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The effect of the GASING method on mathematical problem-solving ability of grade V elementary school students: A mixed-methods study

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Abstract

Background: Mathematical problem solving remains challenging in primary classrooms, and GASING (Gampang, Asyik, dan Menyenangkan) combines concrete activities with enjoyable instruction.
Aims: This study described changes in Grade V students' problem-solving scores following GASING lessons and explored participants' accounts of the learning experience.
Methods: A sequential explanatory mixed-methods study combined a single-group pretest-posttest assessment of 20 students with interviews involving four students and two teachers. The intervention consisted of six 80-minute lessons over three weeks.
Results: Mean scores increased from 44.00 (SD = 6.81) to 86.00 (SD = 7.54), a 42.00-point difference. The reported paired test was $t(19) = -19.741$, $p < .001$; a sign test based on the non-overlapping score ranges also yielded $p < .001$. The class-level normalized gain computed from the reported means was 0.750. Four reported qualitative themes concerned enjoyment, concrete representation, playful participation, and teacher facilitation.
Conclusion: The results indicate a marked within-class improvement after instruction, but the absence of a comparison group, potential assessment-form differences, and incomplete qualitative source records preclude a causal claim.

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INTRODUCTION

Mathematical problem solving involves interpreting a task, selecting and evaluating strategies, and communicating a defensible solution. Contemporary reviews show that the difficulty of a word problem depends not only on computation but also on its linguistic structure, number of operations, and relationship to realistic situations (Vessonen et al., 2024; Wisenöcker et al., 2024). Studies of students' mathematical reasoning further distinguish independent reasoning from the imitation of procedures, highlighting the instructional importance of eliciting and supporting learners' own approaches (Säfström et al., 2024; Säfström et al., 2026). This perspective is relevant to elementary education, where students must connect developing numerical knowledge with problem interpretation.

Affective experiences shape whether children approach or avoid mathematical tasks. A meta-analysis identified a negative association between mathematics anxiety and achievement across educational levels (Barroso et al., 2021), while primary-school evidence links anxiety and test-related worry with performance and academic self-beliefs (Robson et al., 2023; Möhring et al., 2024). Classroom anxiety is also connected to students' appraisals of control and value (Putwain & Wood, 2023). Research in primary education suggests that self-efficacy and motivational engagement are related, although association does not establish direction or causality (Hidayatullah et al., 2024;

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Guntur & Purnomo, 2026; Živković et al., 2023). Consequently, a lesson design intended to improve problem solving should attend to affective conditions without presuming that enjoyment automatically translates into higher achievement.

Concrete representations may help students make sense of operations before working with formal symbols. A meta-analytic review of the concrete–representational–abstract approach describes how students can move from physical resources to visual and symbolic representations (Ebner et al., 2025). Classroom studies of structured arrays and multiplication emphasize that manipulatives and images are useful when learners notice mathematical relationships rather than merely handle objects (Bajwa et al., 2023; Bruno et al., 2024). Evidence from tangible-interface and virtual-manipulative instruction also suggests possible benefits, but the affordances of particular tasks and materials are not interchangeable (Zito et al., 2021; Stigberg et al., 2024; Siller & Ahmad, 2024). Recent reviews caution that representational pictures do not improve every type of word problem and that effects depend on task characteristics (Vessonen et al., 2026).

Game-based and participatory teaching introduces another potentially relevant mechanism: students may become more willing to attempt strategies, discuss errors, and sustain effort. Mathematics research reports variable benefits of games and gamification, with results depending on the learning outcome, design, and comparison condition (Alt, 2023; Anggoro et al., 2025; Cai et al., 2025). Two recent second-order syntheses similarly caution against treating positive averages as evidence that any game design will work in any classroom (Bozkuş et al., 2026; Yao, 2026). Experimental studies of competition structures and meta-analyses of digital games reinforce the need to distinguish cooperation, competition, and task-specific practice (Chen et al., 2026; Kusumawardani & Widhanarto, 2026). Evidence on teacher preparation is important because productive struggle requires responsive prompts rather than either immediate explanation or unsupported discovery (Stewart & Ball, 2023; Göçer & Özeren, 2025).

The GASING approach—Gampang, Asyik, dan Menyenangkan, often translated as easy, enjoyable, and fun—was developed in Indonesia as a sequence of accessible, concrete, and engaging mathematical learning experiences (Surya, 2013). The present manuscript describes a six-session classroom unit combining physical objects, familiar situations, and collaborative practice. These elements are consistent with broader research on representation and engagement, but similarity to a pedagogical theory is not evidence that a particular method causes learning gains. The proposed explanatory contribution is therefore narrower and testable: documenting score changes in one classroom and examining how participating students and teachers described those lessons.

A gap remains between describing a within-group achievement change and understanding what participants believe contributed to it. Sequential explanatory mixed-methods designs can connect quantitative patterns to later qualitative accounts, especially when the integration is explicit rather than a juxtaposition of two datasets (Fetters & Tajima, 2022; Reeping & Edwards, 2022; Creamer, 2023). Researchers have argued that joint displays can support transparent, theory-informed interpretation, while the overall quality of the inference still depends on the quality of each underlying strand (Peters & Fàbregues, 2024; Jackson-Gordon & Plano Clark, 2024). These considerations frame the present study as exploratory and descriptive rather than a controlled test of instructional effectiveness.

This study addresses three questions: (1) how did observed mathematical problem-solving scores change from pretest to posttest after six GASING sessions; (2) what is the size of the class-level normalized gain calculated from the reported aggregate scores; and (3) how did participating students and teachers describe the learning experiences that accompanied these changes? By separating statistical association from causal attribution, the study seeks to provide a cautious account of a local classroom intervention and specific directions for stronger future testing.

METHOD

Research Design

The project used a sequential explanatory mixed-methods framework, with quantitative score summaries examined first and qualitative interviews used to contextualize those summaries. The quantitative component was a single-group pretest–posttest pre-experiment. Because the same classroom received the intervention and there was no concurrent comparison group, the design

cannot separate the GASING lessons from maturation, repeated testing, changes in assessment format, or other time-related influences. The qualitative component focused on participants' reported experiences rather than on measuring a psychological mediator. The three analytic stages are displayed in Figure 1.

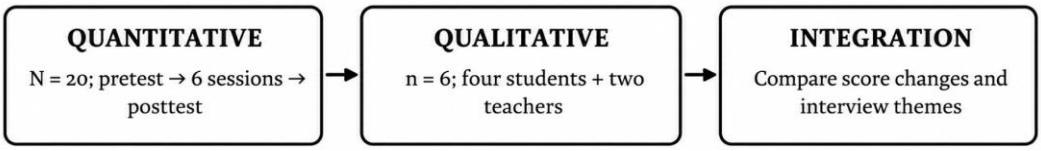


Figure 1. Sequential explanatory study logic (black-and-white reconstruction)

Figure 1 presents the sequence from the classroom assessment to interviews and integrative interpretation. The quantitative strand includes one group of 20 students with measurements before and after six lessons. The qualitative strand includes four students and two teachers interviewed after the intervention. The final stage compares the numeric pattern with themes described in the manuscript. The schematic does not imply that interviewing participants establishes a causal mechanism.

Setting and Participants

The manuscript identifies one Grade V classroom at SD Negeri Nerong, Southeast Maluku, Indonesia, during the second semester of the 2023/2024 academic year. The quantitative sample comprised all 20 students in the classroom, evenly divided by sex (10 girls and 10 boys), aged approximately 10–11 years. Four students were purposively selected for interview to capture differing baseline score profiles, and two teachers participated: the teacher delivering the lessons and a homeroom teacher observing the instruction. Student and teacher accounts represent a small, context-specific subsample and should not be treated as a prevalence estimate or a statistically representative survey. The original manuscript provides participant codes S1–S4 and T1–T2, which are retained in this revision.

Intervention and Measures

The intervention consisted of six GASING learning sessions, each lasting approximately 80 minutes, delivered across three weeks. Described activities involved physical manipulatives, problem contexts related to everyday transactions and farming, collaborative discussions, and games. The available manuscript does not contain sufficient session-level observations or fidelity records to quantify actual exposure to each component. The assessment was a 10-item constructed-response mathematical problem-solving test informed by Polya's four phases: understanding, planning, carrying out, and reviewing (Polya, 1957). The scoring rubric, evidence of instrument reliability, and full item-level results were not supplied, so this analysis is limited to reported total scores and cannot establish separate improvement in each Polya indicator. The evidence streams and their appropriate interpretive scope are summarized in Table 1.

Table 1. Evidence Sources and Permissible Inferences

Evidence source	Participants/time	Information available	Interpretive boundary
Pretest assessment	20 Grade V students, before lessons	Aggregate mean, SD and range	Baseline classroom performance only
GASING lessons	One class, six 80-minute meetings	Described use of objects, stories and games	Intervention exposure not independently measured
Posttest assessment	Same 20 students, after lessons	Aggregate mean, SD and range	Within-class change; not a causal effect
Student interviews	Four purposively selected students	Manuscript-preserved English excerpts	Participants' reported experiences
Teacher interviews	Two classroom teachers	Manuscript-preserved English excerpts	Practitioner observations and interpretations

Table 1 differentiates measurements, instructional exposure, and retrospective accounts. The achievement summaries describe the entire classroom rather than a comparison between randomized groups. The qualitative accounts come from six purposively selected participants. Neither the instructional descriptions nor the interviews provide independent evidence that a particular lesson component caused the score change. This distinction establishes the limits applied throughout the analysis.

Qualitative Interview Guide and Source Handling

The original manuscript describes Indonesian-language semi-structured interviews conducted after the posttest, with student conversations lasting approximately 25–40 minutes and teacher interviews approximately 38–52 minutes. The protocol explored previous experiences, concrete materials, confidence, group participation, everyday contexts, observed reasoning, and teacher roles. Table 2 condenses the seven areas in the source interview guides without introducing additional interview questions. The source manuscript states that original recordings and standalone Indonesian transcripts are no longer available; accordingly, this revision treats preserved English quotations as unattributed-to-audio manuscript excerpts and does not assert independent transcript verification, recoding, or reliability statistics. This limitation is substantive rather than editorial and is taken into account in interpreting the themes (Braun & Clarke, 2022, 2024). The seven interview domains, with examples of the corresponding prompts, are shown in Table 2.

Table 2. Condensed Semi-Structured Interview Domains

Domain	Student prompt	Teacher prompt
Previous instruction	How did you feel about earlier mathematics lessons?	How was problem solving usually taught?
First encounter / implementation	What felt different when objects and stories were introduced?	How were materials and activities organized?
Concrete problem solving	How did the objects help you understand a task?	How did students respond to representation?
Reasoning processes	What steps did you take to solve the problem?	Were changes noticed in understanding or planning?
Affect and motivation	Did your confidence or enjoyment change?	What engagement-related changes were observed?
Collaboration and teaching role	How did classmates support your thinking?	How did the teacher's role change?
Everyday transfer / reflection	Did familiar contexts help, and what should change?	What conditions would support future use?

Table 2 condenses parallel topics from the student and teacher protocols. The domains cover prior experience, problem representation, reasoning, affect, and instructional roles. Student questions focus primarily on personal perceptions and examples. Teacher questions invite observations and interpretations of classroom processes. These prompts support exploratory explanation but cannot independently identify which component produced the numerical changes.

Quantitative Analysis and Integration

Descriptive analysis used the reported pretest and posttest means, standard deviations, and ranges. The source manuscript reports a paired-samples t statistic of t(19) = -19.741 based on pretest minus posttest, with a difference standard deviation of 9.515. Because the reported Shapiro–Wilk result for paired differences is W = 0.876, p = .015, the normality assumption is not met at the .05 level; therefore, the t test is reported with caution and complemented by an exact two-sided sign test. The reported score ranges do not overlap (maximum pretest = 60; minimum posttest = 80), so every student's posttest must exceed that student's pretest, permitting an exact sign-test calculation from the summary alone (20 positive differences; two-sided p = 2/2^20 = .00000191). No unobserved individual score, Wilcoxon statistic, or uncertainty interval was generated.

The class-level normalized gain was calculated from aggregate means as (86.00 − 44.00)/(100 − 44.00) = .750, taking 100 as the reported maximum possible score. This is distinct from the mean of 20 individually normalized gains; the two quantities should not be interchanged without original paired observations (Hake, 1998). The interview material was organized under four themes already identified in the source manuscript; fresh coding, theme validation, and inter-rater agreement could not be audited without original records. Integration used a joint display that explicitly distinguished directly observed score patterns from possible participant interpretations (Creamer, 2023; Peters & Fàbregues, 2024).

RESULTS AND DISCUSSION

Results

Pretest–Posttest Score Pattern

The reported descriptive statistics show a large increase in the classroom mean over the six-session period. The initial mean was 44.00, whereas the post-instruction mean was 86.00, producing an increase of 42.00 score points. As shown in Table 3, the entire posttest range lies above the entire pretest range. Such a separation documents within-group improvement but does not indicate how much of that improvement would have occurred in the absence of GASING. The reported score summaries are compared in Table 3.

Table 3. Descriptive Pretest and Posttest Statistics (N = 20)

Measure	N	Minimum	Maximum	Mean	SD
Pretest	20	30	60	44.00	6.81
Posttest	20	80	100	86.00	7.54
Posttest – pretest	20	—	—	+42.00	—

Table 3 shows that the mean score increased by 42 points after the classroom instruction. The standard deviations indicate dispersion around each time point's mean. The pretest and posttest ranges do not overlap. Therefore, every student's posttest score must exceed their pretest score even though the paired raw scores are unavailable. These descriptive statistics cannot rule out testing or instrument-form effects. A graphic restricted to these reported class summaries is presented in Figure 2.

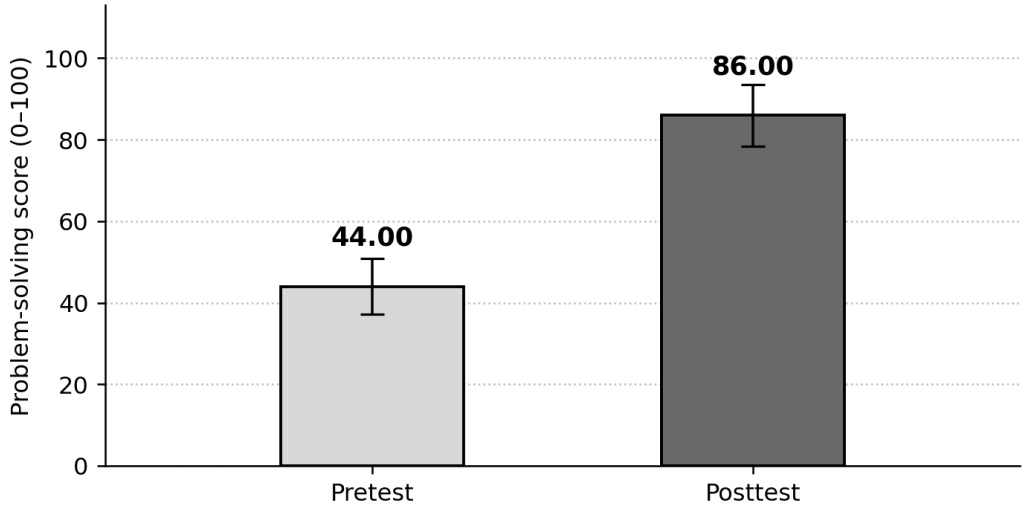


Figure 2. Reported pretest and posttest mean scores, with ±1 SD error bars (N = 20)

Figure 2 shows the reported increase from 44.00 to 86.00 on a 0–100 scoring scale. The vertical whiskers correspond to the separately reported standard deviations of 6.81 and 7.54. They are not confidence intervals or the standard deviation of paired change scores. The plot contains no synthesized student trajectories or reconstructed individual observations. Visual separation is descriptive evidence of score change, not proof of an intervention-specific effect.

Assumption Checks and Paired Inference

For inferential context, the source document reports a paired t statistic of −19.741 with 19 degrees of freedom and $p < .001$, consistent with the direction of the reported means. The reported Shapiro–Wilk test of paired differences has $p = .015$, which argues against a normality assumption for these differences. To avoid reliance on that assumption, the exact sign test assesses whether the direction of within-student change is balanced: all 20 changes are positive because the posttest minimum exceeds the pretest maximum, giving $p \approx .00000191$. Neither the t test nor the sign test resolves the lack of a comparison condition, and neither should be interpreted as establishing causality. The associated statistics and their distinct roles are summarized in Table 4. Table 4 reports the inferential and gain calculations that can be supported by the manuscript summary.

Table 4. Reported and Recomputed Quantitative Results

Analysis	Value	Interpretation
Paired t test (reported)	$t(19) = -19.741$; $p < .001$	Evidence of within-group score change; normality caveat
Shapiro–Wilk, paired differences (reported)	$W = 0.876$; $p = .015$	Normality not supported at $\alpha = .05$
Exact sign test (recomputed)	20 positive / 0 negative; $p = .00000191$	Change direction unlikely under a 50:50 null
Class-level normalized gain (recomputed)	$g = (86 - 44)/(100 - 44) = .750$	High gain under the stated Hake rule

Table 4 distinguishes statistics transcribed from the source from calculations derived solely from published summary values. The reported Shapiro–Wilk result raises an assumption concern for the paired t test. The sign test evaluates the direction of change without requiring the normality of score differences. The normalized gain of .750 is a ratio of class means rather than an average of individual gain ratios. No statistic in this table isolates the treatment effect from other explanations for change.

Qualitative Themes

The manuscript reports four recurring themes in posttest interviews: a shift toward enjoyment, concrete representation as a support for understanding, active participation through games and group work, and the teacher's facilitative role. Because original Indonesian audio and standalone transcripts are unavailable, the summaries below are interpretations of excerpts preserved in the supplied manuscript, not newly validated findings. Table 5 includes short quotations already present in that source, with participant identities retained as codes. Reported accounts should be understood as perceptions that may illuminate, but cannot establish, processes linked to achievement. Representative excerpts and the limits of interpretation are summarized in Table 5.

Table 5. Reported Interview Themes and Representative Excerpts

Reported theme	Illustrative excerpt from manuscript	Conservative interpretation
Enjoyment and reduced fear	S2: "I actually wanted to try to solve the problem."	A student described greater willingness to attempt a task.
Concrete representation	S3: "I could see with my own eyes that 6 groups of 7 made 42."	An object-based example reportedly made multiplication visible.
Play and participation	S1: "The games."	The student identified games when asked about motivation.
Teacher as facilitator	T1: "I am watching, listening, asking questions to provoke thinking."	A teacher described a more facilitative instructional stance.

Table 5 contains the four theme labels already reported in the original paper. Each quotation is taken from the supplied English-language manuscript rather than reconstructed from audio. The excerpts provide examples of how participants narrated instructional experiences. They do not measure mathematics anxiety, intrinsic motivation, or teaching quality with validated instruments. The absence of original recordings and transcripts limits independent confirmation of these interpretations.

Joint Interpretation of Quantitative and Qualitative Evidence

The explanatory connection between the two strands is conceptual rather than a statistically tested mediation model. The score pattern can be linked to student and teacher narratives about easier task entry, manipulatives, and collaborative effort, but these links remain alternative explanations offered by participants. The most consequential design concern is that a teacher interview describes the pretest as abstract numeric items and the posttest as story-context items; if those forms differed systematically, part of the observed change may reflect differences in task accessibility rather than learning alone. Table 6 therefore includes plausible threats and the type of evidence needed to distinguish them. Table 6 connects the numerical results with participants' accounts while preserving rival interpretations.

Table 6. Joint Display of Findings, Accounts, and Alternative Explanations

Quantitative observation	Reported qualitative account	Integrated interpretation and caution
Mean increased 44 → 86	Students describe familiar stories and objects	Representation may aid task entry; alternate forms may also differ in difficulty.
All posttest scores ≥ 80; all pretest scores ≤ 60	Students describe willingness to attempt problems	Willingness may support engagement; repeated testing and teaching time remain possible influences.
Class-level gain = .750	Teacher describes guiding rather than immediately explaining	Facilitation is a proposed instructional process, not a measured causal mediator.
Sign test $p < .001$	Interview themes describe positive experiences	Quantitative change and positive accounts are congruent but do not independently verify one another.

Table 6 brings score evidence and narrative interpretations into a single display. The first two rows indicate possible roles for representations and engagement in classroom learning. The third row distinguishes an instructional hypothesis from a measured mediator. The final row shows that statistically detectable change is compatible with participants' positive accounts. None of the rows excludes competing explanations such as easier posttest wording, practice effects, or contemporaneous instruction.

Discussion

Interpretation of the Quantitative Improvement

The central quantitative finding is a marked increase in scores after six GASING lessons, with a class-level normalized gain of .750. This is a descriptive within-class improvement, not an experimentally identified effect attributable to GASING. The strong paired contrast should be read alongside three limitations: a single group of 20 learners, absent instrument validation and paired raw scores, and evidence that test forms may have differed in contextual framing. These qualifications matter because Vessonen et al. (2024) found that word-problem characteristics are associated with performance, while Wisenöcker et al. (2024) demonstrated the significance of how real-life considerations are incorporated into tasks. If a pretest emphasizes decontextualized calculations and a posttest emphasizes familiar stories, measured performance may change for assessment-related reasons even when both forms address nominally similar mathematics.

It is nevertheless plausible that students benefited from linking visible groupings with multiplication structures, as reported in the interviews. Bajwa et al. (2023) showed how attention to arrays can support multiplicative ideas, while Bruno et al. (2024) illustrated the significance of conceptual modeling for problem-solving strategies. Siller and Ahmad (2024) and Zito et al. (2021) further highlight the promise and limits of physical and digital manipulatives in primary instruction. Ebner et al. (2025) provide a broader quantitative synthesis of concrete–representational–abstract interventions, but their review does not validate the specific effect size observed here. The present study thus agrees with a wider pedagogical rationale for concrete-to-symbolic activity without producing a controlled estimate of the GASING method's independent contribution.

Affective and Motivational Interpretations

Participants' reported movement from apprehension to greater willingness to try is conceptually consistent with research connecting anxiety, confidence, and mathematical performance (Barroso et al., 2021; Robson et al., 2023; Möhring et al., 2024). Evidence from Fishstrom et al. (2022), however, warns that improvements in academic achievement do not necessarily imply accompanying reductions in anxiety. A small intervention study combining mathematics instruction and relaxation further illustrates why achievement and anxiety should be examined as separate outcomes (Scheman et al., 2026). In the present study, no validated pretest and posttest measure of anxiety was collected, so the qualitative theme should remain a perception-based account rather than be written as evidence of measured emotional change. Živković et al. (2023), Hidayatullah et al. (2024), and Guntur and Purnomo (2026) offer related findings about self-efficacy and motivation in elementary mathematics, but their correlations should not be used to assert a

mechanism in the current sample. More direct future measurement could test whether affective variables mediate or merely accompany score gains.

The role of games also deserves careful qualification. Alt (2023) documented how different mathematics gamification activities relate to learners' experiences, and Anggoro et al. (2025) found heterogeneous effects of game-based learning on higher-order mathematics outcomes. Cai et al. (2025) synthesized problem-solving outcomes across digital game interventions, while Chen et al. (2026) examined the design of competition mechanisms among primary learners. Reviews by Bozkuş et al. (2026), Yao (2026), and Ratinho et al. (2026) indicate that game effects depend on design features, age group, outcomes, and methodological quality; their conclusions cannot be directly transferred to six largely non-digital GASING lessons. Thus, the reported play theme identifies a candidate condition for engagement, not a demonstrated explanation of the 42-point increase.

Teacher Facilitation and Instructional Conditions

A teacher's reported change from explaining procedures to observing and questioning students is compatible with scholarship on maintaining productive struggle. Stewart and Ball (2023) found that primary teachers encounter tension between supporting students and preserving their responsibility for reasoning. Säfström et al. (2024, 2026) show the value of diagnosing a learner's difficulty and matching feedback to the specific reasoning stage. Göçer and Özeren (2025) also situate mathematics teaching beliefs alongside anxiety and curiosity. In the present manuscript, however, there are no structured classroom observations or validated teacher practice measures to establish how consistently facilitative behavior occurred; the interview theme is therefore best framed as a teacher-reported shift.

Methodological Contribution and Transferability

The useful contribution of the mixed-methods design is the juxtaposition of a strong descriptive score change and participants' descriptions of learning conditions. This is the kind of inferential transparency encouraged by Reeping and Edwards (2022), Fetters and Tajima (2022), Creamer (2023), and Peters and Fàbregues (2024). Jackson-Gordon and Plano Clark (2024) further emphasize connecting stages of explanatory sequential designs, rather than treating interview data as a post hoc confirmation of treatment effects. Because original source interviews cannot be audited, the qualitative strand is less transparent than desirable under contemporary guidance on thematic-analysis congruence (Braun & Clarke, 2022, 2024). Thus, this paper offers preliminary triangulation of reported experiences and score patterns, not independently verified evidence about a generalizable mechanism.

Generalization is also limited by the classroom scale, institutional setting, and short intervention duration. Reviews of word-problem representations (Vessonen et al., 2026) and interventions targeting mathematical problem posing (Zhang et al., 2024) both indicate that task-specific outcomes matter when comparing instructional approaches. Studies involving fifth graders and concrete materials (Siller & Ahmad, 2024), digital game instruction (Kusumawardani & Widhanarto, 2026), and teacher-designed mathematical tools (Stigberg et al., 2024) suggest avenues for comparison, but none serves as a missing control condition in this study. The design therefore warrants carefully scoped conclusions and prospective replication rather than universal claims about curriculum reform.

Implications, Limitations, and Future Work

For classroom practice, the described sequence—familiar contexts, manipulatives, discussion, and guided movement toward abstract reasoning—provides an actionable lesson-design hypothesis. Teachers may examine whether tasks make mathematical structures visible, whether games permit productive mistakes, and whether prompts sustain student reasoning; these are recommendations informed jointly by the source narratives and contemporary literature, not established effects of the intervention. Future studies should preregister a comparison-group design, match pretest and posttest items on structure and difficulty, document scoring reliability, provide independent assessment, and retain anonymized paired scores. Student engagement and mathematics anxiety should be measured with appropriate instruments alongside lesson observations. Prospective

interviews should preserve consent-compliant audio, original-language transcripts, translation decisions, coding notes, and an explicit audit trail.

CONCLUSION

This single-class sequential explanatory mixed-methods study reported an increase in mathematical problem-solving scores from 44.00 (SD = 6.81) to 86.00 (SD = 7.54) after six GASING sessions. The class-level normalized gain computed from these means was .750, and every posttest score exceeded the entire pretest range. The reported paired t statistic and a summary-derived exact sign test both indicated a within-group score difference, although the reported normality assumption for the t test was not met. Student and teacher accounts preserved in the source manuscript described enjoyment, concrete representation, playful collaboration, and a facilitative teaching stance. Taken together, the evidence documents promising classroom change and participant perceptions, but it does not establish that GASING alone caused the gains or that the proposed cognitive and affective mechanisms were measured. Replication with equivalent test forms, a comparison group, validated measures, and accessible qualitative source records is needed before stronger effectiveness claims are warranted.

AUTHOR CONTRIBUTIONS STATEMENT

Arnacikalati: contributed to the implementation of the GASING method, interpretation of research findings, and preparation of the manuscript. H. Dede Margo Irianto: contributed to refining the research design, evaluating methodological consistency, and critically reviewing the manuscript. Ai Sutini: contributed to the development and evaluation of research instruments, interpretation of quantitative and qualitative findings, and refinement of the manuscript. Yohanes Surya: contributed to the conceptual interpretation of the GASING instructional approach, its pedagogical implementation, and the theoretical discussion of the findings. Mai Rosalli Matondang: contributed to organizing research data, integrating quantitative and qualitative findings, preparing tables and figures, and reviewing the manuscript.

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