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Research Article

Math dance and song: Means to reduce student mathematical anxiety and promote engagement

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After the pandemic, students suffered mathematical anxiety and poor engagement in classroom activities caused by their learning gap. So, the teacher integrated math dance and song to reduce mathematical anxiety and promote engagement. The study determined the effectiveness of math dance and song in reducing student mathematical anxiety and promoting better engagement. A practical action research design with 100 grade 7 students participated to address the classroom-based problem. Hence, the survey questionnaire, interview guide questions, and journal writing prompts were used as data collection instruments validated by the experts in mathematics education. Wilcoxon Signed-Rank Test and Rosenthal correlation coefficient were used to determine significant differences and practical significance before and after integrating math dance and song. The results show that math dance and song diminished student mathematical anxiety, making them active, energized, and motivated. However, students' engagement increased in behavioral, cognitive, emotional, and social aspects.

Keywords: Anxiety, Dance, Engagement, Math class, Practical action research, Song

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1. Introduction

The Philippine Department of Education [DepEd] launched a new agenda called MATATAG, which is pronouncing taking care of students' well-being, inclusive education, and promoting a positive learning environment (DepEd, 2023). In this regard, a teacher must find ways to enrich classroom learning activities by integrating strategies that motivate the students to thrive more inside the classroom. Also, the teacher must respond to student diversity through a learning environment that caters to diverse student learning needs (DepEd, 2016). So, a teacher may integrate various learning activities in classroom lessons, like games, dances, songs, poems, and teacher-made learning materials to cater to the learning needs. In addition, a teacher must enrich the classroom lessons with simple integration of Information and Communications Technology [ICT] tools available in schools (DepEd, 2016). Therefore, integrating various learning activities using ICT may reduce student mathematical anxiety and increase student engagement.

To promote a positive learning environment, a teacher may integrate dance and music as part of learning activities within the classroom. Combining dance and music in teaching mathematics concepts benefits the K to 12 students in their learning environment (Segarra et al., 2018). Similarly, Leandro et al. (2018) found that body movement to assimilate mathematics concepts produces better learning achievement. So, a body movement in the teaching-learning process can be used inside the classroom, like dance and singing. When body movement is integrated into the learning process, the students understand the concepts better and retain longer in memory (Becker, 2013).

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On the other hand, Pacita Complex National High School is a public school in the City of San Pedro, Laguna, Philippines, that offers junior high school education for more than 4,000 students from grades 7 to 10. The school was established in 1999 and continues serving the youth through formal secondary education. However, many students struggle to learn school subjects in the post-pandemic time due to the learning gap and loss brought about by distance learning, particularly in mathematics subjects. Students need help developing the competencies even though face-to-face classes are now permitted.

Based on the second grading mathematics quarterly test result in Grade 7, the mean percentage score [MPS] is 47.70, below the targeted 75 and the lowest MPS in all grade levels. So, it calls the attention of the grade 7 mathematics teacher to determine the root causes and provide student intervention. As observed by the teachers, students have low mathematical engagement, feel nervous when the mathematics teacher gives learning activities, and are worried about the result of their summative test. Also, 33.91 % of grade 7 students have low numeracy levels based on the result of the numeracy intervention tool for Laguna learners. So, a simple poll survey is conducted to elicit data for gap analysis, root-cause analysis, and listing all possible interventions. Based on the survey, students struggle in mathematics due to too many lessons and are not interested in the lesson. However, they suggested adding more exercises and physical activities that motivate them to learn. So, the researcher proposed adding math dance and song to build a love for mathematics learning since the grade 7 students preferred physical activities within the lesson.

This study adds to the literature on utilizing dance and song in mathematics education to engage students in learning Behaviorally, cognitively, emotionally, and socially. Mathematics lessons become engaging when math dance and song are integrated despite the abstract nature of mathematics lessons. Therefore, mathematics teachers should make the lessons lively by integrating math dance and song.

2. Literature Review

Dance enhances student motivation and academic performance (Singh et al., 2012). Also, it connects the mathematical understanding of the students and the public mathematical views (Budinski et al., 2022). Therefore, dance can be used to motivate the students which leads to their better academic performance. Dance can promote mathematical engagement (Gerofsky, 2013). Hence, dance engages the students in mathematics learning. Shamir et al. (2019), who employed a math dance and music program for grade 7 students in Science, Technology, Engineering, and Mathematics [STEM] classes, have proven this. They found that the students improved their mathematical ability and interest after repeatedly doing the math dance and coding math music. Integrating dance movements and musical beats helps the students to connect mathematics to other learning areas.

Understanding mathematics concepts is enhanced by music because of the connection of mathematics to music (McDonel, 2015). Integrating song into mathematics teaching makes the lesson lively and engaging. Using songs in teaching aids enhances the students' mathematical performance, leading to a better learning experience because it continuously engages them in learning activities (Ngalim & Chinye, 2018). Through song, students become interested in their lessons. Integrating songs in mathematics learning positively contributes to students' mathematical understanding (Hilton & Saunders, 2021). Therefore, singing may be used in mathematics learning as a motivational activity. On the other hand, Lesser et al. (2019) found that interactive songs reduced students' anxiety in Statistics when integrated with the lesson. The literature above supports the study's claim that math song with music delivers better teaching. Viñas et al. (2021) found that music and dance enhance students' awareness of learning, foster critical and logical thinking in problem-solving situations, stimulate creativity for developing innovative procedures and resources for conflict resolution, and improve collaborative teamwork skills.

On the contrary, Asian countries reported that students experienced math anxiety when performing mathematics learning tasks (OECD, 2013). Mathematical anxiety seems to be one of the contributing factors that negatively affect students' math performance, which is prominent among Asians and most vital in previous studies involving custom tests that assessed problem-solving skills (Zhang et al., 2019). A student with mathematical anxiety tends to ignore tasks and is not doing well at performing academic tasks (Sokolowski & Ansari, 2017). An anxious student tends not to perform mathematically due to fear, worry, or negative feelings toward the subject. Mathematically anxious students may avoid mathematics, which harms their learning opportunities and ability to progress. Mathematical anxiety is one of the common problems in a classroom setting (Lesser et al., 2019). Therefore, teachers must pay attention to how to reduce the student mathematical anxiety.

Mathematical anxiety refers to feelings of fear, frustration, tension, and helplessness that students experience when engaging with mathematical tasks, which can significantly impair their learning and

performance (Ashcraft & Ridley, 2005). Mathematical anxiety is an external contributing factor that hampers the student's learning goal and academic performance (Carey et al., 2016). Students with mathematical anxiety engage less in math tasks and tend to answer or avoid math problems incorrectly. Therefore, the teachers may do activities that reduce student mathematical anxiety to make the lesson meaningful.

In addition, student memory is distracted by mathematical anxiety since their sensations and thoughts are not in focus. If a student receives a mathematical problem, mathematical anxiety causes working memory disruption (Brewster & Miller, 2020). Thus, students' mathematical performance would decline because working memory is occupied by worry and fear, which makes them unable to do calculations (Shi & Liu, 2016). So, the teacher must find ways to reduce the mathematical anxiety of the students to boost their confidence, love for learning, and passion for thriving. High mathematical anxiety yields low student mathematical engagement (Quintero et al., 2021). Brewster and Miller (2020) suggested that a proper intervention is necessary to motivate mathematically anxious students to thrive and aid learning to bring out student engagement. Therefore, the teachers must do activities that turn anxiety into engagement.

Furthermore, Morgan (2014) claims that students fail to learn due to disengagement, resulting in low learning performance and interest. Student engagement is essential when teachers want their students to perform well academically. Deci and Ryan (2000) defined engagement as student involvement that happens among the students, teachers, and learning materials. Student engagement is vital for academic improvement and success. So, student engagement must be sustained throughout the whole class to motivate the students to learn more. However, secondary school students' mathematical engagement declined gradually (Martin et al., 2015). Hence, it is vital to measure the students' mathematical engagement (Wang et al., 2016) and provide interventions to improve it. Therefore, the teachers must provide engaging activities that catch the students' attention and interest while learning the math lessons.

Student engagement has many dimensions (Christenson et al., 2012; Fredricks & McColskey, 2012; Wang & Degol, 2014) composed of three connected dimensions such as behavioral, cognitive, and emotional, but Wang et al. (2016) added the social dimension. It connotes the student's actions, thinking, feelings, and socialization within the school. Lei et al. (2018) conducted a meta-analysis discovering that behavioral engagement is linked to higher academic accomplishment, followed by emotional and cognitive engagement. Student engagement was most commonly assessed from a behavioral standpoint—behavioral engagement (Bond et al., 2020; Henrie et al., 2015)—with indications like attendance, participation, completed assignments, on-task conduct, and time spent. Behavioral engagement tells how the student deals with classroom activities and behaves inside the classroom, measured by conformity with school rules, concentration, attention, participation, and homework completion (Fredricks & McColskey, 2012). Lai (2021) found that student group peer interaction, utility value, and interest value are positively correlated to behavioral engagement but adversely connected to perceived task difficulty.

On the other hand, cognitive engagement shows how the student deals with complex ideas using self-regulation, cognitive strategies, and deep learning (Zimmerman, 1990), measured by employed learning strategies (Greene, 2015). Hence, the students are cognitively engaged in the classroom if their needs for autonomy and competence are addressed. Practices that promote autonomy and competence by allowing students choice and voice in their learning, concentrating on learning for learning, structuring learning to assure students' success throughout the process, and fostering a classroom environment in which mistakes and retries are acceptable (Reschly et al., 2020).

Meanwhile, emotional engagement means having a learning interest and valuing the learning measured by enjoyment, interest, and value of learning (Fredricks & McColskey, 2012). Emotional engagement is needed to motivate students to learn (Martin & Bolliger, 2018). However, Wang et al. (2016) described social engagement as students' social interaction with classmates and teachers while working with others. All aspects of student engagement are vital to measuring classroom engagement because students with high learning engagement attend school often and obtain higher grades than those with low engagement levels (Bear et al., 2018). Hence, the teacher dramatically improves student engagement behaviorally, cognitively, and emotionally through intervention (Pedler et al., 2020). Therefore, the teachers must engage the students' behavior, cognition, emotion, and social aspects through interventions like dance and song activities to reduce anxiety.

The literature review above justifies the need to address the student mathematical anxiety and promote student engagement to have a positive learning environment conducive to mathematics learning. However, many studies focused on the effect of dance on students' mathematics performance (e.g., Budinski et al., 2022; Leandro et al., 2018; Shamir et al., 2019) and the effect of music on students' mathematics learning (e.g., Hilton & Saunders, 2021; McDonel, 2015; Ngalim & Chinye, 2018; Segarra et al., 2018). Few studies have

used dance and music to aid in delivering mathematics lessons, particularly to secondary students. So, the study focuses on integrating math dance and song as teaching aids to reduce students' mathematical anxiety and promote student engagement as a gap from the previous studies.

In this study, the researcher examines how effective the math dance and song are as part of daily lessons in reducing student mathematical anxiety brought on by their learning gap for the past two years of the pandemic and promoting student engagement. The researcher believes that appropriate student-teacher interactions motivate students to engage in class activities by creating an emotionally positive environment (Ruzek et al., 2016) through math dance and song integration in the daily lesson. This action research helps the students boost their confidence and passion for mathematics learning. Helping the students means helping the school since the school's performance is greatly affected by the students' learning performance.

3. Background

The study was anchored on the student involvement theory of Astin (1984), which claims that educational practices must lead to student psychological and physical energy involvement, resulting in student learning and development (Burch et al., 2015). This theory explains student engagement in terms of the cognitive aspect of performing a classroom activity, the emotional aspect of demonstrating an enjoyable state of mind, and the physical aspect of physical innervation (Kahn, 1990). Student engagement addresses low student achievement, boredom, and dropout rate (Wang & Degol, 2014). When the students are engaged in learning, they perform well academically, persist even in difficulties, and build harmonious relationships with peers and teachers.

Also, the study relied on the engagement theory of learning introduced by Kearsley and Schneiderman (1999). The theory puts forth that social interaction and performance tasks engaged the students meaningfully as classroom activities. The teacher must engage students in learning by relating the lesson to them, enhancing the students' creativity through various learning opportunities, promoting collaboration, and integrating technology into teaching. Therefore, students increased their creativity, collaboration, and artistic skills related to math concepts through math dance and song. Meanwhile, processing efficiency theory explains the two roles of anxiety: increasing worry that reduces student processing, working memory capacity that limits the resources available, and controlling performance (Eysenck & Calvo, 1992). So, math anxiety must be addressed first to gain better engagement that yields better learning.

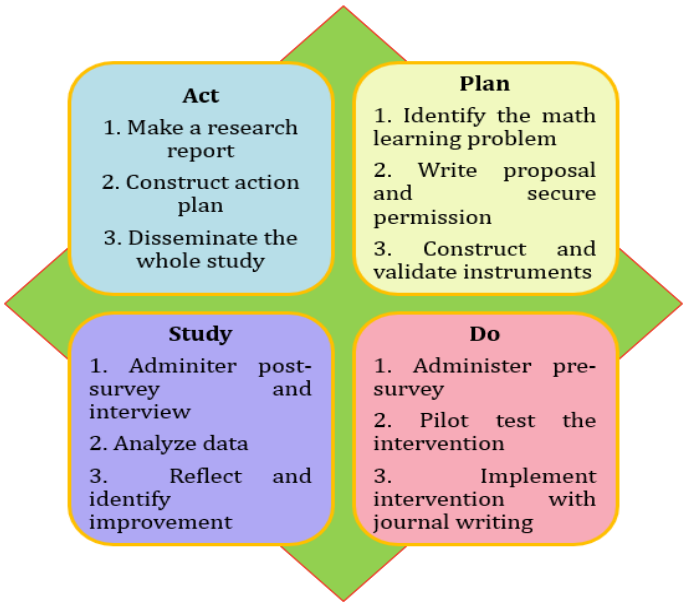
The study integrated eight math dances and eight math songs in the daily lesson of grade 7 mathematics to reduce student mathematical anxiety and promote engagement. The dance steps are math symbols like plus, minus, times, divides, and equal signs. Also, some geometric shapes are included in the dance like angles, lines, circles, squares, rectangles, and triangles. On the other hand, mathematical terms were included in the lyrics of the songs like point, line, plane, angle, statistics, population, mean, median, mode, and sample. The dance and song minimized student mathematical anxiety and increased engagement. One math dance and song were used weekly to familiarize the students with steps and lyrics. The titles of math dances were Ever After, Beautiful Life, Made You Look, Paru-Paro G, Dancing Statistics, National Statistics Dance, National Statistics Month Dance, and Math TikTok Dance. The titles of math songs were Types of Angle Song, Polygon Song, Types of Quadrilateral, Geometry Song, Statistics Song, Statistics Math Song, National Statistics Month Jingle, and Statistics Song on Mean, Median, Mode, and Range. The interventions were integrated into the motivation or during the lesson proper so that the math lesson becomes lively and enjoyable. Math dance and song motivate the students to be more engaged and lessen mathematical anxiety. The students' body movements and rhythms increase their' learning interest, leading to better engagement. Hence, the math dance and song played for a specific day are relevant to the math topic to make them relevant to the lesson. Through math dance and song, students relate the dance steps and song lyrics to the math concepts being discussed by the teacher.

The grade 7 mathematics lesson was taught for one hour for four days as one of the subjects of grade 7 students. The subject was part of the Basic Education Program and aimed to establish the student's problem-solving skills and critical thinking. The abstract nature of mathematics and the students' learning gap make the students struggle with mathematics concepts. Therefore, related math dance and song to mathematics lessons are integrated to reduce students' anxiety and increase engagement.

Figure 1 presents the study's process under the Plan-Do-Study-Act [PDSA] model introduced by Edward Deming and Walter Shewhart (Taylor et al., 2014). The plan phase started with identifying mathematics learning problems by analyzing the students' outputs and teacher observation. Students needed help dealing with mathematical concepts and improving their mathematical skills. The gap and root-caused analyses addressed the problem based on the data obtained from the initial survey and classroom observations. The

teacher found that sixty-nine percent of her class struggled in her lesson due to too many lessons. Students needed to be more interested and see math lessons' relevance in their lives. So, she consulted them on how they wanted to be taught by her. The students suggested adding activities, physical exercise, and dance to make the lesson more interesting.

Figure 1
Conceptual Paradigm



The research proposal and instruments were constructed after reviewing the literature submitted to the school head for permission. Similarly, instrument validation was done to establish content validity, and pilot testing was done to establish reliability. Then, before implementation, parental consent was sent to the parents as a protocol to ensure voluntary participation. Under the do phase, once approval was secured, a pre-survey was administered to measure before the implementation to measure the student mathematical anxiety and engagement. Then, pilot implementation was done for two weeks to get participants' feedback on improving the implementation. A simple survey was given to the participants to elicit suggestions for improvement. The implementation lasted two months by integrating the math dance and song into daily lessons to reduce the student mathematical anxiety and improve the engagement in classroom activities. Also, weekly math journals were collected for the students to elicit immediate feedback.

After two months, the study phase came by administering the post-survey and conducting interviews. Also, the teacher's classroom observation was used as data for comparison before and after the implementation. Then, data were analyzed using statistical software and manual coding. Also, reflections on teachers' practices and areas for improvement were considered for the next implementation cycle. However, under the act phase, the action plan and terminal report were amde and submitted to the school head for suggestions. Similarly, dissemination was made through conferences, meetings, and publications.

3.1. Research Questions

This study seeks to establish the effectiveness of math dance and song in reducing student mathematical anxiety and promoting engagement in grade 7 mathematics. Specifically, it answered the following questions:

RQ 1) What is the student mathematical anxiety level before and after integrating math dance and song as part of the daily lesson?

RQ 2) What is the level of student engagement before and after integrating math dance and song as part of the daily lesson in terms of a)behavioral, b) cognitive, c) emotional, and d) social?

RQ 3) Is there a significant difference in the student mathematical anxiety and engagement before and after integrating math dance and song into the daily lesson?

RQ 4) How do the math dance and song reduce student mathematical anxiety and promote engagement?

RQ 5) What are the students' suggestions for improving math dance and song?

4. Method

4.1. Research Design

The study utilized a practical action research design since the study aimed to reduce student mathematical anxiety and promote engagement through integrating math dance and song in daily lessons. Practical action research aims to solve classroom problems teachers encounter within their capacity using available resources (Stowell & Kramarova, 2022). Also, it justified the claim of math dance and song to reduce student mathematical anxiety and promote engagement.

4.2. Participants

The 100 participants voluntarily participated from three sections of Grade 7 students under the Basic Education Program [BEP] at Pacita Complex National High School for the school year 2022-2023. Each section has an average of forty-five students who experienced mathematical anxiety due to their learning loss caused by the COVID-19 pandemic class disruption and loss of mathematical engagement caused by the difficulty of understanding mathematics concepts. Their participation was highly appreciated, but they received no favors or incentives.

Table 1 shows the participants' demographic characteristics. Most participants were female at 13 years old, which was the ideal age for grade 7. Participants' ages varied from 12 to 15 years old. Hence, more students from the Genesis section participated voluntarily than the other two.

Table 1
Demographic profile of the participants

Variable	*Frequency*	*%*
Sex		
Male	39	39
Female	61	61
Age		
12 years old	11	11
13 years old	64	64
14 years old	20	20
15 years old	5	5
Section		
Andrew	31	31
Ezekiel	33	33
Genesis	36	36

4.3. Instrumentation

The study used a survey questionnaire, interview guide questions, and student journals as tools for data collection, as suggested by Greene (2015), to use multiple tools to measure student engagement. For the survey questionnaire, a ten-item survey questionnaire for mathematical anxiety adapted from Reyes (2019) and a twenty-item survey questionnaire for student engagement adapted from Burch et al. (2015), Fredricks et al. (2016), and Wang et al. (2016) was constructed with modifications. Mathematical anxiety can be measured using a self-report instrument that measures feelings of anxiety (Brewster & Miller, 2020). The instruments were subjected to content validation in the first week of March 2023 by experts in mathematics education, such as the education program supervisor of mathematics, master teacher, and head teacher. Experts' suggestions like correcting grammatical errors, proper punctuation marks, adding Filipino subtitles, and making the sentence shorter were strictly followed. After revision, the instruments' final copies were sent to the experts for content validation in the third week of March 2023. Then, the group of experts critically examined again the revised instruments in their suggestions were considered in the revisions. Hence, approval from content validators was secured first before pilot testing to ensure the validity of the instruments.

Table 2 depicts the results of expert validation. The research instruments were suitable for data collection as validated by the group of experts in mathematics education. The three instruments' format and design, content, clarity, and usefulness were accepted as proof of content validation. Content validation is a requirement for instrument development (Halek et al., 2017), performed by expert judgment of the subject matter and thinking about items within the research instrument (Ismail & Zubairi, 2022). The judgment of

experts confirmed the accuracy, accountancy, and appropriateness of each item found in the research instruments. Therefore, the three instruments were valid to use.

Table 2
Results of Expert Validation

Criteria	*Survey Questionnaire*	*Interview guide*	*Journal writing prompts*	*Interpretation*
Format and design	3.00	2.85	3.00	Suitable
Content	3.00	2.80	2.90	Suitable
Clarity	3.00	2.90	2.90	Suitable
Usefulness	3.00	2.90	2.85	Suitable

When the content validity was established, the survey questionnaire was pilot-tested on non-participants from one section with forty students in the fourth week of March 2023 to determine the reliability indices using Cronbach's alpha. During the pilot testing, improvements were identified like integrating math symbols in dance steps, regular math song and dance integration in the lesson, and the time lapses must be 3 to 5 minutes only. Hence, these improvements were strictly followed in the implementation. Table 3 shows that the questionnaire was reliable based on the variables for mathematical anxiety and engagement regarding behavioral, cognitive, emotional, and social factors. Since content validity and reliability were established, the questionnaire was a valid and reliable data collection tool.

Table 3
Reliability indices of survey questionnaire using Cronbach's alpha

Variable	*No. of items*	*α*	*Interpretation*
Anxiety	10	.915	Excellent
Behavioral	5	.918	Excellent
Cognitive	5	.892	Good
Emotional	5	.930	Excellent
Social	5	.884	Good

The researcher added the five-item interview guide questions to elicit qualitative data. Although few studies use interview techniques to investigate student engagement (Deng et al., 2020), it was better to collect qualitative data that captures a detailed description of the student experience related to mathematical engagement. The qualitative method helped describe how the student gets engaged and how engagement evolves (Fredricks & McColskey, 2012). Also, student journals were collected weekly to collect students' views on the teacher's practices.

For positionality, the researcher has been a public school teacher for eleven years and a private school teacher for nine years, teaching secondary school mathematics. She was the participants' teacher who implemented the intervention and collected data except for the interview, which another teacher did. She bracketed her ideas on how math dance and song influenced the student to become active in reducing anxiety and producing better mathematical engagement.

4.4. Data Gathering Methods

In the fourth week of February 2023, a simple survey via group chat was sent to the students asking about their learning challenges in mathematics, reasons for having difficulties, and possible solutions. The data served as the basis for making a research proposal. Then, a school head's permission was secured first in the second week of March 2023 through a formal letter signed by the mathematics master teacher. Once granted, informed consent and assent were given to the parents and students in the third week of March 2023 by sending a printed copy during class hours so the teacher could explain the details to the students. The informed consent and assent were written in Filipino, informing the parents about the research title, objective, proponent, participants' roles, and data confidentiality. Both parents and students must affix their names and signatures as proof of voluntary participation. Thus, parents were informed via group chat about the letter so that they were aware. However, only those students whose parents agreed to join were considered participants. Those who disagreed still received interventions, but their information was set aside. However, parents' queries were solved via group chat or cellphone text.

Then, the pre-survey was administered during class hours in the first week of April 2023 to ensure the students were the survey respondents. After one hour, the answer sheets were collected and tabulated. Then, the result was kept confidential for future use. Consequently, math dance and song integration was done for

two months (April and May 2023) as part of the daily lessons to avoid additional student burdens. After the implementation, a post-survey was administered in the first week of June 2023. Results from pre-survey and post-survey were considered to test the hypothesis in the second week of June 2023 for the significant difference in the student mathematical anxiety and engagement before and after integrating math dance and song in the daily lesson.

For the qualitative part, another teacher conducted twenty semi-structured interviews in the third week of June 2023 to elicit meaningful and factual data, and twenty student journals were randomly considered additional data sources in the fourth week of June 2023.

4.5. Ethical Considerations

As evidence for ethical considerations, a formal letter was secured for permission from the school head, parents, and students before the implementation phase. Participants can refuse or discontinue participation at any time without consequences. Their identities were not disclosed to anyone, and data collected from them were stored in the researcher's laptop only for two years with confidentiality. Pseudonyms replaced their names; only summary data were included in the study. Also, permission from the authors of the adapted questionnaire was secured via email as part of respect. Hence, dissemination was done via faculty meetings, research conferences, school learning action cells, and online publications to share the study's findings worldwide so that others can benchmark the intervention in this study.

4.6. Data Analysis

Jamovi version 2.4.14 was the tool to analyze quantitative data for descriptive statistics like median ($\tilde{x}$), interquartile range [IQR], Shapiro-Wilk test, and Levene's test. The study employed a Wilcoxon Signed-Rank Test to test the hypothesis and determine the significant difference in the student mathematical anxiety and engagement before and after the implementation. Hence, the Rosenthal correlation coefficient (r) was computed in MS Excel (Fritz et al., 2012; Mangiafico, 2016), which indicates the effect size. However, a thematic analysis was used through manual coding for qualitative data. The transcripts were written in an MS Excel file and repeatedly read to determine the codes. Themes were derived from categories of codes to reflect the students' actual experiences of how math dance and song reduce student mathematical anxiety and promote engagement. However, to establish the credibility of qualitative data, member checking was done in the second week of July 2023 to verify the truthfulness and completeness by returning the data to the participants and asking for their agreement.

Table 4 depicts tests for the homogeneity of variances and normality as prerequisites for inferential statistics (Hanusz & Tarasińska, 2015). The Shapiro-Wilk test values ($p < .05$) signify that the data was not normally distributed. However, Levene's test value implies that the variances are homogeneous since all significant values except anxiety from post-survey are more than the significance level of .05 alpha. Therefore, the non-parametric test for the significant difference was used for pre-survey and post-survey responses since the data are ordinal naturally and do not resemble a normal distribution. The table below justifies that a non-parametric test of difference, notably the Wilcoxon Signed-Rank Test, must be used rather than a counterpart in the parametric test requiring data distribution normality.

Table 4
Homogeneity of Variances Using Levene's Test and Normality Test Using Shapiro-Wilk

Variable	*Levene's test*				*Shapiro-Wilk*		
	Statistic	df_1	df_2	*Sig.*	*Statistic*	*df*	*Sig.*
Pre-survey							
Anxiety	.077	1	98	.782	.918	100	<.001
Behavioral	1.006	1	98	.318	.916	100	<.001
Cognitive	.504	1	98	.479	.952	100	.001
Emotional	.070	1	98	.791	.921	100	<.001
Social	1.434	1	98	.234	.937	100	<.001
Post-survey							
Anxiety	5.053	1	98	.027	.957	100	.002
Behavioral	.776	1	98	.381	.916	100	<.001
Cognitive	.516	1	98	.474	.917	100	<.001
Emotional	.927	1	98	.338	.893	100	<.001
Social	1.025	1	98	.314	.888	100	<.001

5. Results

Table 5 shows the student mathematical anxiety levels before and after. It shows that students felt nervous during math class and received the teacher's questions. They got tense before taking the exam, afraid of committing the wrong answer, and worried about their math performance. However, they became confident during math hours after the math dance and song integration. They did not feel nervous in class discussions or tense about taking the examination. Hence, they were not worried about failing in assessments or committing mistakes. Therefore, the dance and song reduced the student's mathematical anxiety ($\tilde{x}$=2).

On the other hand, before the math dance and song integration, as shown in the table below, students needed to focus on their math class and put less effort into it. They should have done homework on time, not participated well in class discussions, and lost interest in learning if the math lesson needed to be easier to understand. However, their behavioral engagement increased after the math dance and song integration. Students were trying to learn math even though the lessons were hard to understand; they stayed focused and put effort into math learning. Also, their class participation increased, and doing their math activities and homework on time were good manifestations of behavioral engagement. The math dance and song made the students behaviorally engaged due to students' interaction with other students and the teachers. Overall, the student behavioral engagement before was low ($\tilde{x}$=2), while high ($\tilde{x}$=3) after integrating the math dance and song.

After the math dance and song integration, they became curious about their work and ensured they were correct. Students explored various ways of solving problems and tried to understand where they got wrong and which retries and mistakes were acceptable. Similarly, they did math activities more than what was expected of them. Hence, the student cognitive engagement before was low ($\tilde{x}$=2), while high ($\tilde{x}$=3) after integrating the math dance and song. Also, they felt excellent learning math lessons since their emotional engagement was touched in the class. The student emotional engagement increased after integrating the math dance and song into daily lessons. Overall, the student emotional engagement before was low ($\tilde{x}$=2), while high ($\tilde{x}$=3) after integrating the math dance and song.

Before integration, student social engagement could not have been higher since they did not care about the ideas of others and failed to work with others, so they failed to enjoy group activities. They failed to extend their arms to help struggling classmates in math. However, their social engagement increased after the math dance and song integration. They enjoyed the group activities more than doing them individually. They helped their classmates who were struggling in math or worked more with others to help them. Also, they became careful about others' ideas and tried to understand them. Hence, the student social engagement before was low ($\tilde{x}$=2), while high ($\tilde{x}$=3) after integrating the math dance and song.

Table 5
Student Mathematical Anxiety and Engagement Level Before and After Integrating Math Dance and Song

Variable	*Before*			*After*		
	$\tilde{x}$	*IQR*	*Verbal Interpretation*	$\tilde{x}$	*IQR*	*Verbal Interpretation*
Mathematical Anxiety	3	1.50	Very High	2	1.50	Low
Student Engagement						
Behavioral	3	2	Low	3	1	High
Cognitive	2	1	Low	3	1	High
Emotional	2	2	Low	3	1	High
Social	2	2	Low	3	1	High

Table 6 depicts the result of the test of difference before and after the integration of math dance and song on the student mathematical anxiety and engagement. The p-values of less than a .05 significance level signify the existence of significant differences in responses before and after. Having negative computed values manifests that after intervention, the student mathematical anxiety was reduced while the engagement was increased. It means that math dance and song effectively reduced the student mathematical anxiety and promoted mathematical engagement when integrated into the daily lessons. Hence, the effect size of the firm very strongly justifies the practical significance of the said intervention. It connotes that the math dance and song must be integrated religiously into the daily lesson.

Table 6
Significant Difference Using Wilcoxon Signed-Rank Test Before and After with Effect Size Using r

Variable	*Mean difference*	*SE difference*	*95% Confidence Interval*		*Statistic*	*p*	*r*
			Lower	*Upper*			
Anxiety	−1.50	0.1069	−1.50	−1.000	309	<.001	.66
Behavioral	1.50	0.1028	1.50	2.000	3450	<.001	.81
Cognitive	1.50	0.0870	1.50	1.500	3091	<.001	.81
Emotional	1.50	0.1004	1.50	2.000	3423	<.001	.79
Social	1.50	0.0861	1.50	1.500	3466	<.001	.79

Table 7 depicts the themes explaining how math dance and song reduce student mathematical anxiety and promote engagement. Through math dance and song, students became active in class discussions and even recitation because they were energized before the start of the new lesson. They were motivated to listen attentively to the math teacher and were able to connect the previous lesson to the new lesson. Hence, they could socialize with classmates during math dances and songs. So, math dance and song reduce student mathematical anxiety by keeping them interested in learning new math lessons since dances and songs are related to the current lesson and promote engagement through having fun, exciting, and motivating classes.

Table 7
Themes on How Math Dance and Song Reduce Students' Mathematical Anxiety and Promote Engagement

Theme	Description
Activate learning	Students participated actively in class discussions and brainstorming to share ideas and solutions to math problems.
Energize the body	The students' bodies were energized and ready to take on activities given by the math teacher.
Motivate to listen	Students were attentive to listening to the teacher's instruction. They pay attention to the teacher's voice to perform the activities well.
Socialize with others	Students did not feel shy since all of them were dancing and singing during math class. They enjoy singing and dancing in class and perform as a group.
Connect new lesson	Students were able to connect the math song and dance to the new lesson since they contained math terms and concepts.

The math dance song motivated the students to move their bodies and sing in a loud which boosted their confidence. Students were able to socialize with others while enjoying the dance, losing shyness while singing together, and connecting the math dance and song to the new lesson. The words of the participants support the findings above.

> "Yes, dancing and singing makes me lose my shyness to socialize in class."-Participant 11
>
> "Yes, our math song contains new lessons. That is why I am also learning." – Participant 19
>
> "Yes, through dance, I enjoy class discussion even more." – Participant 20

Table 8 displays the students' recommendations for improving math dance and song. A student suggested creating a new math dance with new dance steps and a popular song. Also, they suggested that they have simple but enjoyable dance movements and lyrics so they can easily catch them. However, they suggested that games be included in the math dance and song on occasion to make it more exciting and fun for them. Their suggestions demonstrated that they enjoy incorporating math dance and song into the daily lesson to motivate them, energize their bodies, and make the math lesson more engaging.

Table 8
Students' Suggestions for Improving Math Dance and Song

Suggestions	Description
Math dance and song with games	Adding games in the math dance and song to have twist and excitement
New math dance and song	Additional and new math dances and songs must be introduced in every lesson.
More dance movement	Add dance moves that are energetic and require whole-body movement.
Simple but enjoyable math dance and song	Making the math dance and song simple in moves and lyrics but enjoyable for the students.

Despite the enjoyment felt by the students due to the integration of math dance and song, students suggested more enjoyable songs and dances that were timely in the current music and trends but with simple moves. Also, they suggested adding games in the math dance and song to add thrill and excitement. The participants' words support the findings above.

"It is more enjoyable if new songs and dances are included." - Participant 3

"Keep the dance steps simple and straightforward." - Participant 9

"If possible, I would like to have math dance and song with games on occasion." - Participant 10

6. Discussion

The study aimed to determine the effectiveness of math dance and song in reducing student mathematical anxiety and promoting engagement in grade 7 mathematics classes. Findings reveal that math dance and song reduce student mathematical anxiety, making them more confident in math lessons and activities supporting the findings of Lesser et al. (2019). Incorporating dance and song into mathematics lessons improves student learning (Segarra et al., 2018). Students are happy, energized, motivated, and learn more effectively when they move their bodies during class hours, which is aligned with the findings of Shamir et al. (2019). As a result, the math concepts are retained in their memory for longer. The students' interest value in math work increases their behavioral engagement toward math learning, coherent with the study of Lai (2021).

Including dance in daily lessons increases student mathematical engagement (Budinski et al., 2022), whereas music increases student mathematical understanding (Hilton & Saunders, 2021). On the other hand, the math teacher must address math anxiety to increase student engagement and avoid disrupting working memory (Brewster & Miller, 2020). Moreover, math dance and song remove students' anxiety, making them alive and energetic. On the other hand, anxious students tend to avoid doing the tasks and not perform well in academic tasks (Sokolowski & Ansari, 2017) because their working memory is occupied by fear and worry (Shi & Liu, 2016), which causes memory disruption (Brewster & Miller, 2020). Since math anxiety is addressed by math dance and song, students are engaged cognitively. Through math dance and song, teacher-student interaction in class activities created an emotionally positive environment (Ruzek et al., 2016). Dance and song enhance students' awareness of learning, foster critical and logical thinking in problem-solving situations, stimulate creativity for the implementation of innovative procedures and improve collaborative teamwork skills (Viñas et al., 2021).

The students with high mathematical anxiety have low mathematical engagement, coherent with the findings of Quintero et al. (2021). Including math dance and song in the daily lesson has increased student mathematical engagement. Therefore, students can solve math problems in various ways, increase class participation, pay attention to math work, and attempt to understand their mistakes while solving. They are also confident in exploring math activities because they enjoy learning and feel great when dealing with academic tasks (Shamir et al., 2019). Furthermore, they enjoy group activities in which they assist struggling classmates by sharing ideas and understanding one another. Students with high emotional engagement are motivated to learn (Martin & Bolliger, 2018). The combination of dance and song in teaching mathematics produces a better learning environment, supporting the findings of Segarra et al. (2018). Student behavioral, cognitive, emotional, and social engagement improved, which are necessary to motivate students to attend school regularly and perform well academically (Bear et al., 2018).

Through student involvement theory, student engagement surpasses student anxiety, boredom, and disengagement (Wang & Degol, 2014). The student's physical and psychological energy involvement in math dance and song resulted in positive learning and enjoyment. Due to the inclusion of math dance and song in the daily lesson, the students perform better in the classroom, demonstrate a positive mindset, enjoy the group activity, and work positively with others. Thus, using the lens of engagement theory, meaningful classroom activities such as social interaction and productive learning tasks influenced by math dance and song improve student mathematical engagement and reduce anxiety. The study supports the engagement theory through the integration of dance and song in classroom teaching, students can be engaged in learning math lessons.

Meaningful student engagement in classroom activities occurs when social interaction and productive tasks—such as math-related dance, songs, and collaborative projects—are integrated into the lesson, as these approaches foster active participation and deeper learning (Kearsley & Shneiderman, 1999). However, the teacher is critical in improving student behavioral, cognitive, and emotional engagement (Pedler et al., 2020). So, math teachers may integrate dance and song in their daily lessons to motivate the students to integrate body movements that connect math concepts to music and dance. Hence, the study proves the benefits of

dance and song to improve student engagement and reduce anxiety, therefore teachers may use them as motivational activities to engage the students. Practically speaking, math dance and song make the math lesson lively, interactive, and engaging in the eyes of the students.

The math teacher admitted that the math dance and song implementation needed improvement, such as some dance steps that needed to be clarified for the students and unrelated to the math lesson. The dances and songs are adapted from YouTube videos that are shown during the class hour with the teacher. So, for the next implementation cycle, the teacher intends to create an original pre-recorded video for math dance and song. Furthermore, a more extended implementation period with consistent integration of math dance and song will be implemented in the next school year to maintain the reduction of student mathematical anxiety while improving engagement. Also, the study is limited to one school for one grade level since practical action research is the study's nature.

7. Conclusions and Recommendations

Students are worried about their mathematical performance before implementing the math dance and song. However, student anxiety is reduced after integrating the math dance and song into regular class hours. Previously, student mathematical engagement was low. However, it improves behavior, cognition, emotion, and social engagement after including mah dance and song in daily lessons. Significant statistical differences exist in student mathematical anxiety and engagement before and after the math dance implementation. It justified that the intervention effectively reduces mathematical anxiety while increasing mathematical engagement, which teachers must maintain as an integral part of the daily lesson. The math dance and song encourage students to participate in class discussions. They can socialize with others and energize their bodies before the start of the lesson by dancing. However, they suggested having a simple dance with new movements and an enjoyable song with games to make it more exciting and fun.

The study's implementation is limited to two months for one school since the design was practical action research. Also, the student experiences are outside the scope of the study, and test results are not used as data evidence. As a result, future researchers may incorporate students' experiences and examination results when investigating math dance and song as an integrated part of the daily lesson. Similarly, they may conduct studies integrating dance and song as motivational or assessment activities in other disciplines in a longer implementation period. However, the math teacher must incorporate games to make the math dance and song more engaging. Furthermore, dance and song may be integrated into other disciplines to investigate the effect on student learning. Therefore, a more extended implementation of math dance and song for the entire school is highly recommended for future study.

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