Effectiveness of the GASING Method in Improving Numeracy Skills in Indonesia's Frontier Region

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Abstract
Indonesia's frontier, outermost, and disadvantaged regions face persistent educational disparities, particularly in foundational numeracy. This study examines the effectiveness of the GASING (*Gampang, Asyik, dan Menyenangkan*-Easy, Fun, and Enjoyable) method in enhancing numeracy skills among teachers (n=32) and students (n=64) in Manggarai Barat Regency, East Nusa Tenggara Province, Indonesia. Situated within the geography of education framework, this research employs a pre-experimental one-group pre-test and post-test design across five numeracy domains: foundational number sense (Bakal Kubagi), addition, multiplication, subtraction, and division. The intervention was implemented over 17 days as part of the Gejur Rekeng Le program. Results demonstrate substantial score gains across all domains for both groups. Teachers exhibited mean gains ranging from +18.8 to +66.6, while students showed gains from +45.3 to +75.6. The highest absolute gains were observed where pre-test baselines were lowest, particularly in division and foundational number sense. These findings suggest that the GASING method is a viable pedagogical intervention for addressing numeracy deficits in geographically marginalized regions, with implications for educational equity policy in Indonesia's archipelagic context.

1. Introduction

Indonesia, the world's largest archipelagic state spanning over 17,000 islands across three time zones, faces a formidable challenge in delivering equitable educational services to its geographically dispersed population. The spatial dimension of educational inequality has received growing scholarly attention, with recent studies highlighting how geographic location fundamentally shapes access to learning opportunities and educational outcomes (Delprato et al., 2024; Bernard et al., 2023). Within the Indonesian context, this spatial disparity is most acutely manifest in the nation's *daerah* 3T, an acronym denoting *terdepan* (frontier), *terluar* (outermost), and *tertinggal* (disadvantaged) regions where educational indicators consistently lag behind national averages (World Bank, 2020).

The numeracy crisis in Indonesia has been well documented. PISA 2022 results reveal that approximately 70% of Indonesian students failed to achieve minimum competency in mathematics (OECD, 2023). This learning deficit follows a distinct spatial pattern, with rural and remote regions exhibiting significantly lower achievement levels compared to urban centers (Putra et al., 2022; Randall et al., 2022). East Nusa Tenggara (NTT) Province, which encompasses Manggarai Barat Regency, epitomizes this geographic disparity. As one of Indonesia's least developed provinces, NTT contends with limited educational infrastructure, teacher shortages, and geographic isolation that collectively constrain pedagogical quality (Rosser et al., 2022).

The geography of education, as a subdiscipline, posits that spatial factors including accessibility, remoteness, and the distribution of educational resources are not merely contextual variables but fundamental determinants of educational opportunity (Butler & Hamnett, 2007; Reardon et al., 2022). Recent empirical work has demonstrated that over 60% of factors affecting educational quality are spatially contingent, encompassing school resources, student backgrounds, and neighborhood characteristics (Sharma & Patil, 2022). In developing countries, this spatial dimension intersects with socioeconomic disadvantage to create compounded barriers to educational achievement (Delprato et al., 2024; Luo et al., 2022). Hayvon (2024) articulated the "geography of opportunity" framework, asserting that social and economic opportunities are unevenly distributed across regions, creating "islands of opportunity" amid broader disadvantage. Empirical evidence from multiple contexts supports this position: in China, regional inequality in educational development between urban and rural areas has been extensively documented (Luo et al., 2022; Wu et al., 2024), while in sub-Saharan Africa, Delprato et al. (2024) demonstrated that spatial proximity significantly influences educational attainment. The growing urban-rural educational gap identified by Thomsen et al. (2024) across European contexts further underscores the universality of spatial educational inequality.

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Against this backdrop, the GASING method developed by Prof. Yohanes Surya at the Surya Institute has emerged as a promising pedagogical innovation specifically designed for resource-constrained environments. GASING, an acronym for *Gampang* (easy), *Asyik* (fun), and *Menyenangkan* (enjoyable), employs a three-stage instructional sequence grounded in constructivist learning theory, particularly the concrete–representational–abstract (CRA) sequence advocated by Bruner (1966): concrete manipulation, abstract representation, and mental calculation (Surya & Moss, 2012; Prahmana & Suwasti, 2014). A growing body of empirical literature supports the GASING method's effectiveness. Safitri et al. (2025) found statistically significant improvements in procedural understanding of multiplication ($p = 0.001$). Gultom et al. (2025) reported pre-test scores averaging 22.11 increasing to 69.03 post-intervention. Zaimah (2025) documented that the method not only improved learning outcomes but also transformed students' perceptions of mathematics. However, these studies were predominantly conducted in urban or semi-urban settings, leaving the method's efficacy in frontier regions underexplored.

Indonesia's disadvantaged, frontier, and outermost regions classification system formally recognizes spatial disadvantage as a policy-relevant category. The 2020–2024 National Medium-Term Development Plan identified equitable distribution of quality education in disadvantaged, frontier, and outermost regions as a strategic priority (Global Partnership for Education, 2024). The dual focus on teacher and student outcomes reflects the recognition that teachers in disadvantaged, frontier, and outermost regions face distinct professional challenges: Putra et al. (2022) found that Indonesian teachers' mathematical and didactic knowledge averaged only 3.71 on a 5-point scale. Teachers in remote areas are particularly disadvantaged, experiencing limited access to professional development, pedagogical resources, and peer networks (Schleicher, 2020).

Despite growing interest in the GASING method, empirical studies examining its effectiveness in disadvantaged, frontier, and outermost regions remain limited, and virtually none have adopted a geography of education lens. This study addresses this gap by evaluating the effectiveness of the GASING method in improving numeracy skills across five arithmetic domains among teachers and students in Manggarai Barat. Specifically, this research aims to: (1) assess the magnitude of score improvement following the GASING method intervention for both teachers and students; (2) compare the patterns of improvement across different numeracy domains; and (3) discuss the findings within the context of educational equity in Indonesia's frontier regions.

2. Method

2.1. Study Design

This study employed a pre-experimental one-group pre-test and post-test design (Creswell & Creswell, 2018). While this design does not include a control group a limitation acknowledged in the discussion it is appropriate for evaluating a targeted intervention in a naturalistic educational setting where randomization is ethically and logistically constrained. The independent variable was the GASING method intervention, and the dependent variable was numeracy performance as measured by domain-specific assessments.

2.2. Study Context and Setting

The study was conducted in Manggarai Barat Regency, located in the western part of Flores Island, East Nusa Tenggara Province, Indonesia. Manggarai Barat is officially designated as a disadvantaged, frontier, and outermost regions, characterized by rugged mountainous terrain, limited transportation infrastructure, and significant distances between population centers. The regency's geographic isolation contributes to chronic educational challenges, including teacher shortages, limited access to instructional materials, and below-average performance on national competency assessments.

2.3. Participants

Participants were selected through purposive sampling as part of the Gejur Rekeng Le program, a collaborative initiative between Bakti BCA and the GASING Academy. The study involved two groups: teachers ($n = 32$), consisting of in-service primary school teachers from various schools across Manggarai Barat holding at minimum a bachelor's degree in education; and students ($n = 64$), consisting of primary school students from participating schools in the regency. Teacher participants ranged in age from 24 to 52 years ($M = 36.4$, $SD = 7.8$), with teaching experience spanning 1 to 27 years ($M = 11.2$, $SD = 6.5$). All teacher participants held active assignments at public primary schools within the regency. Student participants were drawn from Grades 3 to 6 (ages 8–13), with the distribution as follows: Grade 3 ($n = 14$), Grade 4 ($n = 18$), Grade 5 ($n = 17$), and Grade 6 ($n = 15$). The purposive inclusion of students across multiple grade levels was intended to capture a broad range of numeracy development within the primary schooling cycle.

2.4. Intervention Protocol

The GASING method intervention was implemented over a 17-day period from September 23 to October 9, 2024. The training covered five numeracy domains delivered in structured sequence: *Bakal Kubagi* (foundational number sense), *Penjumlahan* (addition), *Perkalian* (multiplication), *Pengurangan* (subtraction),

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and *Pembagian* (division). For each domain, instruction followed the GASING three-stage protocol: concrete exploration using manipulatives, transition to abstract representation, and development of mental calculation fluency.

2.5. Instruments

Numeracy performance was assessed using domain-specific tests administered at two time points. For *Bakal Kubagi* (foundational number sense), a conventional pre-test/post-test format was used. For the remaining four domains, pre-tests and diagnostic tests were administered. All instruments were developed by the GASING Academy trainers and aligned with the national primary mathematics curriculum. Each test was scored on a 0–100 scale. Content validity of the instruments was established through expert review by two mathematics education specialists affiliated with the GASING Academy, who confirmed alignment with the primary mathematics curriculum competency standards. Face validity was verified through a pilot administration with a small group of primary school students (n = 8) outside the main sample. Internal consistency reliability was estimated using Cronbach's alpha; coefficients ranged from $\alpha = .78$ to $\alpha = .87$ across the five domain tests, indicating acceptable to good reliability (George & Mallery, 2003). Inter-rater reliability for scoring was not applicable given the objective nature of the tests (numerical responses only).

2.6. Data Analysis Strategy

Data were analyzed using descriptive statistics, including mean scores, standard deviations, and score gains (post-test/diagnostic score minus pre-test score) for each numeracy domain and participant group. Comparative analysis between teacher and student groups was conducted to identify differential patterns of improvement. Visual representations, including bar charts, radar plots, and heatmaps, were generated using Python (matplotlib and seaborn libraries). To assess the statistical significance of pre-to-post score gains, paired-samples t-tests were conducted for each numeracy domain separately for teachers and students, using a significance threshold of $p < .05$ (two-tailed). Prior to testing, normality of difference scores was verified using the Shapiro-Wilk test. Where the normality assumption was violated (Shapiro-Wilk $p < .05$), the non-parametric Wilcoxon signed-rank test was applied as an alternative. Effect sizes were computed using Cohen's d for paired comparisons to quantify the practical magnitude of improvement beyond statistical significance (Cohen, 1988). All inferential analyses were conducted using Python (scipy.stats library).

3. Results and Discussion

3.1. Results

3.1.1. Teachers' Numeracy Performance

Table 1 presents the descriptive statistics for teachers' pre-test and post-test/diagnostic scores across all five numeracy domains. The results indicate substantial improvements following the GASING method intervention, with mean gains ranging from +18.8 to +66.6 points.

Table 1. Descriptive Statistics of Teachers' Numeracy Scores (n=32)

Domain	Pre-Test Mean	Post/Diag Mean	Mean Gain	Min Gain	Max Gain
Bakal Kubagi (foundational number sense)	24.7	86.6	+61.9	+30	+100
Penjumlahan (addition)	75.9	94.7	+18.8	–10	+100
Perkalian (multiplication)	34.1	88.4	+54.4	+20	+80
Pengurangan (subtraction)	69.4	94.7	+25.3	–20	+90
Pembagian (division)	22.8	89.4	+66.6	+40	+100

As illustrated in Figure 1, the most dramatic improvements were observed in *Pembagian* (division), where the mean score increased from 22.8 to 89.4 (+66.6), and *Bakal Kubagi* (foundational number sense), which showed a gain of +61.9. The relatively smaller gain in *Penjumlahan* (addition, +18.8) reflects the higher pre-test baseline (75.9), suggesting that teachers already possessed reasonable competency in addition prior to the intervention.

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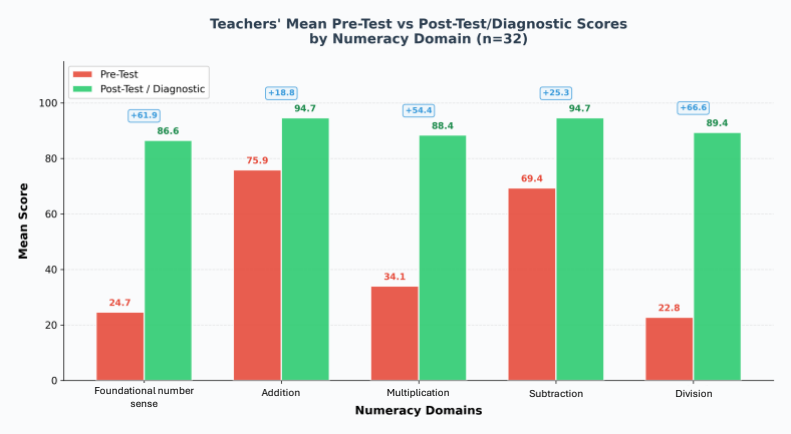

Figure 1. Teachers' Mean Pre-Test vs Post-Test/Diagnostic Scores by Numeracy Domain (n=32)

The box plot distribution (Figure 2) reveals that post-intervention scores were not only higher on average but also exhibited reduced variance, indicating more consistent mastery across the teacher cohort. The interquartile range for post-test/diagnostic scores in most domains clustered between 80 and 100, suggesting that the majority of teachers achieved strong competency following the intervention.

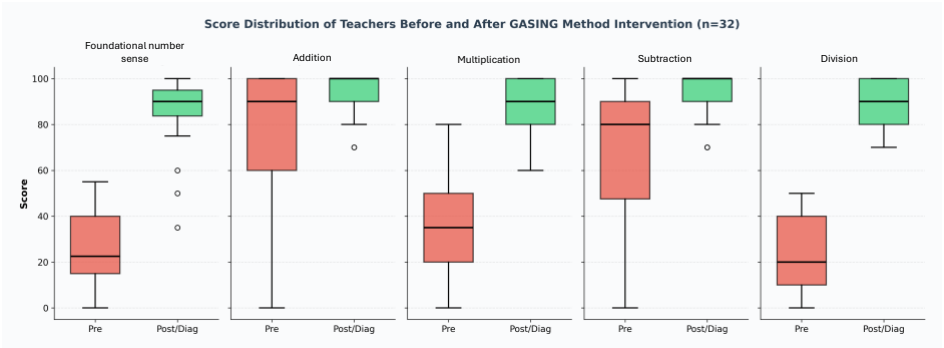

Figure 2. Score Distribution of Teachers Before and After GASING Method Intervention (n=32)

3.1.2. Students' Numeracy Performance

Student performance data revealed even more pronounced pre-intervention deficits and correspondingly larger absolute gains. Table 2 summarizes the descriptive statistics for students across all five domains. Students' pre-test scores were markedly lower than teachers' across all domains, with *Pembagian* (division) recording a mean of only 3.8 and *Bakal Kubagi* (foundational number sense) averaging 7.2. Following the GASING intervention, diagnostic test scores rose substantially, with all domains reaching mean values between 79.4 and 81.4 (Figure 3). The most striking proportional gains were observed in *Pembagian* (division), where scores increased nearly twenty-fold from the pre-test baseline.

Table 2. Descriptive Statistics of Students' Numeracy Scores (n=64)

Domain	Pre-Test Mean	Diagnostic Mean	Mean Gain	Gain (%)
Bakal Kubagi (foundational number sense)	7.2	79.6	+72.4	1005.6%
Penjumlahan (addition)	36.1	81.4	+45.3	125.5%
Perkalian (multiplication)	7.3	80.2	+72.8	997.3%
Pengurangan (subtraction)	13.1	80.2	+67.0	511.5%
Pembagian (division)	3.8	79.4	+75.6	1989.5%

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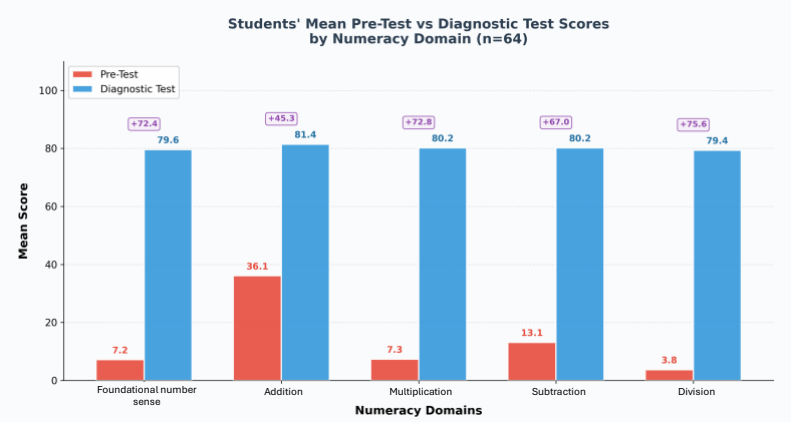

Figure 3. Students' Mean Pre-Test vs Diagnostic Test Scores by Numeracy Domain (n=64)

3.1.3. Comparative Analysis: Teachers vs Students

A comparative analysis of mean score gains between teachers and students (Figure 4) reveals that students demonstrated higher absolute gains than teachers in four out of five domains (*Bakal Kubagi* (foundational number sense), *Perkalian* (multiplications), *Pengurangan* (subtraction), and *Pembagian* (division)), while teachers showed higher gains only in *Penjumlahan* (addition). This pattern is largely attributable to the substantially lower pre-test baselines among students, which provided greater room for improvement.

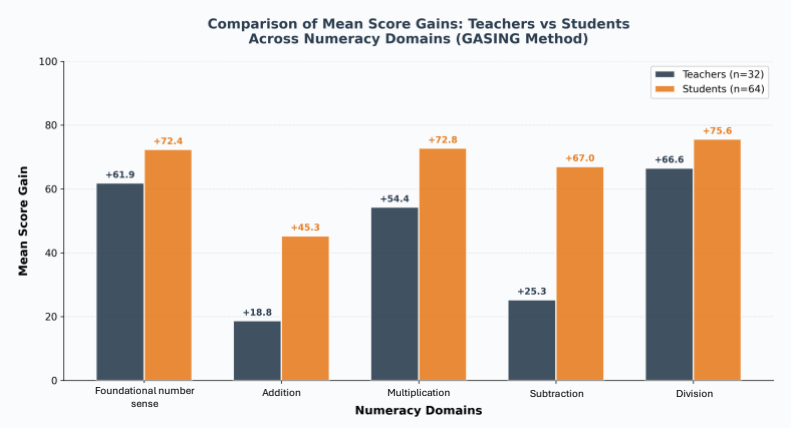

Figure 4. Comparison of Mean Score Gains: Teachers vs Students Across Numeracy Domains

The radar chart (Figure 5) provides a visual representation of the performance profiles before and after the intervention for both groups. Teachers exhibited an asymmetric pre-test profile, with relatively strong performance in *Penjumlahan* (addition) and *Pengurangan* (subtraction) but weak performance in *Pembagian* (division) and *Bakal Kubagi* (foundational number sense). Post-intervention, the profile expanded and became more balanced. Students' pre-test profile was uniformly low across all domains; the diagnostic profile expanded dramatically, approaching the 80–100 range across all domains.

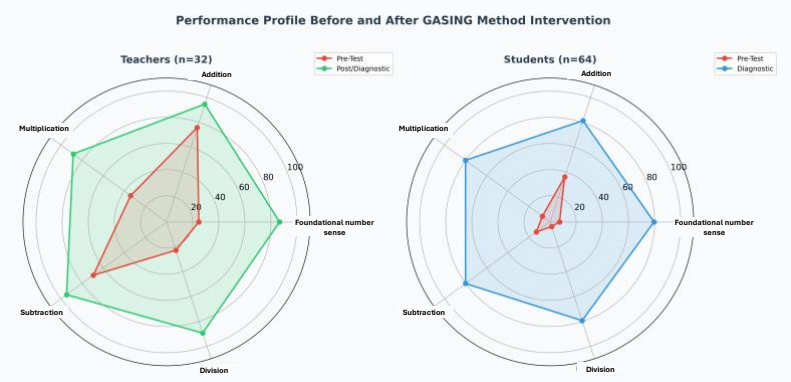

Figure 5. Performance Profile Before and After GASING Method Intervention

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3.2. Discussion

3.2.1. Effectiveness of the GASING Method in a Frontier Context

The results provide robust evidence that the GASING method is effective in improving numeracy skills among both teachers and students in Manggarai Barat. The magnitude of score gains particularly among students, where improvements exceeded 60 points in four of five domains is noteworthy and consistent with findings from prior GASING studies conducted in non-frontier settings (Safitri et al., 2025; Gultom et al., 2025). This convergence suggests that the method's effectiveness is not contingent upon urban educational infrastructure, reinforcing its suitability for geographically marginalized contexts.

The exceptionally low pre-test scores observed among students (ranging from 3.8 to 36.1) underscore the severity of the numeracy deficit in this frontier region. These baselines are consistent with the broader learning crisis documented in Indonesia's disadvantaged, frontier, and outermost areas (OECD, 2023; Randall et al., 2022). That the GASING intervention elevated mean scores to the 79–81 range within 17 days suggests that the deficit is primarily pedagogical rather than cognitive a finding with significant policy implications.

3.2.2. Geography of Education Perspectives

Viewed through the geography of education framework, the findings illuminate how spatial disadvantage shapes the starting conditions for educational interventions. The stark contrast between pre-test baselines in Manggarai Barat and national averages reflects the cumulative impact of geographic isolation, limited resource allocation, and inadequate teacher preparation factors that Bernard et al. (2023) term "regional opportunity structures." The rapid improvement following a relatively brief intervention suggests that these opportunity deficits are remediable when appropriate pedagogical strategies are deployed.

This interpretation aligns with Reardon et al.'s (2022) conceptualization of achievement gaps as "opportunity gaps", reflecting differential access to educational resources rather than inherent differences in student capacity. In Manggarai Barat, the GASING method effectively served as an equalizing mechanism, providing access to structured, evidence-based instruction that is routinely available in urban settings but conspicuously absent in frontier regions. The finding that students could reach diagnostic scores of approximately 80 across all domains challenges the deterministic view that geographic peripherality inevitably produces poor educational outcomes, supporting a more nuanced understanding in which spatial disadvantage operates through mediating factors amenable to intervention (Thomsen et al., 2024; Hayvon, 2024).

3.2.3. Differential Patterns of Improvement

The domain-specific patterns merit discussion. The inverse relationship between pre-test baseline and magnitude of gain suggests a ceiling effect: domains with higher initial competency offered less room for improvement. Conversely, the dramatic gains in *Pembagian* (division) and *Bakal Kubagi* (foundational number sense) indicate that these domains, while severely deficient at baseline, are highly responsive to structured instruction. The finding that teachers showed lower gains than students in most domains has dual implications. First, it confirms that the GASING method is particularly effective for novice learners a characteristic of the constructivist CRA approach that builds understanding from concrete foundations (Bruner, 1966). Second, it suggests that teachers may benefit from more intensive professional development targeting advanced pedagogical content knowledge beyond basic arithmetic fluency.

3.3. Implications

The findings carry significant implications for educational equity policy in Indonesia. First, the concurrent training of teachers and students represents an efficient implementation model for resource-constrained environments, ensuring that improved instructional practice is immediately applied and sustained. Second, the method's minimal dependence on technology and expensive materials makes it logistically feasible in regions with limited infrastructure. Third, the integration of local language framing (*Gejur Rekeng Le*) with the GASING methodology exemplifies culturally responsive pedagogy that may enhance engagement in ethnically diverse frontier communities. The demonstrated effectiveness supports the GASING method's potential for scaled deployment across other frontier and disadvantaged areas in Indonesia's archipelago.

3.4. Limitations

Several limitations must be acknowledged. First, the pre-experimental design without a control group precludes causal inference; observed improvements may be partially attributable to maturation effects, test familiarity, or regression to the mean (Creswell & Creswell, 2018). Second, the 17-day intervention window limits assessment of long-term retention and transfer. Third, purposive sampling within the *Gejur Rekeng Le* program may introduce selection bias. Fourth, the absence of inferential statistical testing (e.g., paired t-tests or Wilcoxon signed-rank tests) limits the ability to establish statistical significance. Future studies should employ quasi-experimental or experimental designs with control groups, conduct longitudinal follow-up assessments,

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and incorporate inferential statistical analyses to strengthen causal claims. Fifth, several potential sources of bias merit explicit acknowledgement. Social desirability bias may have inflated post-test scores if participants were motivated to perform well due to the program's collaborative sponsorship context (Bakti BCA and GASING Academy). Hawthorne effect bias whereby participants perform better simply because they are aware of being observed or evaluated cannot be ruled out in the absence of a control group. Trainer expectancy bias is also possible, as the instruments were developed by GASING Academy trainers who also delivered the intervention, potentially creating alignment between instructional emphasis and assessment content that artificially amplifies apparent gains. Additionally, the exclusive reliance on quantitative test scores as outcome measures may not fully capture qualitative dimensions of learning, such as shifts in students' mathematics self-efficacy or metacognitive awareness. Future studies should triangulate quantitative findings with qualitative methods and employ independent instrument development to mitigate these biases.

4. Conclusion

This study examined the effectiveness of the GASING method in improving numeracy skills among teachers and students in Manggarai Barat, a designated disadvantaged, frontier, and outermost regions of Indonesia. The findings demonstrate substantial improvements across all five numeracy domains for both participant groups, with teachers exhibiting mean gains from +18.8 to +66.6 and students showing gains from +45.3 to +75.6. Situated within the geography of education framework, these results suggest that the numeracy deficit in Indonesia's frontier regions is primarily a function of inadequate pedagogical exposure rather than inherent limitations. The GASING method's concrete-to-abstract instructional sequence, combined with its minimal resource requirements and culturally responsive implementation through the *Gejur Rekeng Le* program, makes it a viable intervention for reducing spatial educational inequality. Future research should employ rigorous experimental designs, conduct longitudinal assessments, and explore the method's integration with digital learning platforms to enhance its reach across Indonesia's vast archipelago.

Author Contributions

All authors contributed equally to this paper. All authors have read and approved the final manuscript.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that AI-assisted tools were used only to improve readability and language under strict human oversight; no content, ideas, analyses, or conclusions were generated by AI.

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