive flexibility. Although its improvement was the smallest among the four indicators, the values achieved still demonstrate meaningful progress that can be attributed to the use of a multi-strategy approach in the GASING method (Lestari & Hardini, 2022). This signifies progress in students' ability to view and solve problems from various perspectives. For the originality indicator, the average score increased from 25 on the pre-test to 63 on the post-test, with a difference of 38 points. This result reflects an improvement in students' ability to generate unique and unusual ideas. According to Runco & Jaeger (2012), originality is the core of true creativity, namely producing something new and different. This increase in originality occurred because the GASING method creates a pressure-free learning atmosphere, giving students the confidence to try unconventional solution strategies (Beghetto & Kaufman, 2017; Munandar, 2012).

For the elaboration indicator, the average score increased from 31 to 67, with a difference of 36 points. This improvement shows that students are increasingly able to develop and elaborate on ideas in a more structured and in-depth manner.

Elaboration is associated with higher-order cognitive skills at the analysis and evaluation levels in Bloom's revised taxonomy (Anderson & Krathwohl, 2001), and its fairly significant improvement in this study reflects the success of the concrete-to-abstract stages of the GASING method in building the depth of students' mathematical conceptual understanding (Bruner, 1966; Van de Walle et al., 2019). Overall, the greatest increase occurred in the fluency indicator with a difference of 55 points, while the smallest increase was in the flexibility indicator with a difference of 34 points. The analysis of the development of the average scores for each creative thinking indicator is presented in the following Figure 5 and the magnitude of the increase in scores for each creative thinking indicator between the pre-test and post-test can be seen in Figure 6.

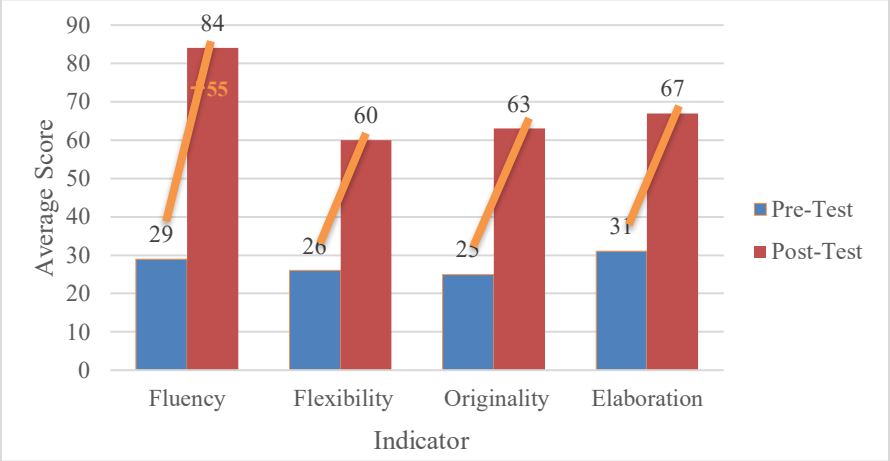

Figure 5. Comparison of Pretest and Posttest Scores for Each Indicator

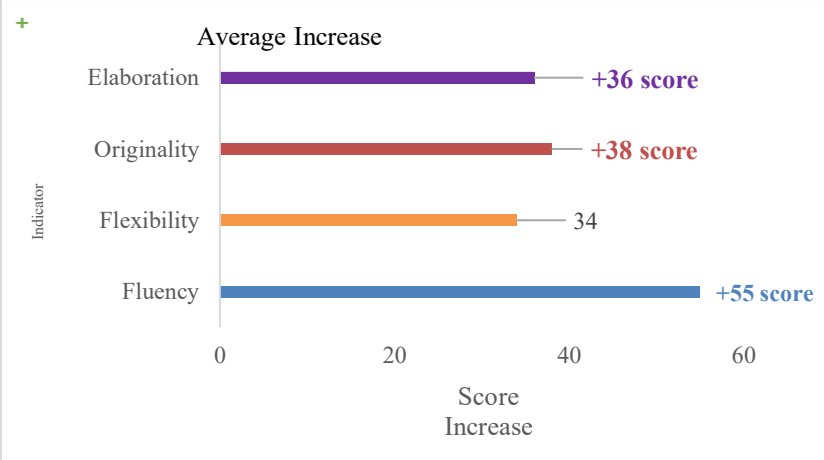

Figure 6. The Magnitude of the Increase Scores on Each Creative Thinking Indicator in the Pre-test and Post-test

These findings confirm that the implemented learning was effective in developing all aspects of students' creative thinking skills, which include fluency, flexibility, originality, and elaboration as core components of creative thinking (Titikusumawati et al., 2023). The pattern of higher increases in the fluency and

originality indicators compared to flexibility and elaboration can be explained theoretically. Fluency and originality tend to develop more rapidly because they are directly stimulated by the characteristics of GASING, which emphasizes freedom to experiment, repetition, and a non-pressurizing learning atmosphere, encouraging students to try various approaches (Boaler, 2016; Jensen, 2019; Surya, 2025). In contrast, flexibility and elaboration demand a higher level of cognitive integration and require a longer intervention period to develop optimally (Beghetto & Kaufman, 2017). These findings are consistent with Leikin's (2018) view that the development of mathematical creativity is progressive and varies across indicators depending on the characteristics of the learning approach used. The N-Gain value of 0.4827 (medium category) obtained in this study illustrates that within a limited intervention period, the GASING method was already able to produce meaningful changes in students' creative thinking skills.

This result is consistent with the findings of Ndiung & Menggo (2024), who concluded that active and innovative learning approaches in elementary school consistently produce improvements in mathematical creative thinking skills in the medium-to-high category, depending on the duration of the intervention and the complexity of the material. Thus, the improvement in the medium category in this study does not represent a failure, but rather a reasonable and pedagogically meaningful achievement given the short intervention period, and greater potential can be achieved if the GASING method is implemented continuously and consistently (Lestari & Hardini, 2022; Manurung et al., 2025). Subsequently, the N-Gain test was conducted. The average pre-test score was 30.95 and the average post-test score was 64.95, with an N-Gain of 0.4827 (48.27%), which falls within the medium improvement category. This can be seen in Table 2.

Table 2. Results of the *N-Gain*

Group	Pre-test Mean	Post-test Mean	Average N-Gain	N-Gain Score (%)	Category
Experimental Class	30.95	64.95	0.4827	48.2711	Medium

This categorization follows the criteria established by Hake (1999), which divides learning effectiveness into three categories: high (≥0.70), medium (0.30–0.70), and low (≤0.30). This refers to the effectiveness category of *N-Gain*, as presented in Table 3.

Table 3. Effectiveness Category of *N-Gain*

Range *N-Gain*	Classification
$N\text{-}Gain \geq 0.70$	High
$0.30 \leq N\text{-}Gain \leq 0.70$	Medium
$N\text{-}Gain \leq 0.30$	Low

The N-Gain value of 0.4827, situated within the medium category, indicates that the GASING method is capable of exerting a real and fairly strong influence on the development of students' mathematical creative thinking skills (Hake, 1999). The following Figure 7 illustrates the comparison of pre-test and post-test averages as well as the position of the N-Gain within the effectiveness category.

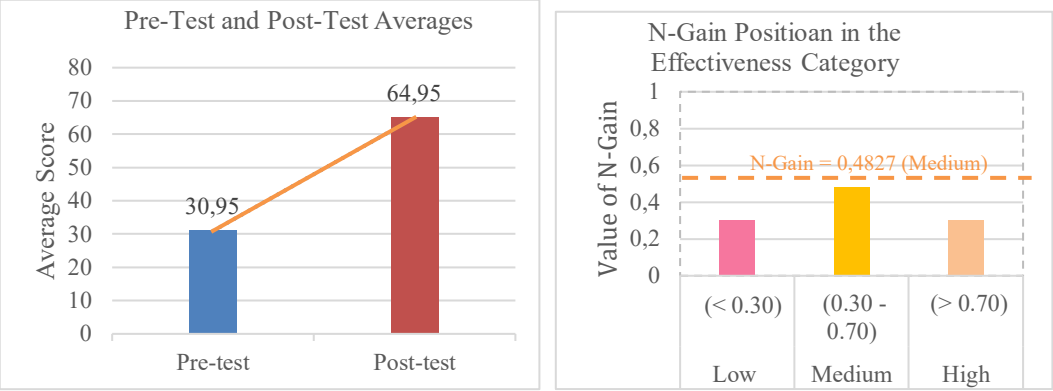

Figure 7. Comparison of Pre-Test and Post-Test Averages and Position of N-Gain in the Effectiveness Category

4. Conclusion

Overall, the GASING method, by promoting active engagement and integrating concrete materials, games, music, and movement, demonstrates promise as an effective and enjoyable approach to developing mathematical creative thinking in elementary school students. The study highlights GASING's alignment with students' cognitive developmental characteristics and 21st-century learning principles emphasizing creativity, critical thinking, and problem solving. Accordingly, teachers are encouraged to integrate GASING consistently to create meaningful and enjoyable learning experiences that strengthen higher-order thinking skills and support improvements in mathematics education quality and students' creative character. Future research with larger and more diverse samples, longer intervention periods, and control group designs will be valuable in building more robust evidence of GASING's effectiveness.

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