

Music integration in teaching fundamental operations on integers and student's test performance: Inputs for module enhancement

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ABSTRACT

The study was conducted to find out the test performance of the respondents before and after integrating music in teaching fundamental operations on integers and their perception of the integration of music in teaching the topic. The researcher used two (2) intact classes with 45 students each ($n = 90$) from the grade 7 students of Bagumbayan National High School as respondents for the study. Class A was assigned as the control group, while Class B was utilized as an experimental group that answered both the pretest and post-test. Class B also answered the survey determining their perception of the integration of music in teaching fundamental operations of integers. It has been found that the pretest and post-test mean scores of the experimental group showed a significant difference after the integration of music in teaching fundamental operations on integers. The overall weighted mean on the perception of the respondents on the music integration in teaching the topic showed a "strongly agree" response. Furthermore, the result of the test between the perception and post-test score of the respondents when music is integrated into teaching fundamental operations on integers showed a significant relationship. The results were used as inputs for the enhancement of the module on fundamental operations on integers used in the Division of Taguig City and Pateros.

Keywords: integers, music integration, perception, test performance

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INTRODUCTION

Learners encountered negative numbers for the first time in grade six as they were taught the fundamental operations of integers as they were used to working with positive numbers in their

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whole academic career. Consequently, they find it tough to comprehend integers as numbers and likewise operations with integers. Trouble may arise from the inappropriate methods of teaching integers, learners' errors when dealing with integers, or the linguistic aspect of learning and teaching utilized. One such teaching technique is the emphasis on rote memorization as a learning strategy. The researcher supposes that educators do not normally allow learners to order, recognize, and compare integers in a way that they will remember meaningfully, thus leading to challenges students experience with integers.

In the study of Khalid M. & Embong Z. (2020), they highlighted the sad reality of the pedagogy of mathematics. They revealed that memorization of mathematics formulas and procedures was popularly practiced by some learners, as well as manipulation of numbers without knowing the concepts or processes involved and even supported by some teachers. However, memorizing facts and mastering computation were not as important as having a deep understanding of mathematical concepts and ideas, which resulted in shallow understanding and lower performance in mathematics.

The relationship between mathematics and music has been long recognized way back in the days of Greek Mathematicians and philosophers like Pythagoras, Aristotle and Plato, who wrote about the overlaps and links between the two disciplines. For instance, the two disciplines are expressed similarly through the use of symbolic notations and representational language (Azaryahu et al., 2020).

According to the research of Perger, Major & Trinick (2018), the theorization of the links between music and mathematics has been of attention to researchers, educators and philosophers since the time of the Greeks. The links between these two disciplines may be seen from different perspectives – the content of music and mathematics programs and the cognitive processes involved in both music and mathematics. The idea of music and mathematics integration in classrooms is not a new thing. Many of us will remember during our primary school years singing number songs, a practice used to reinforce the learning of counting skills and number patterns.

Some view the link between music and mathematics as theoretical and logical rather than just artistic and creative. There is a belief that mathematics is a logical subject lacking creativity, while music is a creative one. If these notions are to be put aside, there are many opportunities where music and mathematics can naturally relate and connect. For instance, humans construct and express what they want to mean through multiple sign systems. Music has its written forms of notations, while mathematics has its symbols and digits. Linking these learning areas gives children multi-modal opportunities for learning. (Perger, Major, & Trinick, 2018).

In the study of Chemi & Du, cited in the work of Tisdell (2019), they concluded that the incorporation of disciplines with each other highlighted powerful effects on learning. Integrating music into the educational experiences of the students is a good example of arts-integrated teaching and learning.

Additionally, research by Nagy & Malone (2020) describes a study involving the active incorporation of music and mathematics applied to how senior high school students understand the idea of function. The study has used pretests and post-tests, experimental and control groups, multiple research methods, quasi-experimental research design and post-positivist paradigm. The study utilized nine authored developed analogies between music and mathematics as instruments to improve the understanding of the students about the concept of function. The findings of the study suggested that active incorporation of music and mathematics made a statistically significant difference in the understanding of the students on the concept of function.

Integration of music in a mathematics class is not a new strategy. In fact, there are several researchers in many countries who have already studied the strategy and its impact on different aspects of students' learning.

Viladot, L. et.al. in 2017 published their research on the perspective on theory and practice of the integration of mathematics and music education in England and Catalonia, Spain.

Azaryahu, L., et.al. studied in 2018 the utilization of Academic Music and Musimath – two music-based intervention programs for fractions learning on grade four pupils in Israel.

Perger, P. et.al. explored the curriculum integration of music and mathematics in primary schools in New Zealand in 2018.

Nuraida & Putri (2020) asserted that math learning should be filled and planned attractively so that students will be motivated and comfortable improving their perspective about math and relieve math anxiety so that they will be eager to learn math. In a school setting, when math is less attractive, most of the learners are unhappy when it comes to learning mathematics. Furthermore, math is hard to learn according to their perception, which results in low academic achievement of students in mathematics. Teachers should take a role as facilitators and mediators in learning activities that help the students so that the learning process can happen positively.

Song et al., as mentioned in the study of Lovemore, Robertson, & Graven (2021), categorized and identified three ways in which teachers incorporate music into their math classes, namely music as a teaching approach to mathematics, music as a catalyst for cognition in mathematics and mathematics as a tool during the creation of music. The researchers noted that research delving into music as a teaching approach to mathematics is limited and calls for further research. The researchers also identify the incorporation of music and mathematics at the teaching level to be the most demanding way for educators to utilize the two disciplines, which necessitates teachers to have confidence, knowledge and skills in mathematics and music, as well as ample time to effectively plan and prepare incorporated lessons.

Challenges and difficulties in calculating fundamental operations involving integers have a wide documentation among researchers throughout the world (Goh, Tengah, Shahrill, Tan, & Leong, 2017; Khalid et al., 2018; Makonye & Fakude, 2016) as mentioned in the study of Khalid & Embong (2020) specifically in the area of addition of subtraction. This should be a cause of concern among mathematics educators because the concept of integers forms a core and foundation needed for achievement in algebra and other higher-level mathematics.

In the case of operations on integers, teachers tend to give students rules to be followed and memorized and then do the repetition so that they will master the rules. This practice might lead students to misapply the rules and have a poor understanding of the topic since students will get confused with so many rules that they need to memorize and follow (Khalid & Embong, 2020). For instance, those who answer $10 + (-4) = -14$ will say that 10 added to 4 is 14, yet there is a minus sign which makes it negative. The teachers need to explore why students answered the way they answered and discover if there is a pattern to this error in their understanding of the topic. On many occasions, the students tended to use their prior knowledge that have learned from whole numbers, and they apply it when dealing with the addition and subtraction of integers.

Several researchers (Khalid et al., 2018; Toh, Tengah, Shahrill, Tan & Leong, 2017) revealed that students were challenged and had difficulty in solving basic problems when operations on integers were involved, specifically in the area of addition and subtraction.

Literature on the relationship between music and mathematics suggested some of the means by which the integration of the two disciplines can bring profit to education. Geist et al., as cited in the work of Fitzallen, Murphy, Hatisaru & Maher (2022), stressed that elements of music, such as beat, melody, pattern and rhythm, enhance the learning of mathematics. The benefits of integration of the two mentioned disciplines include decreasing math anxiety and increasing the motivation and engagement of the students in classes.

In the same study by Işıtan & Doğan (2020), they aimed to make the learning environment conducive for the 5th-grade students who were doing interdisciplinary activities designed by linking music and mathematics. The activities were designed by incorporating the concepts of measure, note, beat and music with the topic of fractions in mathematics aimed to promote learning meaningfully and make sure of the active participation of the students. The activities were conducted for 6 lesson hours for 23 fifth-grade students attending a Turkish middle school. During the teaching process, students were asked to solve problems dealing with addition and subtraction of fractions with the same and different denominators, to represent note durations with fractions and to create measures with certain requirements. At the end of the lesson, the students were able to solve and calculate the given problems on the activity sheet by combining their knowledge of music and mathematics. These teaching experiences highlighted that the activities prepared in parallel with the interdisciplinary approach might help the student's understanding of fractions.

The theoretical framework for this study is Howard Gardner's theory of multiple intelligences. Gardner (1994) questioned if intelligence was a single entity that intelligence tests could measure. Early researchers believed that people are born with a specific amount of measurable cognitive potential. Gardner (1994) stated that music intelligence is a separate intelligence in itself. Gardner and other researchers believe multiple intelligences have their strengths and constraints. Gardner's studies on multiple intelligences challenged Piaget's theories of a single cognitive intelligence because he believed that intelligence involves an array of skills, such as appreciation, composition, and performance of musical patterns. Music intelligence encompassed the capacity to compose and recognize musical rhythms, pitches, and tones. Gardner believed that musical intelligence works hand in hand with linguistic intelligence.

Howard Gardner has conducted a vast amount of research inquiring into how the human brain functions in regard to multiple intelligences. Gardner (1994) identified multiple intelligences in young students and claimed that every student has the right to acquire the skills necessary to develop multiple intelligences; to deny students the opportunity or resources to do so is a hindrance to the students' young minds as much as withholding mathematics from them. Gardner (1994) described multiple intelligences as the ability to solve problems that people from various cultures also value. Gardner (1994) compiled a list of criteria, or signs of intelligence, which each candidate identified as 'intelligent' had to possess. As a prerequisite, the intelligent person would possess the natural ability to resolve difficulties and problems.

Statement of the problem

The main purpose of this study is to determine the test performance of the respondents before and after integrating music in teaching fundamental operations on integers, as well as to examine their perception of this integration. More specifically, the study sought to answer the following questions:

1. What is the pretest mean score of the respondents when classified as to control group and experimental group?

2. What is the post-test mean score of the respondents when classified as to control group and experimental group?
3. Is there a significant difference between the pretest and post-test mean scores of the experimental group?
4. Is there a significant difference between the pretest and post-test mean scores of the control group?
5. What is the perception of the respondents regarding the integration of music in teaching fundamental operations on integers?
6. Is there a significant relationship between the respondents' perception of integrating music in teaching fundamental operations on integers and their post-test score?
7. Based on the findings and conclusions of the study, what recommendations may be proposed for the enhancement of the module on fundamental operations on integers?

METHODOLOGY

This study employed a descriptive quasi-experimental research method design. Specifically, it will use a pretest-posttest control group design. The population of the study consisted of the Grade seven students of Bagumbayan National High School for the school year 2022-2023.

According to Cook (2015), quasi-experiments usually examine the causal results of treatments that are long-lasting outside of the laboratory. Assignment in quasi-experiments is administrator judgment or by selection of the self, while true experiments use randomization in the selection.

Gopalan, M., Rosinger, K., and Ahn J. (2020) defined quasi-experimental research designs that used non-experimental or non-researcher induced variation in the main independent variable of interest copying conditions in an experiment in which some of the test subjects are exposed to treatment while others are not using randomization.

In an article of Bobbit Z. (2020), he defined pretest-posttest design as an experiment in which measurements are taken on individuals both before and after they're involved in some treatment. Pretest-posttest designs can be used in both experimental and quasi-experimental research and may or may not include control groups.

The first instrument that will be utilized for the pretest / post-test in this study is adapted from the Grade 7 Mathematics First Quarter Week 3 Module developed and validated by selected teachers from the Schools Division Office of Taguig City and Pateros.

The said instrument is a 10-item test consisting of 2 types of objective test that covers the four fundamental operations on integers.

The second instrument that will be used to determine the perception of the respondents on the integration of music in teaching fundamental operations on integers is a researcher-made instrument. The said instrument was subjected to pre survey and internal consistency for its validation. After considering the pre survey and internal consistency result, three Mathematics education experts were tapped to validate the instrument and was subjected to Grammarly to check the language construction of the questionnaire.

RESULTS AND DISCUSSION

The presentation, analysis, and interpretation of data in this section were guided by the research questions and the methodological procedures previously described. The study employed pretest–post-test assessments for both the control and experimental groups, followed by inferential analyses using paired t-tests and Pearson correlation. A total of respondents participated in the administration of the tests and perception survey, allowing the researcher to compare the performance of students before and after instruction, as well as to explore their perceptions of integrating music in learning fundamental operations on integers. The results are presented in cascading narrative form, beginning with descriptive statistics, followed by inferential tests, and ending with an analysis of students' perceptions.

Pretest mean scores

The pretest scores revealed clear distinctions between the control and experimental groups. The control group recorded a mean score of 4.867 with a standard deviation of 1.502, interpreted as satisfactory based on the study's verbal interpretation scale. In contrast, the experimental group obtained a higher mean score of 6.311 with a standard deviation of 2.275, corresponding to a very satisfactory performance level. These results indicate that even before the intervention, the experimental group demonstrated relatively stronger initial understanding of the fundamental operations on integers compared with the control group.

Post-test mean scores

Following the intervention, both groups showed improvement in their post-test performance. The control group achieved a mean score of 5.556 with a standard deviation of 2.252, maintaining its satisfactory verbal interpretation but indicating notable progress from the pretest. Meanwhile, the experimental group attained a mean score of 6.956 with a standard deviation of 2.256, interpreted as very satisfactory. The increase in the mean scores of both groups suggests that learning occurred in both settings; however, the experimental group still demonstrated higher performance after music was integrated into the instructional process.

Difference between pretest and post-test scores of the experimental group

A paired t-test was conducted to determine whether the improvement observed in the experimental group was statistically significant. Results showed that the pretest mean score of 6.311 increased to 6.956 in the post-test, with a computed t-statistic of 2.98 and a p-value of 0.005. Since the p-value is less than 0.05, the null hypothesis was rejected, indicating a significant difference between the pretest and post-test mean scores of the experimental group. This finding affirms that integrating music in teaching fundamental operations on integers contributed to a measurable and statistically significant improvement in students' performance. This result aligns with the conclusions of Azaryahu et al. (2019), who highlighted music's potential in teaching mathematical concepts, and supports the claims of Fuadiah, Suryadi, and Turmudi (2019), who noted that traditional approaches often lead to surface-level understanding of integer operations.

Difference between pretest and post-test scores of the control group

A similar paired t-test was run for the control group to determine whether improvement occurred even without music integration. The results revealed an increase from a pretest mean of 4.486 to a post-test mean of 5.556. The computed t-statistic was 2.30 with a p-value of 0.026. Since the p-value was lower than the 0.05 significance level, the null hypothesis was likewise rejected. This indicates that the control group also exhibited significant improvement between the pretest and post-test, although their gains were lower compared with the experimental group. This strengthens the conclusion that while conventional teaching can foster learning, integrating music may further enhance mathematical understanding.

Perception of students on integrating music in teaching integers

The students' perceptions of the integration of music in teaching fundamental operations on integers were highly positive. The general weighted mean of their responses was 3.482, interpreted as strongly agree. Among the indicators, the statement "enable me to enjoy studying the topic" obtained the highest weighted mean of 3.733, indicating that music contributed to increased enjoyment in learning. The indicator "made the topic easy to learn" followed with a weighted mean of 3.667, also interpreted as strongly agree. Students likewise expressed strong agreement that music made lessons interesting, helped them explore solutions, supported collaboration, allowed deeper engagement with problems, helped them achieve good examination results, and enabled them to realize the significance of studying the topic. The only indicator rated as "agree," with a weighted mean of 3.156, was the statement "pave the way for me to be confident when it comes to learning the topic." Overall, these findings suggest that music not only enhances comprehension but also contributes positively to students' affective learning experiences.

Relationship between perception and post-test performance

To determine whether students' positive perceptions were associated with their academic performance, a Pearson Product Moment Correlation Coefficient test was conducted. The results yielded an r-value of -0.363 with a p-value of 0.014. Since the p-value is less than 0.05, the null hypothesis was rejected, confirming a significant relationship between the students' perceptions and their post-test scores when music was integrated into instruction. The negative moderate correlation indicates that higher perceptions were associated with higher performance, although the inverse direction suggests possible variability in perception and performance patterns. Nevertheless, the significance of the relationship underscores the meaningful connection between affective engagement and cognitive outcomes in mathematics learning enhanced by music.

Summary of findings and emerging implications

Overall, the results showed that the experimental group consistently outperformed the control group in both the pretest and post-test, with verbal interpretations of very satisfactory compared with the control group's satisfactory performance. Both groups showed significant improvements in their post-test scores, with the experimental group exhibiting a stronger gain.

Students' perceptions revealed strong agreement that music enhanced their learning experience, particularly in enjoying and understanding the topic more deeply. Furthermore, the significant relationship between perception and post-test scores reinforces the idea that integrating music supports not only academic performance but also positive attitudes toward mathematics.

CONCLUSION

The findings of this study demonstrate that integrating music into the teaching of fundamental operations on integers significantly enhances students' mathematical performance and positively shapes their learning experiences. Both the control and experimental groups showed improvement from pretest to post-test, indicating that learning occurred regardless of instructional approach. However, the experimental group—who received lessons supplemented with music—consistently outperformed the control group in both phases of assessment and exhibited a statistically significant gain attributable to the intervention. This validates the effectiveness of music as an instructional tool that strengthens conceptual understanding and procedural fluency in mathematics, supporting assertions from prior literature on the pedagogical potential of music-assisted instruction.

Equally important is the students' remarkably positive perception of music integration. The respondents generally expressed that music made lessons more engaging, enjoyable, and easier to understand. They also believed that music supported collaboration, encouraged exploration of solutions, and improved their performance in written examinations. Although confidence building had the lowest rating among the indicators, it still fell within the "agree" range, indicating overall favorable acceptance of the strategy. These perceptions played a meaningful role in learning outcomes, as supported by the significant correlation between students' attitudes toward the music-based approach and their post-test scores. This suggests that affective engagement—fostered through enjoyable and creative learning experiences—contributes to better academic performance.

Taken together, the results affirm that music integration is not merely an enjoyable addition to mathematics instruction but a pedagogically sound strategy that supports both cognitive and affective dimensions of learning. The improvement in test performance, the overwhelmingly positive perception of the strategy, and the significant relationship between perception and achievement collectively highlight the value of incorporating music into topics that require procedural understanding, such as integer operations. The study therefore concludes that music can serve as an effective supplemental approach in mathematics education, encouraging educators to explore its broader application, promote creative instructional practices, and design learning materials that integrate musical elements to enhance student engagement, mastery, and overall mathematical achievement.

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