

The Effects of Music on Basic Mathematics Fact Fluency for Third Grade Students

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Gaps in achievement test scores continue to exist in students depending upon race, gender, income, and ethnicity according to the Center on Education Policy (CEP), an advocate for public schools (Cooper, 2011). School districts and schools are struggling to close the achievement gap that exists. In the 2010-2011 school years, 34.4% of African American students in the third grade failed to pass the Georgia Criterion-Referenced Competency Test (CRCT) in the research school (Report card reference, 2010-2011). According to the School Improvement Plan (2011), the focus was Mathematics Fact Fluency specifically in the area of addition and subtraction. Furthermore, this plan highlighted African American students as a subgroup to focus on mathematics (School Improvement Plan, 2011).

The achievement gap in mathematics narrowed since 2009-2010 CRCT scores when 49% of African American students failed to meet the standards set forth by the state (Governor's Office of Student Achievement, 2010). However, the gap continued to exist, and there was a need to discover solutions to help students succeed in the area of basic mathematics computation. As a school, the focus was to improve students' mathematics scores. The purpose of this study was to understand if implementing mathematics-related music into the general music class twice a week will improve African American students, as well as all students' basic mathematics fluency computation.

The research school student demographics were 56% White, 37% Black, 5% Multiracial, 1% Asian, and 1% Hispanic. From 2007-2010, the achievement gap in mathematics scores for African American students widened an average of 2 points each school year. Currently, the gap is narrowing but continues to exist. The School Improvement Plan (2011) focused on the subgroup of African American students' improving mathematics fact fluency. The data collected revealed a need to research strategies for improving African American students' mathematics fact fluency.

Strategies to improve students' ability to perform mathematical computations at or above grade level continue to be a need for the school. Researches by Geist and Geist have revealed the relationship between music and mathematics. However, focusing on basic mathematics facts and using mathematics-related music to improve students' scores has not been thoroughly examined. With the implementation of No Child Left Behind (NCLB) Act (2001), students of all races, backgrounds, ethnicities, income, and gender were to find success in the classroom. However, minorities are being "left behind" (Cooper, 2011). Research is vital to understanding what will help students perform on or above grade level in mathematics.

General education teachers and music educators could benefit from this study. Music is valuable to students' education and can be used to enhance curriculum (Edelson & Johnson, 2003). However, the purpose of music education classes are to provide a myriad of experiences such as improvisation, singing, dancing, and instruments while building a foundation for music literacy. Students participating in the study could benefit from additional instruction with mathematics-related music.

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Review of Literature

NCLB mandated that educators evaluate how they educate subgroups such as minorities, special education students, English language learners, and students from low-socioeconomic backgrounds. Focusing on students from low-socioeconomic backgrounds, NAEP revealed fourth-grade students who participated in free or reduced lunch programs scored an average of 22 points lower on assessments than students who did not qualify for school lunch programs (Geist & Geist, 2009). According to research, students indicated low performance in mathematics achievement when identified by family income (Hursh, 2007). Family income has been identified as the most consistent cause of poor mathematics scores. When comparing economically disadvantaged students to their advantaged counterparts, they were found to be approximately a year behind when entering kindergarten (Wang, 2010).

In some cases, schools have chosen to focus more on content and have reduced or removed the arts from the curriculum. High-stakes testing has caused many schools curriculum to focus on basic academic skills and cut back on resource classes such as performing arts, technology, physical education, and visual arts (Kestrom, 2007). According to Viglione (2009), removing resource classes results in stifled creativity and frustration. By depleting the arts from curriculum, students began to feel less competent. Arts programs are creative outlets for students and promote personal accomplishments.

The role of music depends upon administrators understanding and supporting the positive effect of music programs on academia. Educators need to collaborate across the curriculum and be aware of the effect music has on students' academic achievement (Kestrom, 2007). In order to expand relationships between the arts and academia, the mission needs to be clear between collaborating educators, and educators need support from administration (Strand, 2006). Next, educators need to connect critical and creative thinking to make meaningful connections across curricula. Infusing arts into curriculum connected learners with their personal feelings and developed skills to foresee learning challenges.

Other studies proved the effect of music curriculum on students' achievement. Johnson and Memmott (2006) examined the relationship between varying quality school music programs to standardized test scores. The study indicated that students participating in high and low quality music programs continued to make improvements in academic achievement (Johnson & Memmott, 2006). According to Wetter, Koerner, and Schwaninger (2009), students who played instruments scored significantly higher in academics. Furthermore, data indicated students who participated in musical training for more than one year increased students' achievement even more. Additionally, when children participated in musical training before age 7, the brain increased in size and function. When individuals listened to music or used spatial reasoning, neurons in the brain fired together creating pathways (Kells, 2008). The more students use the pathways, the stronger the connection becomes, which leads to improved skills.

Music has played a vital role in literacy development according to studies by Lorraine, Rasinski, Johnson, Memmott and Bintz. Using music as an instructional strategy enhanced personal development, encouraged comradery, and connected writing and reading (Bintz, 2010). Singing developed memory, improved phrasing, and helped all students learn across the curriculum (Johnson & Memmott, 2006). Young children have recognized and used rhymes correctly with the use of music. Music is a series of patterns which students can apply to writing their own songs and stories. Reading fluency is the ability to read passages quickly, accurately, and with expression (Hudson, Lane & Pullen, 2005). Using music in the classroom has empowered students to read fluidly and with prosody (Lorraine & Rasinski, 2004).

Understanding the value of integrating music strategies into curriculum creates an engaging learning environment for students.

Music has been an effective strategy for developing young readers (Bintz, 2010; Lorraine & Rasinski (2004). However, music can be used to enhance mathematics activities. Observations recorded by Geist and Geist (2009) in a Head Start classroom suggested that students responded more to mathematics activities that included music. When students had free playtime, they could be seen creating patterns using songs learned in previous lessons. Head Start educators were challenged with integrating music into their mathematics lessons, but as they became more comfortable, the lessons were successful. Music reinforces concepts that are vital to academic achievement by developing critical thinking skills which enhances reading, communication, writing, and mathematics (Kelstrom, 2007).

Many researchers support the idea that mathematics and music are closely related (Shore & Strasser, 2006; Geist & Geist, 2006; Nichols & Hong, 1997; Kells, 2008; Edelson & Johnson, 2003; Schellenberg, 2004; Gardiner, 2000). Musicians and mathematicians must master patterns, numbers, and ratios just to name a few concepts. Music is composed of pitches, rhythms, and dynamics, making it very complex with varying dimensions (Shore & Strasser, 2006). The basic structure of music contains mathematical elements such as steady beat, rhythm, tempo, volume, melody, harmony, spatial properties, sequencing, counting, and patterning (Geist & Geist, 2008). Musical experiences develop mathematical thinking. Children as young as infants began building mathematics foundations through music by mimicking interactions with others during musical play. One is unable to resist reacting physically to music. Most children cannot sit still when they hear a song or an instrument. However, if they do not move their bodies, they will look and move toward the sound. Music rouses emotions and affects individuals (Shore & Strasser, 2006). Using a combination of instruments, rhythms, and harmony, music goes beyond pictures and words.

Music has tremendous influence over individuals. Music stirs feelings in everyone no matter the person's age. Listening to music causes neurons to connect and form causing the brain to light up in many different areas (Shore & Strasser, 2006). Children react to music. Utilizing music in the classroom enables students to amalgamate experiences, change into new activities, calm down for rest time, share cultural differences, and build self-worth and sense of comradery (Shore & Strasser, 2006).

Research has indicated utilizing music as an entryway to create strong connections between music and mathematics lead to academic gains (Nichols & Honig, 1997). Musicians must master concepts such as patterns, ratios, proportions, and numbers which are used in all mathematical processes (Kells, 2008). Music and mathematics are linked. If educators learned to identify musical elements, they could be applied to promote mathematical thinking. Steady beat is an example of a musical element which incorporates beat and is essential to musical experiences. This reinforces numerical relationships while adding visual and auditory stimulation (Geist & Geist, 2008). In opposition to steady beat is rhythm. Where steady beat remains the same, rhythm varies in structure. Rhythm develops students' patterning skills by repeating, predicting, and extending patterns (Edelson & Johnson, 2003). For example, in the song "She'll Be Coming 'Round the Mountain," when the teacher sings "we'll all have to sleep with grandma," the children quickly follow with "we'll all have to sleep with grandma." The melody of "She'll Be Coming 'Round the Mountain" is made up of repetitive patterns. The repetitive patterns changed pitch from low to high and then back down again which creates the melody or tune of the song (Geist & Geist, 2008). Melody is the distinguishable tune that stands out against the rhythm and harmony. Introducing students to sequences of even and odd

numbers can be performed through repeated melodies or the chorus of a song (Edelson & Johnson, 2003). Just like emergent literacy, emergent mathematics may be promoted by elementary teachers utilizing music and their understanding of steady beat, rhythm, and melody (Kells, 2008).

One of the first forms of communication for children is music (Geist & Geist, 2008). Consider an adult singing "ABC's" to an infant. The adult will keep a steady beat while emphasizing rhythm and the strong beats of 1 and 3 in the song. Rocking the child or tapping the beat on the hand reinforces the mathematical experience. As the child grows, hearing the same song, "ABC's," they might play jingle bells to the beat of the song while attempting to sing some of the words.

Teachers can implement steady beat by playing an instrument and creating movement. Educators do not need musical training to implement music into mathematics lessons. Integrating music into mathematics lessons can be as simple as a set of rhythmic instruments, posters of musical instruments, CD player, musical selections, and any object which can serve as a conductor's baton (Edelson & Johnson, 2003). Almost any activity can be turned into a musical experience. If a student is playing with sorting colored beads, the teacher can chant, while keeping a steady beat, a phrase that will help students identify and sort beads (Geist & Geist, 2008). In order to differentiate instruction, teachers can change the speed or tempo of chanting or playing an instrument. Changing to a slower tempo allows students time to process the information and speeding it up creates a challenge for more advanced students.

Researchers have connected music to mathematical learning (Kells, 2008). Children naturally make music even when it is not present. For example, very young children open cabinet doors and bang on pots and pans to create music and demonstrate emerging mathematical understandings (Geist & Geist, 2008). Elementary students developed higher cognitive skills by singing songs in a round. Rounds are sung at alternating intervals and create harmony. Using music of higher complexity, such as rounds, produces cognitive growth for a long time.

Shaw's study (as cited in Shore & Strasser, 2006) on the Mozart Effect placed preschool students into four groups. For 10 min a day over the course of 8 months, children were tested for spatial-temporal reasoning. The first group participated in piano lessons, another group had singing lessons, a third group had computer lessons, and the last group did not participate in any extra lessons. The final results of Shaw's study indicated that students who participated in piano lessons had a 34% increase in spatial-temporal reasoning which proved to be long term. Schellenberg's (2004) research proved that students who participated in music classes improved their IQ and academic achievement. Some school systems have implemented piano lessons to enhance spatial-temporal intelligence (Shore & Strasser, 2006). Unfortunately, the costs of funding a keyboard lab are excessive and often space is problematic. As such, installing a keyboard lab to improve students' IQ and spatial-temporal intelligence is not cost effective (Shore & Strasser, 2006).

Additional research supports the idea that there are ways to achieve improved IQ and spatial-temporal intelligence at a much lower cost. Gardiner (2000) compared first-grade students involved in music classes. The first group of students participated in Kodály Method music classes while the other first-grade students participated in regular music classes. The Kodály Method involved teaching pitches sequenced in complexity. After seven months, the students which participated in Kodály music classes soared past their counterparts in mathematics even if they were slightly behind before beginning the study (Gardiner, 2000).

Most music educators are not trained in Kodály, but exposing students to music and instruments continues to make academic differences in students. Educators can all be musical

even without training. Infusing curriculum with musical elements such as rhythm, melody, and steady beat engages students and leads to academic gains (Geist & Geist, 2008).

Despite research conducted on music and its influence on mathematics, limited research has been conducted on utilizing the music classroom to specifically teach basic mathematics fact fluency. The purpose of the study was to examine the effect of using mathematics-related music during general music class to improve student achievement. In addition, the study examined students' attitudes toward mathematics achievement compared to the attitudes of students not participating in mathematics-related music classes. The study was beneficial to music specialists and educators interested in interventions to enhance mathematics instruction. Students benefitted by participating in additional mathematics instruction.

Research Questions

1. How does students' basic mathematics fact fluency achievement for students participating in mathematics-related music classes improve compared to scores of students not participating in mathematics-related music classes?

2. Will mathematics-related music instruction improve students' attitudes toward mathematics?

3. Will mathematics-related music increase students' engagement in mathematics?

Variable Definitions

Mathematics-related music: Mathematics-related music is basic mathematics fact skills put to music. The strategies include addition, subtraction, and computation to enhance students' basic mathematics fact fluency.

Mathematics fact fluency achievement: Mathematics fact fluency achievement is students' basic mathematics fluency achievement scores which is a measurable outcome with grades and standardized test scores (Kestrom, 2007). Regional Educational Services Agency's (RESA) Georgia RESA Assessment of Student Programs (GRASP) mathematics screening probe focusing on basic mathematics fact fluency pretest and posttest scores will be used to determine students' achievement.

Student mathematics attitudes: The Third-Grade Student Survey is a 10-item survey of students' feelings and beliefs regarding mathematics taken before and at the completion of the research.

METHODS

Setting and Participants

The participants in this study were enrolled in a Title I elementary school located in south east Georgia. The school system was comprised of one comprehensive high school (grades 9 through 12), one middle school (grades 4 through 8), two elementary schools, and one alternative school. The school district served approximately 1,689 students with 144 employees. The elementary school selected to participate in the study was new to students and staff. There were 471 students enrolled at this school. The student demographics were 56% White, 37% Black, 5% Multiracial, 1% Asian, and 1% Hispanic. Ten percent of the students were served in special education classes, with 4% of the student population in gifted resources. Sixty-nine percent of the students were economically disadvantaged.

The study targeted 38 third-grade students ages 8 to 10. Two classes in general music were used for participation in the study. The classes were selected by convenience sampling

due to the availability of the participants (Creswell, 2008). The study provided useful information, but due to the convenience sampling, care should be exercised in generalizing findings to the population. The two third-grade classes were described as Group A and Group B. Group A ($N = 19$) was considered the control group while the other class described as B ($N = 19$) was the treatment group. Forty-two percent were boys and 58% were girls participating in the study. The students' ethnicity was 61% Caucasian, 34% African American, and 5% Multiracial. Thirty-seven percent received additional assistance in mathematics and reading through the Early Intervention Program (EIP), and 11% were enrolled in gifted classes. Fifty-three percent participated in free or reduced lunch program.

Group A and B students were similar in nature. Both classes were placed randomly into homerooms. Both Group A and Group B consisted of 11 males and 8 females. Thirty-seven percent of the students in Group A participated in free or reduced lunch, while 68% participated in Group B. The demographics of Group A were 58% Caucasian, 37% African American, and 5% Multiracial. Group B consisted of 63% Caucasian, 32% African American, and 5% Multiracial. Four students were repeating the third-grade in Group A, while one student was repeating in Group B. Forty-two percent of the students in Group A participated in gifted resource, while 42% received additional assistance in mathematics and reading through EIP. Eleven percent of the students in Group B participated in gifted resources, and 32% were EIP students.

The School Improvement Plan (2011) focused on raising basic mathematics fluency scores for all students especially the subgroup of African American students. Since the study focused on mathematics achievement, students' Criterion-Referenced Competency Test (CRCT) scores were used to reveal students who scored below standard, met the standard, and exceeded the standard for mathematics.

Table 1. Comparison of Group A and Group B CRCT Mathematics Scores

Classes	N	CRCT <800 Mathematics	CRCT 800-849 Mathematics	CRCT >849 Mathematics	No Test Data Available
Group A	19	1	14	3	1
Group B	19	2	13	3	1

Note. N = Number of students. CRCT <800 Mathematics = Students scoring below 800 on the mathematics domain of the CRCT did not meet the standard. CRCT 800-849 Mathematics = Students scoring between 800 and 849 on the mathematics domain met the standard. CRCT >849 = Students scoring above 849 on the mathematics domain of the CRCT exceeds the standard.

Table 1 indicates the number of students who scored below standard, met standard, and exceeded standard on the CRCT for each group. Analysis of the data in Table 1 indicates that most students in both groups met the standard score for mathematics, with only a few students not meeting the standard. The same number of students exceeded the standard for mathematics.

The teacher-researcher was a veteran teacher of 16 years with experience teaching general music, chorus, show choir, and drama. The veteran teacher had 11 of the 16 years experience in elementary school. Other teachers involved in the study were five third-grade classroom teachers. They were used for consultation. Two third-grade teachers whose classes were selected to participate as the control and treatment groups administered the Student Engagement Walkthrough Checklist (SEWC; Jones, 2009) daily during mathematics instruction.

Intervention

The teacher-researcher began the study by obtaining permission from the principal where the study took place. After receiving permission to begin the study, the researcher met with the five third-grade teachers participating in the study by explaining their role in the research and obtaining their consent. Next, two third-grade classes were selected due to students' CRCT mathematics score similarities. The two third-grade classes selected to participate in the study were randomly designated as the control group while the other was labeled the treatment group. The teacher-researcher explained the study to the students and obtained the necessary consent from parents (Appendix D) and participants (Appendix E).

The action research began during the third 9 weeks of school and lasted for 6 weeks. Classes participated in music twice a week in the afternoons on Monday and Thursday for a total of 80 min of instruction each week. The teacher-researcher was the sole instructional teacher for the music classes. However, the homeroom teachers taught their third-grade students mathematics but used the same materials and methods of instruction. All students were expected to achieve the same standards in mathematics and music.

The action research began with third-grade homeroom teachers administering the GRASP Mathematic Computational Screening (Appendix A) to the treatment and control group. Students were assessed in basic mathematics computation. The GRASP scores were collected by the researcher to be used as a pretest and compared with performance at the end of the study. Students in the control and intervention group were administered the Skills Tutor assessment during their computer lab time before beginning intervention and following intervention. Following the GRASP pretest, the teacher-researcher surveyed both classes during their music class to evaluate students' attitudes towards mathematics and music instruction using the Third-Grade Student Survey (Appendix B). The survey aided the researcher in gaining qualitative data to determine students' instructional attitudes towards mathematics and music to understand if mathematics-related music instruction will improve student success.

The treatment group received 15 min of mathematics-related music instruction at the beginning of class twice a week for six weeks. The mathematics strategies used in the mathematics-related music for addition included counting by one or two, sums to five, sums to ten, doubles, doubles plus one, doubles plus two, adding tens, nines, word problems, and carrying. Subtraction strategies included in the music lessons were fact families, counting backwards, zero, subtracting tens, subtracting from tens, carrying, and word problems. In addition to mathematics-related music, the teacher-researcher will use flashcards to increase students' knowledge in basic mathematics fact fluency. The control group did not receive any mathematics-related music during music instruction. However, both groups were administered the Student Engagement Walkthrough Checklist (SEWC) (Appendix C; Jones, 2009) once a week during mathematics instruction. During week 6 of the study, both groups participated in the GRASP Mathematics Computational Screening (Appendix A) assessment and the Third Grade Student Survey (Appendix B). Scores were compared between the treatment class and the control class to determine if mathematics-related music instruction improved students' skills in basic mathematics fact fluency. The students' pre and posttest scores between the treatment group and control group were compared using descriptive statistics and a two-tailed *t*-test.

Data Collection Techniques

The teacher-researcher used several data collection instruments to determine whether or not mathematics-related music improved basic mathematics achievement scores of third-grade students. The assessments included GRASP pretest and posttest on basic mathematics fact

fluency, students' attitudes towards instruction, and teacher observation of student engagement. Together these assessments will determine if mathematics-related music has any bearing on students' achievement.

GRASP pretest and posttest (Appendix A). GRASP Mathematic Computational Fluency benchmark tests were created by several mathematics specialists (Georgia RESA Assessment of Student Progress, 2010). Content validity was obtained through duplicated research from Dr. Shapiro, Director of the Center for Promoting Research to Practice at Lehigh University (as cited in Georgia RESA Assessment of Student Progress, 2010). The GRASP assessment was the same for both groups and administered with standardized procedures. Protocols used for the assessments were written down for validity and reliability (Creswell, 2008).

The third-grade Computational Fluency Screener is composed of 40 mathematics problems utilizing single and double digits with addition and subtraction. In order for students to be considered fluent in basic mathematics skills, they must correctly compute 20 digits within a 2-minute time period. The assessment is given to students individually using standardized protocols. Students in Group A and B were assessed using the GRASP at the beginning of the 6-weeks study and the end. The students' GRASP scores between the treatment group and control group were compared using descriptive statistics and a two-tailed *t*-test to determine if students had made significant improvement in basic mathematics skills.

Students' Instructional Attitude Survey (Appendix B). The Students' Instructional Attitude Survey (SIA) was developed by the teacher-researcher. The validity of the survey was established by peer review with five third-grade teachers and a field study consisting of six third-grade students. The SIA survey was administered to the control group and treatment group at the beginning and end of the study. The survey consisted of 10 questions focusing on instructional attitudes toward mathematics and music. Each question required a yes or no answer.

Student Engagement Walkthrough Checklist (Appendix C). The Student Engagement Walkthrough Checklist (SEWC) was used to determine if mathematics-related music causes an increase in student engagement in mathematics lessons. The validity of the instrument was established by peer review with five third-grade teachers. The SEWC was used to gather engagement data during mathematics and music instruction by instructors. The SEWC documented five characteristics through direct observation which included positive body language, consistent focus, verbal participation, student confidence, and excitement. The SEWC is based on a 5-point Likert scale with 5 being *very high* and 1 being *very low*.

RESULTS

The purpose of the research was to determine the effectiveness of mathematics-related music on students' achievement, attitudes, and engagement in basic mathematics fact fluency for third-grade. Two third-grade classes identified as Group A and Group B participated in the study. The control class, Group A, was compared to Group B, the treatment group, by using Students' Mathematic Computational Fluency scores (Appendix A), Student Instructional Attitude Survey (Appendix B), and Student Engagement Walkthrough Checklist (Appendix C). These instruments provided data to be analyzed by the teacher-researcher to determine if mathematics-related music had an impact on participants.

Mathematic Computational Fluency pretest and posttest scores were used for students in both classes to determine the effectiveness of mathematics-related music. Students were

allowed 2 min to answer addition, subtraction and multiplication problems. In order for a student to be considered on target for third-grade computational fluency, their scores should be a 20 or higher. A point is given for each correct digit.

Achievement on Mathematic Computational Fluency pretest results are shown in Table 2. The mean score for students participating in mathematics-related music ($M = 21.95$, $SD = 7.62$) was not significantly higher than control group ($M = 18.84$, $SD = 8.96$). Students in the treatment group did not score significantly higher than students in the control group. Pretest scores did not indicate a wide dispersion of abilities between both groups of students.

Table 2. Achievement on Mathematic Computational Fluency Pretest Results

Group Contrast	N	M	SD	t-value	P
Mathematics-related Music	19	21.95	7.62	2.02	0.26
Control Group	19	18.84	8.96		

The means and standard deviations for students' posttest scores are shown in Table 3. There was not a significant difference between Mathematics-related Music Instruction ($M = 23.89$, $SD = 8.23$) and the Control Group ($M = 20.53$, $SD = 8.62$). Students did not score significantly higher with mathematics-related music instruction.

Table 3. Achievement on Mathematic Computational Fluency Posttest Results

Group Contrast	N	M	SD	t-value	P
Mathematics-related Music Instruction	19	23.89	8.23	2.02	0.23
Control Group	19	20.53	8.62		

Cohen's d was used to calculate the effect size of the mathematics-related music on students' basic mathematic fluency scores. The intervention had a medium effect ($d = 0.41$) on Mathematic Computational Fluency scores for students receiving mathematics-related music as compared to students not receiving mathematics-related music. According to the effect size calculated by Cohen's d , an average student in the treatment group would be expected to outscore about 66% of the students in the control group. Mathematics-related music increased scores approximately 16%.

Students in Group A and Group B completed a survey to measure their opinions and feelings about music and mathematics before and after the intervention. The results from the Students' Attitude Instructional Survey for students participating in the control group are summarized in Table 4. The survey consisted of 10 questions requiring *yes* or *no* answers.

Table 4. Group B Results from Students' Attitude Instructional Survey

Survey Question	Prior to Intervention		Following Intervention	
	Yes	No	Yes	No
1. Do you like to add numbers?	68%	32%	100%	0%
2. Do you like to subtract numbers?	42%	58%	68%	32%
3. Do you like to draw or create things?	84%	16%	84%	16%
4. Are word problems easy for you?	74%	26%	79%	21%
5. Do you like to work with calculators/computers?	89%	11%	89%	11%
6. Do you like to sing?	95%	5%	100%	0%
7. Do you like quiet music while working?	37%	63%	42%	58%
8. Do you like to do puzzles, problems, brain teasers?	58%	42%	68%	32%
9. Do you know the words to lots of songs?	84%	16%	89%	11%
10. Do you hum to yourself?	68%	32%	84%	16%

Questions 1 through 5 and 8 focused on mathematics while 6, 7, 9, and 10 asked about their feelings toward music. Prior to the intervention, students interested in mathematics computation was 69% according to the answers to the mathematics questions. Following the intervention, students' interest increased 81%. Sixty-eight percent of the students liked adding numbers, but following the intervention, the number increased to 100%. All questions increased in percentage that liked doing music and mathematics activities with the exception of two questions. Question 3 indicated 84% liked drawing and creating things prior to the intervention and following the intervention. On question 5, the same amount of students enjoyed working with computers and calculators following the implementation of the intervention. Less than half of the students enjoyed using subtraction prior to the intervention. However, the number increased to 68% following the treatment. Students indicated on question 4 that 74% felt that word problems were easy for them. Following the intervention, 79% reported that word problems were easy for them. This slight increase revealed a minimal change. On question 8, students were asked if they enjoyed working on puzzles, brainteasers, and word problems. Prior to participation in the intervention, 58% of the students answered *yes*. The percentage increased 10% following students' participation in the intervention.

Questions focusing on music increased slightly following the intervention. Ninety-five percent of the students enjoyed singing prior to the research. This number only increased 5% following the intervention. This question indicated how students felt about singing and participating in music class.

The final method used to collect data was the Student Engagement Walkthrough Checklist (SEWC). The engagement checklist was used by the music and homeroom teachers to determine whether student engagement increased during mathematics instruction. Teachers observed the students once a week with a total of six observations. There were five areas teachers considered on the SEWC: positive body language, consistent focus, verbal participation, student confidence, and excitement. The SEWC is based on a 5-point Likert scale with 5 being *very high* and 1 being *very low*. The total number of points for each student was reported as a percent of possible points earned. Means and standardizations of scores for the two groups are shown in Table 5. The mean score for Group A ($M = 57.58$, $SD = 23.92$) was not significantly different from the mean score for Group B ($M = 59.37$, $SD = 21.40$) which received the intervention. Students' engagement in mathematics did not differ significantly by mathematics-related music.

Table 5. SEWC Results for Mathematics Instruction

Group Contrasts	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i> -value	<i>P</i>
Group A	19	57.58	23.92	-0.24	0.4
Group B	19	59.37	21.4		

Means and standard deviations for the Student Engagement Walkthrough Checklists results for the control and treatment group are shown in Table 6. The mean score for music instruction ($M = 71.37$, $SD = 21.51$) was statistically significantly higher than the mean score for mathematics instruction ($M = 59.37$, $SD = 21.40$). While students were participating in mathematics-related music, students viewed music instruction significantly different than mathematics instruction.

Table 6. SEWC Results for Music-related Instruction

Group Comparisons	<i>N</i>	<i>M</i>	<i>SD</i>	<i>t</i> -value	<i>p</i>
Music Instruction	19	71.37	21.51	2.03	0.01
Mathematics Instruction	19	59.37	21.4		

* $p < .05$

The research indicated that mathematics-related music was not very effective on students' achievement scores. Attitudes and student engagement increased when participating in general music classes. The study revealed that students enjoyed mathematics-related music and engaged more in class than when in their homeroom.

DISCUSSION and CONCLUSIONS

Did mathematics-related music have an effect on basic mathematics fact fluency? Did mathematics-related music increase students' attitudes toward mathematics instruction? Did mathematics-related music increase students' engagement in mathematics? The teacher-researcher compared 38 third-grade students to determine the effect of mathematics-related music on mathematics instruction. As the music instructor, the teacher-researcher implemented 15 min of mathematics-related music over the course of 6 weeks. Following the intervention, the treatment and control group revealed no significant difference in academic achievement. However, students' engagement in mathematics-related music was significantly different than the same group of students participating in mathematics instruction.

Mathematics-related music did not have a significant effect on basic mathematics fact fluency. GRASP Mathematic Computational Fluency pre and posttest results were used to determine if there was academic growth for the treatment group when compared to the control group. According to the results from the study, mathematics-related music was not a valid intervention. The students in Group B who participated in the intervention did not make significant gains when comparing their pre ($M = 21.95$, $SD = 7.62$) and posttest ($M = 23.89$, $SD = 8.23$) scores to the control groups pre ($M = 18.84$, $SD = 8.96$) and posttest ($M = 20.53$, $SD = 8.62$) scores. Fourteen students in Group B only slightly improved their achievement scores while three students' scores decreased, and two students' scores stayed the same. In Group A, 15 students increased their achievement scores, while three students' scores decreased, and one student's score remained the same. To determine the effect size of mathematics-related music on students' basic mathematic fluency scores, Cohen's d calculations indicated the intervention had a medium effect ($d = 0.41$) on Mathematic Computational Fluency scores. An average student in the treatment group would be expected to outscore about 66% of the students in the control group. Mathematics-related music increased scores approximately 16%. These results were consistent with previous research by Schellenberg (2004), who found students who participated in music classes improved their academic achievement. Even though the research proved minimal increase in academic gains, it did support the findings of Nichols and Honig (1997) which found that creating strong connections between music and mathematics lead to academic gains.

Did mathematics-related music improve students' attitudes toward mathematics? Students in Group B, who participated in mathematics-related music classes, slightly improved their attitudes toward mathematics. Students' confidence level increased when focusing on addition. Prior to the intervention only 68% of the students enjoyed working addition mathematics problems, while 100% enjoyed addition problems following the intervention.

Music rouses emotions and affects individuals according to Shore and Strasser (2006) which supports the findings of this study.

Did mathematics-related music increase students' engagement in mathematics? Mathematics-related music did not have a significant effect on students' engagement. This was indicated when comparing Group A ($M = 57.58$, $SD = 23.92$) mean scores to Group B mean scores ($M = 59.37$, $SD = 21.40$). There was very little difference between the two classes when observed during mathematics instruction. However, the teacher-researcher used the SEWC to observe student engagement during mathematics-related music instruction. Group B students' engagement in mathematics-related music was compared to their engagement in mathematics instruction. The mean score for music instruction ($M = 71.37$, $SD = 21.51$) was statistically significantly higher than the mean score for mathematics instruction ($M = 59.37$, $SD = 21.40$). Students viewed music instruction significantly different than mathematics instruction. These findings supported the research conducted by Geist and Geist (2008) which found that infusing curriculum with musical elements such as rhythm, melody, and steady beat engages students and leads to academic gains.

Significance/Impact on Student Learning

Research has shown that an achievement gap in mathematics exists, and there was a need to discover solutions to help students succeed in the area of basic mathematics computation. The purpose of this study was to understand if implementing mathematics-related music into the general music class twice a week would improve students' basic mathematics fluency computation. Students responded well to mathematics-related music. Findings supported that students participated significantly more in general music when singing mathematics-related music when compared to classroom mathematics instruction engagement. According to the survey SEWC, the style of music used in the mathematics-related appealed to the students and had a significant effect on their participation. However, the intervention did not have a significant outcome on students' achievement scores. Students need to be more fluent in mathematics computation, but there are other interventions that might be more effective on students' achievement outcomes.

Factors Influencing Implementation

There were several factors that influenced the implementation of the intervention. During the course of the intervention, there was one holiday and two furlough days that interrupted the schedule. These classes had to be made up in order to complete the intervention. There was also a school-wide event, which interfered with scheduling. Following the timeline was difficult when facing scheduling changes and shorter weeks, which affects student instruction.

Another factor that influenced the study was the mathematics-related music used with the students. The students participating in the study may not have enjoyed the mathematics-related music used in the study. Surveying students about the genre of music they enjoy would influence the music selected for the classes and may influence students' academic achievement. Students were asked to learn the words to the mathematics-related music, but due to the amount of time allotted for the study, students struggled to learn all the music. Students needed to learn the words to the songs in order to apply the mathematics rules.

Implications and Limitations

The research did not indicate a significant impact on students' achievement scores. However, the findings did show a positive impact on students' attitudes toward mathematics-related music instruction when in general music class. According to Geist and Geist (2009), students respond more to mathematics activities, which include music. A longitudinal study

would be better to test the effect of mathematics-related music on achievement scores. The teacher-researcher will continue to implement mathematics-related music as well as other strategies implementing mathematics with music standards.

There are several limitations, which should be considered when reviewing the results. Convenience sampling was used due to the availability of the participants. Further, the teacher-researcher was employed at the school used in the research. Utilizing teachers who are not conducting the research would decrease the bias, which may have occurred from the teacher-researcher. Data were only collected for 9 weeks, which is not a considerable amount of time. A longitudinal study would produce results that are more reliable. Due to limited time for research, other data instruments were not available. Additional data provided from other instruments could reveal student growth throughout the year. Also, due to the demographics of the students, the teacher-researcher is unable to make generalizations concerning student populations with various demographics.

Despite research conducted on music and its influence on mathematics, limited research has been conducted on utilizing the music classroom to specifically teach basic mathematics fact fluency. This study was limited to just mathematics-related music. Further study might include expanding mathematics-related music to activities, which incorporate integrated mathematics with various music activities, might more beneficial to students and achievement outcomes.

REFERENCES

- Aldridge, J., & Goldman, R. (2007). *Current Issues and Trends in Education* (2nd ed.). Boston: Pearson.
- Bintz, W. (2010). Singing Across the Curriculum. *The Reading Teacher*, 63(8), 683-686.
- Cooper, J., & Schleser, R. (2006). Closing the achievement gap: Examining the role of cognitive developmental level in academic achievement. *Early Childhood Education Journal*, 33(5), 301-306.
- Cooper, M. A. (2011). The gap persists: New CEP report gives mixed reviews to NCLB. *The Hispanic Outlook in Higher Education*, 21(9), 11-12.
- Edelson, R. J. & Johnson, G. L. (2003). Integrating music and mathematics in the elementary classroom. *Teaching Children Mathematics*, 9(8), 474-479.
- Gardiner, M. F. (2000). Music, Learning, and Behavior: A case for mental stretching. *Journal for Learning Through Music* 4(1), 72-93. <http://music-in-education.org/articles/1-R.pdf>
- Geist, E. A., & Geist, K. (2009). In service training of head start teachers to overcome early risks of mathematics failure: the mathstaar program. *College Student Journal*, 43(4), 988-998. Retrieved from http://www.projectinnovation.biz/csj_2006.html
- Geist, K., & Geist, E. A. (2008). Do re mi, 1-2-3: That's how easy math can be: Using music to support emergent mathematics. *Young Children*, 63(2), 20-25.
- Georgia RESA Assessment of Student Progress (2010). Action research math. Retrieved from <http://grasp1.wgretc.org/ActionResearchMath.htm>
- Governor's Office of Student Achievement. (2010). *2009-2010 Report Card*. Retrieved from <http://gaosa.org/Report.aspx>
- Haycock, K. (2002, January 31). Helping all students achieve: Closing the achievement gap. Retrieved from http://www.cdl.org/resource-library/articles/achieve_gap.php
- Hudson, R. F., Lane, H. B. & Pullen, P. C. (2005). Reading fluency assessment and instruction: What, why and how? *The Reading Teacher*, 58(8), 702-714.
- Hursh, D. (2007). Exacerbating inequality: the failed promise of the No Child Left Behind Act. *Race Ethnicity and Education*, 10(3), 295-308.
- Johnson, C. M., & Memmott, J. E. (2006). Examination of relationships between participation in school music programs of differing quality and standardized test results. *Journal of Research in Music Education*, 54(4), 293-307.
- Jones, R. D. (2009). *Student Engagement Teacher Handbook*. New York: International Center for Leadership in Education. Retrieved from <http://www.leadered.com/pdf/Student%20Engage%20handbook%20excerpt.pdf>
- Kells, D. (2008, December 2). The impact of music mathematics achievement. Retrieved from http://www.kindermusik.com/images/pdfs/research-booklets/01_Music_and_Math_3_to_5_FullResearch.pdf
- Kestrom, J. M. (2007). The untapped power of music: Its role in the curriculum and its effect on academic achievement. *The Clearing House*, 80(5), 239-242.
- Lorraine, W. G., & Rasinski, T. V. (2004). A focus on fluency: How one teacher incorporated fluency with her reading curriculum. *The Reading Teacher*, 58(2), 126-137.
- Nichols, B. L., & Honig, A. S. (1997). Music teaches children about themselves and others. *Early Childhood Education Journal*, 24(4), 213-216.
- Ravitch, D. (2010, June 14). Why I changed my mind. Retrieved from <http://www.thenation.com/article/why-i-changed-my-mind>

- Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science*, 15(8), 511-514.
Retrieved from <http://www.psychologicalscience.org/pdf/ps/musiciq.pdf>
- Shore, R., & Strasser, J. (2006). Music for their minds. *Young Children*, 61(2), 62-67.
- Spohn, C. (2008). Teacher perspectives on No Child Left Behind and arts education: A case study. *Arts Education Policy Review*, 109(4), 3-11.
- Strand, K. (2006). The heart and journey: Case studies of collaboration for arts integrated curricula. *Arts Education Policy Review*, 108(1), 29-40.
- US Department Of Education (2010, December 6). No Child Left Behind. Retrieved from <http://www2.ed.gov/policy/elsec/leg/esea02/index.html>
- US Department Of Education (2011). *The Condition of Education of 2011* (NCES 2011-033). Washington, DC: U.S. Government Printing Office. Retrieved from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2011033>
- Viglione, N. M. (2009). Applying art and action. *Reclaiming Children and Youth*, 18(1), 16-19.
- Wang, A. (2010). Optimizing early mathematics experiences for children from low-income families: A study on opportunity to learn mathematics. *Early Childhood Education*, 37(1), 295-302.
- Wetter, O. E., Koerner, F., & Schwaninger, A. (2009). Does musical training improve school performance? *Instructional Sciences: An International Journal of the Learning Sciences*, 37(4), 365-374.

Appendix A

GRASP



3rd Grade Computational Fluency Screener

					Digits Possible	Digits Correct
69 <u>+4</u>	12 <u>-5</u>	78 <u>+13</u>	90 <u>-17</u>	31 <u>+28</u>	9	
54 <u>-5</u>	69 <u>+4</u>	12 <u>-2</u>	17 <u>+14</u>	9 <u>-5</u>	9	
34 <u>+33</u>	29 <u>-28</u>	72 <u>+5</u>	45 <u>-9</u>	27 <u>+35</u>	9	
46 <u>-26</u>	85 <u>+6</u>	67 <u>-14</u>	11 <u>+24</u>	63 <u>-4</u>	10	
83 <u>+17</u>	92 <u>-6</u>	71 <u>+5</u>	20 <u>-17</u>	12 <u>+56</u>	10	
59 <u>-45</u>	37 <u>+9</u>	15 <u>-4</u>	20 <u>+35</u>	17 <u>-12</u>	9	
10 <u>x4</u>	7 <u>x9</u>	5 <u>x6</u>	8 <u>x3</u>	4 <u>x7</u>	10	
2 <u>x8</u>	10 <u>x5</u>	3 <u>x3</u>	7 <u>x8</u>	6 <u>x6</u>	9	
				Totals		

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Appendix B

Third Grade Student Survey

Thank you for your participation in this voluntary survey. You may withdraw from it at any time. Your responses are anonymous, and your role is limited to the completion this survey. If you have any questions regarding this research, you may contact the principal investigator. Your completion of this survey indicates your consent to participate.

1. Do you like to add numbers?
yes
no
2. Do you like to subtract numbers?
yes
no
3. Do you like to draw or create things?
yes
no
4. Are word problems easy for you?
yes
no
5. Do you like to work with calculators/computers?
yes
no
6. Do you like to sing?
yes
no
7. Do you like quiet music while working?
yes
no
8. Do you like to do puzzles, problems, brain teasers?
yes
no
9. Do you know the words to lots of songs?
yes
no
10. Do you hum to yourself?
yes
no

Appendix C

Student Engagement Walkthrough Checklist

Observations

Very High *High* *Medium* *Low* *Very Low*

Positive Body Language

Students exhibit body postures that indicate they are paying attention to the teacher and/or other students.

Very High *High* *Medium* *Low* *Very Low*

Consistent Focus

All students are focused on the learning activity with minimum disruptions.

Very High *High* *Medium* *Low* *Very Low*

Verbal Participation

Students express thoughtful ideas, reflective answers, and questions relevant or appropriate to learning.

Very High *High* *Medium* *Low* *Very Low*

Student Confidence

Students exhibit confidence and can initiate and complete a task with limited coaching and can work in a group.

Very High *High* *Medium* *Low* *Very Low*

Fun and Excitement

Students exhibit interest and enthusiasm and use positive humor.