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DOES MUSICAL GASING IMPROVE MATHEMATICS LEARNING OUTCOMES? EVIDENCE FROM A PRETEST–POSTTEST QUASI-EXPERIMENTAL STUDY

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ABSTRAK

Pembelajaran matematika di sekolah dasar memerlukan pendekatan inovatif yang mampu mengintegrasikan pengalaman belajar konkret, aktivitas multisensori, dan keterlibatan aktif siswa. Integrasi musik dalam pembelajaran matematika menjadi salah satu alternatif yang perlu diuji secara empiris untuk mengetahui kontribusinya terhadap hasil belajar. Penelitian ini bertujuan menganalisis perubahan hasil belajar matematika siswa setelah penerapan *Musical GASING*, membandingkan peningkatan hasil belajar antara kelompok eksperimen dan kontrol dengan mempertimbangkan kemampuan awal, serta mengidentifikasi variasi hasil antarkelas. Penelitian menggunakan pendekatan kuantitatif dengan desain kuasi-eksperimen *nonequivalent control group pretest–posttest*. Partisipan terdiri atas 131 siswa sekolah dasar di Kabupaten Bangka Tengah, yaitu 65 siswa kelompok eksperimen dan 66 siswa kelompok kontrol. Data dikumpulkan melalui tes hasil belajar sebelum dan sesudah pembelajaran, kemudian dianalisis menggunakan statistik deskriptif, uji perbedaan skor peningkatan, dan analisis kovarians (ANCOVA) eksploratif. Hasil menunjukkan bahwa kedua kelompok mengalami peningkatan, masing-masing sebesar 20,54 poin pada kelompok eksperimen dan 18,71 poin pada kelompok kontrol. Namun, perbedaan peningkatan tersebut tidak signifikan secara statistik ($p = 0{,}399$). Sebaliknya, ANCOVA eksploratif menunjukkan perbedaan skor akhir terkoreksi sebesar 5,57 poin ($p = 0{,}0016$) yang menguntungkan kelompok eksperimen. Variasi peningkatan antarkelas menunjukkan hasil penerapan yang belum konsisten. Dengan demikian, *Musical GASING* berpotensi menjadi alternatif pembelajaran matematika, tetapi bukti yang tersedia belum cukup untuk memastikan keunggulannya secara konsisten dibandingkan pembelajaran konvensional.

Kata kunci: *analisis kovarians*; hasil belajar matematika; *Musical GASING*; pembelajaran matematika; kuasi-eksperimen.

ABSTRACT

Elementary mathematics instruction requires innovative approaches that integrate concrete learning experiences, multisensory activities, and active student engagement. Integrating music into mathematics instruction represents an alternative that requires empirical investigation to determine its contribution to learning outcomes. This study aimed to analyze changes in students' mathematics learning outcomes following the implementation of Musical GASING, compare learning gains between experimental and control groups while accounting for prior ability, and identify variations in achievement across classes. A quantitative approach with a quasi-experimental nonequivalent control group pretest–posttest design was employed. The participants were 131 elementary school students in Bangka Tengah Regency, Indonesia, comprising 65 students in the experimental group and 66 in the control group. Data were collected through pretest and posttest achievement assessments and analyzed using descriptive statistics, gain-score comparisons, and exploratory analysis of covariance (ANCOVA). The results indicated improvements in both groups, with mean gains of 20.54 points in the experimental group and 18.71 points in the control group. However, the difference in learning gains was not statistically significant ($p = 0.399$). In contrast, exploratory ANCOVA indicated an adjusted posttest difference of 5.57 points ($p = 0.0016$) in favor of the experimental group. Variations in learning gains across classes indicated inconsistent implementation outcomes. Thus, Musical GASING shows potential as an alternative approach to mathematics instruction, but the available evidence remains insufficient to establish its consistent superiority over conventional instruction.

Keywords: *analysis of covariance*; mathematics learning outcomes; Musical GASING; mathematics instruction; quasi-experiment.

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INTRODUCTION

Mathematics learning in elementary schools plays an essential role in developing students' conceptual understanding, numerical reasoning, and problem-solving abilities. However, achieving these competencies requires more than the mastery of mathematical procedures; students also need meaningful learning experiences that enable them to connect abstract concepts with concrete representations and everyday activities. The importance of strengthening mathematical competence is reflected in international assessments, which continue to highlight challenges in students' mathematical achievement and the need to improve the quality of mathematics instruction (Mullis et al., 2020; OECD, 2023). At the classroom level, difficulties in understanding mathematical concepts can affect students' ability to apply procedural knowledge and solve mathematical problems (Horan & Carr, 2022; Gultom & Usman, 2025). Therefore, elementary mathematics instruction needs to provide learning experiences that support conceptual understanding while encouraging active student participation and sustained engagement.

One instructional direction that can address these needs is the integration of concrete activities, educational games, music, and movement into mathematics learning. Learning through concrete representations allows students to connect mathematical ideas with observable experiences before progressing toward more abstract forms of understanding (Bruner, 1966; Hiebert & Carpenter, 1992). This principle is also consistent with the concrete–pictorial–abstract approach, which provides opportunities for students to construct mathematical understanding through progressively developed representations (Nasution et al., 2023). Recent research by Byrne et al. (2023) demonstrates that physical manipulatives can support children's learning through hands-on activities, particularly in mathematics, although their effectiveness depends on instructional guidance, the learning objectives, and the quality of implementation. Similarly, Vessonen et al. (2021) found that concrete manipulatives produced better fraction-learning outcomes than virtual manipulatives among fourth- and fifth-grade students in their intervention study. Furthermore, educational games and interactive activities can create learning situations in which students actively engage with mathematical tasks rather than merely receive information. In this context, music and rhythm offer additional possibilities for presenting mathematical concepts through auditory, motor, and cognitive experiences. However, their educational contribution needs to be evaluated in relation to the specific instructional context rather than assumed from their engaging characteristics alone.

Previous research has provided important but not entirely consistent evidence regarding the relationship between music and academic achievement. Sala and Gobet (2017) found that the transfer of music skills to children's cognitive and academic abilities was not sufficiently supported across studies, while their subsequent multilevel meta-analysis emphasized the importance of considering methodological quality when evaluating the academic benefits of music training (Sala & Gobet, 2020). In contrast, more recent research has identified positive outcomes when music is integrated directly into mathematics instruction. Azaryahu and Adi-Japha (2022), through their *MusiMath* intervention involving third-grade students, reported improvements in mathematical knowledge of patterns and symmetry, with gains maintained six months after the intervention. Similarly, Akın (2025), through a meta-analysis of music interventions and mathematics achievement, identified a small-to-moderate positive overall effect, with the magnitude of the effect varying according to intervention characteristics and mathematical content. Wang et al. (2024) also reported a positive overall effect of music integration on mathematical performance through a meta-analysis of 23 studies, while identifying instructional methods, grade levels, and music characteristics as relevant

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moderators. These findings suggest that the relationship between music and mathematics is more promising when musical activities are explicitly connected to mathematical learning objectives rather than treated merely as background activities. Nevertheless, their benefits depend on how these elements are organized and implemented pedagogically. Consequently, an instructional model combining these elements requires direct empirical examination to establish whether its implementation is associated with meaningful improvements in students' mathematics learning outcomes.

The GASING method (Gampang, Asyik, dan Menyenangkan) provides a relevant instructional foundation for this investigation. Its emphasis on accessible, enjoyable, and progressively developed mathematical learning offers an alternative to instruction dominated by procedural explanations and repetitive exercises. Previous research has reported positive contributions of GASING to elementary students' mathematical understanding and learning outcomes. Prasetyo and Retnowati (2020), for example, examined the influence of GASING on students' understanding of arithmetic operations, while Nurjannah and Surya (2019) synthesized findings concerning the implementation of GASING in elementary mathematics education. More recently, Bali and Musrifah (2024) examined its relationship with mathematical resilience and problem-solving in low-resource schools. Additional evidence is provided by Sariningsih et al. (2025), who investigated the combination of GASING and the traditional Mong-Mongan game and reported differences in mathematics learning outcomes between experimental and control groups. Rengkuan et al. (2026) also examined GASING-based mathematics instruction through a quasi-experimental study involving 119 fourth-grade students and reported higher multiplication fluency gains in the experimental group than in the conventional instruction group. These studies provide an empirical basis for considering GASING as an alternative in elementary mathematics instruction. Nevertheless, the existence of positive findings does not automatically establish that every variation of the method will produce comparable outcomes, particularly when additional instructional elements are introduced.

Although previous studies have examined music integration and GASING separately, the combination of these elements in Musical GASING requires more specific investigation. The integration of music, rhythm, and mathematical activities potentially provides students with more varied learning experiences, while the instructional principles of GASING offer a structured foundation for presenting mathematical concepts. The findings of Azaryahu and Adi-Japha (2022), Akın (2025), and Wang et al. (2024) provide support for examining music as an instructional component when it is directly connected to mathematical content. Meanwhile, research on concrete learning materials highlights the importance of ensuring that physical and sensory activities are meaningfully connected to the concepts being taught (Byrne et al., 2023; Vessonen et al., 2021). However, the effectiveness of this combination cannot be inferred solely from the theoretical compatibility of its components. Sala and Gobet (2017, 2020) demonstrate the importance of critically evaluating claims regarding the transfer of music-related activities to academic achievement. Thus, an important empirical question remains: whether the implementation of Musical GASING produces greater improvements in mathematics learning outcomes than conventional instruction, rather than simply generating positive changes within the experimental group.

Another important issue concerns the methodological limitations of evaluating instructional interventions in actual classroom settings. Students are frequently assigned to existing classes rather than individually randomized, creating the possibility of differences in prior ability between experimental and control groups. Such differences can influence the

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interpretation of posttest results if they are not adequately considered in the analysis. Handley et al. (2018) and Gopalan et al. (2020) emphasize the importance of addressing baseline differences, potential confounding factors, and appropriate analytical strategies in quasi-experimental research. These considerations are also reflected in Sala and Gobet's (2020) meta-analysis, which identified baseline differences and control-group characteristics as important moderators when evaluating the effects of music training. Furthermore, students within the same class may share instructional experiences and classroom characteristics, meaning that their achievement scores cannot necessarily be treated as fully independent observations. McNeish (2017) and McNeish and Wentzel (2017) explain that multilevel analysis involving a small number of groups requires particular caution because estimates of uncertainty may become unstable. These considerations are especially relevant when an intervention is implemented across a limited number of classroom groups.

Based on these considerations, the present study addresses three interconnected research questions: (1) How do elementary school students' mathematics learning outcomes change before and after participating in Musical GASING instruction? (2) Do mathematics learning gains differ between students receiving Musical GASING and those receiving conventional instruction when prior achievement is taken into account? (3) To what extent do learning gains vary across experimental and control classes in different schools? These questions are designed to examine not only changes in individual achievement but also the comparative patterns and consistency of outcomes across classroom settings.

Accordingly, this study aims to analyze changes in elementary school students' mathematics learning outcomes following the implementation of Musical GASING, compare achievement gains between experimental and control groups while considering students' prior abilities, and identify variations in learning outcomes across classes and schools. The study employs a quasi-experimental pretest–posttest design involving experimental and control groups in several elementary schools in Bangka Tengah Regency, Indonesia. Its contribution lies in providing comparative empirical evidence on Musical GASING while examining the importance of baseline differences and classroom-level variation in interpreting instructional outcomes. Rather than presuming the superiority of music-integrated instruction, this study evaluates its potential and limitations through multiple analytical perspectives. The findings are expected to inform the development of more evidence-based mathematics instruction and provide a foundation for future research involving stronger experimental controls, a larger number of classroom groups, and systematic evaluation of intervention implementation.

RESEARCH METHOD

This study employed a quantitative approach using a quasi-experimental nonequivalent control group pretest–posttest design. This design was selected to examine changes in students' mathematics learning outcomes following the implementation of Musical GASING and to compare the results with those of students receiving conventional mathematics instruction. Both groups completed a pretest before the instructional intervention and a posttest after the intervention. The use of existing classroom groups without individual random assignment was intended to maintain the natural classroom setting while allowing a comparative evaluation of the instructional approaches.

The participants consisted of 131 elementary school students from five public elementary schools in Bangka Tengah Regency, Indonesia. The students were organized into six existing classes, comprising three experimental classes with 65 students and three control classes with 66 students. The experimental group received mathematics instruction through the Musical

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GASING approach, whereas the control group received conventional mathematics instruction. The assignment of classes to the experimental and control groups was not conducted through individual randomization.

The research procedure consisted of three stages: initial assessment, instructional intervention, and final assessment. In the initial assessment stage, all participants completed a pretest to measure their prior mathematics achievement. During the intervention stage, the experimental classes received instruction using Musical GASING, which integrated the GASING learning approach with musical and rhythmic elements into mathematics activities. The musical component was incorporated as part of the learning process to accompany mathematical activities rather than as an independent music lesson. Meanwhile, the control classes followed conventional mathematics instruction without the specific integration of musical and rhythmic activities used in the experimental group. In the final stage, both groups completed a posttest using the same assessment procedures to measure their mathematics achievement after the instructional period.

The Musical GASING intervention was organized through structured classroom activities that connected mathematical content with musical rhythm. The implementation involved presenting mathematical concepts, guiding students through mathematical activities accompanied by musical or rhythmic patterns, and providing opportunities for students to practice the targeted skills through repeated and guided exercises. The musical elements served as an instructional medium to support students' participation in mathematical activities and to create a more interactive learning experience.

The mathematics achievement test was administered before and after the intervention to obtain quantitative data on students' learning outcomes. The instrument was designed to measure students' understanding and achievement of the mathematics content addressed during the instructional period. Information regarding the number of test items, scoring procedures, instrument validity, and reliability should be reported based on the actual instrument documentation to ensure transparency and methodological accountability.

Data analysis involved descriptive and inferential statistical procedures. Descriptive statistics, including means and standard deviations, were calculated to summarize students' pretest and posttest achievement scores. Learning gains were calculated by subtracting pretest scores from posttest scores. Differences in gain scores between the experimental and control groups were examined using an independent-samples comparison, with Welch's t-test applied when the assumption of equal variances was not satisfied. In addition, an exploratory analysis of covariance (ANCOVA) was conducted using posttest scores as the dependent variable, instructional group as the independent variable, and pretest scores as the covariate to examine differences in final achievement after accounting for initial performance. Statistical significance was determined at the 0.05 level. Given the use of intact classroom groups and the limited number of classes, the inferential findings were interpreted cautiously, particularly regarding the potential dependence of student observations within the same classroom.

RESULT AND DISCUSSION

Results

The study involved 131 students, divided into 65 students in the experimental group and 66 students in the control group. All analyzed students had paired pretest and posttest scores. Based on the data distribution, there were six classes from five elementary schools, namely SDN 5 Simpangkatis, SDN 1 Simpangkatis, SDN 13 Koba, SDN 7 Simpangkatis, and SDN 20

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Sungaiselan. SDN 5 Simpangkatis was the only school in the data that had both an experimental and a control class.

The descriptive analysis revealed differences in prior ability between the two groups. The mean pretest score of the experimental group was 53.62 with a standard deviation of 16.41, whereas the control group obtained a mean of 45.76 with a standard deviation of 16.27. The baseline difference of 7.86 points indicates that the experimental group already had higher initial achievement before the treatment. This condition is important because comparing posttest scores without controlling for prior ability may lead to biased interpretations. The quasi-experimental methodology literature emphasizes the importance of accounting for baseline imbalance when evaluating the outcomes of educational interventions (Handley et al., 2018; Gopalan et al., 2020).

Table 1. Descriptive statistics of mathematics learning outcomes by research group

Group	n	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Gain (Mean ± SD)
Control	66	45.76 ± 16.27	64.47 ± 12.80	18.71 ± 10.75
Experimental	65	53.62 ± 16.41	74.15 ± 12.86	20.54 ± 13.75
Total	131			

Mean = average; SD = sample standard deviation; Gain = posttest − pretest. Statistics were computed from individual-level data, not from simple averages of class means.

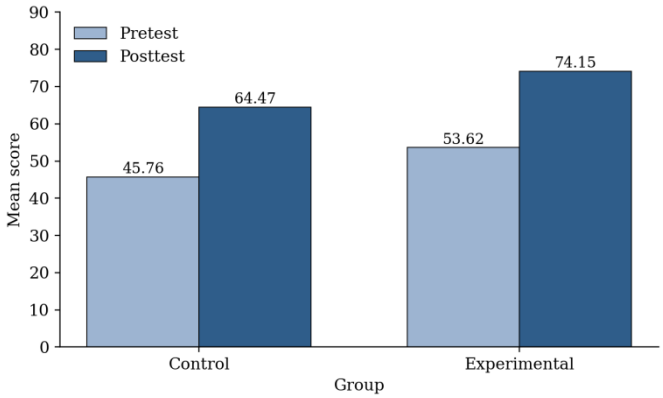


Figure 1. Comparison of mean pretest and posttest scores
Mean scores of the control and experimental groups before and after instruction.

These findings indicate that the two groups did not start from the same level of prior ability. Therefore, the higher posttest score of the experimental group cannot be directly interpreted as evidence that Musical GASING is more effective. This difference must be evaluated together with score gains and analyses that account for students' initial conditions.

The analysis of the six classes showed that all classes experienced an increase in mean scores from pretest to posttest. However, the magnitude of the increase varied across classes, in both the experimental and the control groups.

Table 2. Comparison of mathematics learning outcomes across the six research classes

Class	n	Pretest	Posttest	Gain
Control 1 — SDN 5 Simpangkatis	22	45.23	67.50	22.27
Control 2 — SDN 1 Simpangkatis	21	45.24	63.10	17.86
Control 3 — SDN 13 Koba	23	46.74	62.83	16.09
Experimental 1 — SDN 5 Simpangkatis	23	58.48	72.39	13.91
Experimental 2 — SDN 7 Simpangkatis	22	53.18	76.59	23.41
Experimental 3 — SDN 20 Sungaiselan	20	48.50	73.50	25.00

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All figures are expressed in score points. Gain is the difference between the mean posttest and pretest scores, not a percentage increase.

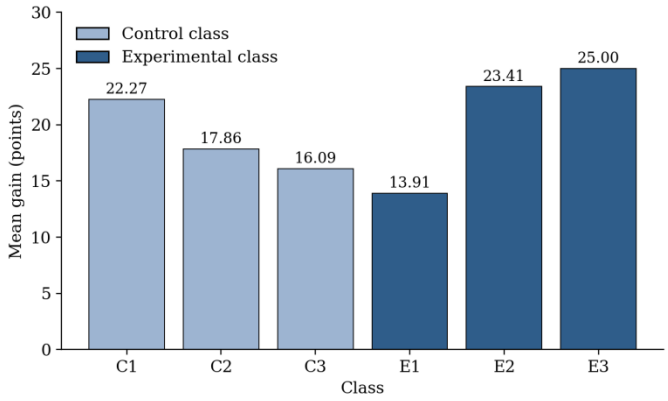


Figure 2. Variation in mean score gains across classes
C1–C3 = control classes; E1–E3 = experimental classes.

Within the experimental group, the largest gain occurred in Experimental class 3 at SDN 20 Sungaiselan (25.00 points), followed by Experimental class 2 at SDN 7 Simpangkatis (23.41 points). In contrast, Experimental class 1 at SDN 5 Simpangkatis showed a gain of only 13.91 points, lower than that of all control classes. Within the control group, the highest gain occurred in Control class 1 (22.27 points).

These differences show that learning gains were not uniform across the classes that received the treatment. Although Musical GASING conceptually integrates musical elements and mathematics learning activities, the magnitude of score gains cannot yet be attributed to this approach alone. Sala and Gobet (2017, 2020) showed that the benefits of music training for cognitive and academic achievement may differ according to intervention characteristics and the quality of the research design. Accordingly, the between-class variations in this study should be discussed as an empirical finding rather than disregarded in order to sustain the initial assumption regarding the superiority of Musical GASING.

A comparative analysis was conducted to determine whether the mathematics learning gains of the experimental group differed from those of the control group. Based on individual-level data, the experimental group achieved a mean gain of 20.54 points, whereas the control group showed a gain of 18.71 points. Thus, the difference in mean gains between the two groups was 1.83 points.

To evaluate this difference, an exploratory analysis was conducted using Welch's independent samples t-test on individual gain scores. The analysis yielded $t = 0.846$ with approximately 121.05 degrees of freedom and $p = 0.399$. This result indicates that the difference in gains between the two groups was not statistically significant at the 0.05 level when student scores were analyzed under the assumption of independence.

Table 3. Results of the exploratory comparison of learning outcomes

Parameter	Result
Number of experimental students	65
Number of control students	66
Mean gain, experimental	20.54
Mean gain, control	18.71
Gain difference	1.83
Welch's t statistic	0.846
Degrees of freedom	121.05

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Parameter	Result
p-value	0.399
Significance level	0.05

The test results are exploratory because they do not yet account for the clustering of students within six classes. They show that the experimental group had a slightly higher mean gain than the control group, but the statistical evidence from the gain-score comparison is insufficient to establish a convincing difference. This finding is important because improvements in both groups do not in themselves demonstrate the superiority of a particular instructional method. Furthermore, students in this study were nested in different classes, so the assumption of independence among observations needs to be considered. McNeish (2017) explained that a small number of groups can cause problems in estimating uncertainty in clustered data analysis. Therefore, the results of the Welch test were not used as the sole basis for drawing conclusions about the effectiveness of Musical GASING.

The difference in pretest scores between the experimental and control groups indicates the need for additional analysis that accounts for students' prior ability. An exploratory analysis was conducted using a linear regression model equivalent to a simple ANCOVA, with posttest scores as the dependent variable, instructional group as the independent variable, and pretest scores as the covariate.

The model results showed that, after adjusting for pretest scores, the estimated difference in posttest scores between the experimental and control groups was 5.57 points. The 95% confidence interval ranged from 2.16 to 8.99 points, with $p = 0.0016$ in a model assuming independent student observations.

Table 4. Results of the exploratory ANCOVA

Parameter	Estimate
Dependent variable	Posttest
Main factor	Instructional group
Covariate	Pretest
Experimental group coefficient	+5.57
95% confidence interval	2.16–8.99
p-value	0.0016
Number of observations	131

The simple ANCOVA model does not yet include class or school effects, the pretest-by-group interaction, or corrections for the small number of clusters. Its results cannot be treated as a definitive causal estimate. The simple ANCOVA results indicate a direction of difference favoring the experimental group after adjustment for prior ability. However, this finding should be interpreted cautiously because it presents a different picture from the gain-score analysis. The gain analysis yielded a small and nonsignificant difference, whereas the simple ANCOVA produced a larger adjusted posttest difference.

This discrepancy is not a computational error but a consequence of the different statistical questions and model assumptions. Gain analysis directly compares score changes, whereas ANCOVA compares final scores at the same level of prior ability as specified by the model. In nonequivalent designs, the choice of approach can affect results when prior abilities differ. More importantly, the treatment was delivered at the class level rather than through individual random assignment of students. With only six classes, the uncertainty of the treatment effect is potentially greater than that indicated by individual-level models. Therefore, this ANCOVA estimate should be reported as a supporting analysis rather than as definitive evidence that Musical GASING has a significant effect on mathematics learning outcomes.

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Discussion

The findings of this study indicate that mathematics learning outcomes improved in both the experimental and control groups following the instructional period. The experimental group demonstrated a mean gain of 20.54 points, while the control group achieved an improvement of 18.71 points. Although the experimental group showed a slightly higher increase, the difference between groups was only 1.83 points and was not statistically significant ($p = 0.399$). This finding suggests that Musical GASING was associated with positive changes in students' mathematics achievement; however, the magnitude of improvement was not sufficiently different from that observed under comparison instruction. Therefore, the improvement within the experimental group should not be interpreted independently as evidence of the intervention's superiority. Learning progress may also reflect students' initial abilities, instructional experiences, and other classroom-related factors.

The improvement observed in both groups highlights the importance of providing structured learning experiences that enable students to develop mathematical understanding. Mathematics achievement involves more than procedural accuracy; students also need to establish meaningful connections between mathematical concepts and their applications. Hiebert and Carpenter (1992) emphasized that understanding develops when students establish connections among mathematical representations and ideas. Similarly, Bruner (1966) explained that learning can be supported through instructional experiences that facilitate the development of understanding from concrete experiences toward more abstract representations. These perspectives provide a relevant foundation for interpreting the improvements observed in this study. Nevertheless, because both groups experienced learning progress, the findings do not establish that the integration of music was the sole factor responsible for the improvement.

From a pedagogical perspective, Musical GASING offers an instructional alternative by combining mathematical activities with musical elements and rhythm. Such integration may provide students with more varied opportunities to engage with mathematical content through auditory, cognitive, and physical experiences. Oliveira (2023) identified different possibilities for integrating music and mathematics, indicating that the two learning domains can be connected through instructional activities. Furthermore, Way and Ginns (2024) discussed embodied learning as an important consideration in early mathematics education, particularly in designing learning experiences that involve physical engagement. The use of concrete and interactive learning activities is also consistent with the potential contribution of physical manipulatives to children's learning and development, as reviewed by Byrne et al. (2023). These studies provide a conceptual basis for the development of Musical GASING. However, the present findings do not directly demonstrate which specific musical or physical activities contributed to students' achievement because student engagement and instructional processes were not separately measured.

The findings also need to be considered in relation to previous research on music training and academic achievement. Sala and Gobet (2017) reported that evidence supporting the transfer of musical skills to children's cognitive and academic abilities was limited. Their subsequent multilevel meta-analysis further emphasized that the academic benefits of music training should be evaluated by considering methodological quality and the characteristics of the interventions (Sala & Gobet, 2020). This perspective is relevant to the present study because the integration of music into mathematics instruction does not automatically guarantee higher achievement. Although Musical GASING combines music with mathematical learning activities, its contribution needs to be evaluated through measurable learning outcomes and

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consistent comparisons with alternative instructional approaches. The nonsignificant difference in learning gains found in this study reinforces the importance of maintaining a cautious interpretation of the academic benefits of music-integrated instruction.

The results also provide an opportunity to examine Musical GASING in relation to previous studies of the GASING method. Prasetyo and Retnowati (2020) investigated the application of GASING in supporting elementary students' understanding of arithmetic operations, while Nurjannah and Surya (2019) examined its effectiveness through a meta-analysis of elementary mathematics learning. Bali and Musrifah (2024) further explored the relationship between GASING, mathematical resilience, and problem-solving in low-resource school contexts. These studies establish a relevant background for considering GASING as an alternative in elementary mathematics instruction. However, the present study examines a variation that incorporates musical elements, meaning that its outcomes should not automatically be equated with those of the original GASING approach. The additional musical component represents a pedagogical feature that requires its own empirical evaluation. Consequently, the present findings extend the discussion of GASING by showing that its integration with music may be promising, although its comparative advantage has not yet been established consistently.

An important finding concerns the variation in learning gains across the six research classes. Although all classes demonstrated improvements, the magnitude of these improvements differed considerably. Experimental class 3 at SDN 20 Sungaiselan achieved the highest gain (25.00 points), followed by experimental class 2 at SDN 7 Simpangkatis (23.41 points). In contrast, experimental class 1 at SDN 5 Simpangkatis showed a gain of only 13.91 points. Interestingly, the gain in the control class at the same school was higher, reaching 22.27 points. This pattern indicates that the implementation of Musical GASING did not produce uniform learning outcomes across the participating classes.

The variation across classes is important because instructional outcomes are not determined exclusively by the instructional model itself. Differences in students' initial achievement, classroom characteristics, teaching practices, and the consistency of instructional implementation may contribute to variations in learning progress. Nevertheless, the present study did not collect sufficient observational evidence to establish which of these factors accounted for the differences. Therefore, these variations should be interpreted as evidence of heterogeneous classroom outcomes rather than direct evidence of differences in teacher performance or intervention fidelity. This finding also highlights the importance of examining instructional implementation alongside achievement scores when evaluating educational interventions.

The differences in baseline achievement further complicate the interpretation of the comparative results. Before the intervention, the experimental group had a mean pretest score of 53.62, compared with 45.76 in the control group. The 7.86-point difference indicates that the experimental group already demonstrated higher mathematics achievement before instruction. Consequently, the higher posttest mean in the experimental group cannot be attributed exclusively to Musical GASING. This consideration is particularly important in quasi-experimental research, where existing classes are used without individual random assignment. Handley et al. (2018) emphasized the importance of identifying potential sources of bias and selecting appropriate analytical strategies in quasi-experimental effectiveness research. Similarly, Gopalan et al. (2020) highlighted the opportunities and methodological challenges associated with quasi-experimental designs in educational research. In this context, accounting

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for baseline differences is essential to produce a more balanced interpretation of intervention outcomes.

The additional ANCOVA analysis provides another perspective on the comparative findings. After adjusting for pretest scores, the estimated difference in posttest achievement was 5.57 points in favor of the experimental group, with a 95% confidence interval of 2.16–8.99 and $p = 0.0016$. This result suggests that the experimental group achieved higher posttest scores than the control group when the initial achievement scores were statistically controlled in the specified model. However, this finding differs from the gain-score comparison, which showed no statistically significant difference ($p = 0.399$). The difference between these results reflects the distinct analytical questions addressed by the two approaches. Gain-score analysis compares changes between measurements, whereas ANCOVA estimates differences in final achievement after adjusting for baseline scores. Therefore, the findings should be interpreted together rather than selecting only the statistically significant result to support the effectiveness of the intervention.

More importantly, the ANCOVA model used in this study treated individual student observations as independent and did not fully account for the clustering of students within classes. Since the intervention was delivered at the classroom level, students within the same class may share instructional conditions and learning experiences. Treating all student scores as independent observations may underestimate uncertainty and produce overly optimistic statistical inferences. McNeish (2017) explained that multilevel analysis involving a small number of groups presents particular challenges in estimating model parameters and standard errors. The present study involved only six classes, which limits the reliability of class-level statistical adjustments. Accordingly, the ANCOVA result should be regarded as an exploratory adjusted association rather than definitive evidence of a causal intervention effect.

Taken together, these findings contribute to the discussion of music-integrated mathematics instruction by presenting evidence from multiple elementary school settings. The study demonstrates that Musical GASING can be implemented as an alternative instructional approach and that students in the experimental classes experienced improvements in mathematics achievement. However, the comparison of learning gains does not establish a statistically significant advantage over conventional instruction, while the adjusted ANCOVA result requires caution because of the baseline imbalance and unaddressed classroom clustering. The variation across experimental classes further indicates that the outcomes were not consistent across instructional settings. Thus, the contribution of this study lies not in establishing the superiority of Musical GASING, but in identifying its potential while highlighting the methodological and contextual considerations necessary for evaluating its effectiveness.

Several limitations should be considered when interpreting these findings. First, the nonequivalent group design and the absence of confirmed individual random assignment limit the ability to establish causal relationships between the intervention and learning outcomes. Second, the experimental and control groups differed in their initial achievement, which may have influenced the comparative results. Third, the study involved only six classes, limiting the ability to account adequately for the dependence of student observations within classroom groups. Fourth, information concerning intervention fidelity, instructional duration, teacher characteristics, and the consistency of implementation was insufficient to explain the variation in learning gains across classes. Finally, the use of achievement scores as the primary outcome measure did not provide direct evidence of changes in student engagement, mathematical confidence, or the specific learning processes associated with Musical GASING.

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Future research should therefore involve a larger number of schools and classroom groups to provide more reliable estimates of intervention outcomes and classroom-level variation. More rigorous group assignment procedures, preferably involving cluster randomization when feasible, would also strengthen the evaluation of its comparative effectiveness. In addition, researchers should document the validity and reliability of assessment instruments and systematically evaluate intervention fidelity through classroom observations and implementation records. Combining achievement measurements with qualitative evidence of student participation, learning experiences, and instructional practices would further clarify how Musical GASING operates in different classroom contexts. Such improvements would provide a stronger empirical foundation for determining whether the integration of music into GASING can produce consistent and meaningful improvements in elementary mathematics learning.

CONCLUSION

This study shows that the mathematics learning outcomes of elementary school students improved both in the experimental group taught with the Musical GASING approach and in the control group receiving comparison instruction. The mean gain of the experimental group was 20.54 points, whereas that of the control group was 18.71 points, with a difference in gains of 1.83 points. The gain-score comparison showed that this difference was not statistically significant ($p = 0.399$). Meanwhile, the exploratory ANCOVA yielded an estimated adjusted posttest difference of 5.57 points favoring the experimental group. However, this result should be interpreted with caution because of differences in prior ability and the clustering of students within six classes, which have not been fully accounted for in the analytical model. Variations in learning gains across classes also indicate that the implementation of Musical GASING did not produce consistent achievement across all experimental groups. Thus, Musical GASING shows potential as an alternative approach to mathematics instruction in elementary schools, but the evidence from this study is insufficient to conclude that it is consistently more effective than comparison instruction. Further research involving a larger number of classes, stronger control of prior ability, and evaluation of intervention fidelity is needed to obtain more convincing evidence of effectiveness.

The findings of this study have several practical and methodological implications. For teachers, Musical GASING may serve as a complementary approach to elementary mathematics instruction, particularly to increase variation in learning experiences through the integration of music, rhythm, and movement. However, its use should be accompanied by careful attention to classroom conditions and students' prior abilities, given the inconsistent gains observed across experimental classes. For schools and policymakers, the adoption of Musical GASING should be preceded by teacher training and the development of standardized implementation guidelines, so that variations in instructional quality do not undermine its potential benefits. For researchers, future studies are recommended to involve a larger number of classes and schools and to employ more comparable or randomized group assignment. Analyses should be multilevel or cluster-adjusted to account for the nesting of students within classes. Instruments with documented validity and reliability are also needed, together with systematic measurement of intervention fidelity through classroom observation. Combining quantitative outcomes with qualitative data on student engagement and teaching processes would further clarify the mechanisms through which Musical GASING may influence mathematics learning outcomes.

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REFERENCES

Akın, A. (2025). Let me make mathematics and music together: A meta-analysis of the causal role of music interventions on mathematics achievement. *Educational Studies, 51*(4), 386–404. https://doi.org/10.1080/03055698.2023.2216826

Azaryahu, L., & Adi-Japha, E. (2022). "MusiMath" – A music-based intervention program for learning patterns and symmetry. *The Journal of Experimental Education, 90*(2), 319–343. https://doi.org/10.1080/00220973.2020.1799316

Bali, M. M. E. I., & Musrifah. (2024). GASING method and mathematical resilience: Impact on primary students' problem-solving in low-resource schools. *Pegem Journal of Education and Instruction, 14*(3), 58–68. https://doi.org/10.47750/pegegog.14.03.06

Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press.

Byrne, E. M., Jensen, H., Thomsen, B. S., & Ramchandani, P. G. (2023). Educational interventions involving physical manipulatives for improving children's learning and development: A scoping review. *Review of Education, 11*(2), Article e3400. https://doi.org/10.1002/rev3.3400

Gopalan, M., Rosinger, K., & Ahn, J. B. (2020). Use of quasi-experimental research designs in education research: Growth, promise, and challenges. *Review of Research in Education, 44*(1), 218–243. https://doi.org/10.3102/0091732X20903302

Gultom, R., & Usman, H. (2025). Hubungan pemahaman konsep dan kemampuan pemecahan masalah matematika pada siswa kelas IV SD. *Jurnal Pendidikan Dasar Indonesia, 10*(1), 33–41. https://doi.org/10.26737/jpdi.v10i1.5478

Handley, M. A., Lyles, C. R., McCulloch, C., & Cattamanchi, A. (2018). Selecting and improving quasi-experimental designs in effectiveness and implementation research. *Annual Review of Public Health, 39*, 5–25. https://doi.org/10.1146/annurev-publhealth-040617-014128

Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 65–97). Macmillan.

Horan, E., & Carr, M. (2022). The relationship between conceptual and procedural knowledge in mathematics: A meta-analytic review. *Educational Psychology Review, 34*(4), 2243–2274. https://doi.org/10.1007/s10648-022-09689-2

McNeish, D. (2017). Small sample methods for multilevel modeling: A colloquial elucidation of REML and the Kenward-Roger correction. *Multivariate Behavioral Research, 52*(5), 661–670. https://doi.org/10.1080/00273171.2017.1344538

McNeish, D. (2018). Thanks coefficient alpha, we'll take it from here. *Psychological Methods, 23*(3), 412–433. https://doi.org/10.1037/met0000144

McNeish, D., & Wentzel, K. R. (2017). Accommodating small sample sizes in three-level models when the third level is incidental. *Multivariate Behavioral Research, 52*(2), 200–215. https://doi.org/10.1080/00273171.2016.1262236

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 international results in mathematics and science*. TIMSS & PIRLS International Study Center.

Nasution, M. K., Surya, E., & Syahputra, E. (2023). Effectiveness of concrete-pictorial-abstract approach in improving fraction understanding of elementary students. *Journal of Mathematics Education, 14*(2), 213–226. https://doi.org/10.22342/jme.v14i2.pp213-226

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https://doi.org/10.51878/elementary.v7i1.16736

Nurjannah, S., & Surya, E. (2019). Meta-analisis efektivitas metode GASING dalam pembelajaran matematika di sekolah dasar. *Jurnal Pendidikan Matematika Indonesia, 4*(2), 55–62. https://doi.org/10.26737/jpmi.v4i2.1016

OECD. (2023). *PISA 2022 results (Vol. I): The state of learning and equity in education*. OECD Publishing.

Oliveira, M. P. (2023). A integração entre a Música e a Matemática: Uma revisão sistemática de literatura. *Revista de Ensino de Ciências e Matemática, 14*(1), Article a08. https://doi.org/10.26843/rencima.v14n1a08

Prasetyo, T., & Retnowati, E. (2020). Pengaruh metode GASING terhadap pemahaman konsep operasi hitung siswa sekolah dasar. *Jurnal Riset Pendidikan Matematika, 7*(1), 42–53. https://doi.org/10.21831/jrpm.v7i1.31025

Rengkuan, F. C., Nurlaelah, E., & Mulyaning A., E. C. (2026). Enhancing fourth-grade students' multiplication fluency through GASING-based mathematics instruction: A quasi-experimental study. *Journal of Advanced Sciences and Mathematics Education, 6*(4), 240–249. https://doi.org/10.58524/jasme.v6i4.1596

Sala, G., & Gobet, F. (2017). When the music's over. Does music skill transfer to children's and young adolescents' cognitive and academic skills? A meta-analysis. *Educational Research Review, 20*, 55–67. https://doi.org/10.1016/j.edurev.2016.11.005

Sala, G., & Gobet, F. (2020). Cognitive and academic benefits of music training with children: A multilevel meta-analysis. *Memory & Cognition, 48*(8), 1429–1441. https://doi.org/10.3758/s13421-020-01060-2

Sariningsih, K. R., Parmiti, D. P., & Yudiana, I. K. E. (2025). The Gasing method with the traditional game-based Mong-Mongan approach on the mathematics learning outcomes of third grade elementary school students. *Jurnal Ilmiah Sekolah Dasar, 9*(2), 400–407. https://doi.org/10.23887/jisd.v9i2.96608

Vessonen, T., Hakkarainen, A., Väisänen, E., Laine, A., Aunio, P., & Gagnon, J. C. (2021). Differential effects of virtual and concrete manipulatives in a fraction intervention on fourth and fifth grade students' fraction skills. *Investigations in Mathematics Learning, 13*(4), 323–337. https://doi.org/10.1080/19477503.2021.1982586

Wang, Y., Zhang, J., & Mao, Y. (2024). Harmonizing mathematics: Unveiling the impact of music integration on academic performance – A meta-analysis. *Thinking Skills and Creativity, 52*, Article 101554. https://doi.org/10.1016/j.tsc.2024.101554

Way, J., & Ginns, P. (2024). Embodied learning in early mathematics education: Translating research into principles to inform teaching. *Education Sciences, 14*(7), Article 696. https://doi.org/10.3390/educsci14070696

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