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# EFFECTIVENESS OF GASING METHOD IN IMPROVING ELEMENTARY STUDENTS' BASIC ARITHMETIC ABILITY

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**Abstract**

Elementary students' numeracy deficits remain a persistent concern in Indonesia, particularly in resource-constrained regions, yet no prior study has simultaneously evaluated the GASING Method across all five basic arithmetic domains within a single intensive community-based program. This study examined the effectiveness of the GASING Method in the Pandai Berhitung Program, Central Bengkulu Regency (August 14–30, 2023). Using a pre-experimental one-group pre-test–post-test design ($n = 62$ students, Grades 4–6, recruited via total sampling, as this grade range matched the age level targeted by the GASING training curriculum), data were analyzed through descriptive statistics, N-Gain (Hake, 1998), and the Wilcoxon signed-rank test. Results showed significant improvement across all five domains ($p < .001$), with a high average N-Gain (0.738) and large effect sizes ($r = 0.849$–$0.895$). However, causal inference is limited due to the absence of a control group. These findings position the GASING Method as an accelerated learning intervention with strong potential for short-term numeracy gains in resource-constrained and geographically disadvantaged contexts, and provide a preliminary evidence base for program replication pending further controlled research.

**Keywords:** GASING Method; Basic Arithmetic; N-Gain; Wilcoxon Signed-Rank Test; Numeracy Intervention; Accelerated Learning

## INTRODUCTION

Strong arithmetic skills are the bedrock of more advanced mathematical thinking. Mastering the basic operations, addition, subtraction, multiplication, and division, is not just a school requirement; it shapes how children reason, solve problems, and navigate everyday situations. Jordan et al. (2009), through a four-year longitudinal study of 277 children, demonstrated that number competence developed in kindergarten is a strong predictor of mathematical achievement growth from Grade 1 through Grade 3, even after controlling for general intelligence, reading ability, and socioeconomic status.

In Indonesia, students' numeracy proficiency remains a serious concern. The PISA 2022 results indicated that Indonesian students scored 366 points in mathematics, substantially below the OECD average of 472 points, with only approximately 18.35% of students attaining Level 2, the minimum competency benchmark (OECD, 2023). At the national level, in 2021, 18% of elementary schools (SD/MI) were categorized as "requiring special intervention" in numeracy (Kemendikbudristek, 2022).

In response to this challenge, Prof. Yohanes Surya, Ph.D. developed the GASING Method (Gampang, Asyik, Menyenangkan/Easy, Fun, Enjoyable), designed to enable all students to learn mathematics easily and enjoyably without relying on rote formula memorization (Surya, 2025). The method organizes instruction around a set of arithmetic domains, including a foundational domain known as "BaKalKuBagi" (defined in the Literature Review). The method's pedagogical foundations and its growing institutional adoption, including a national collaboration with the Ministry of Religious Affairs, are elaborated in the following section.

A growing body of research has documented the effectiveness of the GASING Method across a range of contexts. Armianti et al. (2016) reported an N-Gain of 0.59 for multiplication; Kusuma et al. (2019) found a significant effect of GASING on elementary mathematics learning outcomes; Lestari and Hardini (2022) demonstrated its effectiveness for two-digit multiplication; Ramadhanti et al. (2024) found a positive effect of GASING on two-digit addition; Gultom and Usman (2024) reported an increase from 45.70 to 80.50 in three-dimensional geometry; and Maulida et al. (2024) reported a significant effect of cooperative TGT learning with the GASING Method on elementary students' conceptual understanding of multiplication. The meta-analysis by Wibowo et al. (2022) confirmed the consistency of GASING's positive effects, while Tartillah et al. (2025) concluded that GASING is effective in improving learning outcomes and student engagement.

Despite this growing body of evidence, prior research has been notably limited in scope. No study has yet examined all five basic arithmetic domains together within a single program. What is more, the existing studies were all carried out in regular classroom settings, not in the kind of intensive, multi-domain community training context investigated here. This study addresses four objectives: (1) to analyze overall arithmetic competency improvement; (2) to analyze domain-specific effectiveness using N-Gain; (3) to test the statistical significance of improvements using the Wilcoxon signed-rank test; and (4) to identify practical implications for the development of similar programs in regions facing significant numeracy challenges.

## Conceptual Foundations of Arithmetic Competence

Number sense forms the foundation of arithmetic competence and underpins all formal computational learning. Jordan et al. (2009) demonstrated that number competence developed in kindergarten significantly predicts mathematical growth from Grade 1 through Grade 3. Research shows that addition and subtraction are first-order operations, while multiplication and division occupy a more complex second tier (Fuchs et al., 2021). When students do not truly grasp one level, difficulties tend to compound at the next, which is why a holistic approach that covers all four fundamental operations within a single program is particularly relevant.

The Concrete–Pictorial–Abstract–Mental Calculation (CPA+) approach, which forms the pedagogical core of GASING, is well-supported by international research. Azzumar and Juandi (2023) concluded that CPA+ consistently yields positive effects on mathematical understanding across ability levels, a finding corroborated by a systematic review of 39 Scopus-indexed CPA studies across diverse educational contexts (Lutfi & Dasari, 2024). Fuchs et al. (2021) recommended six components of effective mathematics intervention, at least four of which are identifiable within GASING: (1) explicit and systematic instruction; (2) concrete-visual-abstract representation; (3) mathematical language development; and (4) speed-based activities during guided practice sessions.

In Indonesia, numeracy challenges are deeply embedded in the system and closely tied to geography. Kemendikbudristek (2022) reported that numeracy disparities between urban and rural areas remain substantial, making community-based programs like Pandai Berhitung in Central Bengkulu Regency particularly important as tools for narrowing the education gap.

The global numeracy crisis provides essential context for understanding the significance of short-term intensive intervention models. Internationally, low- and middle-income countries consistently underperform on numeracy benchmarks, with PISA 2022 revealing that over 60% of students in participating developing nations failed to reach minimum mathematical proficiency (OECD, 2023). In response, accelerated learning programs — defined as structured, high-dosage instructional interventions designed to achieve in weeks what conventional schooling achieves in months — have attracted growing empirical attention (Fuchs et al., 2021; Rojo et al., 2024). Such programs share three design features aligned with GASING: explicit sequencing of content, concrete-to-abstract instructional scaffolding, and structured practice routines targeting fluency (McNeil et al., 2025). The present study situates GASING within this global accelerated learning paradigm and contributes evidence on its applicability in an Indonesian community context.

**The GASING Method: Foundations and Empirical Evidence**

Prof. Yohanes Surya, Ph.D. of the GASING Academy developed the GASING Method in direct response to Indonesia’s long-standing challenge with low student numeracy. At its heart, the method rests on the belief that every child can learn mathematics well, provided teaching is done in the right way, in a manner that is easy, engaging, and enjoyable, without dependence on rote formula memorization (Surya, 2025). The domain “BaKalKuBagi” is an acronym for: BA (addition), KAL (multiplication), KU (subtraction), and BAGI (division), signifying that this domain builds the conceptual foundations of all four operations prior to their formal instruction. GASING pinpoints what it calls “critical points”, the specific junctures where students most often struggle, and builds learning sequences that work through those difficulties using hands-on, concrete activities.

Sulistiawati (2019) noted that GASING aligns with several learning theory perspectives: the repetitive drills reflect Thorndike's Law of Exercise (behaviorism); the use of physical manipulatives resonates with Piaget's concrete operational stage (constructivism); and the material sequencing fits with meaningful learning principles (cognitivism). In terms of empirical evidence, Armianti et al. (2016) reported an N-Gain of 0.59 for integer multiplication; Wibowo et al.'s (2022) meta-analysis confirmed the consistency of GASING's positive effects; and Maulida et al. (2024) found that combining GASING with cooperative TGT learning had significant effects on students' conceptual understanding of multiplication.

Recent developments reveal an expanding scope of GASING application. Afifasani et al. (2025) reported an N-Gain of 0.56 in a community service program in Sorong, West Papua, demonstrating that GASING works even in geographically remote (3T) regions. Tartillah et al. (2025) concluded that GASING is effective in improving learning outcomes and student engagement, and called for its integration with 21st-century skills and digital tools. The Indonesian Ministry of Religious Affairs (Kementerian Agama RI, 2023) announced a collaboration with Prof. Yohanes Surya to implement the GASING Method in madrasah institutions throughout Indonesia.

Looking across this body of research, three patterns stand out. First, nearly all GASING research employs pre-experimental or quasi-experimental designs without rigorous control groups. Second, the most extensively investigated domains are multiplication and addition, while subtraction, division, and simultaneous multi-domain evaluation are virtually absent — a gap the present study directly addresses. Third, studies reporting explicit N-Gain values are all based on single- or two-domain programs; direct comparisons with this multi-domain study therefore need to be made with care.

**Measuring Effectiveness: N-Gain and the Wilcoxon Test**

Instructional intervention effectiveness is measured through two complementary approaches. First, Hake's (1998) normalized gain (N-Gain), with the formula $g = (S_{post} - S_{pre}) / (100 - S_{pre})$, quantifies the relative effect size in relation to the available improvement space. Classifications are: high ($g > 0.70$), moderate ($0.30 \leq g \leq 0.70$), and low ($g < 0.30$). N-Gain allows fair cross-domain comparisons even when baselines differ; however, it is descriptive by nature and prone to ceiling effects.

Second, the Wilcoxon signed-rank test is employed to examine the inferential statistical significance of paired pre-test and post-test differences. Wilcoxon is preferred because it does not assume a normal distribution, unlike the paired t-test, and is appropriate for ordinal or non-normally distributed continuous data (Sugiyono, 2019). Effect size is computed using the coefficient $r = |Z| / \sqrt{n}$, with the following interpretive thresholds: $r \geq 0.50$ = large, $r = 0.30–0.49$ = moderate, $r < 0.30$ = small (Cohen, 1988). Together, N-Gain and the Wilcoxon test give a thorough picture of effectiveness, consistent with best practices in pre-experimental research (Creswell, 2018; Sugiyono, 2019).

### Conceptual Framework

The conceptual framework of this study is presented in Figure 1. The framework positions the GASING Method as a structured CPA+ intervention operating across five arithmetic domains (BaKalKuBagi, Addition, Multiplication, Subtraction, Division) within an intensive community program. The input consists of heterogeneous learners with varying prior arithmetic competencies. The intervention is operationalized through the sequential CPA+ learning process: Concrete exploration, Pictorial representation, Abstract formalization, and Mental calculation, delivered across 15 intensive days. The outcome is measured through pre-test and post-test scores, N-Gain, and Wilcoxon significance testing across all five domains. Beyond this input–process–outcome sequence, the framework assumes a direct pathway from CPA+ instructional exposure to arithmetic competency gains, consistent with the study's implicit hypothesis that structured, sequential CPA+ instruction produces measurable pre-to-post improvement across all five domains. This pathway is nonetheless conditioned by factors not directly measured in the present design. Student attendance across the 15 intensive days may function as a moderating variable, since irregular attendance would reduce the cumulative CPA+ sequence an individual student actually receives, potentially attenuating gains independent of the instructional model's effectiveness. Facilitator quality and implementation fidelity may similarly moderate outcomes, as the CPA+ sequence depends on facilitators correctly pacing the concrete-to-abstract progression. Because attendance and facilitator-level data were not systematically recorded for the 62 participants, both variables are treated here as acknowledged, unmeasured moderators rather than empirically tested factors (see Limitations).

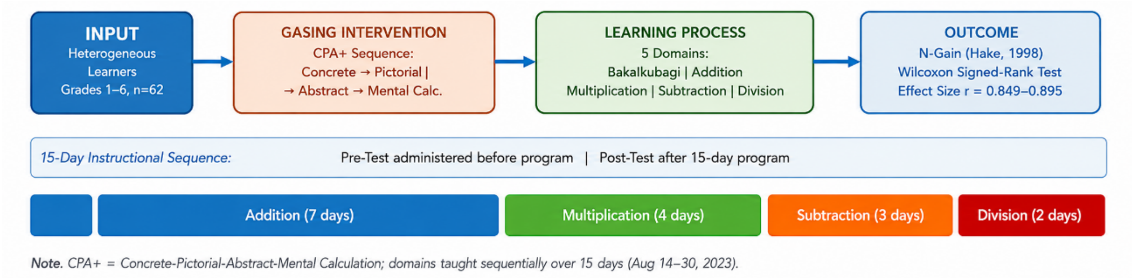


**Figure 1**. Conceptual Framework of the GASING-Based Pandai Berhitung Program

## METHOD

### Research Design

This study employed a quantitative approach with a pre-experimental design, specifically a one-group pre-test–post-test design (Creswell, 2018; Sugiyono, 2019). This design was chosen because the program was a community training initiative: all eligible students were enrolled, making it impossible to form a separate control group. The absence of a control group is acknowledged as a methodological limitation. Three threats to internal validity remain possible: (1) history effects; (2) regression to the mean; and (3) testing effects. The results are therefore descriptive and evaluative; causal conclusions would require a control-group design.

### Research Participants

Participants were students who enrolled and actively took part in the Pandai Berhitung Program utilizing the GASING Method in Central Bengkulu Regency from August 14–30, 2023. Schools sent student delegations: each participating school nominated a group of students drawn at random from available classes, with no selection based on academic ability. Participants were drawn from the registered pool using total sampling. A total of 62 students were analyzed, spanning Grades 4 through 6 from several schools in Central Bengkulu Regency. Of the 62 students, two participants had only partial data; their available data were retained and included per domain according to completeness. The number of valid data pairs analyzed per domain ranged from 59 to 61.

**Program Implementation**

The Pandai Berhitung Program was conducted over 15 effective days from August 14–30, 2023, with daily sessions running from 08:00 to 17:00 WIB (approximately 9 hours per day). The five domains were taught sequentially: Addition for 7 days, Multiplication for 4 days, Subtraction for 3 days, and Division for 2 days; the BaKalKuBagi domain was integrated as a foundational session at the outset of the program. Sessions were led by instructors certified by the GASING Academy. Each session followed a standardized structure: (1) concrete exploration using physical manipulatives; (2) pictorial representation; and (3) formal abstraction, consistent with the Concrete–Pictorial–Abstract–Mental Calculation (CPA+) stages. Instructional materials included number cards, seeds/counters, and illustrated worksheets standardized by the GASING Academy material development team.

**Assessment Instruments**

The instruments used were standardized arithmetic assessment tools developed by the GASING Academy material development team as the official measurement system for GASING training programs nationwide. The instruments covered five domains: (1) BaKalKuBagi; (2) Addition; (3) Multiplication; (4) Subtraction; and (5) Division. Each domain employed a 0–100 scoring range, with parallel pre-test and post-test instruments designed to assess equivalent competency levels. The content validity of these instruments is grounded in their systematic development by subject-matter experts specializing in elementary mathematics and the GASING pedagogical framework. Their practical validity is further supported by consistent use across more than 100 GASING training sites throughout Indonesia, covering a wide range of geographic and demographic settings. This breadth of deployment provides strong ecological support for the instruments' practical use in the field, though it does not by itself constitute psychometric evidence of reliability. Because data collection retained only aggregate domain-level scores rather than item-level responses, internal-consistency estimates such as Cronbach's alpha could not be computed post hoc for the present dataset. This constitutes a specific and disclosed limitation: no direct psychometric evidence (e.g., internal consistency or construct validity coefficients) is available for this particular sample, notwithstanding the instruments' documented content validity and their ecologically supported institutional use. Future studies should retain item-level response data specifically to enable such calculations.

**Data Analysis Technique**

Data analysis proceeded in five stages. First, descriptive statistics: the mean, standard deviation (SD), minimum, and maximum values were computed for the pre-test and post-test of each domain. Second, mean gain was calculated as the difference between post-test and pre-test scores. Third, N-Gain was computed per individual using Hake's (1998) formula: $g = (S_{post} - S_{pre}) / (100 - S_{pre})$, then averaged per domain; participants with a pre-test score of 100 were excluded. The overall average N-Gain was calculated as the arithmetic mean of the five domain N-Gain values: $(0.710 + 0.640 + 0.785 + 0.771 + 0.784) / 5 = 0.738$, without weighting for differences in n across domains. Fourth, the normality of gain distributions was tested using the Shapiro-Wilk test; since all domains exhibited non-normal distributions ($p < 0.05$), the Wilcoxon signed-rank test was employed. Fifth, effect size was computed using $r = |Z| / \sqrt{n}$ (Cohen, 1988). All calculations were performed using Python software (SciPy 1.11).

## RESULTS AND DISCUSSION

### Overview of Overall Improvement

Analysis of 299 valid data pairs (from 62 students across five domains) showed substantial improvement in arithmetic competence. The overall pre-test mean of 13.60 (SD = 23.09) rose to 79.39 (SD = 16.31) at post-test, a mean gain of +65.79 points. The arithmetic average N-Gain across domains reached 0.738 (high category, Hake, 1998). Wilcoxon signed-rank tests across all domains confirmed statistically significant improvements ($p < 0.001$) with large effect sizes ($r = 0.849–0.895$).

Two features stand out in the overall data. First, the very low pre-test mean (M = 13.60) with high variability (SD = 23.09) reflects an extremely heterogeneous initial condition, typical of open community programs without ability-based selection. Second, overall, post-test SD (16.31) was lower than pre-test SD (23.09). In four domains (BaKalKuBagi, Addition, Multiplication, Subtraction), post-test SD was lower than pre-test SD; conversely, the Division domain showed a higher post-test SD (16.85) compared to pre-test SD (0.13) due to its near-zero baseline distribution. Five participants with a pre-test score of 100 on certain domains were excluded from N-Gain calculations because Hake's (1998) formula is undefined for perfect pre-test scores.

Table 1 presents the descriptive statistics and N-Gain Index per arithmetic competency domain. Figures 2, 3, and 4 illustrate the overall pattern of improvement across all domains.

**Table 1.** Descriptive Statistics and N-Gain Index per Arithmetic Competency Domain (n = 62 students)

| Domain | n | Pre-Test M (SD) | Post-Test M (SD) | Gain | N-Gain (Category) |
|---|---|---|---|---|---|
| BaKalKuBagi | 61 | 14.92 (18.35) | 75.56 (16.29) | +60.63 | 0.710 (High) |
| Addition | 60 | 29.35 (26.67) | 81.77 (17.60) | +52.42 | 0.640 (Moderate) |
| Multiplication | 59 | 4.92 (16.99) | 79.02 (15.24) | +74.10 | 0.785 (High) |
| Subtraction | 60 | 18.39 (28.58) | 82.26 (14.98) | +63.87 | 0.771 (High) |
| Division | 59 | 0.02 (0.13) | 78.36 (16.85) | +78.34 | 0.784 (High) |
| OVERALL | 299 | 13.60 (23.09) | 79.39 (16.31) | +65.79 | 0.738 (High) |

Note: M = Mean; SD = Standard Deviation; N-Gain computed per individual then averaged (Hake, 1998); n = complete pre-post data pairs per domain

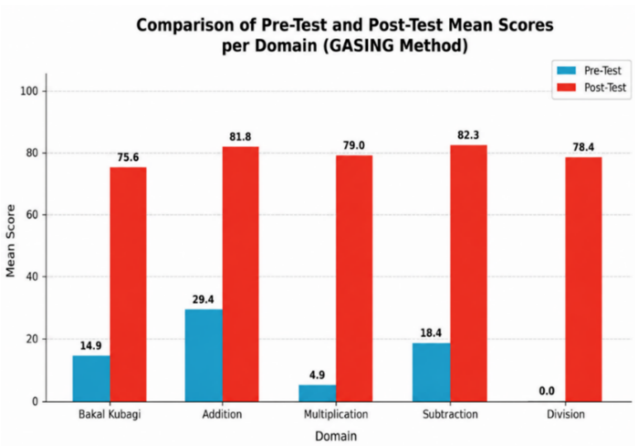


**Figure 2**. Comparison of Pre-Test and Post-Test Means per Domain

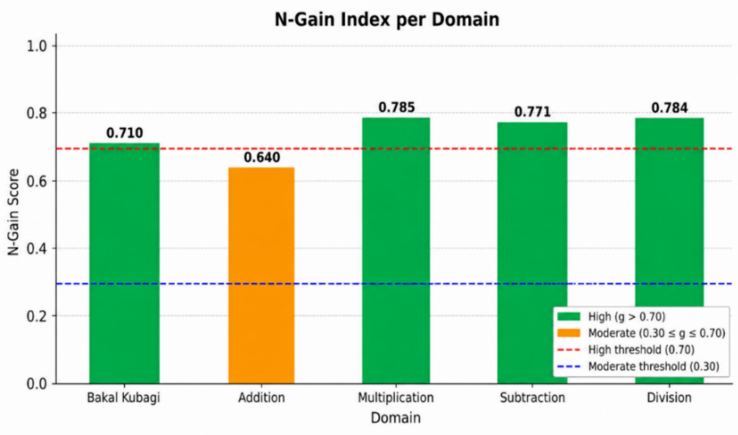


**Figure 3**. N-Gain Index per Domain with Hake (1998) Category Reference Lines

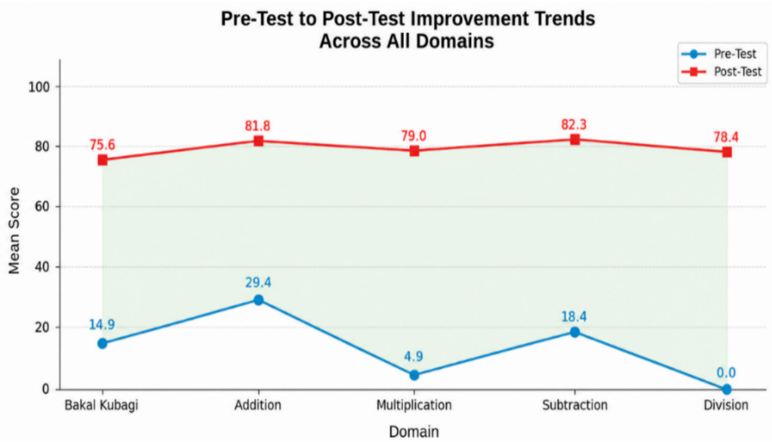


**Figure 4**. Pre-Test to Post-Test Improvement Trends Across All Domains

Figure 2 compares pre-test and post-test means across all five domains. In every domain, the post-test bars clearly exceed the pre-test bars, offering a straightforward visual picture of the program's impact. The Addition domain recorded the highest pre-test mean (29.35), indicating greater prior knowledge among participants, while the Division domain recorded a near-zero pre-test mean (0.02), signifying that virtually no participants possessed prior formal knowledge of division. Despite this wide variability in starting points, both domains converged to similarly high post-test scores (81.77 and 78.36, respectively). The Subtraction domain achieved the highest post-test mean (82.26) across all five domains, reflecting the cumulative benefit of its placement after Addition mastery had been established.

Figure 3 presents the N-Gain index for each domain alongside Hake's (1998) category reference lines at g = 0.70 (high threshold) and g = 0.30 (moderate threshold). Four domains, BaKalKuBagi (0.710), Multiplication (0.785), Subtraction (0.771), and Division (0.784), surpassed the high-category threshold and are displayed in green. Only the Addition domain (0.640) fell within the moderate category (displayed in orange), which is directly attributable to the ceiling effect: Addition's high baseline (pre-test mean 29.35) mathematically constrains the maximum achievable N-Gain through Hake's formula, irrespective of actual instructional effectiveness. All domains are positioned well above the moderate threshold (0.30), confirming consistently strong learning gains across the entire program.

Figure 4 visualizes the pre-to-post improvement trends across all domains as a connected line chart. The pre-test line (blue) exhibits marked variability, ranging from 0.02 (Division) to 29.35 (Addition), reflecting the highly heterogeneous initial conditions of the participants. In contrast, the post-test line (red) is notably uniform, ranging narrowly from 75.56 to 82.26 across all five domains. The shaded area between the two lines represents the magnitude of learning gain; the steepest improvement gradient is observed for the Division domain, which advanced from near zero to 78.36. The convergence of the post-test line suggests that, regardless of starting level, participants reached a similarly high score range after the 15-day program, though without a control group, the degree to which this convergence is attributable solely to the intervention cannot be definitively established.

**Detailed Statistics and Significance Testing**

Table 2 presents detailed statistics per domain including minimum and maximum values, while Table 3 summarizes the Wilcoxon signed-rank test results and effect sizes for each domain. Pre-test distributions in several domains were markedly skewed: the coefficient of variation (CV) for Multiplication reached 345% and for Subtraction 155%, indicating non-normal distributions.

**Table 2.** Detailed Statistics per Arithmetic Competency Domain

| Statistic | BaKalKuBagi | Addition | Multiplication | Subtraction | Division |
|---|---|---|---|---|---|
| Pre-Test Mean | 14.92 | 29.35 | 4.92 | 18.39 | 0.02 |
| Pre-Test SD | 18.35 | 26.67 | 16.99 | 28.58 | 0.13 |
| Pre-Test Min | 0 | 0 | 0 | 0 | 0 |
| Pre-Test Max | 85 | 100 | 100 | 100 | 1 |
| Post-Test Mean | 75.56 | 81.77 | 79.02 | 82.26 | 78.36 |
| Post-Test SD | 16.29 | 17.60 | 15.24 | 14.98 | 16.85 |
| Post-Test Min | 35 | 20 | 40 | 60 | 40 |
| Post-Test Max | 100 | 100 | 100 | 100 | 100 |
| Mean Gain | +60.63 | +52.42 | +74.10 | +63.87 | +78.34 |
| N-Gain | 0.710 | 0.640 | 0.785 | 0.771 | 0.784 |
| N-Gain Category | High | Moderate | High | High | High |

Source: Primary data analysis, n = 62 students

**Table 3.** Wilcoxon Signed-Rank Test Results per Domain

| Domain | n | W | p-value | r (ES) | ES Category | Significance |
|---|---|---|---|---|---|---|
| BaKalKuBagi | 61 | 0.0 | < 0.001 | 0.884 | Large | Significant** |
| Addition | 60 | 25.0 | < 0.001 | 0.849 | Large | Significant** |
| Multiplication | 59 | 1.5 | < 0.001 | 0.895 | Large | Significant** |
| Subtraction | 60 | 3.0 | < 0.001 | 0.877 | Large | Significant** |
| Division | 59 | 0.0 | < 0.001 | 0.895 | Large | Significant** |

Note: W = Wilcoxon statistic; r = effect size ($r \geq 0.50$ = large); ** $p < 0.001$ (two-tailed); normality tests (Shapiro-Wilk) indicated non-normal gain distributions across all domains ($p < 0.05$).

Wilcoxon test results confirmed statistically significant improvements across all domains ($p < 0.001$), with effect sizes r = 0.849–0.895 (all classified as large per Cohen, 1988). These r values correspond to Cohen's d values ranging from 3.21 to 4.01, extremely large mathematically due to the very low baselines inherent in the pre-post design without a control group. W statistics approaching zero across nearly all domains indicate that virtually no participants experienced score declines. In the Addition domain ($W = 25.0$), the presence of negative ranks suggests that some participants experienced post-test score decreases, likely attributable to fatigue or inherent measurement variability at the conclusion of an intensive 15-day program.

**Domain-Specific Competency Analysis**
**BaKalKuBagi**

The BaKalKuBagi domain, an acronym for BA (addition), KAL (multiplication), KU (subtraction), and BAGI (division), evaluates foundational readiness across all four arithmetic operations prior to formal instruction. The pre-test mean of 14.92 (SD = 18.35) increased to 75.56 (SD = 16.29) with a mean gain of +60.63 and N-Gain = 0.710 (high). The Wilcoxon statistic $W = 0.0$, $p < 0.001$, $r = 0.884$ (large). This domain's N-Gain ranked fourth among the five domains, which can be explained by two factors: its content is more conceptual in nature, and its pre-test mean of 14.92 is higher than those for Multiplication (4.92) or Division (0.02), resulting in a more constrained improvement space.

**Addition**

The Addition domain recorded the highest pre-test mean (29.35; SD = 26.67), indicating greater prior knowledge. Post-test scores increased to 81.77 (SD = 17.60) with a mean gain of +52.42. N-Gain = 0.640 (moderate), the only domain to fall into this category. Two participants with pre-test scores of 100 were excluded from N-Gain calculations. Wilcoxon $W = 25.0$, $p < 0.001$, $r = 0.849$ (large). The N-Gain of 0.640 must be interpreted in the context of the ceiling effect: a pre-test mean of 29.35 means that the mathematically available improvement space is smaller than for domains with near-zero baselines. A lower N-Gain does not indicate that the program was less effective for Addition; rather, many participants had already partially mastered this competency before the training.

**Multiplication**

The Multiplication domain exhibited a dramatic improvement profile. The pre-test mean of 4.92 (SD = 16.99) increased to 79.02 (SD = 15.24) with a mean gain of +74.10. N-Gain = 0.785 (highest; high category). One participant with a pre-test score of 100 was excluded from N-Gain calculations. Wilcoxon $W = 1.5$, $p < 0.001$, $r = 0.895$ (large). The low pre-test mean (4.92) indicates that multiplication was almost entirely new material for the majority of participants. This success reflects the effectiveness of the GASING approach, which introduces multiplication through repeated addition and concrete number pattern exploration before transitioning to formal multiplication tables, consistent with Fuchs et al.'s (2021) recommendations.

**Subtraction**

The Subtraction domain recorded the highest post-test mean (82.26) and the smallest post-test SD (14.98) among all domains, with N-Gain = 0.771 (high category). The pre-test mean of 18.39 (SD = 28.58) increased to 82.26 with a mean gain of +63.87. Wilcoxon $W = 3.0$, $p < 0.001$, $r = 0.877$ (large). The SD reduction from 28.58 to 14.98 was the most dramatic across all domains. The Subtraction domain (N-Gain 0.771) achieved a higher value than Addition (N-Gain 0.640), despite receiving only three days of instructional time compared to seven days allocated to Addition. This anomaly reflects the interaction between learning sequence effects — Subtraction was taught after Addition mastery had been established — and the mathematical characteristics of the N-Gain formula.

**Division**

The Division domain presented the most distinctive data profile: 61 of the 62 participants recorded a pre-test score of 0. The pre-test mean of 0.02 (SD = 0.13) signifies that virtually all participants possessed no prior formal knowledge of division. The post-test mean increased to 78.36 (SD = 16.85) with an absolute mean gain of +78.34 (the highest across all domains) and N-Gain = 0.784 (high). Wilcoxon $W = 0.0$, $p < 0.001$, $r = 0.895$

(large). Within 15 days, the program was associated with substantial division competence gains from a near-zero starting point, consistent with GASING's emphasis on introducing entirely new competencies through concrete, activity-based approaches (Surya, 2025; Afifasani et al., 2025). Given the absence of a control group, causal attribution to the program alone requires appropriate caution.

**Comparative Analysis with Prior Research**

Table 4 positions the findings of this study alongside those of prior GASING research. Numeric N-Gain comparisons are only possible with studies that report them explicitly; comparative studies are presented with notations of "Sig. positive" or "Effective (consistent)" in the N-Gain column.

**Table 4.** Comparative Analysis of GASING Program Results with Prior Research

| Researcher (Year) | Domain/Material | Pre-Test | Post-Test | N-Gain / Effectiveness |
|---|---|---|---|---|
| Armianti et al. (2016) | Integer multiplication | , | , | 0.59 (Moderate) |
| Kusuma et al. (2019) | General mathematics (elementary) | , | , | Significant positive |
| Aprijon (2020) | Addition & Multiplication | , | 69.75 | Higher than conventional |
| Wibowo et al. (2022) | Meta-analysis GASING elementary | , | , | Positive (consistent) |
| Alianti et al. (2024) | Whole number addition, Grade 3 | , | , | Significant positive |
| Gultom & Usman (2024) | 3D geometry | 45.70 | 80.50 | ~0.64 (Moderate–High)* |
| Maulida et al. (2024) | Multiplication (TGT+GASING) | , | , | Significant positive |
| Mutiara et al. (2024) | Numeracy, Grade IV elementary | , | , | Significant positive |
| Afifasani et al. (2025) | General arithmetic (Sorong) | , | , | 0.56 (Moderate) |
| Tartillah et al. (2025) | SLR of 26 GASING articles | , | , | Effective (consistent) |
| This Study (2023) | 5 arithmetic domains | 13.60 | 79.39 | 0.738 (High) |

Source: Compiled from verified publications; (, ) = not reported in source; *)

N-Gain ~0.64 for Gultom & Usman (2024) was calculated by the authors from reported pre-test (45.70) and post-test (80.50) data using Hake's (1998) formula.The overall N-Gain of this study (0.738) exceeds those of Armianti et al. (2016) for multiplication (0.59) and Afifasani et al. (2025) for general arithmetic (0.56). This difference is partially attributable to the Multiplication and Division domains beginning from very low baselines, which mathematically yields higher N-Gain values. What sets this study apart is, first, the simultaneous coverage of five domains enabling cross-domain profile analysis; second, the inclusion of Wilcoxon significance testing; and third, the confirmation of large effect sizes ($r \geq 0.849$) across all domains.

Three main patterns emerge from comparing these results. First, N-Gain gradients are inversely proportional to baseline scores, consistent with the mathematical properties of Hake's (1998) formula. Second, a consistent reduction in post-test SD across four of five domains indicates a trend toward reduced competency variability, though this interpretation requires caution without individual quartile data. Third, all domains achieved N-Gain ≥ 0.640 with Wilcoxon $p < 0.001$, a pattern consistent with GASING's methodological coherence across domains, though cross-study comparisons remain constrained by design differences.

**Theoretical Contribution**

Beyond its practical findings, this study makes a distinct theoretical contribution to the literature on numeracy intervention and accelerated learning. First, the study positions GASING as a multi-domain CPA+ intensive model — that is, a structured pedagogical system that bridges informal, concrete mathematical experience and formal abstract computation across all four fundamental arithmetic operations within a compressed instructional timeline. This conceptualization extends prior applications of the Concrete–Pictorial–Abstract–Mental Calculation (CPA+) framework (Azzumar & Juandi, 2023), which have largely been examined in single-domain or regular classroom contexts, to a multi-domain intensive community program setting.

Second, the convergence of post-test scores across domains despite highly heterogeneous baselines supports the theoretical premise of accelerated learning: that intensive, well-sequenced instruction can substantially compress the time required for competency acquisition (Tartillah et al., 2025). The near-uniform post-test range (75.56–82.26) achieved from diverse starting points is consistent with equity-oriented learning acceleration theory, which holds that high-dosage, structured intervention can offset prior learning gaps within short timeframes (Fuchs et al., 2021).

Third, the consistency of large effect sizes (r = 0.849–0.895) across all five domains contributes to numeracy intervention theory by demonstrating that GASING's methodological coherence — the sequential concrete→pictorial→abstract→mental calculation progression — generalizes across arithmetic domains of varying cognitive complexity. This finding supports the theoretical position that CPA+ is not merely a domain-specific instructional scaffold but a transferable pedagogical architecture applicable to both foundational (addition, subtraction) and higher-order (multiplication, division) arithmetic operations (Iyamuremye & Burns, 2025).

**Pedagogical and Policy Implications**

First, the 15-day intensive program was linked to substantial, statistically significant gains across all five basic arithmetic domains, including for a domain entirely new to participants (Division: N-Gain 0.784, r = 0.895 from a baseline of 0.02). While the pre-experimental design precludes strong causal claims, these results provide a preliminary evidence base to support consideration of replication in resource-constrained regions. The relatively brief 15-day duration makes this model operationally and financially more accessible for local governments.

Second, the Addition N-Gain (0.640) reflects a ceiling effect attributable to its high baseline, not a program deficiency, with the effect size r = 0.849 confirming genuine effectiveness. Programs should be supplemented with differentiated pre-assessment and enrichment materials for participants with higher prior knowledge, including adaptive approaches that adjust instructional pathways based on individual competency levels.

Third, the consistency of large effect sizes (r ≥ 0.849) across all five domains supports the interpretation that GASING's methodological coherence, the sequential application of concrete→pictorial→abstract principles, supports learning across diverse arithmetic domains (Sulistiawati, 2019; Tartillah et al., 2025). Fourth, this study did not systematically measure implementation fidelity; future research should document facilitator performance quality to identify determinants of result consistency across program replications. Fifth, the endorsement by the Ministry of Religious Affairs RI (Kementerian Agama RI, 2023) represents policy momentum for integrating similar programs into the national madrasah network. Sixth, given that 82% of Indonesian students have not reached Level 2 mathematical competency in PISA 2022 (OECD, 2023), community-based programs like GASING could serve as meaningful complements to long-term curriculum reform, pending further controlled research.

**Limitations**

Several limitations warrant explicit acknowledgment. First, without a control group, strong causal claims cannot be made; three internal validity threats remain: history effects, regression to the mean, and testing effects. Second, as noted in the Methodology, internal-consistency reliability could not be computed for the present instruments due to the unavailability of item-level response data; this represents a specific psychometric gap rather than an absence of content validity. Third, the absence of a retention study means that the long-term durability of learning outcomes has not been evaluated. Fourth, pre-test distribution data indicate highly non-normal and potentially bimodal distributions in several domains. Fifth, N-Gain computed per individual and then averaged may yield different values from aggregate mean-based N-Gain. Sixth, subgroup analysis by grade level was not conducted due to the unavailability of structured grade data.

**Recommendations**

Based on the findings and their limitations, six recommendations are offered. First, the GASING-based Pandai Berhitung program warrants replication in other regions facing similar numeracy challenges, particularly in 3T areas. Second, future studies should use designs that include a control group. Third, retention studies at 3, 6, and 12-month post-program intervals should be conducted. Fourth, differentiated initial assessments and enrichment modules for participants with higher prior knowledge should be developed. Fifth, replication studies conducted in substantially different sociocultural contexts may consider supplementary psychometric documentation of the GASING Academy instruments to further substantiate cross-contextual transferability. Sixth, qualitative research documenting the learning process and student experiences would complement the existing quantitative data.

**CONCLUSION**

This study examined the effectiveness of the GASING Method in the Pandai Berhitung Program in Central Bengkulu Regency, drawing on data from 62 students (59–61 per domain) during a 15-day intensive program in August 2023. Five main conclusions emerge.

First, the program produced substantial overall improvement: the mean increased from 13.60 to 79.39 (gain of +65.79 points) with an average N-Gain of 0.738 (high category, Hake, 1998). Second, all domains demonstrated statistically significant improvements (Wilcoxon, $p < 0.001$) with large effect sizes ($r = 0.849$–$0.895$), confirming that the improvements constitute genuine intervention effects. Third, effectiveness was consistent across all five domains. Ranked from highest to lowest N-Gain: Multiplication (0.785), Division (0.784), Subtraction (0.771), BaKalKuBagi (0.710), and Addition (0.640). Addition was the sole moderate-category domain, logically explained by the ceiling effect arising from its higher baseline. Fourth, in four of the five domains, post-test SD was lower than pre-test SD, indicating a trend toward reduced competency variability, although the Division domain exhibited the opposite pattern due to its near-uniformly zero pre-test distribution. Fifth, the Division domain's substantial gain from a near-zero baseline (0.02) to a post-test mean of 78.36, with N-Gain = 0.784 and $r = 0.895$, suggests that the program was associated with meaningful competence development even for entirely new arithmetic material within a short timeframe. Given the pre-experimental design, however, causal attribution requires appropriate caution and should be examined further using controlled study designs.

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