

Improving Numeracy Performance Through the GASING Method

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Abstract

Numeracy is foundational to academic success, yet many Indonesian primary school students struggle with mathematics under instruction that emphasises rote memorisation over conceptual understanding. This study examined the improvement in numeracy performance associated with the GASING (Gampang, Asyik, Menyenangkan / Easy, Enjoyable, Fun) method among primary school students and teachers in Bojonegoro District, Indonesia. A one-group pre-test–post-test design was employed with 97 students and 50 teachers who completed a 15-day intensive training programme covering five numeracy domains: number recognition, addition, multiplication, subtraction, and division. Performance was assessed using curriculum-aligned numeracy tests administered at pre-test and post-test. Paired-samples t-tests showed statistically significant gains across all domains. Students improved from a composite pre-test mean of 30.51 (SD = 17.55) to 83.08 (SD = 9.53), $t(96) = 35.25$, $p < .001$, Cohen's $d_z = 3.58$, equivalent to a 2.72-fold gain; the largest domain gain was in division (6.28-fold). Teachers improved from 73.56 (SD = 13.11) to 97.70 (SD = 2.98), $t(49) = 15.16$, $p < .001$, $d_z = 2.14$. Because the design included no control group, these results indicate improvement associated with the intervention rather than its isolated causal effect. The findings nonetheless suggest that the GASING method, delivered through an integrated teacher–student training model, is associated with substantial numeracy gains and with positive affective changes reported by participants.

Keywords: gasing method, numeracy performance, mathematics education, primary education, conceptual understanding



INTRODUCTION

Mathematics education is a cornerstone of primary school curricula worldwide, shaping students' cognitive development and long-term academic trajectories (Good & Brophy, 2008; Hattie, 2009). Numeracy, the capacity to understand numbers, perform calculations, and apply mathematical reasoning, is a fundamental life skill, essential not only for academic progress but also for participation in modern society and the workforce (Dowker & Nuerk, 2020). Strong numeracy supports the logical reasoning, decision-making, and problem-solving demanded in the twenty-first century (Hattie, 2009).

Despite its importance, persistent difficulty in learning mathematics remains a global concern. Many students experience mathematics anxiety, low self-confidence, and weak conceptual understanding, all of which undermine learning outcomes (Ashcraft & Kirk, 2001; Beilock, 2010). These difficulties are frequently linked to instruction that prioritises rote memorisation and procedural fluency over deep conceptual comprehension (Hiebert & Lefevre, 1986; Mayer, 1992).

In Indonesia, weak numeracy is well documented in international assessments. In the Programme for International Student Assessment (PISA) 2022, Indonesian 15-year-olds scored 366 in mathematics, far below the OECD average of 472, placing the country 70th of 81 participating systems; only about 18% of Indonesian students reached at least Level 2 proficiency, compared with an OECD average of 69% (OECD, 2023). National monitoring through the Asesmen Kompetensi Minimum (AKM) similarly reports that a substantial proportion of primary school students have not attained minimum numeracy competence (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi [Kemendikbudristek], 2023). A recurring contributing factor is the prevalence of teacher-centred instruction that emphasises speed and correctness over meaning-making (Wijaya et al., 2024). Moreover, many primary teachers, particularly those without specialised mathematics backgrounds, report limited confidence in teaching the subject, which can compound students' difficulties (Merriam, 2022; Wijaya et al., 2024).

Bojonegoro District, East Java, reflects these national patterns. District-level education authorities have identified numeracy as a strategic priority following internal assessments showing that a large share of primary students perform below expected competence in basic arithmetic operations, and that many teachers request additional support in mathematics pedagogy (Dinas Pendidikan Kabupaten Bojonegoro, 2023). Within this context, local authorities sought an evidence-informed approach capable of strengthening both teacher competence and student numeracy. The GASING method, developed by Surya to make mathematics easy, enjoyable, and fun through a structured concrete-to-abstract progression, was selected as the candidate intervention (Surya, 2022; Siregar et al., 2014).

Literature Review

Contemporary research consistently emphasises conceptual understanding as central to effective mathematics learning. Learners with a solid conceptual foundation demonstrate stronger problem-solving, better retention, and greater transfer to novel contexts than those trained primarily through procedural routines (Hiebert & Lefevre, 1986; Mayer, 1992). The GASING method operationalises this principle through its

"critical point" structure, in which each topic is sequenced from the easiest concept to the most difficult so that learners consolidate understanding before advancing (Siregar et al., 2014; Surya, 2022).

Gardner's (1993) theory of multiple intelligences suggests that learners differ in cognitive strengths and that instruction engaging multiple modalities supports more inclusive learning. In the present intervention this theory is not invoked as a general claim but is reflected concretely in the design: number facts are rehearsed through songs (musical modality), operations are modelled with finger techniques and movement (bodily-kinesthetic modality), and concepts are co-constructed in paired teacher–student work (interpersonal modality). These modalities were embedded in the daily training protocol described in the Method, allowing the theoretical rationale to be tied to observable instructional activities rather than treated as an abstract justification.

A further well-established principle is the progression from concrete to abstract representation. Students construct deeper understanding when instruction begins with concrete manipulatives, proceeds through visual representation, and culminates in symbolic abstraction (Dienes, 1960); this sequence is the backbone of GASING instruction (Surya, 2022).

Teacher professional development is also decisive for student achievement. A strong association exists between high-quality teacher training and improved learning outcomes (Darling-Hammond & Berry, 2006), because effective development equips teachers with both content mastery and pedagogical strategy (Merriam, 2022). The integrated model used here, in which teachers are trained and immediately apply the method with students under supervision, is intended to translate this association into classroom practice.

Finally, the integration of music, movement, and positive affect into mathematics instruction has growing empirical support. Rhythmic elements, songs, and physical movement are associated with stronger memory consolidation, higher engagement, and reduced mathematics anxiety (Schellenberg & Peretz, 2008; Meltzoff, 1999), and positive emotional experience supports neurological processing and retention (Fredrickson, 2001; Beghetto & Kaufman, 2014). In this study, the presence of such elements was not merely assumed; their implementation was logged in trainer observation records and their perceived effects were captured through participant reflections, as detailed in the Method.

Research Gap and Objectives

Although prior work supports conceptual understanding, structured progression, teacher development, and affective engagement, most studies examine these elements in isolation, focusing on students or teachers, on a single operation, or on short interventions (Hattie, 2009; Merriam, 2022). Existing GASING research is similarly narrow: studies have addressed single topics such as addition (Siregar et al., 2014), multiplication (Armianti et al., 2016), or spatial geometry (Gultom & Usman, 2024), typically with small samples and without simultaneously evaluating teacher and student outcomes across the full set of basic operations. Empirical evaluations of integrated programmes that target teacher competence and student numeracy together, across multiple domains, in a single Indonesian district remain scarce.

This study addresses that gap by evaluating the GASING method delivered through an integrated 15-day training programme for primary teachers and students in Bojonegoro District. It examines the improvement associated with the intervention in numeracy performance across five domains, the corresponding change in teacher numeracy mastery, and the affective benefits reported by participants. The following research questions are posed:

1. To what extent is GASING instruction associated with pre-test to post-test improvement in students' numeracy performance across five domains (number recognition, addition, multiplication, subtraction, and division)?
2. Do teachers show statistically significant improvement in numeracy mastery following participation in GASING training?
3. What qualitative benefits emerge from GASING implementation with respect to student and teacher attitudes toward mathematics?

METHODS

Research Design

This study used a one-group pre-test–post-test design (a pre-experimental design). A single cohort of participants was assessed before the intervention (pre-test), monitored through diagnostic assessments during the programme, and reassessed after the intervention (post-test). No control or comparison group was included; the design therefore supports inferences about within-group change over time but not causal attribution relative to an untreated group. This limitation is acknowledged explicitly and revisited in the Discussion and Conclusion. The programme delivered parallel instruction to teachers and students: teachers received trainer-led instruction and then immediately applied the content with assigned students under the supervision of training specialists.

Participants and Sampling

Participants were 50 primary school teachers and 100 primary school students drawn from multiple schools across Bojonegoro District. Participants were recruited through purposive sampling in coordination with the District Education Office: schools were nominated by the office on the basis of identified numeracy needs, and teachers and students within those schools were enrolled by school leaders. Inclusion criteria for teachers were current employment as a primary school class or mathematics teacher and willingness to complete the full 15-day programme; inclusion criteria for students were current enrolment in the upper primary grades (Grades 4–6) at a participating school and parental consent. Because enrolment was voluntary, the sample may be more motivated than the general population, a point addressed among the study limitations.

Teachers represented diverse backgrounds: their highest qualifications ranged from the bachelor's (S.Pd.) to the master's (M.Pd.) level, and teaching experience varied across the cohort. Many teachers had no specialised mathematics qualification and taught mathematics as part of a general primary teaching role, which is typical of Indonesian primary schools and directly relevant to the study's focus on building teacher numeracy confidence.

Students were organised into six instructional groups (Classes A–F) for logistical and supervisory purposes. Group assignment was based on the school of origin and the practical organisation of the training venue rather than on prior ability, so that each group contained students of mixed initial performance. Each teacher was responsible for two assigned students, producing a 1:2 teacher-to-student ratio that allowed close individual support.

For the quantitative analyses, complete-case data were used: participants missing a pre-test or post-test score on a given measure were excluded from that analysis. This yielded an analytic sample of 97 students (three of the original 100 had incomplete post-test records) and all 50 teachers.

Instruments

Numeracy performance was measured with five curriculum-aligned achievement tests (not questionnaires), one for each domain: number recognition, addition, multiplication, subtraction, and division. Each domain test comprised a set of structured items presented in written, short-answer computational format, with several items also requiring brief conceptual responses; each test was scored on a standardised 0–100 percentage scale. Tests were timed, with a fixed administration window per domain, and the same instrument set was used at pre-test and post-test to permit direct comparison of gains.

Item difficulty within each test was calibrated to span basic procedural tasks through to more demanding problem-solving items, ensuring discrimination across performance levels. The instruments were developed from the national primary mathematics competency indicators and were reviewed by subject-matter experts (experienced mathematics teacher-trainers and a curriculum specialist) for content validity; items flagged as ambiguous or misaligned were revised before administration. Internal consistency was estimated with Cronbach's alpha for each domain test, with all values meeting the conventional threshold for acceptable reliability ($\alpha \geq 0.70$).

Because the same instrument was administered twice, a testing (practice) effect cannot be excluded. Three procedures were used to limit this threat: the 13-day interval between pre-test and post-test reduced verbatim recall of items; correct answers were not reviewed with participants during the programme; and item order was varied at post-test. The residual risk is acknowledged as a limitation.

The GASING Intervention

GASING instruction follows a structured concrete-to-abstract progression organised around a "critical point" for each topic that learners must master before advancing (Siregar et al., 2014; Surya, 2022). Its core instructional principles, as implemented here, were: (1) concrete-to-abstract progression using manipulatives and finger-counting techniques; (2) engagement of multiple modalities through songs, movement, games, and varied representations; (3) deliberate use of joyful, playful activity as a pedagogical feature; (4) carefully sequenced concept building; and (5) integrated teacher–student interaction.

The wider GASING framework also references eight broader competencies (the "GASING 8C": creativity, critical thinking, communication, collaboration, character, culture/citizenship, computational logic, and compassion). The present study measured numeracy performance only; the 8C competencies were not assessed quantitatively. They are therefore reported here solely as the programme's stated pedagogical orientation, and the qualitative findings that bear on them (for example, observed collaboration and creativity) are presented as participant- and trainer-reported impressions rather than measured outcomes.

Procedure

The programme ran for 15 consecutive days and comprised three phases.

Phase 1 : Pre-training (Day 1). All participants completed the pre-test across the five domains, establishing baseline performance.

Phase 2 : Intensive training (Days 2–14). Each day followed a four-session structure: Session 1, trainer-led instruction for teachers (08.00–10.00 WIB); Session 2, teacher-led practice with students under supervision (10.00–12.00 WIB); Session 3, trainer-led instruction for students (13.00–15.00 WIB); and Session 4, teacher-led reinforcement practice (15.00–17.00 WIB). Diagnostic assessments were administered on Days 7, 10, and 13 to monitor progress and refine instruction.

Phase 3 : Post-training (Day 15). All participants completed the post-test across the five domains.

Overall attendance across the programme reached 99%, indicating strong engagement and near-complete participation.

Data Analysis

Quantitative data were analysed using descriptive statistics (means and standard deviations) and paired-samples t-tests comparing pre-test and post-test scores within each domain and for an overall composite (the mean of the five domain scores per participant). For each comparison, the mean gain, the t statistic with degrees of freedom, the two-tailed p value, and the standardised effect size (Cohen's d_z for paired data) were computed; 95% confidence intervals for the mean gain were also obtained. Fold-increase (post \div pre) and percentage-improvement metrics were reported as supplementary descriptive indicators. Statistical significance was set at $\alpha = .05$. Analyses were conducted in Python (SciPy).

Qualitative data were drawn from three sources: written participant reflections collected at the end of the programme, structured trainer observation records completed during each training day, and short testimonial statements provided voluntarily by teachers. Statements originally given in Indonesian were translated into English by a bilingual member of the research team and checked by a second member for fidelity. The qualitative material was analysed thematically: two researchers independently read the reflections and observation records, generated initial codes, and grouped them into themes; discrepancies were resolved through discussion. Trustworthiness was supported by triangulating across the three data sources and by retaining illustrative quotations. The

testimonials reproduced below were selected as representative of recurring themes and are reported with participant consent.

RESULTS AND DISCUSSION

Results

Student Numeracy Performance

Students (n = 97) improved significantly on every domain and on the overall composite. The composite score rose from a pre-test mean of 30.51 (SD = 17.55) to a post-test mean of 83.08 (SD = 9.53), a mean gain of 52.58 points, 95% CI [49.62, 55.54], $t(96) = 35.25$, $p < .001$, with a very large effect size (Cohen's $d_z = 3.58$); this corresponds to a 2.72-fold increase. The largest domain gain was in division, which rose from 12.89 (SD = 15.87) to 80.93 (SD = 13.85), $t(96) = 36.41$, $p < .001$, $d_z = 3.70$ (a 6.28-fold increase), followed by number recognition (3.98-fold) and multiplication (2.99-fold). Addition, in which students began from the highest baseline, showed the smallest, though still significant, gain (1.62-fold). Full results appear in Table 1.

Table 1. Student Pre-Test and Post-Test Performance by Domain (n = 97)

Mathematical Domain	Pre M	Pre SD	Post M	Post SD	Mean Gain	t (96)	p	Cohen's dz
Number Recognition	19.74	19.02	78.51	13.64	58.76	32.99	<.001	3.35
Addition	56.91	27.17	91.96	10.86	35.05	13.45	<.001	1.37
Multiplication	26.80	25.19	80.10	14.68	53.30	20.31	<.001	2.06
Subtraction	36.19	23.91	83.92	12.55	47.73	21.64	<.001	2.20
Division	12.89	15.87	80.93	13.85	68.04	36.41	<.001	3.70
Overall composite	30.51	17.55	83.08	9.53	52.58	35.25	<.001	3.58

Note: M = mean; SD = standard deviation; dz = Cohen's d for paired samples. All p values are two-tailed; exact values were < .001 in every case. Mean gain = post-test M – pre-test M.

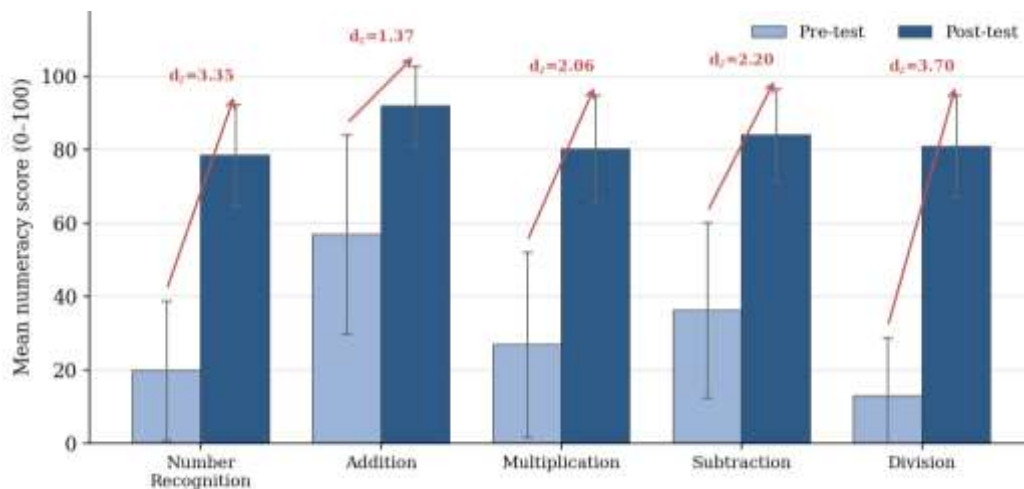


Figure 1. Student numeracy performance by domain (n=97), Mean pre- and post-test scores with SD; all gains $p < .001$

The pattern of gains indicates that the method was most effective for foundational and initially weak domains: the three largest gains occurred where pre-test performance was lowest (division, number recognition, multiplication), consistent with greater room for improvement in those areas.

Teacher Numeracy Performance

Teachers (n = 50) also improved significantly on every domain and on the composite, although gains were smaller than students' because teachers began from substantially higher baselines. The composite score rose from 73.56 (SD = 13.11) to 97.70 (SD = 2.98), a mean gain of 24.14 points, 95% CI [20.94, 27.34], $t(49) = 15.16$, $p < .001$, $d_z = 2.14$ (a 1.33-fold increase). As with students, the largest gain was in division, from 45.40 (SD = 22.79) to 98.20 (SD = 5.60), $t(49) = 17.23$, $p < .001$, $d_z = 2.44$. Full results appear in Table 2.

Table 2. Teacher Pre-Test and Post-Test Performance by Domain (n = 50)

Mathematical Domain	Pre M	Pre SD	Post M	Post SD	Mean Gain	t (49)	p	Cohen's dz
Number Recognition	68.40	15.89	98.10	3.63	29.70	13.76	<.001	1.95
Addition	86.00	17.14	98.80	3.28	12.80	5.60	<.001	0.79
Multiplication	80.80	20.49	96.40	7.22	15.60	6.22	<.001	0.88
Subtraction	87.20	17.85	97.00	5.44	9.80	4.56	<.001	0.65
Division	45.40	22.79	98.20	5.60	52.80	17.23	<.001	2.44
Overall composite	73.56	13.11	97.70	2.98	24.14	15.16	<.001	2.14

Note. M = mean; SD = standard deviation; dz = Cohen's d for paired samples. All p values are two-tailed; exact values were < .001 in every case.

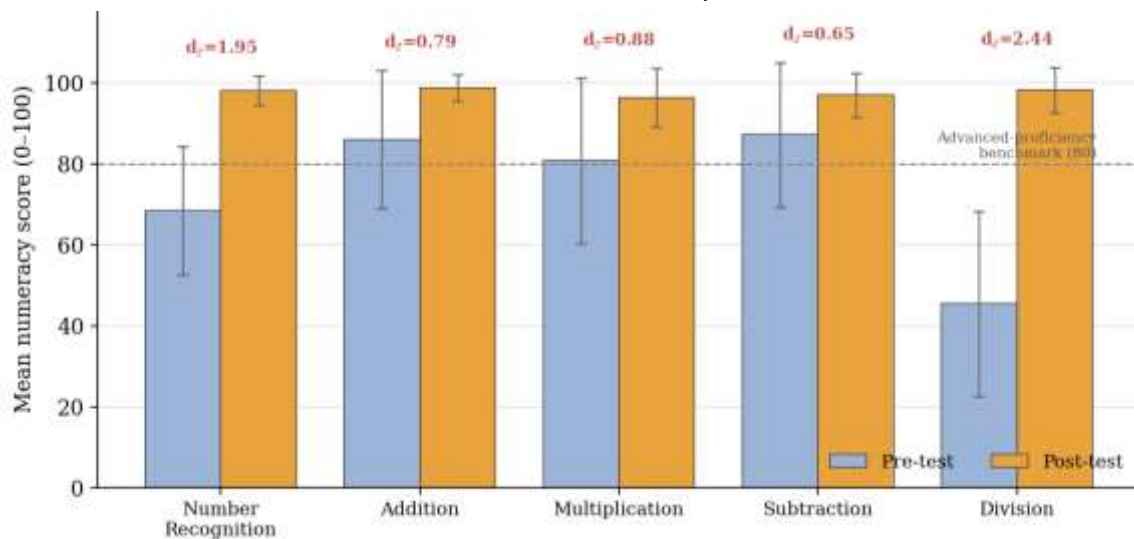


Figure 1. Teacher numeracy performance by domain (n=50), Mean pre- and post-test scores with SD; all gains $p < .001$

Distribution and Mastery

A mastery benchmark of a composite score of 80 was adopted, corresponding to the programme's predefined criterion for advanced proficiency; the 60-point benchmark used at baseline reflects the minimum competence threshold used in district reporting. Among teachers, the proportion meeting the 60-point baseline benchmark rose from 86% at pre-test to 100% at post-test, and all 50 teachers (100%) reached the 80-point advanced-proficiency benchmark after training. Among students, only 9% met the 60-point benchmark at pre-test, whereas after training 99% reached 60 and 60% reached the 80-point advanced benchmark. These distributional shifts corroborate the mean-level gains reported above.

Performance by Student Class

Gains were consistent across the six instructional groups (Classes A–F), with composite gain factors ranging from 2.31 to 2.86 (Table 3). Because group assignment was based on school of origin and venue logistics rather than ability, and because group sizes were similar (approximately 16 students each), the consistency of gains suggests that the intervention performed comparably across heterogeneous groups. Class-level differences should nonetheless be interpreted cautiously given the modest size of each group and small baseline differences.

Table 3. Composite Performance Improvement by Student Class

Class	n	Pre-test M	Post-test M	Mean Gain	Gain Factor
A	16	30.2	86.3	56.1	2.86×
B	17	29.7	81.7	52.0	2.75×
C	16	32.7	79.7	47.0	2.44×
D	16	31.6	83.3	51.7	2.64×
E	16	35.0	81.6	46.6	2.33×
F	16	39.4	91.1	51.7	2.31×

Note. n values are approximate group sizes for the analytic sample. Class-level means are descriptive; per-class standard deviations were not available in the source records and should be added by the authors if reported.

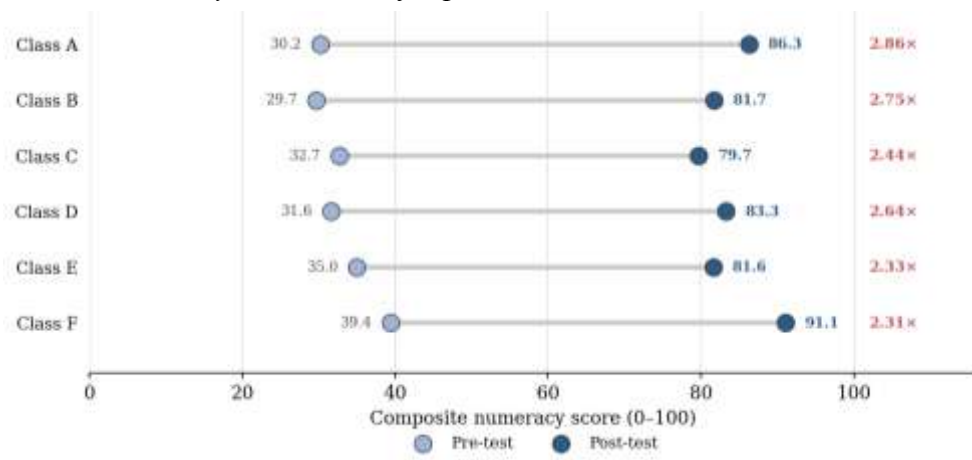


Figure 3. Composite numeracy improvement by student class (A-F), each class improved 2.31-2.86 fold from pre- to post-test

Qualitative Findings

Thematic analysis of participant reflections and trainer observation records yielded seven recurring themes describing the perceived impact of the GASING method: (1) facilitated concept mastery, with participants reporting clearer, simplified understanding; (2) accelerated mathematical thinking, with noticeably faster computation; (3) joy in learning mathematics among students; (4) joy in teaching mathematics among teachers; (5) enhanced self-confidence and reduced mathematics anxiety; (6) stimulated creativity in both students and teachers; and (7) strengthened collaborative learning through close teacher–student interaction. These themes are perceptions reported by participants and trainers, not measured psychological constructs, and should be read as complementary to the quantitative findings.

Two representative teacher testimonials illustrate the affective themes. One teacher reflected that after learning the GASING method she became more enthusiastic and more motivated to make learning enjoyable, and that the method changed how she thought about teaching mathematics (Mega Puspita Sari, S.Pd.). Another observed that before the programme her pupils had been fearful and lacked confidence in mathematics, whereas afterwards they became braver and more self-assured (Riska Hestingtyas, S.Pd.). Both statements were volunteered with consent and were selected as typical of the confidence and enjoyment themes identified across the data.

Discussion

This study examined the improvement in numeracy performance associated with the GASING method among primary students and teachers in Bojonegoro District. Across all five domains, both groups showed statistically significant pre-to-post gains with large effect sizes. The findings are interpreted below in relation to existing literature, with attention to the design's limits on causal inference.

Interpretation in Light of Prior Research

The students' composite gain ($d_z = 3.58$) is consistent with research indicating that conceptually focused instruction can produce larger gains than typical procedural teaching (Hiebert & Lefevre, 1986; Mayer, 1992). Rather than equating the present effect sizes directly with those of other studies, whose interventions, samples, and measures differ, the comparison is framed at the level of pattern: like earlier GASING studies on single operations (Siregar et al., 2014; Armianti et al., 2016), the method here was associated with marked improvement, and the present study extends that pattern across all five basic operations and to teachers as well as students.

The teachers' smaller gains are plausibly attributable in part to a ceiling effect: teachers began near the top of the scale on most domains (for example, addition and subtraction pre-test means exceeded 85), leaving limited room for measured improvement (Darling-Hammond & Berry, 2006). Consistent with this, the teachers' largest gain occurred in division, the one domain in which their baseline was low (45.40).

The especially large division gain among students (6.28-fold) contrasts with the modest addition gain (1.62-fold), where students already possessed stronger skills. This pattern is consistent with the zone of proximal development, in which instruction yields

the greatest measured gains when directed at material that is challenging but attainable for learners (Vygotsky, 1978). This interpretation is offered as a plausible account rather than a demonstrated mechanism, since the study did not directly assess developmental readiness.

That all teachers reached the advanced-proficiency benchmark is a notable outcome for a short professional-development programme. It should, however, be read alongside alternative explanations: the high baseline competence of many teachers, the voluntary and likely motivated nature of the sample, and the immediate (rather than delayed) timing of the post-test. These factors temper any claim of uniformly transformative effectiveness.

Limitations and Causal Interpretation

Several limitations constrain interpretation. First, and most importantly, the one-group pre-test–post-test design has no control group; the observed gains therefore show improvement following the intervention but cannot, on their own, establish that the GASING method caused the improvement rather than maturation, repeated testing, or concurrent instruction. Second, the use of the same instrument at both time points introduces a possible practice effect, mitigated but not eliminated by the procedures described in the Method. Third, the post-test was administered immediately after training, so the durability of gains is unknown. Fourth, participation was voluntary and confined to a single district, so the sample may be unusually motivated and the results may not generalise to other regions. Finally, the affective findings rest on self-report and observation rather than validated instruments. Accordingly, throughout this paper the relationship between the GASING method and the observed gains is described as an association rather than a proven causal effect.

CONCLUSION

In this one-group pre-test–post-test study, participation in a 15-day GASING training programme was associated with substantial and statistically significant improvements in the numeracy performance of both primary school students and teachers in Bojonegoro District. Students' composite scores increased 2.72-fold ($t(96) = 35.25$, $p < .001$, $d_z = 3.58$), with the largest domain gain in division (6.28-fold), while teachers' scores increased 1.33-fold ($t(49) = 15.16$, $p < .001$, $d_z = 2.14$) with universal attainment of the advanced-proficiency benchmark. Participants also reported greater confidence, reduced anxiety, and increased enjoyment of mathematics. Because the design lacked a control group, these results indicate improvement associated with the programme rather than its isolated causal effect.

Subject to that caveat, the findings suggest several tentative implications. The integrated teacher–student training model appears to be a feasible and promising approach to strengthening primary numeracy and teacher confidence simultaneously; the sequenced five-domain structure offers a coherent curriculum framework; and the prominence of affective gains supports attention to confidence and enjoyment as part of mathematics reform. Claims about large-scale adoption should await stronger evidence,

including controlled comparisons, broader and more representative samples, cost-effectiveness analysis, and longer-term follow-up.

Future research should therefore (1) employ randomised or quasi-experimental designs with comparison groups to test causal effects; (2) extend follow-up assessment to 3-, 6-, and 12-month intervals to evaluate durability; (3) expand to multiple districts and diverse school contexts; (4) incorporate longitudinal qualitative interviewing with validated affective measures; (5) examine implementation costs and cost-effectiveness; and (6) investigate the optimal training duration and intensity.

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