Curricula:
Journal of Curriculum Development
https://ejournal-education.upi.edu/curricula

Effectiveness of the GASING method on mathematical problem-solving skills

Dona Oktafiyenti[1], Arie Rakhmat Riyadi[2], Andhin Dyas Fitriani[3]
[1, 2,3] Universitas Pendidikan Indonesia, Bandung, Indonesia
donaoktafiyenti@upi.edu[1], arie.riyadi@upi.edu[2], andhindyas@upi.edu[3]

ABSTRACT

Mathematical problem-solving skills are an important component of the elementary school Mathematics curriculum, yet they remain a challenge for students in Indonesia. This study aims to test the effectiveness of the Gampang, Asyik, dan Menyenangkan (GASING) method as an alternative learning resource for developing fourth-grade students' mathematical problem-solving competencies. The study used a quasi-experimental design with unequal control groups involving 60 students at SDN 63 Surabayo, Agam Regency, West Sumatra (30 experimental, 30 control). The instrument consisted of eight (8) items based on Polya's validated four-step framework and measured abilities before and after treatment. The experimental group obtained higher post-test scores with a significant effect and greater learning improvement. The GASING method eliminated low-level learning outcomes and placed most students in the high-level category. These findings support integrating the GASING method as an evidence-based learning resource in the elementary school Mathematics curriculum, particularly in contexts that emphasize higher-order thinking skills and differentiated learning.

ARTICLE INFO

Article History:
Received: 10 May 2026
Revised: 4 Sep 2026
Accepted: 24 Sep 2026
Publish online: 17 Oct 2026

Keywords:
elementary Mathematics; GASING method; problem-solving; Polya's framework

Open access
Curricula: Journal of Curriculum Development is a peer-reviewed open-access journal.

ABSTRAK

Kemampuan pemecahan masalah matematis merupakan komponen penting dalam kurikulum matematika sekolah dasar, namun masih menjadi tantangan bagi murid di Indonesia. Penelitian ini bertujuan untuk menguji efektivitas metode Gampang, Asyik, dan Menyenangkan (GASING) sebagai sumber belajar alternatif dalam mengembangkan kompetensi pemecahan masalah matematis murid kelas IV. Desain penelitian menggunakan kuasi-eksperimental dengan kelompok kontrol tidak setara yang melibatkan 60 murid di SDN 63 Surabayo, Kabupaten Agam, Sumatera Barat (30 eksperimen, 30 kontrol). Instrumen terdiri dari delapan (8) butir soal berbasis kerangka empat langkah Polya yang telah divalidasi dan digunakan untuk mengukur kemampuan sebelum dan sesudah perlakuan. Kelompok eksperimen memperoleh skor post-test yang lebih tinggi dengan pengaruh yang signifikan dan peningkatan belajar yang lebih besar. Metode GASING mengeliminasi hasil belajar kategori rendah dan menghasilkan mayoritas murid berkategori tinggi. Temuan ini mendukung integrasi metode GASING sebagai sumber pembelajaran berbasis bukti dalam implementasi kurikulum matematika SD, khususnya dalam konteks yang menekankan kemampuan berpikir tingkat tinggi dan pembelajaran berdiferensiasi.

Kata Kunci: *kemampuan pemecahan masalah; kerangka Polya; Matematika SD; metode GASING;*

How to cite (APA 7)
Oktafiyenti, D., Riyadi, A. R., & Fitriani, A. D. (2026). Effectiveness of the GASING method on mathematical problem-solving skills. *Curricula: Journal of Curriculum Development, 5*(4), 1305-1324.

Peer review
This article has been peer-reviewed through the journal's standard double-blind peer review, where both the reviewers and authors are anonymised during review.

Copyright
2026, Dona Oktafiyenti, Arie Rakhmat Riyadi, Andhin Dyas Fitriani. This is an open-access article distributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0) https://creativecommons.org/licenses/by-sa/4.0/, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author, and source are credited. *Corresponding author: arie.riyadi@upi.edu

https://doi.org/10.17509/curricula.v5i4.720

INTRODUCTION

Mathematical problem-solving is widely recognized as one of the most critical competencies in Mathematics education, serving both as a fundamental learning objective and as a means of developing higher-order thinking skills (Szabo et al., 2020; Verschaffel et al., 2020; Wahab et al., 2024). Solving mathematical problems requires students to engage in complex cognitive processes, including comprehension, strategic planning, execution, and reflection. Polya formalized this framework in his book "*How to Solve It: A New Aspect of Mathematical Method*", a seminal work on problem-solving heuristics. Despite decades of research and policy attention, many elementary school students worldwide still struggle with mathematical problem-solving, particularly in developing countries where instructional approaches have inadequately supported these higher-order thinking skills (Wahab et al., 2024).

In Indonesia, improving mathematical problem-solving skills is particularly pressing. Results from the Program for International Student Assessment (PISA) 2022 indicate that Indonesian students scored well below the OECD average in Mathematics, with a mean score of 366 compared to the OECD average of 472 (see: https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html). The Trends in International Mathematics and Science Study (TIMSS) has similarly documented persistent gaps in Indonesian students' mathematical reasoning and problem-solving abilities (see: https://timssandpirls.bc.edu/timss2019/). Prior research shows that Indonesian elementary students struggle to translate word problems into mathematical operations and apply problem-solving strategies (Fitriani, 2025; Nurdianti et al., 2025). These international assessments and local studies underscore the urgency of identifying and implementing effective pedagogical approaches to enhance students' mathematical problem-solving competence meaningfully (Trisnani et al., 2024).

Addition and subtraction are foundational arithmetic skills that underpin more complex mathematical understanding, as Carpenter and colleagues explain in *Children's Mathematics: Cognitively Guided Instruction*. For fourth-grade elementary students, mastering these operations, especially in problem-solving contexts, is crucial for later mathematical learning. However, conventional teaching approaches that remain dominant in many Indonesian Mathematics classrooms tend to emphasize procedural fluency over conceptual understanding and problem-solving strategies (Trisnani et al., 2024; Zana et al., 2024). This emphasis leaves students ill-prepared for the demands of mathematical problem-solving, which requires flexible thinking and strategic approaches beyond applying memorized procedures.

As stipulated by the Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi (Kemendikbudristek) in 2022, within the framework of Indonesia's current national curriculum (Kurikulum Merdeka), Mathematics learning at the elementary level is explicitly oriented toward the development of students' higher-order thinking skills (HOTS), student agency, and differentiated learning outcomes. In 2022, Badan Standar Kurikulum dan Asesmen Pendidikan (BSKAP) also stated that problem-solving is a core competency in the Mathematics learning progression, particularly in the Phase B (Grades 3-4) learning objectives, where students are expected to apply arithmetic operations to solve real-world problems. Despite this curricular emphasis, many teachers still struggle to translate these

https://doi.org/10.17509/curricula.v5i4.720

goals into classroom practice, although recent classroom evidence shows that contextual approaches using concrete objects can strengthen elementary students' understanding under the Kurikulum Merdeka (Marlina & Harinaredi, 2025; Trisnani et al., 2024). This gap between curricular intent and instructional practice underscores the need for evidence-based instructional resources that can effectively bridge the two.

The GASING method (an acronym for *Gampang, Asyik, dan Menyenangkan*, or in English, Easy, Fun, and Enjoyable) was developed by Professor Yohanes Surya, as presented in his book *"GASING Mathematics: Easy, Fun, and Enjoyable"*, and serves as an innovative approach to Mathematics instruction that aims to make mathematical learning accessible, engaging, and enjoyable for students. The method is grounded in the principle that Mathematics should be taught through concrete experiences before progressing to abstract representations, aligning with Bruner's 1966 theory *of Instruction*, which emphasizes the enactive-iconic-symbolic progression. The GASING approach emphasizes mental computation, pattern recognition, and number sense development through structured activities that progress from physical manipulation to mental computation, as operationalized in the *GASING Basic Mathematics Training Module: Bakalkubagi*. The GASING method has attracted considerable attention in Indonesian Mathematics education as a promising alternative to traditional instruction.

Several studies have examined its effectiveness in improving mathematical achievement (Matahelumual & Yohamintin, 2025; Maulida et al., 2024; Munawaroh & Nurtamam, 2024); however, relatively few have specifically investigated its impact on problem-solving skills as measured through validated frameworks such as Polya's heuristics. This gap matters because problem-solving involves metacognitive and strategic processes that go beyond computational accuracy (Wahab et al., 2024). Understanding whether the GASING method can effectively enhance these higher-order processes carries important implications for Mathematics pedagogy. The evidence base has grown considerably in recent years: a systematic literature review of 25 GASING studies published between 2014 and 2024 confirmed the method's consistent effectiveness for basic mathematical operations while also cataloging recurring methodological weaknesses across the field, and an intensive multi-domain community program further corroborated large computational gains across five arithmetic domains (Gesiradja et al., 2025).

Polya's four-step problem-solving framework, comprising understanding the problem, devising a plan, carrying out the plan, and looking back, provides a theoretically robust lens for assessing problem-solving skills. This framework has been extensively validated in Mathematics education research and remains one of the most widely used models for teaching and assessing mathematical problem-solving (Fitriani, 2025; Szabo et al., 2020). By assessing student performance at each of Polya's four steps, researchers can better understand how instructional interventions affect different dimensions of the problem-solving process. This study's novelty lies in its systematic examination of the GASING method's impact on mathematical problem-solving skills, operationalized through Polya's four-step framework, in the context of elementary-level addition and subtraction instruction. Meanwhile, prior studies have examined the GASING method's effectiveness for computational achievement and conceptual understanding (Buknoni et al., 2026; Maulida et al., 2024; Munawaroh & Nurtamam, 2024).

https://doi.org/10.17509/curricula.v5i4.720

No previous research has rigorously evaluated its effect on higher-order problem-solving processes using a validated rubric aligned with Polya's stages; indeed, the most comprehensive synthesis of the GASING literature published to date reports Mathematics performance, learning engagement, and conceptual understanding as the field's principal outcome measures, with problem-solving competency notably absent as a distinct construct (Gesiradja et al., 2025). Furthermore, applying normalized gain analysis alongside parametric effect-size estimation provides a more robust empirical basis for evaluating instructional effectiveness than previous GASING studies, making this a methodologically distinct contribution to the Indonesian Mathematics education literature. This study addresses the following research questions: Is there a significant difference in mathematical problem-solving skills between students taught using the GASING method and those taught using conventional learning? How do learning gains (as measured by normalized gain scores) compare between the two groups?

The study hypothesizes that the GASING method, with its emphasis on a concrete-to-abstract-to-mental-computation progression and engaging learning activities, will yield significantly greater improvements in problem-solving skills than conventional learning. This study contributes to the existing literature in several ways. First, it provides empirical evidence regarding the effectiveness of the GASING method specifically for problem-solving skills, extending prior research that has primarily focused on computational achievement. Second, by applying Polya's framework to both instruction and assessment, the study provides a theoretically grounded evaluation of problem-solving competency development. Third, the quasi-experimental design, with pre-test and post-test measurements and normalized gain analysis, provides robust empirical evidence of instructional effectiveness. Fourth, the study offers practical insights for educators in developing countries seeking evidence-based approaches to improve mathematical problem-solving instruction in elementary schools.

LITERATURE REVIEW

Mathematical Problem-Solving Skills

Researchers have extensively studied mathematical problem-solving as a central competency in Mathematics education. Polya's four-step framework (understanding the problem, devising a plan, carrying out the plan, and looking back) remains the most widely referenced model for both instruction and assessment of problem-solving processes. Research has confirmed that structured problem-solving instruction grounded in this framework can substantially improve students' higher-order thinking skills (Fitriani, 2025; Szabo et al., 2020). Despite its widespread adoption, students in many developing countries, including Indonesia, continue to demonstrate below-average performance on international assessments such as PISA and TIMSS, particularly in tasks requiring strategic mathematical reasoning (see: https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html; https://timssandpirls.bc.edu/timss2019/).

https://doi.org/10.17509/curricula.v5i4.720

The GASING Method

The Concrete-Representational-Abstract (CRA) instructional framework, grounded in Bruner's theory of cognitive development, offers a research-supported approach to building mathematical understanding progressively, from physical manipulation to abstract reasoning. A recent meta-analysis demonstrated that CRA-based instruction significantly improves mathematical performance, particularly for students with learning difficulties, by anchoring conceptual understanding in tangible experiences (Ebner et al., 2025). A systematic review documented the broad implementation of concrete-pictorial-abstract approaches across levels of Mathematics education (Azzumar & Juandi, 2023). This theoretical foundation underpins the GASING method, which similarly employs a concrete-to-abstract-to-mental-computation (CRA+) progression to develop students' number sense and computational fluency (Gesiradja et al., 2025).

Prior research on the GASING method has primarily focused on its effectiveness for computational achievement and conceptual understanding (Maulida et al., 2024; Munawaroh & Nurtamam, 2024). A synthesis of ten studies concluded that the GASING method consistently enhances elementary students' mathematical comprehension, both cognitively and affectively (Matahelumual & Yohamintin, 2025). The quasi-experimental evaluation extended the method to conceptual understanding of integer operations in lower secondary school (Buknoni et al., 2026). This computational focus persists even in the most methodologically ambitious recent GASING research: an intensive community-based program spanning all five basic arithmetic domains (n = 62) reported uniformly large effect sizes (r = 0.849-0.895) and a high average N-Gain (0.738), yet, as a one-group pre-test-post-test design without a control group, could not rule out history, maturation, or testing threats to internal validity, nor did it extend to problem-solving outcomes.

A systematic review of 25 Scopus- and SINTA-indexed GASING studies published between 2014 and 2024 corroborates this pattern at a field-wide level: its thematic synthesis characterizes the field's reported outcomes as Mathematics performance, learning engagement, and conceptual understanding, with problem-solving competency notably absent as a distinct measured construct, and it further reports that most reviewed studies were limited by small sample sizes and a lack of control groups (Gesiradja et al., 2025). However, a critical gap exists: no study has systematically examined whether the GASING method can enhance problem-solving skills as operationalized through Polya's framework. Conventional learning, which remains dominant in Indonesian Mathematics classrooms, tends to prioritize procedural fluency over the metacognitive and strategic processes required for problem-solving (Trisnani et al., 2024; Zana et al., 2024). This limitation underscores the need for alternative instructional approaches that explicitly cultivate problem-solving competencies within elementary Mathematics education.

The GASING Method in Indonesian Elementary Mathematics Curriculum

The GASING method's relevance extends beyond its instructional mechanics to its alignment with the goals of Indonesia's current national curriculum (Kurikulum Merdeka). As outlined in the Introduction, the Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi

https://doi.org/10.17509/curricula.v5i4.720

(Kemendikbudristek) and the Badan Standar Kurikulum dan Asesmen Pendidikan (BSKAP) established, in 2022, higher-order thinking and problem-solving as core competencies within the Profil Pelajar Pancasila and the Phase B (Grades 3-4) Mathematics learning progression. By embedding arithmetic in contextual, progressively challenging problem-solving activities, the GASING method is a curriculum-aligned instructional resource that can serve as a mediating bridge between curriculum policy and classroom practice. From a curriculum design perspective, the GASING method exemplifies Tyler's principle of aligning learning experiences with stated educational objectives, as articulated in his book "*Basic Principles of Curriculum and Instruction*".

Ornstein and Hunkins, in their book "*Curriculum: Foundations, Principles, and Issues*", argued that curriculum implementation requires not only specifying learning goals but also selecting appropriate learning resources that operationalize those goals in classroom practice. The GASING method functions as precisely such a resource: its structured yet flexible instructional sequence can be deployed within existing curriculum frameworks without wholesale content restructuring. This positions the study not merely as an investigation of a teaching method, but as a contribution to curriculum evaluation and evidence-based curriculum development in Indonesian elementary education.

METHODS

Research Design

This study employed a quasi-experimental nonequivalent control group design with pre-test and post-test measurements, as described by Creswell and Creswell in their book *"Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*". The researcher selected a quasi-experimental design because random assignment of individual students to treatment conditions was not feasible in the school context; instead, intact classroom groups were assigned to experimental and control conditions. Although this design does not eliminate all threats to internal validity, it constitutes a rigorous approach for evaluating instructional interventions in naturalistic educational settings when true experimental designs are impractical (Shadish, Cook, and Campbell, in *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*). **Table 1** presents the research design.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
Experimental	O_1	X (GASING)	O_2
Control	O_3	— (Conventional)	O_4

Source: Research 2026

Participants

The study was conducted at SDN 63 Surabayo, a public elementary school located in Lubuk Basung District, Agam Regency, West Sumatra, Indonesia. Participants included 60 fourth-grade students across two intact classrooms: 30 in the experimental group and 30 in the control group. Additionally, 25 fifth-grade students from the same school participated in the instrument pilot study. We used purposive sampling to select the school and classrooms, and

https://doi.org/10.17509/curricula.v5i4.720

we assigned the two fourth-grade classes to treatment conditions based on administrative considerations. We selected the fifth-grade class for the pilot study to ensure participants had sufficient mathematical background to respond to all items while remaining independent of the actual research sample.

Instrument

The problem-solving skills instrument comprised eight open-ended Mathematics items involving addition and subtraction operations in real-world problem contexts. Each item assessed student performance across all four steps of Polya's problem-solving framework. The scoring rubric allocated points for each Polya step as follows: Understanding the Problem (P1, maximum score 2), Devising a Plan (P2, maximum score 2), Carrying Out the Plan (P3, maximum score 3), and Looking Back (P4, maximum score 3), yielding a maximum score of 10 per item and 80 total points, converted to a 100-point scale.

Instrument Validation

The instrument underwent rigorous validation. Mathematics education specialists reviewed the instrument for content validity, evaluating each item for curriculum alignment, appropriateness for the target grade level, and fidelity to the Polya framework. After content validation, we piloted the instrument with 25 fifth-grade students at the same school. We conducted item analysis using SPSS version 26 to assess construct validity and reliability. We evaluated construct validity using Pearson product-moment correlations between each item score and the total score. All eight items demonstrated statistically significant correlations exceeding the critical r-table value of 0.396 (df = 23, α = .05), confirming that each item contributed meaningfully to the overall construct. **Table 2** presents the full item validity analysis results.

Table 2. Item Validity Analysis Results (n = 25)

Item	r-computed	r-critical	p-value	Mean	SD	Decision
1	0.747	0.396	< .001	8.16	1.77	Valid
2	0.673	0.396	< .001	6.04	1.77	Valid
3	0.865	0.396	< .001	6.60	2.20	Valid
4	0.783	0.396	< .001	6.84	2.15	Valid
5	0.571	0.396	.003	6.56	2.66	Valid
6	0.816	0.396	< .001	7.00	1.98	Valid
7	0.840	0.396	< .001	6.24	2.63	Valid
8	0.869	0.396	< .001	6.48	2.74	Valid

Note. r-critical at df = 23, α = .05 (two-tailed) = 0.396. All items are valid (r-computed > r-critical).
Source: Researcher, 2025

As shown in **Table 2**, all eight items yielded Pearson correlation coefficients ranging from 0.571 to 0.869, all exceeding the critical r-table value of 0.396 and attaining statistical significance ($p < .05$). Items 3, 7, and 8 demonstrated particularly strong correlations ($r \geq$

https://doi.org/10.17509/curricula.v5i4.720

0.84), indicating high discriminatory power. These results confirm that all items validly measure the intended problem-solving construct. We conducted a reliability analysis using Cronbach's alpha to assess the instrument's internal consistency. **Table 3** presents the reliability analysis results.

Table 3. Reliability Analysis Results (Cronbach's Alpha)

Variable	k (Items)	$\Sigma\sigma^2 i$	$\sigma^2 t$	Cronbach's α
Problem-Solving Skills	8	41.19	191.33	0.897

Note. k = number of items; $\Sigma\sigma^2 i$ = sum of item variances; $\sigma^2 t$ = total score variance. Interpretation: α ≥ .90 = Excellent; .80-<.90 = Good; .70-.79 = Acceptable (George & Mallery, IBM SPSS Statistics 26 Step by Step).
Source: Researcher, 2025

The Cronbach's alpha coefficient of 0.897 falls within the "Good" reliability category (George & Mallery, in IBM SPSS Statistics 26 Step by Step), indicating strong internal consistency. This value exceeds the 0.70 threshold for acceptability in that classification, confirming that the eight items reliably measure the problem-solving skills construct. The overall pilot study results (M = 67.40; SD = 17.29; range = 37.50-100.00) further demonstrated adequate difficulty levels and sufficient score variance, confirming the instrument's suitability for the target population. **Figure 1** presents the scoring rubric based on Polya's four-step problem-solving framework used to evaluate each item.

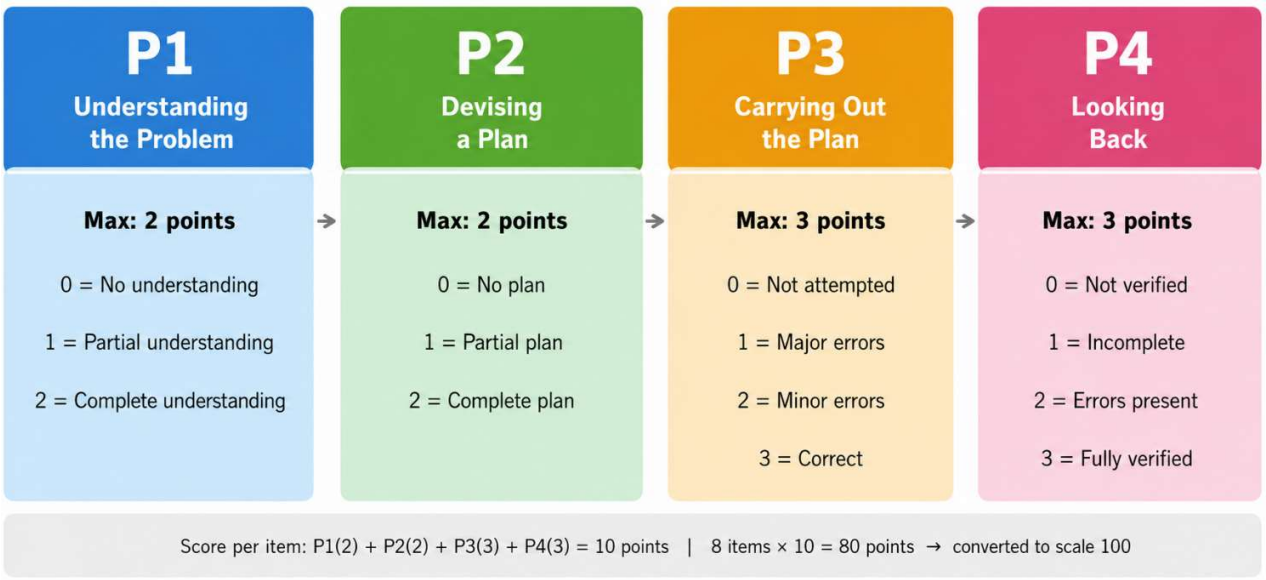


Figure 1. Polya's Four-Step Framework: Scoring Structure per Item
Source: Researcher, 2025

Figure 1 illustrates the scoring rubric based on Polya's four-step problem-solving framework applied to each test item. The rubric allocates a maximum of 2 points for understanding the problem (P1) and devising a plan (P2), and a maximum of 3 points each for carrying out the plan (P3) and looking back (P4), yielding a total of 10 points per item. This structured rubric evaluated student performance not only on computational accuracy but also on the quality of their problem-solving process across all four cognitive stages.

https://doi.org/10.17509/curricula.v5i4.720

RESULTS AND DISCUSSION

Pre-Test and Post-Test Score Comparison

Before the intervention, the two groups showed different baseline scores. The control group had a higher pre-test mean (M = 15.79) than the experimental group (M = 9.17), indicating the experimental group started from a lower baseline. After five instructional sessions, both groups improved; however, the gains differed substantially between conditions. The experimental group reached a post-test mean of 75.54, while the control group attained a post-test mean of 55.67. The between-group post-test difference was statistically significant ($p = .002$), with a large effect size (Cohen's $d = 0.84$), based on the conventional benchmarks proposed by Cohen in his book "*Statistical Power Analysis for the Behavioral Sciences*". **Figure 2** illustrates the pre-test-to-post-test score trajectories for both groups.

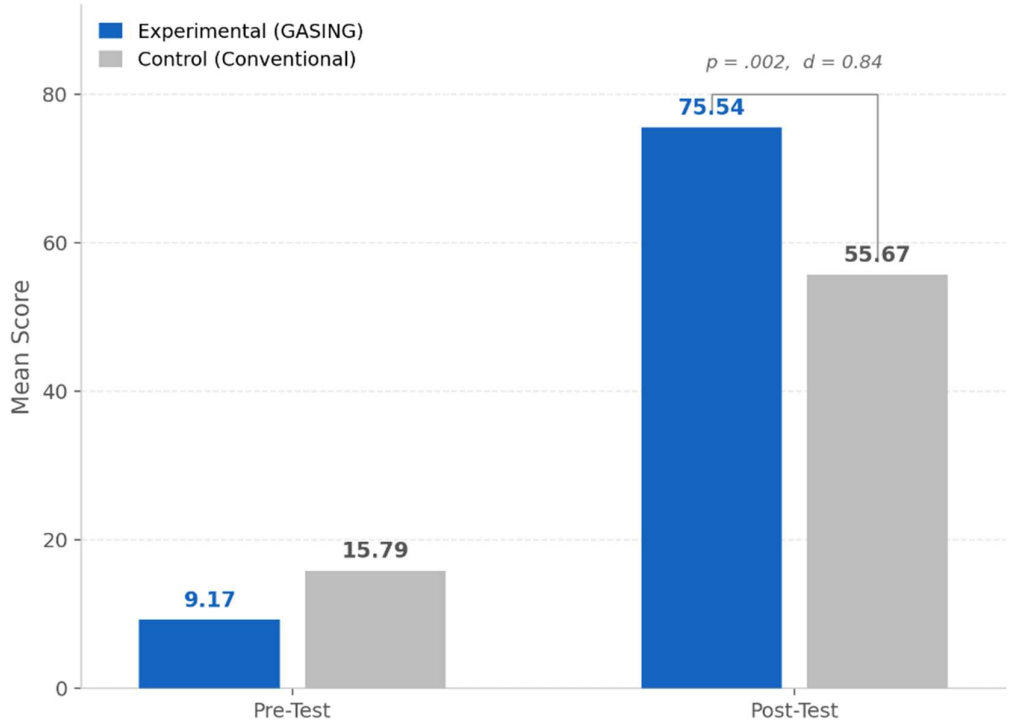


Figure 2. Pre-Test and Post-Test Score Comparison Between Experimental and Control Groups
Source: Researcher, 2025

Normalized Gain (N-Gain) Analysis

To account for differences in pre-test baselines, we computed normalized gain scores (g) for each student using the formula: g = (post-test - pre-test) / (maximum score - pre-test). The experimental group achieved a mean N-Gain of g = 0.74, categorized as great improvement according to classification criteria ($g \geq 0.70$ = high; $0.30 \leq g < 0.70$ = medium; $g < 0.30$ = low) (Hake, 1998). The control group achieved a mean N-Gain of g = 0.50, placing it in the medium improvement category. An independent-samples t-test confirmed that this difference was statistically significant ($p < .001$), with a very large effect size (Cohen's $d = 1.01$). **Figure 3** presents the N-Gain score comparison between groups.

https://doi.org/10.17509/curricula.v5i4.720

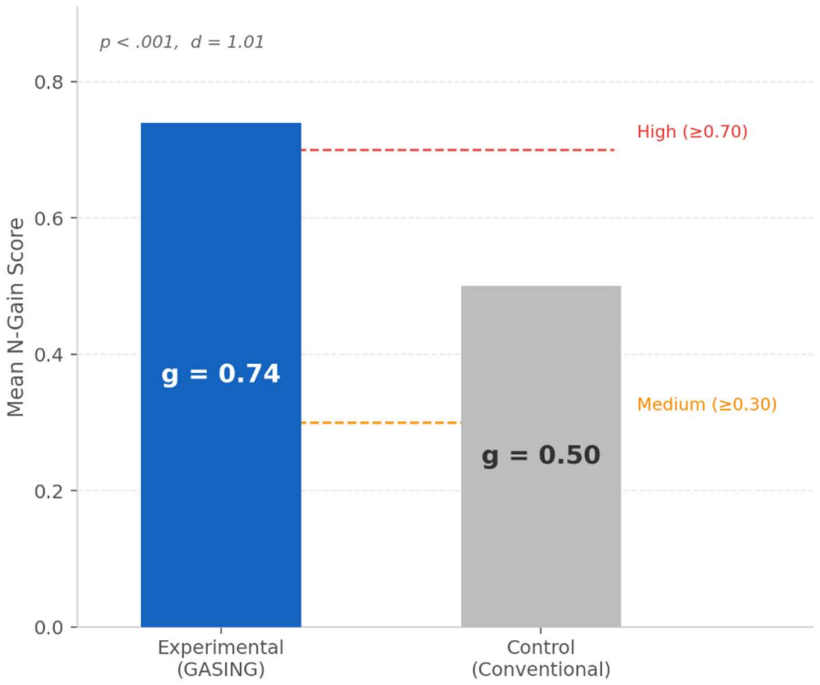


Figure 3. Normalized Gain (N-Gain) Score Comparison Between Experimental and Control Groups
Source: Researcher, 2025

Distribution of Students by N-Gain Category

Analysis of individual N-Gain distributions reveals the breadth of the GASING method's impact across student ability levels. In the experimental group, no students (0%) were classified in the low improvement category ($g < 0.30$); 46.7% achieved medium improvement ($0.30 \leq g < 0.70$); and 53.3% reached great improvement ($g \geq 0.70$). In the control group, by contrast, 23.3% of students fell in the low category, 56.7% in the medium category, and only 20.0% in the high category. **Figure 4** illustrates this distribution across both groups.

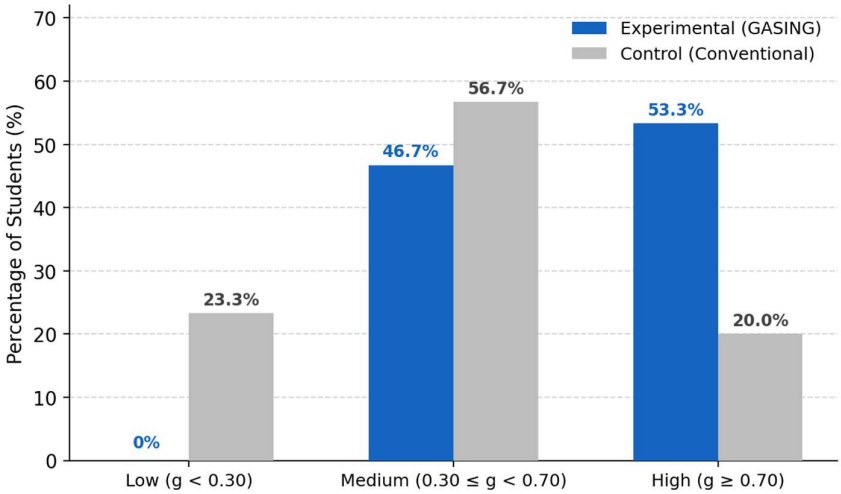


Figure 4. Distribution of Students by N-Gain Category
Source: Researcher, 2025

https://doi.org/10.17509/curricula.v5i4.720

Discussion

Superior Effectiveness of the GASING Method in Enhancing Problem-Solving Skills

The present study demonstrates that the GASING method produced significantly greater gains in mathematical problem-solving skills than conventional learning, as evidenced by post-test score differences (M = 75.54 vs. M = 55.67; d = 0.84) and normalized gain analysis (g = 0.74 vs. g = 0.50; d = 1.01; p < .001). These findings corroborate and extend prior syntheses of the GASING literature (Gesiradja et al., 2025; Matahelumual & Yohamintin, 2025), which established the method's effectiveness for computational achievement and mathematical comprehension, and align with the consistently large effect sizes reported in the most extensive multi-domain GASING evaluation to date (r = 0.849-0.895 across five arithmetic domains), by demonstrating that the GASING approach similarly enhances higher-order problem-solving processes as operationalized through Polya's four-step framework.

Similarly, a study of fourth-grade students at SD Negeri 54 Banda Aceh confirmed that GASING instruction significantly improved students' problem-solving abilities and reported statistically significant improvements in procedural mathematical understanding (p = .001) after GASING-based multiplication instruction among Phase B elementary students, further indicating that the method's effectiveness extends across mathematical topics (Hayati et al., 2024). Supporting evidence from the Indonesian elementary Mathematics context further indicates that structured, media-based instructional approaches focused on arithmetic operations yield measurable gains in students' mathematical problem-solving skills (Siregar & Siregar, 2025). The experimental group's superior outcomes, despite starting from a lower pre-test baseline (M = 9.17 vs. M = 15.79 in the control group), further strengthen these findings.

This reversal of initial disadvantage suggests that the GASING method's instructional features, specifically its concrete-to-abstract-to-mental-computation (CRA+) progression, can accelerate learning gains beyond what prior attainment alone would predict. A 2025 meta-analysis of 30 single-case design studies found a statistically significant overall effect size of Tau-BC = 0.9965 (p < .0001) for CRA-based Mathematics instruction (Ebner et al., 2025), indicating that scaffolded concrete-to-abstract progressions constitute a highly effective intervention framework in Mathematics. These results extend prior research on the GASING method, which has primarily documented its effectiveness for computational skills, by demonstrating that it also enhances higher-order problem-solving abilities aligned with Polya's framework (Gesiradja et al., 2025; Matahelumual & Yohamintin, 2025).

Mechanism of Effect: CRA Progression, Conceptual Understanding, and Polya's Framework

The theoretical mechanism by which the GASING method enhances problem-solving skills emerges from the convergence of three reinforcing elements: the CRA+ instructional sequence, conceptual depth, and explicit alignment with Polya's problem-solving heuristics. Grounded in Bruner's enactive-iconic-symbolic theory of cognitive development, the CRA framework has repeatedly supported the transition from procedural to conceptual understanding by anchoring abstract mathematical ideas in tangible experiences before

https://doi.org/10.17509/curricula.v5i4.720

progressing to symbolic notation (Azzumar & Juandi, 2023; Ebner et al., 2025). The GASING method's CRA+ progression therefore provides cognitive scaffolding that builds the conceptual foundation students need to engage flexibly and strategically with mathematical problem-solving tasks.

The alignment of GASING instruction with Polya's four-step problem-solving process is especially salient. The GASING method's structured progression through concrete, representational, and mental-computation phases provides instructional scaffolding precisely at the planning and execution stages where students in conventional instruction encounter the greatest difficulty. Studies using Polya's framework further confirm that many students across grade levels struggle most with the looking-back stage, indicating limited metacognitive self-monitoring skills that explicit problem-solving instruction must deliberately cultivate (Wahab et al., 2024).

Floor-Raising and Ceiling-Raising Effects Across Student Ability Levels

The N-Gain category analysis reveals particularly informative patterns. The complete absence of students with "low" improvement ($g < 0.30$) in the experimental group, compared to 23.3% in the control group, suggests that the GASING method effectively ensures minimum learning achievement for all students, including those who might otherwise struggle with mathematical problem-solving. This "floor-raising" effect is educationally significant because it suggests the method may be particularly effective at preventing students from falling behind (Rojo et al., 2024). This finding is consistent with meta-analytic evidence on CRA instruction, indicating particularly strong effects for students with Mathematics learning difficulties, and with the observation that student engagement patterns diverge by achievement level, with higher-achieving students benefiting from positive affective engagement while lower-achieving students particularly benefit from collaborative and structured learning opportunities (Ebner et al., 2025; Martins et al., 2022).

At the same time, 53.3% of experimental group students achieved "high" improvement ($g \geq 0.70$), compared with only 20.0% in the control group, showing that the GASING method also raises the achievement ceiling. This dual pattern, raising both the floor and the ceiling, suggests the method works across the ability spectrum, a highly desirable characteristic in the heterogeneous classroom conditions typical of Indonesian elementary schools. Meta-analytic evidence shows that structured word problem-solving interventions yield meaningful gains among elementary schoolers (Myers et al., 2022; Vessonen et al., 2025). Together with the particularly strong CRA effects reported for students with learning difficulties, this supports the interpretation that the GASING method's structured CRA+ sequence serves a protective function for academically at-risk students (Ebner et al., 2025). At the same time, the method's mental computation and pattern-recognition challenges provide enough cognitive stretch to drive large gains among already-proficient learners.

The Role of Motivational Engagement in Learning Gains

Beyond its cognitive-developmental features, the GASING method's emphasis on making Mathematics "*Gampang, Asyik, dan Menyenangkan*" (Easy, Fun, and Enjoyable) likely contributed to observed learning gains through motivational pathways. A substantial body of

https://doi.org/10.17509/curricula.v5i4.720

research consistently shows that student engagement and motivation are strongly associated with Mathematics achievement (Schukajlow et al., 2023; Xia et al., 2022). A comprehensive review of elementary school engagement showed that teacher and peer support significantly boosts student engagement, which multiple studies link to academic achievement; students who disengage show declining performance over time (Martins et al., 2022). Research on enjoyment and perseverance in mathematical reasoning found that enjoyment can act as a potential barrier to children's perseverance, underscoring the importance of designing instruction that cultivates strategic engagement, not merely positive affect (Barnes, 2020).

Examining the relationships among motivation, engagement, and Mathematics achievement among 1,538 Chinese primary school students, largely confirmed that motivation and engagement are associated with Mathematics achievement, and identified a group of struggling students whose low scores were linked to maladaptive motivation and engagement (Xia et al., 2022). A comprehensive review of emotions and motivation in Mathematics education further confirmed that instructional contexts embedding real-world, enjoyable, and contextually meaningful tasks generate measurable benefits in student motivation, particularly for younger and lower-achieving students who are most at risk in Indonesian elementary Mathematics classrooms (Schukajlow et al., 2023). A 2023 systematic review in Frontiers in Psychology further confirmed that game-based learning methods in Mathematics significantly improved both student motivation and academic achievement, with effects particularly pronounced for collaborative engagement and intrinsic goal orientation (Hui & Mahmud, 2023). The GASING method's design philosophy embeds concrete, game-like activities within a structured problem-solving framework, providing motivational scaffolding alongside cognitive scaffolding and offering a dual mechanism that explains its broad effectiveness across student ability levels.

Comparison with Prior Research and Effect Size Contextualization

The effect sizes observed in this study (Cohen's d = 0.84 for post-test scores and d = 1.01 for N-Gain) are substantially larger than those typically found in field-based educational interventions, where effects considered small under Cohen's conventional benchmarks are already large relative to most interventions (Kraft, 2020). A 2025 systematic review and meta-analysis of 115 studies reported a large average effect of word problem-solving interventions among elementary school students (Hedges' g = 0.95), while cautioning that large effects may partly reflect researcher-developed outcome measures; the GASING method's observed effect sizes are therefore comparable to those of well-designed word problem-solving interventions (Vessonen et al., 2025). Within the GASING literature specifically, comparably large or even larger effects have been reported, for instance, r = 0.849-0.895 (equivalent to Cohen's d ≈ 3.21-4.01) in a five-domain community intervention. However, these magnitudes are partly attributable to near-zero pre-test baselines and the absence of a control group. These conditions mathematically bias the N-Gain formula and non-parametric effect sizes toward inflation.

The present study's more moderate but still large effect sizes (d = 0.84-1.01), obtained under a genuine between-groups comparison with a non-degenerate baseline, therefore offer a methodologically more conservative and arguably more credible estimate of the GASING method's true impact. Several intersecting factors may explain these large effects. First, the GASING method represents a fundamentally different instructional philosophy from

https://doi.org/10.17509/curricula.v5i4.720

conventional learning, rather than merely a modification of existing practices. The shift from teacher-centered procedural transmission to student-centered conceptual development through concrete experiences represents a substantial pedagogical change that should produce meaningful differences in higher-order outcomes such as problem-solving, consistent with evidence that supporting students to struggle productively with challenging tasks is fundamental to Mathematics learning (Russo et al., 2021). The finding that both groups improved significantly from pre-test to post-test warrants careful interpretation.

The control group's significant improvement (pre-test M = 15.79 to post-test M = 55.67) indicates that conventional learning is not ineffective; rather, it is less effective than the GASING method. This nuanced finding suggests that the GASING method's superiority is attributable not to the comparison condition's failure but to the genuine added value of its instructional approach. Studies of Indonesian Mathematics classrooms have documented persistent difficulties in aligning classroom practice with higher-order thinking goals; conventional learning can produce procedural improvement, but it tends to prioritize procedural fluency over the metacognitive and strategic processes higher-order problem-solving demands (Trisnani et al., 2024; Zana et al., 2024). The GASING method addresses precisely this gap. Initial novelty effects in innovative instructional approaches in low-resource educational contexts may also amplify intervention impacts, a consideration when interpreting the magnitude of the observed effects.

Theoretical Implications: Bridging CRA, Constructivism, and Polya's Heuristics

The present findings contribute to a growing body of evidence supporting the integration of CRA instructional frameworks with explicit problem-solving heuristic instruction as a particularly effective approach for elementary Mathematics. The GASING method combines conceptual understanding and strategic problem-solving support, the key determinants of word problem performance, through its CRA+ progression aligned with Pólya's stages (Verschaffel et al., 2020). Similarly, teaching mathematical problem-solving through Pólya's heuristic equips learners with transferable ways of thinking, consistent with the GASING method's integrated design (Szabo et al., 2020). The causal loop illustrated in **Figure 5** depicts how these mutually reinforcing elements create a self-amplifying cycle of engagement, comprehension, and strategic problem-solving competency.

https://doi.org/10.17509/curricula.v5i4.720

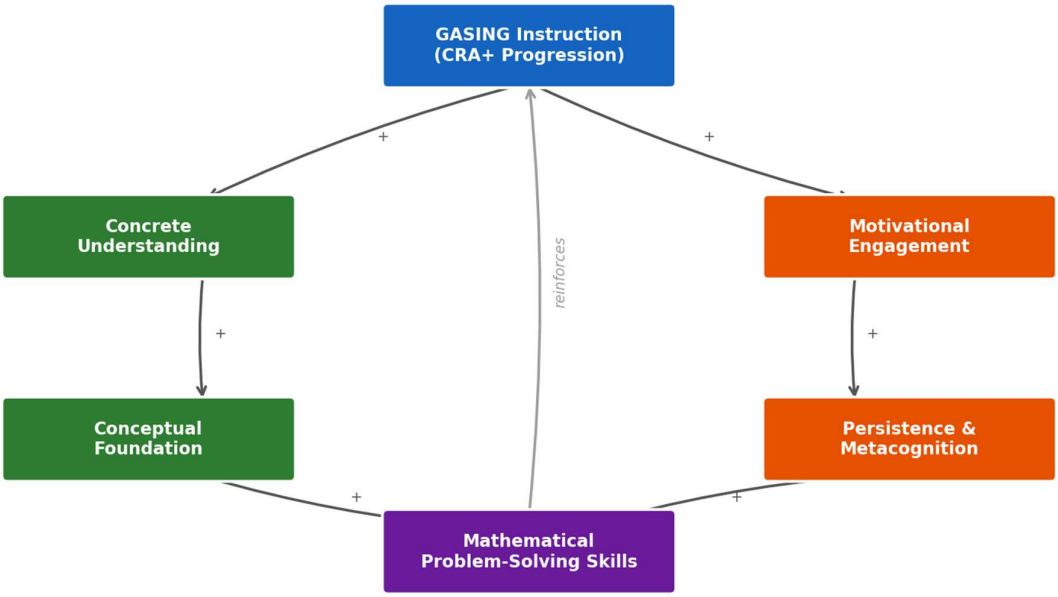


Figure 5. Causal Loop Diagram: Mechanism of GASING Method Effect on Mathematical Problem-Solving
Source: Researcher, 2025

From a constructivist perspective, the GASING method creates opportunities for productive struggle and engagement with challenging but accessible tasks that build both procedural fluency and strategic flexibility (Russo et al., 2021). The concrete manipulation phase of GASING instruction provides the cognitive foundation for students to engage with Polya's understanding and planning stages. In contrast, the mental computation phase develops the fluency needed for efficient execution. This theoretical coherence between the GASING method's instructional sequence and established problem-solving theory may explain why its effects transfer beyond computational accuracy to the broader metacognitive processes captured by Polya's framework. These findings support the theoretical proposition that instructional approaches emphasizing conceptual understanding and concrete-to-abstract-to-mental-computation progression are more effective for developing problem-solving skills than approaches focused solely on procedural transmission (Verschaffel et al., 2020).

Practical Implications for Indonesian Elementary Mathematics Education

For practitioners in Indonesian elementary schools, these findings carry direct instructional implications. The GASING method's demonstrated effectiveness across the ability spectrum makes it particularly well-suited for the heterogeneous classrooms characteristic of Indonesian public schools, where a single teacher must simultaneously address the needs of students with widely varying mathematical backgrounds. Research shows that Indonesian elementary Mathematics teachers often lack the pedagogical knowledge and confidence to integrate critical thinking into routine instruction, a gap that structured, evidence-based

https://doi.org/10.17509/curricula.v5i4.720

approaches such as the GASING method can address without extensive curriculum restructuring (Trisnani et al., 2024).

The method's compatibility with existing curriculum content (addition and subtraction in Grade 4) shows that effective problem-solving instruction need not introduce entirely new content, but rather requires a pedagogical reorientation toward conceptual understanding and strategic thinking. This finding aligns with recent quasi-experimental evidence from Indonesian elementary classrooms showing that active, student-centered instructional models, such as Problem-Based Learning (PBL), significantly outperform conventional learning on Mathematics learning outcomes, reinforcing the broader case for transitioning away from teacher-centered procedural transmission in Indonesian primary Mathematics education (Anugraheni et al., 2025; Putri & Astuti, 2025). The GASING method's accessibility and enjoyment features are also practically significant in the Indonesian context, where student motivation and engagement in Mathematics have been identified as persistent challenges (see: https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html).

Recent analyses of Indonesian fifth-grade students' numeracy literacy show that, although their procedural numeracy is fairly good, students still struggle to select appropriate solution strategies, indicating the need for instructional approaches that build strategic problem-solving ability alongside procedural fluency (Rahmah & Zulfadewina, 2025). By transforming routine arithmetic instruction into an engaging, concrete, and progressively challenging problem-solving experience, the GASING method addresses both the cognitive and affective barriers to mathematical achievement documented in Indonesian elementary education. These findings thus support integrating the GASING method as an evidence-based component of teacher professional development programs targeting mathematical problem-solving instruction, especially in developing-country contexts where innovative yet structured pedagogical approaches are critically needed.

Building on these implications, several practical recommendations follow. Elementary Mathematics teachers should adopt the GASING method as a primary or supplementary approach for teaching arithmetic operations, especially for students who struggle with problem-solving tasks, because its concrete-to-abstract progression makes it accessible even to students with limited prior mathematical attainment. School principals and curriculum coordinators should facilitate professional development programs that train educators in GASING-based instruction, equipping them with the pedagogical strategies needed to implement the method effectively in heterogeneous classrooms. Education policymakers and curriculum developers should consider integrating evidence-based approaches such as the GASING method into official elementary Mathematics curriculum guidelines, where foundational problem-solving competencies are first developed.

Limitations and Directions for Future Research

Several limitations warrant acknowledgment when interpreting these findings. First, the quasi-experimental design, while appropriate for the school context, does not provide the same internal validity guarantees as a fully randomized controlled trial; threats such as selection bias and classroom-level confounds cannot be fully excluded (Shadish, Cook, and

https://doi.org/10.17509/curricula.v5i4.720

Campbell, in "*Experimental and Quasi-Experimental Designs for Generalized Causal Inference"*). Similarly, these limitations apply to quasi-experimental designs in education research (Gopalan et al., 2020). Even so, this design represents a methodological improvement over much of the existing GASING literature: a systematic review of 25 GASING studies found that pre-experimental one-group designs without control groups were common across the field, limiting causal inference; by contrast, the present study's nonequivalent control-group design allows for a direct between-groups comparison, though it does not achieve the internal validity of full randomization (Gesiradja et al., 2025).

Second, the study was conducted in a single public elementary school in Agam Regency, West Sumatra, which limits the generalizability of findings to other geographic regions, school types, and socioeconomic contexts in Indonesia. Third, the relatively brief intervention period (five sessions) may not capture the long-term effects of the GASING method; sustained exposure may produce even larger or qualitatively different effects on problem-solving skill development. Fourth, this study focused exclusively on addition and subtraction; future research should examine whether these findings generalize to other arithmetic domains, including multiplication, division, and fractions, or to higher grade levels. Future research should address these limitations through larger, multi-site randomized controlled trials with extended intervention periods and delayed post-tests assessing the sustainability of learning gains.

Process-tracking studies employing think-aloud protocols or real-time observation of students' problem-solving behaviors during GASING-based instruction would provide deeper insight into the specific mechanisms through which the method enhances each of Polya's four stages. Comparative studies examining the GASING method against other innovative approaches, such as Realistic Mathematics Education (RME) and PBL, would help establish the method's relative advantages. Investigating the GASING method's effects on mathematical affect, including self-efficacy, Mathematics anxiety, and intrinsic motivation, would further clarify the motivational pathways through which GASING instruction contributes to achievement outcomes.

CONCLUSION

This quasi-experimental study provides empirical evidence that the GASING method is significantly more effective than conventional learning in enhancing fourth-grade elementary students' mathematical problem-solving skills in addition and subtraction. Students taught using the GASING method achieved significantly higher post-test scores and substantially greater normalized learning gains than students receiving conventional instruction. The GASING method was effective across the ability spectrum, eliminating "low" improvement outcomes while producing a majority of "high" improvement outcomes. These findings are consistent across both post-test score and normalized gain analyses. The results support the theoretical position that instructional approaches grounded in a concrete-to-abstract-to-mental-computation progression and engaging learning experiences yield superior problem-solving outcomes than teacher-centered procedural instruction.

https://doi.org/10.17509/curricula.v5i4.720

For practitioners, these findings support adopting the GASING method as an evidence-based approach to improving mathematical problem-solving instruction in elementary schools. As Mathematics education continues to emphasize higher-order thinking skills and problem-solving competencies, approaches such as the GASING method that bridge concrete understanding and abstract mathematical reasoning merit sustained attention from researchers, policymakers, and educators committed to improving mathematical outcomes for all students. Accordingly, elementary teachers are encouraged to adopt the GASING method for arithmetic problem-solving instruction, supported by school-level professional development and the integration of evidence-based approaches into Mathematics curriculum guidelines. At the same time, future research should test its generalizability through multi-site randomized designs.

AUTHOR'S NOTE

The authors declare no conflict of interest regarding the publication of this article. The authors affirm that the data and content of this article are free from plagiarism. The authors sincerely thank the principal, teachers, and students of SDN 63 Surabayo for their permission, support, and participation throughout this research.

REFERENCES

Anugraheni, I., Gufron, A., & Purnomo, Y. W. (2025). The impact of realistic problem-based learning on mathematical connection abilities: Evidence from elementary schools in Indonesia. *Cogent Education, 12*(1), 1-16.

Azzumar, F., & Juandi, D. (2023). Concrete-pictorial-abstract approaches to Mathematics education: A systematic literature review. *Journal of Mathematics and Mathematics Education, 13*(1), 1-11.

Barnes, A. (2020). Enjoyment in learning Mathematics: Its role as a potential barrier to children's perseverance in mathematical reasoning. *Educational Studies in Mathematics, 106*(1), 45-63.

Buknoni, Y., Wahyudin, W., & Iriawan, S. B. (2026). Efektivitas metode GASING untuk meningkatkan pemahaman konsep bilangan bulat di sekolah. *Scholaria: Jurnal Pendidikan dan Kebudayaan, 16*(2), 194-203.

Ebner, S., MacDonald, M. K., Grekov, P., & Aspiranti, K. B. (2025). A meta-analytic review of the concrete-representational-abstract math approach. *Learning Disabilities Research and Practice, 40*(1), 31-42.

Fitriani, E. (2025). The effectiveness of Polya's problem-solving strategy in enhancing mathematical word problem comprehension among fifth-grade students. *Jurnal Penelitian Ilmu Pendidikan, 18*(2), 181-192.

Gesiradja, M. C., Sudiapermana, E., Lutfiansyach, D. Y., & Shantini, Y. (2025). Evaluating the effectiveness, challenges, and contextual applications of the GASING Mathematics

https://doi.org/10.17509/curricula.v5i4.720

method in Indonesia: A systematic literature review. *Pedagogia Jurnal Ilmu Pendidikan, 23*(3), 318-335.

Gopalan, M., Rosinger, K., & Ahn, J. B. (2020). Use of quasi-experimental research designs in education research: Growth, promise, and challenges. *Review of Research in Education, 44*(1), 218-243.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64-74.

Hayati, Z., Satriani, N., Raharti, N., & Hijriati, H. (2024). GASING Mathematics instruction for enhancing problem-solving skills in elementary school students. *Genderang Asa: Journal of Primary Education, 5*(2), 25-36.

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*(1), 1-15.

Kraft, M. A. (2020). Interpreting effect sizes of education interventions. *Educational Researcher, 49*(4), 241-253.

Marlina, A. D. D., & Harinaredi, H. (2025). Analysis of the Kurikulum Merdeka on plane figures: A case study of elementary school students. *Curricula: Journal of Curriculum Development, 4*(2), 1639-1650.

Martins, J., Cunha, J., Lopes, S., Moreira, T., & Rosário, P. (2022). School engagement in elementary school: A systematic review of 35 years of research. *Educational Psychology Review, 34*(2), 793-849.

Matahelumual, M. M. E., & Yohamintin. (2025). Analisis pengaruh penggunaan metode GASING terhadap pemahaman matematis siswa di sekolah dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 10*(3), 253-266.

Maulida, S. A., Isrokatun, I., & Julia, J. (2024). Pengaruh pembelajaran kooperatif TGT dengan metode GASING terhadap pemahaman konsep matematis perkalian dua angka di SD. *SJME (Supremum Journal of Mathematics Education), 8*(1), 101-113.

Munawaroh, A. A., & Nurtamam, M. E. (2024). Pengaruh metode GASING dalam meningkatkan kemampuan pemahaman konsep matematis kelas 4 SD berdasarkan gender. *Jurnal Didika: Wahana Ilmiah Pendidikan Dasar, 10*(2), 288-295.

Myers, J. A., Witzel, B. S., Powell, S. R., Li, H., Pigott, T. D., Xin, Y. P., & Hughes, E. M. (2022). A meta-analysis of Mathematics word-problem solving interventions for elementary students who evidence Mathematics difficulties. *Review of Educational Research, 92*(5), 695-742.

Nurdianti, D., Sugiyono, S., & Suryatin, S. (2025). Analysis of fourth grade elementary students' mathematical problem-solving abilities. *STEAM Journal for Elementary School Education, 1*(2), 64-77.

Putri, S. A. E., & Astuti, S. (2025). The influence of the PBL model on Mathematics learning outcomes in primary school. *Curricula: Journal of Curriculum Development, 4*(2), 1327-1340.

https://doi.org/10.17509/curricula.v5i4.720

Rahmah, M., & Zulfadewina, Z. (2025). Analysis of fifth-grade students' numeracy literacy skills in Mathematics. *Curricula: Journal of Curriculum Development, 4*(2), 1847-1858.

Rojo, M., Gersib, J., Powell, S. R., Shen, Z., King, S. G., Akther, S. S., ... & Lin, X. (2024). A meta-analysis of Mathematics interventions: Examining the impacts of intervention characteristics. *Educational Psychology Review, 36*(1), 1-10.

Russo, J., Bobis, J., Downton, A., Livy, S., & Sullivan, P. (2021). Primary teacher attitudes towards productive struggle in Mathematics in remote learning versus classroom-based settings. *Education Sciences, 11*(2), 1-13.

Schukajlow, S., Rakoczy, K., & Pekrun, R. (2023). Emotions and motivation in Mathematics education: Where we are today and where we need to go. *ZDM - Mathematics Education, 55*(2), 249-267.

Siregar, A. F., & Siregar, N. (2025). Smart multiplication media on mathematical problem-solving skills among in Madrasah Ibtidaiyah. *Curricula: Journal of Curriculum Development, 4*(2), 1051-1062.

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in Mathematics education supporting the sustainability of 21st-century skills. *Sustainability, 12*(23), 1-28.

Trisnani, N., Retnawati, H., & Wuryandani, W. (2024). Challenges of Indonesian elementary school Mathematics teachers in integrating critical thinking into the classroom. *Journal on Mathematics Education, 15*(3), 905-924.

Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in Mathematics education: A survey. *ZDM Mathematics Education, 52*(1), 1-16.

Vessonen, T., Hellstrand, H., Kurkela, M., Aunio, P., & Laine, A. (2025). The effectiveness of mathematical word problem-solving interventions among elementary schoolers: A systematic review and meta-analysis. *International Journal of Educational Research, 132*(1), 1-19.

Wahab, A., Kusuma, Y. S., Juandi, D., Turmudi, T., Buhaerah, B., & Syaiful, S. (2024). Understanding students' struggles in solving mathematical problems: A systematic literature review using Polya's framework. *Jurnal Pendidikan Progresif, 14*(3), 1728-1753.

Xia, Q., Yin, H., Hu, R., Li, X., & Shang, J. (2022). Motivation, engagement, and Mathematics achievement: An exploratory study among Chinese primary students. *SAGE Open, 12*(4), 1-13.

Zana, F. M., Sa'dijah, C., Susiswo, L. A., Zulnaidi, H., & Zulnaidi, H. (2024). Curriculum and teacher assessment practices in Mathematics learning: Alignment with higher order thinking skills in Indonesian secondary schools. *Journal on Mathematics Education, 15*(4), 1311-1334.

https://doi.org/10.17509/curricula.v5i4.720