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Integrating GASING and teaching at the right level: an adaptive learning model to strengthen elementary students' conceptual understanding of addition

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ABSTRACT

Mastery of addition concepts is an important foundation for developing numeracy literacy in elementary schools. The GASING method (Easy, Fun, and Enjoyable) has been shown to improve student engagement and learning outcomes; however, few studies have integrated it with a differentiation approach based on students' initial abilities. Meanwhile, *Teaching at the Right Level* (TaRL) has been applied in adaptive learning, but its implementation within innovative mathematics learning models remains empirically limited. This study aimed to analyze the effectiveness of integrating the GASING method and TaRL in improving elementary students' mastery of addition concepts. The study employed a quasi-experimental *non-equivalent control group* design involving 88 third-grade students, consisting of 43 students in the control group and 45 students in the experimental group. The experimental group received the GASING method integrated with TaRL, whereas the control group received the GASING method without TaRL. Data were collected through pretest and posttest assessments of students' addition concept mastery. The Mann-Whitney test showed no statistically significant difference in initial ability between the control and experimental groups ($p = 0.063$), indicating comparable baseline conditions. The results of the *independent samples t-test* on N-Gain scores showed a statistically significant difference in conceptual improvement between the experimental and control groups ($p < 0.001$), with a large effect size (Cohen's $d = 0.83$). These findings indicate that the increase in students' mastery of addition concepts was significantly higher among students who received the integrated GASING and TaRL approach than among those who received the GASING method alone. The findings suggest that combining the structured and enjoyable characteristics of GASING with TaRL-based differentiation can provide more responsive mathematics instruction by aligning learning activities with students' initial levels of understanding. This integration offers a practical instructional alternative for strengthening foundational addition concepts while accommodating differences in students' learning readiness. The study contributes empirical evidence on the integration of GASING and TaRL and extends research on differentiated mathematics instruction at the elementary school level.



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Introduction

Mastery of addition concepts in elementary school constitutes an essential foundation for the development of more advanced mathematical competencies and students' numeracy literacy. Addition is not merely a basic arithmetic operation but also an important conceptual foundation for understanding more complex

mathematical relationships, including subtraction, multiplication, division, place value, measurement, and problem solving. A strong conceptual understanding of addition enables students to establish relationships among numbers, develop and compare mathematical representations, select appropriate strategies, and solve contextual problems flexibly rather than relying solely on memorized procedures (Alfianti & Murtiyasa, 2023; Karimah et al., 2024). At the elementary school level, therefore, learning addition needs to emphasize not only the accuracy of numerical answers but also students' understanding of why particular strategies work and how mathematical ideas are interconnected. Conceptual mastery developed at this stage can subsequently influence students' readiness to engage with more complex mathematical content and to apply mathematical knowledge in everyday situations.

Conversely, difficulties in understanding basic arithmetic operations can have long-term consequences for students' subsequent mathematics learning. Various studies have shown that misconceptions in basic operations, including addition, may become obstacles when students encounter more advanced mathematical concepts, particularly when those concepts require flexible reasoning and the integration of several mathematical procedures (Asmara & Purnomo, 2023; Ocsis et al., 2024). Students who have not developed a stable conceptual understanding may tend to depend on mechanical procedures, counting strategies, or memorized rules without understanding the underlying mathematical relationships. Such difficulties can also affect students' confidence and willingness to engage with mathematics, particularly when they repeatedly experience failure in solving mathematical tasks. Consequently, strengthening addition concepts from the early stages of elementary education is important not only for improving immediate learning outcomes but also for preventing the accumulation of learning difficulties across subsequent grades.

The importance of strengthening foundational mathematics is further reflected in the continuing challenges surrounding students' numeracy performance. In the Indonesian context, students' performance in international assessments such as PISA and TIMSS has highlighted persistent challenges in mathematical reasoning, analysis, and the application of mathematical knowledge to unfamiliar situations (Banerjee et al., 2017). These challenges indicate that mathematics learning needs to move beyond the transmission of procedural knowledge toward learning experiences that enable students to construct concepts, interpret mathematical information, reason systematically, and apply mathematical ideas to contextual situations. Several factors contribute to these challenges, including teacher competence in designing and implementing meaningful mathematics instruction (Fauzan et al., 2024; Rezeki et al., 2026), curriculum implementation and alignment with students' learning needs (Hayati et al., 2024; Putra et al., 2025), and limitations in educational infrastructure and learning resources (Fenanlampir et al., 2019). These factors suggest that improving students' mathematical competence requires not only curriculum reform but also instructional approaches that are responsive to differences in students' learning readiness and provide opportunities for students to construct mathematical understanding through appropriate learning experiences.

Accordingly, strengthening addition concepts at the elementary level has become increasingly important for supporting students' readiness for advanced mathematics and the development of broader twenty-first-century competencies. Numeracy literacy requires students to interpret quantitative information, reason with numbers, select appropriate mathematical strategies, and use mathematical knowledge to address problems in meaningful contexts. Similarly, critical thinking and problem-solving competencies cannot develop optimally when students possess only procedural knowledge without a sufficiently developed conceptual foundation. Conceptual mastery of basic operations such as addition therefore represents an important starting point for developing students' broader mathematical competencies (Hendriana et al., 2025). This condition calls for learning approaches that can simultaneously provide structured mathematical experiences, encourage active student participation, and accommodate differences in students' initial levels of understanding.

One instructional innovation that has been developed to strengthen foundational mathematics learning is the GASING method, which emphasizes learning that is *Gampang, Asyik, dan Menyenangkan* or Easy, Fun, and Enjoyable. The GASING method provides students with systematic learning experiences through concrete activities, gradual development of mathematical concepts, visualization, and repeated practice that is designed to make mathematics more accessible and engaging. Rather than positioning students as passive recipients of mathematical procedures, GASING encourages them to experience mathematical concepts through structured activities and progressively develop appropriate strategies. Recent research has demonstrated the potential of GASING to improve students' motivation, engagement, and mathematical problem-solving abilities (Hidayah et al., 2025). These characteristics make GASING particularly relevant for elementary mathematics because students at this developmental stage benefit from learning experiences that connect abstract mathematical ideas with concrete and understandable representations.

Despite these advantages, the implementation of a structured instructional method such as GASING does not automatically eliminate differences in students' learning readiness. Elementary classrooms are inherently heterogeneous, with students entering the same grade with different levels of prior knowledge, conceptual understanding, learning pace, and ability to perform basic mathematical operations. When students with substantially different initial abilities receive identical learning activities and instructional targets, some students may experience tasks that are too difficult, whereas others may encounter activities that do not provide sufficient challenge. Such conditions may reduce the effectiveness of instruction because the same instructional treatment may not adequately respond to the actual learning needs of every student. Therefore, the effectiveness of GASING may be strengthened when its systematic learning sequence is combined with an approach that explicitly recognizes students' current levels of learning.

In this context, *Teaching at the Right Level* (TaRL) offers a relevant complementary approach. TaRL emphasizes organizing instruction according to students' actual learning levels rather than relying exclusively on grade-level expectations or a predetermined curriculum sequence. Students are assessed to identify their current level of understanding and subsequently receive learning activities that correspond to their demonstrated abilities. This principle enables teachers to adjust the complexity, pacing, and type of learning activities according to students' readiness. Recent research has demonstrated the effectiveness of TaRL-oriented interventions in strengthening literacy and numeracy through ability-based grouping and differentiated instruction (Imron et al., 2025). The central principle of TaRL is therefore particularly relevant to mathematics learning because mastery of foundational concepts such as addition develops progressively, and students who have not mastered prerequisite concepts may require different learning experiences from those who have already achieved a higher level of understanding.

The potential of TaRL has also been demonstrated through large-scale educational interventions. Laksana et al. (2025) highlight the relevance of evaluating TaRL within scalable educational programs and emphasize that evidence from instructional interventions needs to be examined not only under controlled or small-scale conditions but also in relation to their implementation within regular school systems. The TaRL methodology is fundamentally based on reorganizing instruction according to children's actual learning levels rather than following a prescribed syllabus alone. Evidence from randomized controlled trials has further demonstrated that different versions of TaRL implementation can produce different outcomes depending on how the approach is adapted to the existing school context and implementation conditions (Laksana et al., 2025). This body of research suggests that the effectiveness of TaRL is not simply determined by ability-based grouping itself but also by how the principle is integrated into instructional design, teacher practice, learning materials, and the broader classroom context.

Although GASING and TaRL have each demonstrated considerable potential, relatively few studies have systematically examined their integration in elementary mathematics learning, particularly for the mastery of addition concepts. Existing research on GASING has generally focused on the overall effectiveness of the method in improving learning outcomes, motivation, engagement, numeracy, or mathematical problem-solving abilities. In many cases, however, the heterogeneity of students' initial abilities has not been positioned as a central component of the instructional design. Jediut et al. (2025), for example, highlight the relevance of innovative mathematics learning approaches for improving students' learning outcomes, but the differentiation of instructional activities according to students' initial mathematical abilities remains an area requiring further investigation. Consequently, the question remains whether the benefits of GASING can be enhanced when its structured and enjoyable learning characteristics are combined with a systematic mechanism for identifying and responding to differences in students' current learning levels.

At the same time, much of the existing TaRL research has been conducted within literacy and numeracy improvement programs, including remedial or large-scale educational interventions (Laksana et al., 2025). Although this research provides strong evidence for the importance of aligning instruction with students' actual learning levels, less attention has been given to how TaRL can be embedded within an established mathematics learning model that already possesses its own systematic instructional characteristics. This limitation is particularly relevant in the Indonesian elementary school context, where teachers may require instructional models that do not merely identify students' different ability levels but also provide concrete strategies for translating those differences into classroom activities. Integrating TaRL with GASING may therefore address two complementary instructional needs: GASING provides a structured pathway for learning mathematical concepts, while TaRL determines how that pathway can be adapted to students' current levels of understanding.

The conceptual gap addressed in this study therefore concerns how differentiation based on students' actual ability levels can strengthen the effectiveness of a structured mathematics learning method in

developing conceptual rather than merely procedural mastery. Addition learning should not be reduced to students' ability to obtain correct answers. Students need to understand number relationships, recognize different representations of addition, explain the strategies they use, and apply addition to contextual problems. A learning design that accommodates differences in initial ability may provide greater opportunities for students to work with mathematical tasks that are neither excessively difficult nor insufficiently challenging. In this regard, the integration of TaRL into GASING may enable teachers to maintain the systematic and enjoyable characteristics of GASING while adjusting the learning content, activities, and level of support according to students' current conceptual understanding. Such integration may be particularly valuable for foundational mathematics learning, where differences in prerequisite knowledge can strongly influence students' subsequent progress (Sariningsih et al., 2025).

The novelty of this study lies in the development and empirical examination of a synergistic learning design that combines the systematic, concrete, and enjoyable characteristics of the GASING method with the ability-based differentiation principles of TaRL. This integration is not intended merely to add a differentiation strategy to an existing learning model; rather, it positions students' current learning levels as an integral consideration in the organization of mathematical instruction. In the integrated model, students' initial abilities become a basis for determining the level of learning activities, instructional support, and mathematical tasks they receive, while the GASING framework provides a structured and engaging pathway through which addition concepts can be developed. This design consequently seeks to make mathematics instruction more adaptive without abandoning the systematic characteristics that distinguish GASING from other instructional approaches.

Empirically, the study extends previous research on GASING by shifting attention from general learning outcomes toward the development of conceptual mastery under differentiated instructional conditions. At the same time, it extends the application of TaRL beyond its more common use in literacy and broad numeracy intervention programs by embedding its principles within an innovative local mathematics learning model. The integration of the two approaches consequently offers a potentially complementary framework: GASING addresses *how* mathematical concepts can be introduced and practiced through concrete, systematic, and enjoyable experiences, whereas TaRL addresses *for whom, at what level, and with what degree of instructional adjustment* those experiences should be provided. This distinction provides a stronger theoretical basis for understanding why differentiated implementation may produce different learning gains even when students receive the same overarching instructional model.

Based on these conceptual and empirical gaps, this study proposes a mathematics learning model based on the integration of GASING and TaRL as an adaptive instructional strategy for improving elementary school students' conceptual understanding of addition. The model combines the concrete and systematic stages of GASING with ability-based grouping and adjustment of learning materials and activities according to students' current levels of understanding, consistent with the principles of TaRL. The integration is expected to provide students with learning experiences that are appropriately matched to their readiness while maintaining the engaging and structured characteristics of GASING. Accordingly, this study does not only examine whether students improve after receiving the intervention but also compares the magnitude of improvement between students who receive the integrated GASING–TaRL approach and those who receive GASING alone.

Specifically, this study aims to: (1) analyze the difference in the improvement of mathematical conceptual understanding between students who learn through GASING integrated with TaRL and students who learn through the GASING method alone; and (2) measure the effect size of the difference in improvement in students' conceptual understanding of addition between the two groups. Through these objectives, the study seeks to provide empirical evidence concerning whether the integration of ability-based differentiation through TaRL can strengthen the effectiveness of GASING in developing foundational mathematical concepts. The findings are expected to contribute to the literature on adaptive mathematics instruction and provide a practical reference for elementary school teachers seeking to accommodate differences in students' initial abilities while maintaining systematic, concrete, and enjoyable mathematics learning.

Method

Research Design

This study employed a quantitative approach using a quasi-experimental method with a *non-equivalent control group design*. This design was selected because the participants were organized into existing classes across

different elementary schools, making individual randomization impractical. The use of intact classes also allowed the intervention to be implemented under regular school conditions without disrupting the existing organization of students and classroom instruction. The design consisted of two groups: a control group that received mathematics instruction using the GASING method and an experimental group that received the GASING method integrated with the *Teaching at the Right Level* (TaRL) approach. Both groups were administered the same pretest before the intervention and the same posttest after the intervention. The comparison of pretest and posttest scores was used to determine changes in students' conceptual understanding of addition and to examine whether the integrated approach produced greater improvement than the GASING method alone.

The study was conducted during the 2025/2026 academic year in Obaa District. The research was implemented within regular elementary school mathematics classes to maintain the natural learning environment. The intervention focused specifically on addition concepts appropriate to the third-grade elementary school curriculum. The implementation of the intervention was conducted by the classroom teachers in collaboration with the researchers to ensure that the learning procedures were implemented consistently with the assigned instructional conditions.

Participants and Sampling

The population consisted of all third-grade elementary school students in Obaa District during the 2025/2026 academic year. The sample consisted of 88 third-grade students from six existing classes distributed across six different elementary schools. Because the study involved intact classes rather than individually randomized students, *purposive sampling* was used to select the participating schools and classes. The selection considered the characteristics of the schools, classroom organization, student characteristics, availability of the relevant mathematics learning content, and the feasibility of implementing the intervention within the regular instructional schedule.

The six selected classes were divided into two instructional conditions. Three existing classes consisting of 43 students were designated as the control group, while three other existing classes consisting of 45 students were designated as the experimental group. The control group received mathematics instruction using the GASING method (*Gampang, Asyik, dan Menyenangkan*), which emphasizes concrete, systematic, and enjoyable mathematical learning activities. The experimental group received the GASING method integrated with TaRL. Thus, both groups received the GASING method as the core instructional model, while the distinguishing feature of the experimental condition was the incorporation of TaRL principles for identifying students' current learning levels and adjusting instruction accordingly.

Intervention Procedures

The instructional intervention was designed to maintain the core characteristics of GASING in both groups while introducing ability-based differentiation through TaRL in the experimental group. In the control group, mathematics instruction followed the regular GASING sequence, including the use of concrete or accessible representations, systematic explanation and practice, guided mathematical activities, and gradual development of students' understanding of addition. Students were provided with opportunities to practice addition through structured activities and progressively more complex tasks.

In the experimental group, the GASING learning sequence was complemented by the principles of TaRL. Before and during the intervention, students' current levels of conceptual understanding were identified through their responses to learning activities and initial assessment. Students were subsequently provided with learning tasks and instructional support appropriate to their demonstrated level of understanding. This differentiation allowed students who had not yet mastered prerequisite addition concepts to receive more foundational activities and guidance, while students with stronger initial understanding could engage with tasks requiring more complex application and reasoning. Consequently, TaRL was not implemented as a separate instructional model but was integrated into the organization and differentiation of GASING-based mathematics learning.

The two groups were taught during the same academic period and addressed the same general addition content. The principal difference between the groups was therefore the instructional adaptation based on students' current ability levels in the experimental group. This arrangement was intended to isolate the contribution of the GASING-TaRL integration while retaining the GASING method as the common instructional foundation.

Research Instrument

The research instrument was an essay test designed to measure students' conceptual understanding of addition. The test consisted of five questions that assessed several dimensions of conceptual understanding,

including students' ability to explain mathematical concepts, provide reasoning for solution procedures, and apply addition concepts to new situations or contextual problems. The use of essay-based items was intended to obtain information not only about whether students could produce correct answers but also about how they understood and justified their mathematical thinking.

Each student response was assessed using an analytical scoring rubric. The rubric covered four aspects of performance: (1) conceptual understanding, referring to the student's ability to demonstrate an understanding of the underlying addition concept; (2) procedural accuracy, referring to the accuracy and appropriateness of the mathematical procedures used; (3) ability to explain, referring to the clarity and logical consistency of the student's explanation or reasoning; and (4) ability to apply concepts, referring to the student's ability to use addition concepts in unfamiliar or contextual situations. The use of an analytical rubric enabled the assessment to capture different dimensions of conceptual understanding rather than relying solely on the final numerical answer.

Content validity was established through expert judgment involving three experts in mathematics education. The experts reviewed the test items and assessment rubric in terms of their relevance to the learning objectives, suitability for third-grade students, clarity of wording, and alignment with the intended indicators of addition conceptual understanding. Revisions were made based on the experts' recommendations before the instrument was administered to the research participants.

The reliability of the scoring process was assessed using inter-rater reliability because the instrument consisted of essay responses requiring analytical scoring. The inter-rater reliability coefficient was 0.86, indicating a high level of agreement between the raters in scoring students' responses. This result supported the consistency of the scoring procedure and indicated that the analytical rubric could be applied with a high degree of scoring agreement.

Data Collection Procedure

Data collection was conducted through pretest and posttest administration. The pretest was administered to students in both groups before the instructional intervention. Its purpose was to establish students' initial levels of conceptual understanding of addition and to determine whether the two groups had comparable baseline abilities. The same assessment framework was subsequently used for the posttest after completion of the instructional intervention.

The posttest was administered to both groups after the intervention to measure students' conceptual understanding following the respective instructional treatments. The pretest and posttest were administered under comparable testing conditions, and students' responses were scored using the same analytical rubric. The use of the same assessment framework across the two measurement points enabled the researchers to examine the extent of students' conceptual improvement over the course of the intervention.

Data Analysis

The data analysis was conducted in several stages. First, descriptive statistics were calculated for the pretest and posttest scores to describe students' conceptual understanding before and after the intervention. The improvement in students' conceptual understanding was subsequently examined using the normalized gain (*N-Gain*) score. The *N-Gain* was calculated from the pretest and posttest scores to represent the proportion of the possible improvement achieved by each student. The resulting *N-Gain* scores were then used as the primary indicator for comparing the magnitude of conceptual improvement between the control and experimental groups.

Before testing the difference in improvement between the groups, the distribution of the data was examined using the Shapiro–Wilk normality test. The normality test was conducted for the relevant pretest and posttest data to determine whether the assumptions required for subsequent parametric analyses were satisfied. Because the pretest data were not normally distributed, the Mann–Whitney U test was used to compare the initial conceptual understanding of the control and experimental groups. This non-parametric test was selected because it does not require the assumption of normally distributed scores and was therefore appropriate for examining baseline differences under the observed distribution of the data.

The homogeneity of variance assumption was examined using Levene's Test. This analysis was conducted to determine whether the variability of scores was sufficiently comparable between the control and experimental groups. A significance value greater than 0.05 was interpreted as indicating no statistically significant evidence of unequal variances.

To examine the effectiveness of the intervention, the *N-Gain* scores of the control and experimental groups were compared using an *independent samples t-test*. This analysis was used to determine whether the mean improvement in conceptual understanding differed significantly between students who received GASING integrated with TaRL and those who received GASING alone. The null hypothesis stated that there was no statistically significant difference in mean *N-Gain* scores between the two groups, whereas the alternative hypothesis stated that a statistically significant difference existed. Statistical significance was determined at an alpha level of 0.05.

In addition to statistical significance, the magnitude of the difference between the groups was evaluated using Cohen's *d* as a measure of effect size. The effect size was interpreted to determine whether the statistically significant difference represented a small, moderate, or large practical difference in students' conceptual improvement. Reporting both the significance test and effect size allowed the study to distinguish between the existence of a statistically detectable difference and the practical magnitude of the instructional effect.

All statistical analyses were conducted using SPSS. The statistical procedures were selected according to the characteristics and distribution of the data and were applied at a significance level of 0.05. The analytical sequence consisting of baseline comparison, assumption testing, calculation of normalized gain, between-group comparison, and effect-size estimation was intended to provide a comprehensive assessment of the effectiveness of integrating GASING with TaRL in improving elementary students' conceptual understanding of addition.

Results and Discussions

Descriptive Analysis, Baseline Equivalence, and Improvement in Conceptual Understanding

Descriptive statistical analysis was first conducted to provide an overview of students' initial and final levels of mathematical conceptual understanding in the experimental and control groups before further hypothesis testing (Setiyani & Purwati, 2025). The descriptive results are presented in Table 1.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Group	N	Pretest Mean	Posttest Mean	SD Posttest
Experimental	45	19.22	50.82	19.522
Control	43	23.09	40.12	15.707

As shown in Table 1, the experimental group had a mean pretest score of 19.22, whereas the control group had a mean pretest score of 23.09. Following the learning intervention, the mean posttest score increased to 50.82 in the experimental group and 40.12 in the control group. Although the experimental group started with a lower mean pretest score than the control group, it achieved a higher mean posttest score after the intervention. The difference in the descriptive means therefore suggests a greater improvement in the experimental group; however, statistical testing was required to determine whether the groups differed significantly in their initial ability and subsequent improvement. Before comparing the groups, the distribution of the pretest and posttest scores was examined using the Shapiro–Wilk test. The results are presented in Table 2.

Table 2. Results of the Shapiro–Wilk Normality Test

Group	Data	Shapiro–Wilk Statistic	Sig.
Control	Pretest	0.799	< .001
Control	Posttest	0.956	.096
Experimental	Pretest	0.672	< .001
Experimental	Posttest	0.967	.226

The Shapiro–Wilk results show that the pretest scores of both the control group ($p < .001$) and experimental group ($p < .001$) were not normally distributed. In contrast, the posttest scores of the control group ($p = .096$) and experimental group ($p = .226$) were normally distributed because both significance values exceeded .05. Because the pretest scores did not satisfy the normality assumption, a non-parametric test was used to examine whether the two groups differed in their initial conceptual understanding.

Table 3. Mann–Whitney U Test Results for Pretest Scores

Group	N	Mean Rank	Mann–Whitney U	Z	Asymp. Sig. (2-tailed)
Control	43	48.74	785.000	−1.867	.063
Experimental	45	40.44			

The Mann–Whitney U test indicated no statistically significant difference in initial conceptual understanding between the control and experimental groups, $U = 785.000$, $Z = -1.867$, $p = .063$. Although the control group had a higher mean rank (48.74) than the experimental group (40.44), the difference did not reach the .05 significance level. This result is important for interpreting the subsequent comparison because it indicates that the two groups did not demonstrate a statistically significant difference in their initial conceptual understanding before the intervention. Therefore, the higher posttest performance observed in the experimental group cannot be attributed to a statistically significant baseline advantage.

The absence of a statistically significant baseline difference also provides a reasonable basis for examining the magnitude of improvement achieved by each group. The improvement in students' mathematical conceptual understanding was therefore analyzed using the normalized gain (*N-Gain*) score, calculated from the difference between posttest and pretest scores relative to the maximum possible score. The *N-Gain* analysis provides an estimate of the proportion of possible improvement achieved by students during the intervention.

Table 4. Descriptive Statistics of N-Gain Scores

Group	N	Mean N-Gain	SD
Control	43	0.2250	0.16729
Experimental	45	0.3931	0.23030

Table 4 shows that the experimental group obtained a higher mean *N-Gain* score (0.3931) than the control group (0.2250). The difference indicates that students who received the GASING method integrated with TaRL demonstrated greater normalized improvement in conceptual understanding than students who received the GASING method alone. Nevertheless, because descriptive differences do not by themselves establish statistical significance, an independent samples *t*-test was conducted to determine whether the difference in *N-Gain* scores between the two groups was statistically significant.

Table 5. Results of the Independent Samples *t*-Test for N-Gain Scores

Comparison	t	df	Sig. (2-tailed)	Mean Difference
Experimental – Control	3.902	86	< .001	0.16808

As presented in Table 5, the independent samples *t*-test revealed a statistically significant difference in *N-Gain* scores between the experimental and control groups, $t(86) = 3.902$, $p < .001$. The mean difference was 0.16808, indicating that the normalized improvement in the experimental group was 0.16808 points higher than that of the control group. These findings provide statistical evidence that the integration of GASING and TaRL produced greater improvement in students' conceptual understanding of addition than the GASING method alone.

The higher improvement observed in the experimental group can be interpreted in relation to the complementary characteristics of GASING and TaRL. The GASING method is oriented toward systematic, gradual, concrete, and enjoyable mathematics learning, which can facilitate students' development of mathematical conceptual structures in a coherent manner (Hijriani & Simarmata, 2023). This characteristic is particularly relevant to addition learning because students need to develop conceptual relationships between numbers and operations rather than merely memorize calculation procedures. Understanding addition as a foundation of numeracy can be supported through simple, meaningful, and accessible representations that allow students to connect mathematical ideas with their existing knowledge (Nisa et al., 2023).

However, the effectiveness of a common instructional approach may be constrained by differences in students' initial abilities. Elementary classrooms contain students with heterogeneous levels of prior knowledge, learning readiness, and conceptual understanding. A uniform learning approach may provide insufficient support for students with lower initial abilities while providing insufficient challenge for students who have already mastered the prerequisite concepts (Cahyono, 2022). Consequently, the integration of TaRL in the experimental group may have strengthened the GASING learning process by aligning learning

activities with students' actual levels of mastery rather than treating all students as having the same instructional needs. To determine the magnitude of the difference between the two groups, Cohen's d was calculated as an effect-size measure.

Table 6. Effect Size of N-Gain Scores (Cohen's d)

Group	Mean N-Gain	Cohen's d	Effect Size
Experimental	0.3931	0.83	Large
Control	0.2250		

As shown in Table 6, the Cohen's d value was 0.83, which indicates a large effect size. Thus, the difference between the two groups was not only statistically significant but also substantial in magnitude. The result suggests that the integration of the GASING method with the Teaching at the Right Level (TaRL) approach made a meaningful contribution to students' improvement in mathematical conceptual understanding (Andari et al., 2024). The large effect size further strengthens the interpretation that the observed difference was educationally meaningful rather than merely a consequence of the relatively large sample or statistical sensitivity.

The finding is consistent with previous research emphasizing the importance of ability-based instruction in developing foundational skills. The integration of TaRL in the present study follows the principle of grouping and supporting students according to their actual level of mastery rather than relying exclusively on grade-level placement (Hayati et al., 2024). This principle is consistent with the broader evidence that ability-level-based instruction can improve foundational learning outcomes when instructional activities are appropriately aligned with students' current competencies (Banerjee et al., 2017; Gultom & Usman, 2024). Research conducted in international contexts has similarly demonstrated the potential of TaRL to strengthen foundational literacy and numeracy through interventions that respond directly to students' learning needs (Sholikah et al., 2023). In the present study, TaRL complemented the existing GASING structure by enabling students to engage with addition tasks that were more closely aligned with their current level of readiness.

The greater improvement in the experimental group also suggests that adaptive learning may play an important role in facilitating deeper conceptual understanding. From a constructivist perspective, students actively construct knowledge by connecting new information with cognitive structures and experiences that they already possess. When addition concepts are introduced and practiced according to students' current levels of understanding, students may have greater opportunities to connect new mathematical ideas with prior knowledge and progressively reorganize their conceptual structures. Such alignment may also reduce the likelihood of misconceptions because students are not required to move prematurely toward concepts for which their prerequisite understanding remains insufficient (Susilowati et al., 2024).

These findings extend previous research on the GASING method. Earlier studies have highlighted the potential of GASING to improve students' motivation and problem-solving abilities (Fauser et al., 2024). The present findings indicate that the contribution of GASING may be strengthened when its systematic learning structure is combined with a differentiated instructional approach. Rather than replacing the core principles of GASING, TaRL provides an adaptive mechanism through which the same learning framework can be adjusted according to students' current levels of understanding (Niam, 2020). The result therefore suggests that the effectiveness of innovative mathematics learning may depend not only on the characteristics of the instructional model itself but also on the extent to which the model can accommodate differences in students' learning readiness.

The main contribution of this study consequently lies in strengthening the adaptive dimension of GASING-based mathematics instruction, particularly in the development of addition conceptual understanding among third-grade elementary school students (Ngandoh & Ali, 2024). The combination of GASING and TaRL provides a complementary instructional structure in which GASING contributes systematic, concrete, and enjoyable learning experiences, while TaRL contributes the differentiation mechanism needed to adjust those experiences according to students' actual learning levels. The statistically significant difference in *N-Gain* scores and the large effect size provide empirical support for the proposition that these two approaches can work synergistically in foundational mathematics learning.

From a practical perspective, the findings imply that elementary school teachers need to consider students' differences in learning readiness when implementing innovative and enjoyable mathematics learning methods. An instructional approach may be engaging and systematically designed, but its effectiveness can still be limited when the complexity of learning materials and activities does not correspond to students' current levels of understanding (Gou et al., 2024). Therefore, the integration of GASING and

TaRL can serve as an alternative adaptive learning model for strengthening foundational numeracy skills. Teachers can retain the concrete, systematic, and enjoyable characteristics of GASING while using students' initial ability levels as a basis for adjusting the level of instructional support, learning activities, and mathematical tasks.

Overall, the findings demonstrate that students who participated in the GASING–TaRL intervention achieved greater improvement in addition conceptual understanding than students who received GASING alone. The experimental group achieved a mean *N-Gain* of 0.3931 compared with 0.2250 in the control group, with a statistically significant between-group difference, $t(86) = 3.902$, $p < .001$, and a large effect size of Cohen's $d = 0.83$. Because the groups did not differ significantly in their initial conceptual understanding ($p = .063$), the findings provide support for interpreting the higher improvement in the experimental group in relation to the instructional intervention rather than a statistically significant baseline difference. These results strengthen the empirical basis for integrating ability-based differentiation into innovative mathematics learning and suggest that the combination of GASING and TaRL has considerable potential for supporting the development of foundational addition concepts in elementary education.

Conclusions

Based on the research results and data analysis, it can be concluded that students who received mathematics instruction using the GASING method integrated with the Teaching at the Right Level (TaRL) approach showed a significantly greater improvement in mathematical conceptual understanding than students who received instruction using the GASING method alone. The experimental group obtained a higher mean *N-Gain* score (0.3931) than the control group (0.2250), with a statistically significant difference ($p < .001$). The effect size was in the large category (Cohen's $d = 0.83$), indicating a substantial difference in the observed improvement between the two groups. These findings suggest that integrating a level-oriented approach based on students' current learning abilities into GASING-based mathematics learning can provide a more adaptive learning experience, particularly for addition material. These results confirm that mathematics learning designed in an enjoyable manner needs to be complemented by differentiated learning strategies that take students' learning readiness into account. The integration of the GASING method and the TaRL approach strengthens the adaptive dimension of the learning process and has the potential to serve as a relevant alternative model for improving foundational numeracy skills in elementary schools. However, this study is limited to addition material and was conducted in a specific regional context. Therefore, further research is recommended to examine the implementation of the integration of these two approaches across other mathematics topics and at different educational levels to obtain a more comprehensive understanding of its effectiveness.

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