CLOSING THE GAPS IN MATHEMATICS FOR ELEMENTARY-AGED STUDENTS USING VARIOUS MUSICAL INTERVENTIONS

A Record of Study

by

JOEY MICHELLE SHIMEK

Submitted to the Graduate and Professional School of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Chair of Committee,	Mary Margaret Capraro
Co-Chair of Committee,	Robert M. Capraro
Committee Members,	Jamaal Young
	Jennifer Whitfield
Head of Department,	Claire Katz

August 2022

Major Subject: Curriculum and Instruction

ABSTRACT

The purpose of the study was to observe the understanding and motivation of second-grade Tier III students' achievement in skip-counting patterns by implementing music and non-music learning activities. The case study was performed using a qualitative design. A pretest-posttest and repeated measures design was used to analyze and triangulate the data with descriptive statistics. The computer software program, Atlas.ti, allowed me to develop two central themes, understanding of and motivation to learn skip-counting patterns. Video-recorded sessions, transcriptions, and observational notes allowed me to present important information into my results regarding student comprehension and behavior when completing various learning activities. The analysis of the data showed growth in their skip-counting abilities and also revealed positive motivation toward participating in the music learning activities. The growth was confirmed using posttests disposition and content scores, which improved from the pretests. The music and non-music learning activities provided insight for the artifact developed from this record of study in the area of skip-counting.

DEDICATION

To my daughter, Breanne Michelle, the most brilliant, most kind-hearted woman and mother I know. Thank you for making my world more wonderful. You have taught me how to persevere, believe in myself, and make my dreams a reality. I will be forever grateful. Bunches and bunches.

ACKNOWLEDGEMENTS

I want to thank my committee chair, Dr. Mary Margaret Capraro, and my committee co-chair, Dr. Robert M. Capraro, my committee members, Dr. Jennifer Whitfield, and Dr. Jamaal Young, for their advice and support during the research process. Thank you also to Alison Stone and Jennie Fortner, my colleagues at Greens Prairie Elementary School, for their ongoing encouragement and unwavering support during the process of this study. Also, thank you to my cohort members and the department instructors and staff for making my experience at Texas A&M University so enjoyable. Finally, I'd like to thank my family for their belief in me and my spouse for opening doors, assisting me in finding a pathway, and for his patience and love.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a record of study committee consisting of the committee chair, Professor Dr. Mary Margaret Capraro of the Department of Teaching, Learning, and Culture, Professor and Co-Director of Aggie STEM of the Department of Teaching, Learning, and Culture, Dr. Robert M. Capraro, committee co-chair. Also, Instructional Associate Professor and Assistant Department Head of Mathematics, Dr. Jennifer Whitfield, and Associate Professor of the Department of Teaching, Learning, and Culture, Dr. Jamaal Young.

All other work for the record of study was completed by the student independently.

Funding Sources

There were no funding sources provided for this research.

NOMENCLATURE

ADHD	Attention Deficit Hyperactivity Disorder
AVMR	Add+VantageMR®
CSISD	College Station Independent School District
ESL	English as a Second Language
FIE	Full Individual Evaluation
GPES	Greens Prairie Elementary School
GT	Gifted and Talented
IDEA	Individuals with Disabilities Act
IQ	Intelligence Quotient
LEP	Limited English Proficient
MAP	Measures of Academic Progress
MR	Math Recovery
NAEP	National Assessment of Educational Progress
NCES	National Center for Education Statistics
NCLB	No Child Left Behind
NCTM	National Council of Teachers of Mathematics
NWEA	Northwest Evaluation Association
PISA	Programme for International Student Assessment
ROS	Record of Study
RtI	Response to Intervention
SPED	Special Education

SIT	Student Intervention Team
STAAR	State of Texas Assessments of Academic Readiness
STEAM	Science, Technology, Engineering, Arts, and Mathematics
STEM	Science, Technology, Engineering, and Mathematics
TEA	Texas Education Agency
TEKS	Texas Essential Knowledge and Skills

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

The Context

Mathematics is typically taught using traditional structured thinking processes, which causes many students to struggle with specific mathematical ideas. If innovative pedagogies are introduced into classrooms, students will have more significant opportunities to understand these sometimes-difficult concepts. Musical creativity in mathematics has been shown to improve student comprehension by utilizing different rhythms and sequences found in songs. Students who can make links between mathematics and music are more likely to gain from this form of mathematical creativity than students who cannot (Burton et al., 2000; Perger et al., 2018; Rajan, 2016). Incorporating the notion of rhythm into mathematics brings it closer to the child's musical experiences (Baravalle, 1944). Creative arts allow students to use rhythm and sequences to apply that thinking in mathematics. The potential for musical learning activities to positively impact students' understanding of skip-counting patterns relies on teacher implementation of skills and strategies to help students create a strong foundation in mathematics.

National and International Context

In 2002, President George W. Bush signed the No Child Left Behind (NCLB) Act, which set high expectations to close students' achievement gap in kindergarten through twelfth grade. The act advocated for educators' stronger accountability to obtain results, more freedom for states, and proven education methods (U.S. Department of

Education, 2004). The act required annual testing in reading and mathematics for all students, beginning in 3rd grade. The act forced educators to "teach to a test" and focus mainly on procedures rather than teaching students to think creatively and solve all types of mathematics problems.

National and international tests have highlighted little growth in mathematics. According to the National Center for Education Statistics (NCES) (2019), math scores on the National Assessment of Educational Progress (NAEP) report card have declined in 20 states. Forty-eight states showed no significant differences on the 2017 8th grade assessment compared to 2015. From 2005 to 2019, the twelfth-grade math assessment results showed no significant changes. The Northwest Evaluation Association (NWEA) testing system used in 145 countries administered the MAP Growth interim assessment. The 2020 growth norms offer slightly lower means in the earlier grades and slightly greater means in the upper grades. Drops in the average mathematics and reading achievement for grades four and eight are consistent with recent declines reported on the NAEP for this subject and grades (NWEA, 2020). The Programme for International Student Assessment (PISA) (2018) reported in math, and the U.S. students scored an average of 478, which is below the international average of 490. Scores ranged from 591 in China to 325 in the Dominican Republic. Specifically, in Texas, there has been no significant growth from 2012 to 2019 in math scores on the State of Texas Assessments of Academic Readiness (STAAR) tests in grades 3rd through 8th (Texas Education Agency, 2020). Thus, curriculum changes are needed.

The Texas Education Agency agrees that top-down initiatives can be helpful, but the classroom is where the most progress can be made with students. The stagnant yet sometimes declining math scores have forced educators to develop programs to assist students struggling in specific areas. James (2004) explains the Response to Intervention (RtI) model emerged from the 2004 reauthorization of the Individuals with Disabilities Act (IDEA). It was created as an early detection program to support and help students before falling significantly behind their peers' grade level (Preston et al., 2016). Previous research findings show students struggling with math may benefit from early intervention. Several components must be present for RtI to succeed, including high-quality scientifically based classroom instruction, ongoing student assessment, tiered instruction, and parent involvement. Preston et al. (2016) explain the tiered instruction as:

> At Tier I, or the primary level, research-based core instruction is provided to meet the needs of the majority of students. At Tier II, or the secondary level, evidence-based interventions are provided to students who did not make adequate growth in the first level. Finally, at Tier III, or the tertiary level, intensive individualized instruction is provided to students who did not make enough progress in the secondary level (p. 176).

During Tier III instruction, a math specialist can set goals for each student based on their district guidelines and assessments. The intervention activities provided by the specialist can be flexible and adapted to each student. Some math specialists use creative measures for their programs, specifically musical learning activities. Studies have shown the overlapping relationships between mathematics and music and the explicit connections between the procedural and conceptual knowledge inherent in music and math and positive transfer (Azaryahu et al., 2020). Also, there is a high correlation between learning music and spatial-temporal reasoning, primarily used for math skills (Vaughn, 2000).

Skip-counting is essential for students because it sets the foundation for many fundamental mathematics skills, including number patterns, place value, additive and multiplicative processes, time, counting money, and composing and decomposing numbers. According to the National Center on Intensive Intervention (2015), skip-counting should be taught through chants or songs to help build their confidence.

Situational Context

According to the Greens Prairie School Improvement Committee (2019), College Station ISD has almost 14,000 students and some diversity, with 52.82% of the population being White, 22.45% being Hispanic, 13.23% African-American, 7.72% Asian/Pacific Islander, 3.28% Two or more races, and 0.38% American Indian. The economically disadvantaged population accounts for 35.1% of our students, while 34.4% of the student population is designated at-risk.

Over the last five years, our at-risk population has increased by around five percentage points, and our Limited English Proficient (LEP) population has increased by 1%, from 7.4% to 8.5%. Our special education population has doubled over the last three years, making it increasingly challenging to meet all the needs. In addition, our 504-student population continues to increase. The U.S. Department of Education enforces

Section 504 of the Rehabilitation Act of 1973, as amended, (Section 504) a civil rights statute which prohibits discrimination against individuals with disabilities. Section 504 plans include accommodations for students based on their individual needs and ensure that equal access is provided to all (TEA, 2022).

The Hispanic, African American, and Economically Disadvantaged groups are underperforming across core content areas. Overall, students continue to be below state performance in 7^{th}-grade math. In looking at state data on student growth, our district is at an overall “B,” with some campuses identified as Targeted Assistance campuses, a significant area of focus for our district in the 2021-2022 school year.

Our District Improvement Committee plans to continue implementing and refining a consistent RtI process at the elementary level and finalizing the RtI process at the secondary level. Also, the district will purchase a RtI system that meets the needs of all grade spans. Continued data talks will occur with administrators using MAP and STAAR data to track student growth. Further, the district will work to ensure instruction is adjusted based on data analysis, monitor instructional strategies, and pay attention to the staffing of students so that all students can grow to their full potential in the 2021-2022 school year. The committee will ensure scope and sequence are followed in mathematics and that resources are used to address the needs of at-risk learners.

More specifically, my campus has a population of African American 3.9%, Hispanic 11.65%, White 76.52%, Asian 4.48%, Two or More Races 3.05%, Economically Disadvantaged 14.89%, English Language Learners 4%, Special Education 20% (Speech, Resource, Life Skills), and Gifted Talented (GT) 8%.

During the 2019-2020 school year, 20 students received math intervention from the math specialist, while 23 received reading intervention from the reading specialist. The numbers were slightly more remarkable for the 2020-2021 school year. There were approximately 30 students who met Tier III requirements for math due to COVID-19 impacted gaps in teaching and learning. Currently, our campus services 27 students in Tier III for math intervention.

Our Campus Improvement Committee intends to implement the following for the current school year: provide professional development in the RtI process, including effective data gathering to make informed interventions for our students; implement small group instruction and targeted classroom intervention activities based on ongoing student assessment to address the achievement; campus RtI processes will be streamlined; implement consistent small group instruction and classroom intervention to address student achievement.

Our campus MAP and STAAR scores have shown no significant growth for our Tier III students who are seen for intense, individualized instruction. The district programs currently used for math intervention are Bridges and AVMR from Math Recovery.

During the 2020-2021 school year, campus Tier III intervention differed due to COVID-19 restrictions and guidelines. First, not only was I the math specialist for the campus, but I also taught 3rd grade virtually to students from three different elementary campuses. The described situation limited my time pulling students, observing classrooms, and meeting face-to-face with teachers on campus. I could not combine students from different classrooms; therefore, I could see students only once or twice per week. The previous schedule was not beneficial for Tier III students, which was evident in their lack of progress on MAP and STAAR math assessments.

For the 2021-2022 school year, COVID-19 restrictions have been lifted, allowing for more flexibility in scheduling and grouping.

The Problem

Relevant History of the Problem

There is a long history of the connection between music and math. Since ancient civilizations, mathematics has been in existence, such as the Chinese, Incas, Egyptians, and Babylonians. These great cultures studied various mathematical principles using some form of music. Mathematics has many definitions, and there are many parts to the subject, including number theory, concrete thinking, abstract thinking, and problem-solving.

Like mathematics, music has been in existence throughout many cultures in history. Although math is generally viewed as scientific and music is artistic, the two have been linked since the ancient Greeks. Since the ancient Greeks, people have been intrigued with the relationship between music and mathematics, including academics Pythagoras, Plato, and Aristotle (Rothstein, 1982). “Ancient Greek mathematics education was comprised of four sections: number theory, geometry, music, and astronomy” (Shah, 2010, p. 12). Pythagoras believed mathematics could explain everything, including music. He set out to find a mathematical explanation for different pitches. His connections with the music and mathematical ratios are still used to tune instruments today.

The Fibonacci mathematical sequence influences music. The numbers in the Fibonacci sequence are formed by taking the sum of the previous two numbers to get the following number in the series. Architects, artists, and musicians have used the ratio formed by these numbers to structure their creations (PQ, 2016). Leonardo da Vinci has been known to have used Fibonacci's discovery to create the "Last Supper" painting with different dimensions and proportions. The numbers in the sequence can also be found in musical scales and on a piano keyboard.

Many famous composers and musicians integrate mathematics into their music, but Bach is known for this aspect. His works are filled with mathematical methods and concepts, especially the number 14. If we think of the alphabet as reflecting numbers, A=1, B=2, C=2, and H=8, adding these numbers equals 14. In his production of "Goldberg Variations," he uses the different parts to create a mathematical structure seen through 14 other elements, called canons. Another example of how Bach included mathematics into his music was in "The Musical Offering," where Bach's work proposed a mathematical link within the composition (Wildridge, 2019). Beethoven's use of math in his work can be problematic for some to understand, but he brings together the piano keyboard, musical score, and geometric pictures (Marshall, 2016). Lastly, Rauscher et al. (1993) have done extensive research on the "Mozart Effect" for students, explaining the relationship between listening to classical music and increasing spatial reasoning skills. The composers recognized the importance of mathematical concepts in music that helped them create masterpieces.

Many parts of music can be explained mathematically. Elements like pitch, rhythm, tempo, form, and meter relate directly to time and frequency, which are mathematical concepts. Also, musical intervals relating to ratios and time signatures are written as fractions. Studies have shown that students, who engage in musical activities, perform better academically in math than those who do not participate in music. Research has shown a positive correlation among students who use music in different study methods (An et al., 2014; DiDomenico, 2017; Froschauer, 2016; Garrett et al., 2018). When students are skilled in using musical instruments, they learn hand-eye coordination and data analysis when envisioning objects in space and time, which further solidifies math skills, leading to higher test scores. It is also proven through research that children who are taught musical aspects in areas such as mathematics retain information better than those taught in a verbal classroom (Fattal et al., 2019; Leandro et al., 2018; May, 2018). By using rhythms of music, students learn more, retain facts, and remember concepts taught in the classroom by allowing them to recall the rhythm or song about the information they need, which they can use to show their knowledge (Krishnan, 2020).

Significance of the Problem

As I have taught and worked individually with second-grade students at Greens Prairie Elementary School, I have noticed through informal observations, math conversations, and formative and summative assessment tools that students lack conceptual knowledge of basic math skills to solve higher-level thinking problems.

Many teachers struggle to teach basic concepts using only the district-aligned curriculum. Giving teachers additional tools in their toolbox can help them awaken their students' creativity, allowing them to understand mathematical concepts.

One specific concept where students struggle is skip-counting patterns. Learning how to skip-count is the backbone of many other math concepts. Skip-counting fosters a strong foundation for number sense and allows students to connect with patterns in numbers. Telling time and counting money are skills that are influenced by learning the process of skip-counting. Students who typically struggle with multiplication facts do not understand the concept of skip-counting and, therefore, continue to count by ones. Students who learn to skip-count effectively can use this tool to strengthen their multiplication fluency.

Some significant categories associated with my problem are students' math anxiety, lack of creative arts in the math curriculum, lack of skip-counting mastery, and few connections between math and the real world. Encouraging creativity to develop critical thinking skills is a benefit of integrating innovative methods in mathematics (Biller, 1995; Burton et al., 2000; Edelson & Johnson, 2003; Ediger, 2000; Marasco & Behjat, 2014; Perger et al., 2018; Sullivan & Bers, 2018; Tinh & Quang, 2019; Ufuktepe & Ozel, 2002; Vitale, 2011). Students who can relate mathematics to music are more likely to benefit from this type of mathematical creativity than students who do not create connections (Burton et al., 2000; Perger et al., 2018; Rajan, 2016). "Introducing the element of rhythm into arithmetic brings it closer to experiences the child has had in music" (Baravalle, 1944, p. 341).

Musical learning activities have proven beneficial in helping students retain information and promote better understanding and communication. College courses geared toward education do not teach future educators the benefit of integrating music into mathematics. If more research were conducted in schools and preservice teacher programs, more educators and educator programs could see and implement musical activities. It might be beneficial for teachers to be exposed to strategies integrating mathematics and music in their classrooms. I chose to investigate whether musical learning activities in math classrooms can help elementary children develop a deeper understanding of specific mathematics topics.

Research Question

The purpose of this study will be to explore various learning activities and skip-counting songs and videos by artists such as Jack Hartmann or Mr. R, along with the required district intervention curriculum with second-grade students identified as Tier III. They struggle with the foundational knowledge of skip-counting patterns and their relationships to other areas of mathematics, such as time and money. I will seek to examine and measure the growth of TEKS in section 1.5 as required by the state of Texas and answer the following research question:

1) When integrated into the second-grade intervention curriculum, what effects do musical learning activities, specifically songs and videos, have on students' understanding of and motivation to learn skip-counting patterns?

For the purpose of this document, a student's understanding of skip-counting patterns will be associated with the following characteristics: level of comprehension and retention of concepts. A student's motivation is measured by level of engagement and amount of confidence they possess.

Personal Context

I did not choose education; education chose me. Upon graduating from high school, I enrolled in the fall semester of college at Texas A&M University, majoring in Biomedical Sciences because I was going to be an anesthesiologist. When I was growing up, the answer to the age-old question of what I wanted to be when I grew up was always the same, an anesthesiologist. Little did I know that I was destined to be an educator. After some unfortunate circumstances, I withdrew from the university during my second semester and moved back to my hometown, where I enrolled in the community college. I knew I wanted to continue with my education at this point in my life but was no longer sure about pursuing the medical field.

While taking basic prerequisites at the college, I began working at a daycare, teaching four and 5-year-olds a Pre-K curriculum. I quickly realized I enjoyed being in children's presence and delighted in their moments of personal discovery. After receiving my associate's degree from the local community college, I decided to further my education but could not leave my hometown because I had started a family. Fatefully, at about the same time, a new program was launched to earn your degree in Interdisciplinary Studies. I enrolled in the two-year program with my daycare supervisor's encouragement to attain my teaching certificate.

While taking an introductory math course during my second semester, I decided to teach math. My professor focused solely on the conceptual knowledge of mathematics instead of formulas, steps, and processes. She taught us the "why" and how to problem solve, all while making the subject fun. She is the main reason for my selection of this study. Eventually, I graduated with a Bachelor of Science in Interdisciplinary Studies, concentrating in mathematics (4^{th}-8^{th} grade). Upon graduation, I took a job midyear at a Title I campus in my hometown. Unfortunately, the previous teacher had passed away, and I was asked to replace her position as a fourth-grade math teacher.

My first year was excruciating. I had so many obstacles to overcome, but I knew I needed to help those students succeed. Not only did my students have unstable home lives and live in poverty, but their conceptual understanding of mathematics did not exist. Most of my students performed at least two grade levels below 4^{th} grade. The foundation of mathematics was never built for these students because our primary goal was to help them survive and give them things to meet their basic life needs. I was determined to teach them the foundations of numbers and make them love the subject of math.

I stayed on that particular campus in the same classroom, teaching math to 4^{th}-grade students for the next 11 years. I received the Rising Star Award in my second year, Distinguished Teacher of the Year in 2010, and many other prestigious awards, including being selected to appear in an article for the National Council of Teachers of Mathematics (NCTM) in 2007. In addition to teaching my students, I was chosen to present professional development sessions for teachers in my district, showing them different ways to keep students engaged in the classroom.

As an educator, I also furthered my education and received two Master's degrees, one in Elementary Education and the other in Curriculum and Instruction with Mathematics (K-14) concentration. I was an adjunct professor for the college I received my degrees; I taught preservice teachers in an educator preparation program. During my role as a student, teacher, mentor, professor, or colleague, I realized the need for engaging mathematics and intense intervention. As a classroom teacher, I could hold the student's attention with music longer than any other method I used. I had access to various musical activities with songs, lyrics, and hand motions to teach particular math concepts. My students would remember the catchy tunes and repeat the lyrics during assessments. I knew that music could help my students be more successful in mathematics.

I used music for transitions and multiplication; students created their lyrics to teach other mathematical concepts. Music was present in every aspect of my classroom from the beginning to the end. One year my class choreographed a dance to a place value rap song we found on the internet and then produced our music video and uploaded it to YouTube. The state assessment results in the category of place value were the highest they had ever been since I had been teaching at the school.

My love of education has brought me to my current position as a math specialist for grades K-4th. My role is to provide intense, individualized instruction to students categorized as Tier III by the RtI guidelines. Through formative and summative assessment tools, I have noticed that students lack conceptual knowledge of skip-counting patterns and their relationships to other areas of mathematics. The district curriculum for intervention does not include musical activities as an option. My ROS artifact will combine music and non-music learning activity strategies, such as skip-counting songs and manipulatives. I will use the combined learning activities to teach mathematical concepts during intense intervention for second-grade students that align with state standards for skip-counting, the district math curriculum, and the RtI program.

Significant Stakeholders

The second-grade students, identified as Tier III for mathematics at Greens Prairie Elementary School in College Station, Texas, are the study's most significant and immediate stakeholders. Their evaluated and documented data will reflect if using the musical activities effectively taught skip-counting. Also, the second-grade classroom teachers are key stakeholders. Their Tier II classroom intervention activities could be adapted to include musical activities in skip-counting and, therefore, help students refrain from advancing to the Tier III level of intense intervention.

Other stakeholders include district leaders of the curriculum department, campus administrators, teachers, and students who are not currently enrolled in the intervention program. District leaders who write curricula for the elementary math departments across College Station can add additional resources to the mandatory scope and sequence for teachers to follow when engaging with their students. Campus administrators are responsible for ensuring that teachers implement the required programs set by the district. Teachers will be given valuable tools to help them teach the method of skip-counting. Students will benefit from a greater understanding of skip-counting, a fundamental math skill embedded in many mathematical objectives. Therefore, the study results can potentially impact students and their learning directly.

Important Terms

At-Risk Learner – Working memory, processing speed, attentive behavior, and spoken language abilities are all issues that at-risk students face when learning mathematics (Fuchs et al., 2013).

AVMR – Briand (2013) defined the term as: "a professional development program in early mathematics, trains teachers to assess their students' progress and apply those insights to their teaching pedagogy" (p. v).

Bridges Intervention – An instructional module that aids students by providing customized mathematics education in small groups and tracking progress (Lunde, 2021).

Conceptual Knowledge – "The concept of conceptual knowledge focuses on creating a deeper understanding of the meaning of mathematical operations as well as making connections between the relationships among the operations" (Miller et al., 2011, as cited in Lunde, 2021, p. 7).

Creativity – "The generation of imaginative new ideas…integrate existing knowledge in a new way" (Ayele, 2016, p. 3522).

Fluency – A combination of "both the ability to readily perform the mechanics of mathematics (procedures) and the understanding of the mathematics being learned (concepts)" (Cartwright, 2018, p. 202).

Formative Assessment – Formative assessment is a set of tasks used by teachers to measure a student's level of knowledge and understanding to provide feedback and plan future instruction (Baroudi, 2007).

Higher-Level Thinking – According to Alkhatib (2019), “a higher-order thinking level consists of four sub thinking skills, i.e., problem-solving, critical thinking, creative thinking, and decision-making” (p. 1).

Intervention – “Facilitated student engagement and motivation and thus assisted students in achieving the instructional goals in each lesson effectively” (An et al., 2013, p. 15).

MAP – “NWEA MAP interim assessments purport to predict performance on accountability exams and to inform instruction in advance of these exams with the ultimate goal of improving student achievement” (Finnerty, 2018, p. 1).

Math Anxiety – According to Mutlu (2019), “math anxiety is defined as the feelings of tension and anxiety that interfere with the manipulation of numbers and the solving mathematical problems in a wide variety of ordinary life and academic situations” (p. 471).

Math Specialist – Gerretson et al. (2008) define a math specialist as a teacher who takes on the position of a mathematics teacher leader and is frequently a mathematics mentor teacher.

Math Recovery – “A mathematics program for early intervention, designed to build a strong numeracy foundation using a constructivist-based approach to one-on-one and small group instruction” (Wright et al., 2006, as cited in Waller, 2012, p. 16).

Multiplicative Processes – "The multiplicative process for counting groups of groups derives from the operation of addition; if addition is applied to two sets, one numbering a and the other numbering b, and if there is one-to-one correspondence between the members of these sets (i.e., if $a = b$), then the total of $a + b$ can be given by the number $2a$ (or $2b$)" (Lampert, 1986, p. 306).

Music Elements – "Musical elements such as steady beat, rhythm, melody, and tempo possess inherent mathematical principles such as spatial properties, sequencing, counting, patterning, and one-to-one correspondence" (Geist et al., 2012, p. 74).

Musical Intervention – An et al. (2013) explored musical intervention and defined the term as: "students were offered different mathematics content related to a variety of mathematical-musical concepts" (p. 15).

Number Sense – Jordan et al. (2007) "defined number sense operationally as counting skill, number knowledge, and the ability to transform sets through addition and subtraction" (p. 42).

Pedagogy – "The term pedagogical content knowledge denotes teachers' specialized knowledge of math content, students, and instructional strategies that best suit students and the content" (Waller, 2012, p. 1).

Procedural Knowledge – "Procedural knowledge explores the ability to solve math problems by utilizing a step-by-step process" (Miller et al., 2011, as cited in Lunde, 2021, p. 7).

RtI – The U.S. Department of Education (2004) described RtI as specific and coherent evidence-based recommendations for use by educators addressing the challenge of reducing the number of children who struggle with mathematics by using response to intervention (RtI) as a means of both identifying students who need more help and providing these students with high-quality interventions.

Scope and Sequence – "*Scope* is very simply defined as the extent of what is taught. The *sequence* is the order in which the understandings, skills, and values are addressed" (Maker, 2003, p. 26).

Skip-Counting – Gibbs et al. (2018) refer to skip-counting as a way of counting numbers that involves adding a number to the preceding one each time.

Spatial-Temporal Reasoning – "Improved spatial-temporal reasoning leads to improved learning in disciplines that putatively rely on spatial thinking, such as mathematics, physics, engineering, or architecture" (Hetland, 2000, p. 137).

STEM/STEAM – Tillman et al. (2015) referred to this as "STEM (science, technology, engineering, and mathematics) lessons were integrated with arts activities to create an interdisciplinary STEAM (science, technology, engineering, arts, and mathematics)" (p. 302).

Summative Assessment – Dixson and Worrell (2016) define summative assessment as "high-stakes assessments used to get a final assessment of how much learning has taken place" (p. 156).

Closing Thoughts

Students often develop math anxiety due to struggling with mathematical concepts, specifically skip-counting. Students who do not build a strong foundation of skip-counting may grapple with future concepts such as time intervals, counting money, patterns in numbers, multiplication facts, and real-world activities such as keeping scores in sporting events.

This action research study investigates the effects of musical and non-musical learning activities on students' achievement in and disposition to skip-counting patterns when integrated into the second-grade intervention curriculum. I performed a qualitative case study and used qualitative methods in my data collection, including an interview, pre and posttest, exit ticket, and anecdotal notes. Chapter 2 looks more closely at the research surrounding the causes and effects of math anxiety, the importance of personal connections, and how they promote learning. Also, I explored the benefits of creative arts for children, teaching skip-counting, and musical intervention before discussing the solutions and methods in Chapter 3, the analysis and results in Chapter 4, and the conclusions in Chapter 5.

CHAPTER II

LITERATURE REVIEW

Elementary-aged children who lack conceptual understanding of mathematics have difficulty with problem-solving and higher-order thinking skills. Teachers' methods of teaching mathematics directly affect students' ability to apply mathematics to the real world. Allowing students to be creative in their learning can help close the gap in math classrooms. Through my ROS, I will implement learning activities and skip-counting songs and videos by artists such as Jack Hartmann or Mr. R to help students build the foundational knowledge of skip-counting patterns as a steppingstone in future mathematical tasks.

The research presented in the literature review represents an attempt to address the effect of creativity on learning the skills needed to foster an understanding of mathematics for students at the elementary-age level. This review of the literature was designed to include the following topics from prior researchers: the difficulties and struggles in mathematics in elementary-aged children, the causes and effects of math anxiety, the importance of personal connections and how they promote learning, the benefits of creative arts for the child, integration of music into the curriculum, the importance of skip-counting, and disadvantages in integrating music into the curriculum. Research suggests that students who struggle with mathematical concepts can develop math anxiety. Students struggle with mathematical concepts for many reasons prior researchers have discussed.

Causes and Effects of Math Anxiety

Educators generally teach mathematics using structured thinking strategies, causing many students to struggle to comprehend mathematical concepts. Math anxiety can be found in classrooms where creativity is not cultivated in students (Biller, 1995; Burton et al., 2000; Forseth, 1980) and can, unfortunately, be fostered through a teacher's pedagogical strategies (Ayele, 2016; Biller, 1994, 1995; Rufo, 2017; Forseth, 1980; Ufuktepe & Ozel, 2002). "The combination of arts and mathematics can help students balance their education with a combination of creative imagination and logic" (Biller, 1995, pg. 1). Students who experience math anxiety do not flourish under one learning style.

Students who battle with math anxiety often struggle in the same mathematics areas that other students excel in. Math anxiety can occur in specific areas of mathematics, including students' continuous use of immature procedures, such as counting on their fingers, which leads to trouble developing numeracy skills, and remembering formulas and numerical rules (An et al., 2013; Nelson & Powell, 2018; Tomasetto et al., 2020). Students who experience math anxiety have trouble using existing knowledge to apply it to new information, time constraints in learning, inadequate testing procedures, and have negative experiences with teachers in the field of mathematics (An et al., 2011; An et al., 2013; Fiore, 1999; *Math Deficits*, 2017; Mutlu, 2019; Nelson & Powell, 2018; Tomasetto et al., 2020). "A bad experience with a mathematics teacher can cause math anxiety results more from the way the subject matter is presented than from the subject matter itself" (Greenwood, 1984, as cited in

Fiore, 1999, p. 403). If students cannot overcome specific areas where they struggle, their math anxiety will continue to grow and cause problems in their performance.

Students who have low performance due to math anxiety face many other problems attached to low performance. It is important to note that research has found links between understanding mathematical concepts that influence students' understanding as they grow (*Math anxiety causes trouble*, 2012; Nelson & Powell, 2018). Many researchers believe that these observations can be collected when the student is in kindergarten; the observations set a trend of predicting difficulties in the student’s future. Math anxiety can further hinder students throughout their secondary education and adult lives (*Math anxiety causes trouble*, 2012; Nelson & Powell, 2018; Tomasetto et al., 2020). Students who have math anxiety have conceptual, attention, and memory deficits that can affect a student’s math performance (An et al., 2013; *Math anxiety causes trouble*, 2012; Tomasetto et al., 2020). Math anxiety affects many aspects of students’ mental, social, and emotional development throughout their lives.

There are many ways that teachers can inadvertently cause math anxiety in students’ learning and understanding of mathematics. Sometimes during a teacher’s education, their learning could have been based too much on theoretical practices instead of how the subjects they teach relate to the real world and teaching methods not allowing for student-directed learning opportunities (An et al., 2011; Morgan et al., 2015). Teachers' knowledge about pedagogical content from their education and how the subject matter is presented to students instead of the subject matter can affect students' math anxiety (An et al., 2011; Fiore, 1999; Mutlu, 2019). “One cause of math trauma for students is the teaching style in the mathematics classroom" (Ufuktepe & Ozel, 2002, p. 3). If teachers do not have the tools in their pedagogical toolbox necessary to amend the pedagogy required for their curriculum, they will not teach effectively.

Individual students have different learning styles, and teachers must cater to every student's learning needs. There are many lasting effects of developing math anxiety, including teachers who do not allow opportunities for students to express themselves through creativity, teachers who tell students how to solve the problem instead of understanding the processes, and teachers not providing opportunities for mobility in learning styles (*Creative Teacher Exchange*, 1954; Hall & Thomson, 2017; Rajan, 2016). Another cause of math anxiety in students relates directly to classroom teaching pedagogies and how the subject matter is presented to students instead of the subject matter itself (Mutlu, 2019; Ufuktepe & Ozel, 2002). According to *Creative Teacher Exchange* (1954), learning is achieved when the teacher is alert and allows for multiple opportunities for students to express knowledge through creativity. If students do not feel comfortable in their classrooms or with the learning style introduced, they will not be effective learners, potentially affecting their school education.

Personal Connections and How They Promote Learning

Students' connections in their everyday lives are significant and relevant to the mathematics field. Students who struggle with the logistics of mathematics are the ones who cannot form these connections and link existing knowledge to new knowledge (An et al., 2013; Tillman et al., 2015). Students benefit from these connections, mostly made outside of school (Burton et al., 2000; Garrett et al., 2018; Rajan, 2016). "This provides students with the opportunity to apply their mathematical knowledge in meaningful ways and connect new mathematical knowledge to existing knowledge" (An et al., 2013, p. 2). Regardless of the connections, they will benefit students in many aspects of their education, especially mathematics.

Students' personal connections allow them to rely upon their previous knowledge to understand new knowledge concerning what they have already retained. "We integrate and draw on knowledge and experience throughout all that we do. We should educate in the same way" (May, 2018, p. 23). Integrating mathematics with creative arts allows students to develop many skills, such as creating different ways to communicate their knowledge and develop generalizations while opening multi-modal opportunities to open in classrooms (An et al., 2013; May, 2018; Perger et al., 2018). "Students will be afforded meaningful learning opportunities as they synthesize their knowledge and experiences and make relevant connections across subjects" (May, 2018, p. 25). If students have meaningful, relevant connections in their lives, they can make new connections to the field of mathematics.

Life experiences are essential for students to relate mathematics to real-world experiences they understand; if they do not have those relevant experiences, the mathematical concepts will not always be relevant. Students who usually struggle in math are the ones who cannot make personal connections to the real world (Burton et al., 2000; Tillman et al., 2015). Students who struggle with making real-world connections outside of school struggle with mathematical concepts and will not benefit like other students (Garrett et al., 2018; Rajan, 2016; Tillman et al., 2015). "Introducing the element of rhythm into arithmetic brings it close to experiences the child has had in music" (Baravalle, 1944, p. 341). If students do not have relevant experiences, the teachers who try to implement real-world thinking as an alternative learning method will not benefit every student.

In previous studies, popular music was used to teach connections to mathematical aspects and taught students to develop the tools to draw on their knowledge and experiences (Jones & Pearson, 2013; May, 2018). Teachers should adjust their curriculum to incorporate these skills and show their students how relevant and essential these real-world situations are to mathematics (Martinie, 2006; May, 2018). "Students need to be hooked into exploring mathematics by an interesting context, problem, or investigation, and they need to see real-world connections" (Martinie, 2006, p. 274). To fully understand new concepts, students can use previous knowledge forged by connections to retain those concepts better.

Benefits of Creative Arts

Fostering student creativity has a multitude of benefits throughout the field of education. Creativity in students can lead to the development of brainstorming skills, problem-solving skills, student learning skills, interpreting skills, analytical skills, communication skills, imaginative skills, innovative skills, and reasoning skills (Ayele, 2016; Biller, 1995; Froschauer, 2016; Perger et al., 2018; Rajan, 2016; Sullivan & Bers, 2018; Vitale, 2011). This use of creativity helps students develop confidence and express themselves through different creative outlets while keeping students engaged and allowing them to work with others (Annarella, 2000; Baravalle, 1944; Biller, 1994;

Creative Teacher Exchange, 1954; Rajan, 2016; Todhunter-Reid, 2019; Ufuktepe & Ozel, 2002). This kind of creativity in students needs to be nourished to maintain student confidence in their abilities and keep them actively engaged in learning (Annarella, 2000; Ediger, 2000; Sullivan & Bers, 2108). Creativity is a central aspect of diminishing math anxiety for students of all ages.

Many studies focus on the benefits of creative arts on learners' brains. It is widely known that artistic students perform better in cross-curricular studies when different aspects of the arts are integrated into learning, as shown in students scoring higher in numeracy and literacy scores (Simpson Steele, 2016; Vitale, 2011). It has also been shown that students who play instruments produce more grey matter in the brain, and listening to music can raise students' IQs (Vitale, 2011). Divergent thinking skills come from free play; children who possess these skills tend to score higher on tests (Wallace & Russ, 2015). There are many benefits to the brains of students who are creatively and logically challenged at the same time.

If students can freely express themselves and use methods that allow them to learn and retain information effectively, they will have a better chance of success. Freedom in learning in mathematics has open opportunities for creativity and encourages students to work closely with their peers while engaging with their bodies, sounds, and movements to promote learning (Burton et al., 2000; Sullivan & Bers, 2018; Ufuktepe & Ozel, 2002). With the implementation of a student-focused curriculum, teachers can allow students to integrate arts into their learning and develop divergent thinking, which comes from the freedom to play (Annarella, 2000; Simpson Steele, 2016; Wallace &

Russ, 2015). “To motivate students is to have a student-focused curriculum; one in which the student is permitted to discover, ask questions, and to progress in an inquiry approach to learning” (Annarella, 2000, p.5). Students who are allowed freedom in the classroom find learning methods that work for them, creating more successful students.

Student motivation is imperative for student retention of information; if students are not motivated, learning will not occur. Students all have a creative side that needs facilitation and nourishment, which needs to be encouraged by teachers and peers (An et al., 2013; Ediger, 2000; Ufuktepe & Ozel, 2002). By ensuring that students stay motivated, teachers can reach students on the lower level of the academic scale, maintain the interest of successful students, and provide adult involvement where it would otherwise be nonexistent (An et al., 2013; Ufuktepe & Ozel, 2002). “Mathematics-music integrated instruction has the potential of improving students’ attitudes toward learning mathematics and of increasing students’ mathematics achievement” (An et al., 2013, p. 2). Motivated students create avid learners, and avid learners make successful pupils.

Students who can relate their knowledge from instruction to 21st-century methods and experiences will have the upper hand in information retention. Creativity is necessary for 21st-century learning (An et al., 2013; Ayele, 2016; Simpson Steele, 2016). Twenty-first-century thinking allows students to discover new learning opportunities, transform concrete experiences into abstract ones, develop critical thinking skills, and relate lessons to real-world issues (An et al., 2013; Annarella, 2000; Ayele, 2016; Forseth, 1980; Simpson Steele, 2016; Tinh & Quang, 2019). “Creativity is a necessary and vital tool for dealing with the economic, environmental, and humanitarian challenges of the 21st century" (Ayele, 2016, p. 3521). If students have the tools to relate their learning to aspects of the 21st century, they will have a greater chance of creating meaningful connections.

Integration of Creative Arts into the Curriculum

Creativity in the classroom opens many opportunities for teachers to use many different pedagogies within the arts to be included in the teachers' curriculum. By implementing creative activities into the pedagogical content, teachers foster active learning within students, convert concrete experiences to abstract experiences, express their knowledge through creative outlets, develop higher thinking skills, and use those skills to understand broader subject knowledge. Creativity helps students develop skills that are not generally found in the STEM field and improves students' attitudes toward mathematics (An et al., 2014; Ayele, 2016; Burton et al., 2000; *Creative Teacher Exchange*, 1954; Ediger, 2000; Fattal & An, 2019; Forseth, 1980; Leandro et al., 2018; Sullivan & Bers, 2018; Tillman et al., 2015). Teachers who have tried to promote creative outlets in their content sometimes find that they have a difficult time doing so, and teachers who have successfully implemented creative activities have found that working with artists stimulated their imagination, which they brought to the classrooms (An et al., 2011; Garrett et al., 2018). "Traditional mathematics curricula and instructional methods that promote one way to demonstrate mathematics, thereby neglecting conceptual understanding, are considered the key factors that cause mathematics anxiety among students" (Furner & Berman, 2005, as cited in An et al., 2014, p. 153). If teachers effectively adapt the pedagogy used in their classrooms, they can reach a broader range of students.

Developing confidence is one of the most significant benefits of implementing arts into a mathematical curriculum. Students in classrooms that promote the arts in mathematics have a better sense of self-identification. The arts encourage trust in student's abilities, allowing for students to express themselves, and improve their attitudes and confidence toward learning in general (An et al., 2013; Annarella, 2000; Baravalle, 1944; Forseth, 1980; Hall & Thomson, 2017; Todhunter-Reid, 2019; Ufuktepe & Ozel, 2002). Creativity in mathematics also allows students to develop social skills and enhance their self-confidence and self-esteem (Biller, 1994; Burton et al., 2000). "Students do come up with unique ideas if creative expression is encouraged" (Ediger, 2000, p.5). Confidence is an essential characteristic of a well-rounded student.

Balancing education with imagination might seem daunting, but research shows it might not be as tricky as educators first believed. "The combination of arts and mathematics can help students balance their education with a combination of creative imagination and logic" (Biller, 1995, p. 1). Imagination promotes creativity, which helps with problem-solving; combining math and arts can balance differences between logical thinkers and creative thinkers, allowing students to work together to solve problems (Biller, 1994, 1995; Rajan, 2016). "It is widely recognized that students do enjoy the arts and perform better on a range of tasks when the arts play a part in their learning" (Simpson Steele, 2016, p. 116). Imagination is an integral part of allowing students to develop relevant mathematic skills.

Active learning incorporates STEM and the arts to allow students a well-rounded way to retain information. Teachers should integrate the arts into STEM fields as part of the curriculum (Froschauer, 2016). Active learning is thinking creatively and reaching achievement gains where the STEM field fails to foster those types of open-ended behavior and is usually taught with a lack of creative methods (Ayele, 2016; Leandro et al., 2018; Morgan et al., 2015; Sullivan & Bers, 2018; Tillman et al., 2015; Tinh & Quang, 2019). “Students can become so immersed in the experience that learning becomes indistinguishable from the creative aspect” (Tillman et al., 2015, p. 319). Active learning promotes both logical thinking and creative thinking, making up for deficits found in both methods.

Higher-order thinking skills are especially crucial for students who have difficulties in comprehension within the STEM field. Students who have teachers that integrate the arts into mathematics have shown improvements in brainstorming, strategizing, problem-solving, and memorization by allowing students opportunities to express creativity and innovation (Ayele, 2016; Fattal & An, 2019; Sullivan & Bers, 2018; Todhunter-Reid, 2019; Vaughn, 2000). The movement's effectiveness in cognitive abilities helps create divergent thinking skills, which is necessary for comprehending written symbols in reading and math (Fattal & An, 2019; Wallace & Russ, 2015; Vaughn, 2000). “Creativity invites experimentation, formulation of new hypotheses, and opens possibilities” (Ayele, 2016, p. 3524). Higher-order thinking skills often require an understanding of mathematics, nourished by implementing creative arts in mathematics.

Students who experience classrooms where the arts are infused into lessons have a greater chance of exploring experimentation in learning methods, including student-led lessons and a student-focused curriculum (Annarella, 2000; Ayele, 2016). Teachers promoting integrative arts allow students to express their knowledge through personal creativity enabling those teachers to have a greater chance of gauging their student's comprehension of the subject (*Creative Teacher Exchange*, 1954; Sullivan & Bers, 2018). "Traditional STEM curricula and tools do not always successfully foster the open-ended imaginative, playful, and creative behaviors that technology education has the power to cultivate" (Sullivan & Bers, 2018, p. 328). If teachers can engage students in many ways, they will likely reach more students than one engagement method.

Implementing the arts into mathematic curricula can help improve academic performance. Arts can improve other difficulties by enabling students to access broader subject knowledge and meaningful learning (Garrett et al., 2018; Leandro et al., 2108; Perger et al., 2018). Students' primary lessons can still be taught by implementing the arts, allowing teachers to energize the lessons by implementing arts (Garrett et al., 2018; Todhunter-Reid, 2019). "While the arts provide resources and conceptual ideas to engage students and personalize learning, they also support students' access to broader subject knowledge" (Garrett et al., 2018, p. 3). Academic performance improves when artistic aspects are infused into mathematics lessons.

Retention and memory are skills students can develop more effectively when creative arts are utilized in mathematics. "Movement is an effective cognitive strategy to improve memory, and retrieve and enhance learner motivation and morale, thereby strengthening learning" (Jenson, 2005, as cited in Fattal & An, 2019, p. 178). Utilizing creative arts for students in mathematics helps promote knowledge retention, develop problem-solving skills, and encourage conceptual understanding (Fattal & An, 2019; Morgan et al., 2015). Creativity in mathematics emphasizes conceptual understanding and, more significantly, student-directed learning (Morgan et al., 2015). Memory and retention skills are fundamental in mathematics because mathematics often uses memorization techniques.

Creative arts integrated into the mathematics curriculum create beneficial conceptual tools students will use throughout their school years. With creativity in mathematics, students will retain concepts longer, develop memorization skills, and sharpen their phonic awareness (An et al., 2013; Leandro et al., 2018). Music stimulates neuron activity in a student's brain, specifically responsible for math-related reasoning, promoting self-awareness, motivation, and even empathy (An et al., 2013; Colwell & Davidson, 1996). Learning through doing creates greater retention (Leandro et al., 2018). Conceptual understanding of mathematics can be fostered through the creative arts.

Importance of Skip-Counting

A specific area where students may struggle in early elementary mathematics is skip-counting, counting every *n*th number in a series. Several researchers have noted that skip-counting provides a foundation for basic arithmetic operations such as addition and multiplication and allows students to observe and predict patterns in numbers, as well as builds a background for composing and decomposing numbers

(Bray & Blais, 2017; Hazen, 1996; Fernandez, 2008). "Skip-counting, in and of itself, can represent important developmental shifts in working with composite units and should be encouraged for its own sake" (Wilkins & Ulrich, 2017, p. 11). Skip-counting is an essential tool for students to learn and can serve as a prerequisite for future mathematical concepts.

A hierarchy exists for teaching skip-counting. Most researchers believe that teaching skip-counting very early in a particular order is beneficial for the child to become more knowledgeable about whole-number concepts (Bray & Blais, 2017; Fernandez, 2008; Frank, 1989). According to Wilkins and Ulrich (2017), counting by tens lays the foundation for place-value and money; skip-counting by fives aids in telling time and counting money; counting by twos can help students determine whether numbers are even or odd. Several researchers have noted the importance of teaching skip-counting in early mathematics can help students better understand the concepts of whole numbers.

Music is one of the best ways for students to remember a concept. "Much like they begin their early counting as a sing-song, children can also learn to skip-count through repetition and song" (Wilkins & Ulrich, 2017, p. 11). Combining skip-counting and music can help draw upon children's creative imaginations and can be connected with other modes for learning, such as manipulatives, real-world objects, and kinesthetics (Hazen, 1996). When students learn the material through music, they can store information longer in their memory banks and connect them to mathematical concepts for years to come.

Integration of Music into the Curriculum

Several studies have shown that the creative arts' cross-curricular integration offers many benefits for students and teachers. An interesting aspect of STEM courses is that some researchers believe that this field should automatically integrate arts into the teaching curriculum, supporting the connections across all the disciplines (An et al., 2014; Egger, 2019; Froschauer, 2016). Music and movement should be interdisciplinary tools used by teachers because students develop holistic thinking skills, which lead to a deeper understanding of the material (An et al., 2014; DiDomenico, 2017; Egger, 2019; Garrett et al., 2018; Leandro et al., 2018). Teachers can use music across disciplines as an alternative pathway for students who do not benefit from traditional learning methods (DiDomenico, 2017; May, 2018). Evidence regarding the importance of integrating creative arts across multiple disciplines is extensive and relevant to student learning.

Music has multiple benefits in the field of education, specifically in mathematics. When teachers use music in the classroom, they can inspire student creativity, promote attention and engagement, and create an encouraging learning environment (An et al., 2013; DiDomenico, 2017; Geist et al., 2012). The brain relates math and music from very early on in life; if teachers use active participation in music and mathematics, they can apply math in meaningful ways while also increasing student's math abilities (An et al., 2013; DiDomenico, 2017; Geist et al., 2008, 2012). "Music increases elementary students' engagement, helps with memory and recall, and enhances phonemic awareness during literacy instruction" (Dyer, 2011, as cited in DiDomenico, 2017, p. 2). Music has many benefits for students when related to mathematics.

Achievement gains accurately measure student progress over a period, and using the creative arts in mathematics shows a positive trend in student achievement gains. When teachers use the creative arts in mathematics, research has shown that it improves students’ attitudes toward math and learning (An et al., 2013; DiDomenico, 2017; Geist et al., 2012). Teachers can also use music to change and improve students' overall attitudes toward learning in the classroom (DiDomenico, 2017; Geist et al., 2012). “Music can also heighten awareness, stimulate imaginative thinking, increase concentration, relax during tests, and serve as a great background for silent reading, writing, and art” (Cornett, 2007, as cited in DiDomenico, 2017, p. 5). Music integrated with the education field has many benefits for student achievement gains.

Research investigating music and mathematics integration has shown countless benefits of combining music methods into the teaching curriculum. Studies have investigated musical qualities and found that they are instrumental in speech development and comprehension (Colwell & Davidson, 1996; DiDomenico, 2017). Previous research called attention to the relation between music and mathematics and found that the natural similarities in music possess principles vital for teaching mathematics (An et al., 2014; Azaryahu et al., 2020; Geist et al., 2012; Rajan, 2016). If teachers use songs to teach mathematical concepts, they receive the benefits of simultaneously teaching cross-curricular topics (An et al., 2014; DiDomenico, 2017). This research has gained support from many studies that show the ever-growing relationship between mathematics and music.

Some of the benefits that music brings to mathematics perceptually are using movement, color, sounds, or any sensory stimulant to balance relationships between physical and mental learning (Burton et al., 2000; *Creative Teacher Exchange*, 1954). Active music experiences, such as playing an instrument or dancing, causes our brain to release chemicals that have been found to enhance our long-term memory (DiDomenico, 2017; Leandro et al., 2018; Wallace & Russ, 2015). Perceptual awareness in music is also closely related to the understanding that students must think about movements before they make them, which are classified as quick thoughts; they use these while setting goals, executing decisions, and analyzing variables (DiDomenico, 2017; Fattal & An, 2019; Leandro et al., 2018; Wallace & Russ, 2015). Perceptual awareness benefits using creative arts in mathematics and benefits mathematic skills and other skills.

Rhythm in music is one of the most relative aspects of mathematics. Rhythm is an integral part of mathematics (Baravalle, 1944; Colwell & Davidson, 1996; Edelson & Johnson, 2003; Geist et al., 2008). Aspects of rhythm allow students to identify notes, tempo, and patterns, which all are relevant to the study of mathematics (Colwell & Davidson, 1996; DiDomenico, 2017; Geist et al., 2012; Jones & Pearson, 2013). Rhythm allows students to make connections in music (Baravalle, 1944; Colwell & Davidson, 1996). Thus, prior research supports combining aspects of music in mathematics as beneficial for numerous students.

Several researchers have noted the connections between music and mathematics, especially when working with fractions. With the implementation of music into mathematics, "students learned how to identify the notes and the fractional value of each note" (Jones & Pearson, 2013, p. 19). Music helps students determine intervals and identify notes, allowing the teachers to introduce the part-whole concept. The connections made from music to the part-whole concept will enable students to make these connections within the math curricula and help students develop their fractional and subtraction concepts (DiDomenico, 2017; Fattal & An, 2019; Jones & Pearson, 2013; Schmidt-Jones, 2019). This research can be generalized because mathematics teaching and learning can significantly benefit from introducing music into the curriculum.

Other researchers have demonstrated that counting is another aspect of mathematics that can benefit from integrating music. "Music is one of the children's first forms of communication and often is their first interaction with mathematics" (Geist et al., 2008, p. 23). Music can help students understand numerical relationships, pitch, and increase phonic awareness, which is necessary for students to excel in mathematics learning (May, 2018; Geist et al., 2008, 2012; Schmidt-Jones, 2019). "Steady beat activities, such as clapping or marching, help children understand numerical relationships" (Geist et al., 2008, p. 21). Researchers have forged meaningful connections between music and mathematics, given the evidence from previous studies.

Most of the literature on musical aspects, explicitly sequencing, positively relates to mathematics teaching. Music creates rhythmic patterns that can be heard and felt by students, which helps them develop skills in analyzing and creating patterns and sequences (An et al., 2014; Baravalle, 1944; DiDomenico, 2017; Edelson & Johnson, 2003; Geist et al., 2012; Rajan, 2016). Patterning is one of the critical mathematical standards because it helps students develop reasoning skills and enhanced learning strategies (DiDomenico, 2017; Edelson & Johnson, 2003; Geist et al., 2012). “Patterns inherent in the music are heard and felt simultaneously” (Geist et al., 2012, p. 75). Patterns are an apparent connection between mathematics and music.

There is also documentation of a heightened understanding of time measure when mathematics and music are integrated. Time measure is related to music's rhythm and patterns (Jones & Pearson, 2013). Researchers have concluded that music helps students comprehend rhythm to measure time and gives them the necessary skills to read time signatures (Jones & Pearson, 2013; Schmidt-Jones, 2019). Time measure also teaches students intervals and fills the space between notes (Schmidt-Jones, 2019). The crux of the research on the combined lessons of mathematics and music led us to conclude that music and mathematics are closely related. Thus, there are benefits to integrating the creative arts into the mathematics curriculum.

Disadvantages of Integrating Music into the Curriculum

Not all research agrees that music is a helpful strategy for teaching academic subjects. Some researchers blame the lack of successful music transfer to memory on socio-economic status, while others argue that the transferability decreases with age when adolescents' hormones increase (Hetland, 2000; Vaughn, 2000). “Students who study music and do well in math may come from families that value both study of the arts and academic achievement” (Vaughn, 2000, p. 154). Music was thought to have the greatest spatial influence on children from lower socio-economic backgrounds. This concept was developed because children from poorer socio-economic backgrounds likely come from less enriched settings, making them more susceptible to the stimulation offered by music education (Hetland, 2000). Even though not all researchers have come to the same conclusion about the effectiveness of music integration through academics, multiple pieces of research speak to the efficacy of using musical aspects within the classroom.

Several meta-analyses were conducted to measure the effectiveness of using music as a teaching tool. Among the findings of the small amount of literature are words that describe the math music connection as unjustified, inconsistent conclusions, ineffective, weak findings, and small positive effect sizes (Sala & Gobet, 2020; Vaughn, 2000). “Moreover, recent correlational studies have confirmed that music engagement is not associated with domain-general cognitive skills or academic performance” (Sala & Gobet, 2020, p. 1438). Music likely accelerates a universal developmental process in spatial abilities rather than giving a long-term benefit (Hetland, 2000). Although valid in their research, these researchers’ assumptions and conclusions from the data do not represent the study of music integration to help students with skip-counting and other mathematical concepts.

Some researchers in the field have expressed optimism about music instruction. “Studies in which musical jingles were used as memory aids to teach math were excluded because these studies did not provide authentic music instruction” (Vaughn, 2000, p. 150). More frequent use of either teacher-directed or student-centered instructional approaches correlated with student achievement in students without math challenges. More frequent use of manipulatives/calculators or movement/music activities, on the other hand, was not linked to substantial gains in any of the groups (Morgan et al., 2015). Direct teaching in spatial ability was less effective than a mix of direct instruction and separate but concurrent music education (Hetland, 2000). The research surrounding manipulatives and movement does not show improvement in scores. At the same time, the application of music in mathematics supports the concept of using music in mathematics to assist students with difficult mathematical concepts.

Concluding Thoughts

Allowing students to explore their musical creativity in mathematics helps them make necessary connections to understand the subject's processes or concepts. This literature review has investigated many benefits of implementing musical learning activities into the elementary mathematics curriculum. Significant studies have been conducted to highlight the difficulties and struggles in mathematics in elementary-aged children (Martinie, 2016; *Math deficits*, 2017; Mutlu, 2019; Nelson & Powell, 2018; Tomasetto et al., 2020), the causes and effects of math anxiety (An et al., 2013; *Math anxiety causes trouble*, 2012; Nelson & Powell, 2018; Tomasetto et al., 2020), the importance of personal connections and how they promote learning (Burton et al., 2000; Tillman et al., 2015), the benefits of creative arts for the child as a whole (Ayele, 2016; Biller, 1995; Froschauer, 2016; Perger et al., 2018) and integration into the curriculum (An et al., 2014; Ayele, 2016; Burton et al., 2000; *Creative Teacher Exchange*, 1954; Ediger, 2000; Fattal & An, 2019; Forseth, 1980; Leandro et al., 2018; Sullivan & Bers, 2018; Tillman et al., 2015). Also, in reviewing the research literature, it has been noted that skip-counting is an essential concept for students to obtain to be able to solve higher-level thinking problems in mathematics (Bray & Blais, 2017; Fernandez, 2008; Frank, 1989; Hazen, 1996; Wilkins & Ulrich, 2017). Integrating music in the curriculum to teach skip-counting is beneficial, as the research suggests (An et al., 2013; Azaryahu et al., 2020; Baravalle, 1944; DiDomenico, 2017; Edelson & Johnson, 2003; Geist et al., 2012; Rajan, 2016). There is little research to refute music's effectiveness for academic success in mathematics, but researchers have conducted meta-analyses to support their hypotheses (Hetland, 2000; Morgan et al., 2015; Sala & Gobet, 2020; Vaughn, 2000).

To summarize the research presented in this literature review, it is beneficial for students to combine mathematics and creative aspects, specifically music. Through my ROS, I explored musical learning activities, such as songs and videos, and the required district intervention curriculum with second-grade students identified as Tier III. They struggle with the foundational knowledge of skip-counting patterns. I examined and measured the growth of specific objectives required by the state of Texas.

CHAPTER III

METHODOLOGY

Proposed Solution

The goal of my proposed problem of practice was to observe the understanding and motivation of second-grade students' achievement in skip-counting patterns by implementing musical learning activities (Jack Hartmann and Mr. R videos), along with activities from the required curriculum, during Tier III instruction in my classroom. The research question guiding this study was: When integrated into the second-grade intervention curriculum, what effects do musical learning activities, specifically songs and videos, have on students' understanding of and motivations to learn skip-counting patterns?

Outline of the Proposed Solution

I used a pretest-posttest and repeated measures research design with qualitative methods to analyze data for my proposed solution. For the pretest-posttest portion, I interviewed seven of my second-grade Tier III students before and after implementing my planned learning activities. The interviews helped measure two constructs: (1) each student's disposition about learning math, listening to songs, and singing songs, and (2) each student's verbal ability to accurately and efficiently skip-count by 2s, 5s, and 10s. The disposition portion of the interview is detailed in Appendix B.

For the portion of the repeated measurements of the research design, I implemented short learning activities during intervention approximately four times per week for five weeks. The sessions included activities with and without music. For the music activities, I played skip-counting videos with songs from Jack Hartmann and Mr. R. These videos skip-counted by 2s, 5s, and 10s forward and backward. I instructed students to follow the music by listening and singing when applicable. Each time, during the implementation of the music session, I videoed and observed how students were acting and responding during the musical activities. On the days I used non-musical instruction, I taught students skip-counting procedures using number line activities, Unifix cubes, and hundreds charts. Again, I videoed and noted how students reacted and performed during the hands-on activities.

After each session with the students, I had them express their feelings towards the short learning activity on an exit ticket regardless of the activity used. The students chose a sticker with a picture of a face depicting and representing the emotion they felt after each planned learning activity. Students could choose from a green smiley face, a yellow straight face, or a red frown face. Because the participants were second graders, I chose to use the colored faces because this option allowed them to use pictures to express their feelings without reading requirements. The stickers were also something the students were familiar with seeing. After students selected the face sticker representing their emotion after the learning activity, I placed the sticker on the corresponding day on the chart (See Appendix C).

Justification of Proposed Solution

Through the study, I aimed to examine the efficacy of using music, through song and movement, to enhance students' understanding of and motivation to learn skip-counting patterns. Skip-counting is an important prerequisite for mastering the concepts of multiplication and division. Exploring techniques for underperforming students to master skip-counting can help them better understand and master the concepts of multiplication and division while at the same time strengthening their multiplication and division skills for future grades.

At Greens Prairie Elementary School (GPES) in College Station Independent School District (CSISD), standardized performance assessments inform our assessment team that most of the GPES third and fourth-grade students struggle with the concept of multiples and multiplication. My study aimed to build a stronger foundation of skip-counting in second-grade intervention students as a precursor for multiplication in the upper grades. The study participants already had deficiencies in many areas of mathematics, including skip-counting. According to the TEKS, skip-counting by 2s, 5s, and 10s is an objective students should master by the end of the 1^{st} grade. Helping students see the patterns in skip-counting lays a solid base for multiplication and division.

Study Context and Participants

The study was conducted with second-grade intervention students at GPES in CSISD. GPES serves approximately 600 students in grades Pre-K through 4th. The average second-grade class size at GPES is 20 students. The 2021-2022 second-grade population consists of 96 students, of which 75% are Caucasian, 8% are Hispanic, 7% are African American, 3% are Asian, and 3% are coded as other races. Of the 96 second-grade students, eight students are categorized as ELLs or SPED.

In the beginning, this study included seven second-grade students identified as Tier III in mathematics. According to MAP data and other formative assessments conducted by the classroom teachers, these seven Tier III students were at least two mathematical grade levels behind their peers. To address this deficiency, the GPES Student Intervention Team (SIT) Committee agreed to place the Tier III students into an intensive, individualized program that targets gaps in their mathematical skill set.

Because I am the teacher for these Tier III students in the intensive intervention class, my study used convenience sampling. Though this type of sample adds a limitation to my study and does not allow it to be generalized, my study still provides insight into how music could enhance student learning for those identified as mathematically deficient.

For my case study, I chose three students out of the seven, second-graders. The final three participants were chosen because they were the only ones who did not have any missing data points at the end of the research. I studied how these three students' understandings, behaviors, and accuracies changed over the five-week intervention activities.

Proposed Research Paradigm

My study used qualitative methods along with descriptive statistics to analyze and triangulate the data. Descriptive statistics were used to determine any growth from the pretest to posttest by measuring percent accuracy and elapsed time in completing the verbal interview of skip-counting by 2s, 5s, and 10s. Frequency counts, daily disposition scores, video-recorded sessions, and pretest/posttest data were used to help investigate any change in student motivation across the length of the case study.

The two videos chosen for the music activity portion of the study, *Workout & Count* and *Count Back Cat,* were written and performed by Jack Hartmann and Mr. R. The videos can be found on Youtube. I chose these two videos because of the rhythm and meter they contained. Both songs had a rhythmic pattern with an upbeat tempo that I thought would make it easier for the students to pay attention, stay engaged, and follow along with the songs. Also, the meter, with its repetitive characteristic, allowed the students to follow how the music changed and transitioned throughout the songs. I played the videos for the students on the days that were assigned the music learning activities. I encouraged students to participate by listening and singing when prompted. I took observational notes, video-recorded the musical learning activity, and transcribed the recorded sessions. These three modes of capturing the events and happenings in the musical learning activities helped me triangulate the data and added some validity and reliability to my study, particularly because I was the sole researcher.

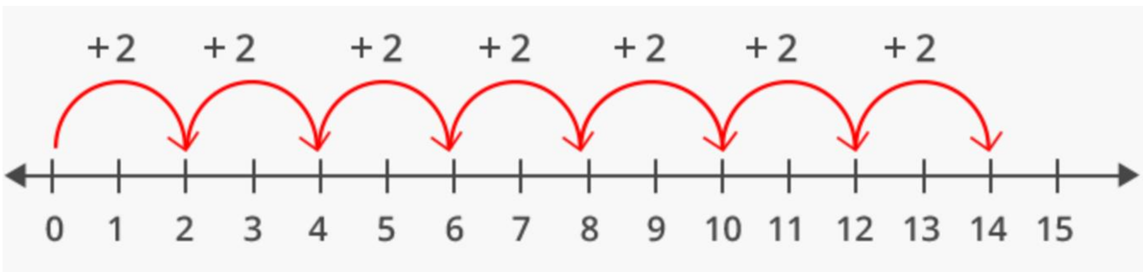
Jack Hartmann's video focused on teaching students skip-counting patterns going forward (i.e., increasing arithmetic sequence). I encouraged students to participate by listening, moving, singing, and skip-counting when prompted. The purpose of the video was to ask participants to join in different exercise activities while the video skip-counted forward in different sequences. The video began with the chorus, where students repeated what the singer was saying and copied the exercises seen on the screen. The first skip-counting pattern was counting by 5s to 50 while the numbers were shown on the screen. The next pattern was skip-counting by 5s from 50 to 100. Next, the performer invited the students to skip-count along by 2s while mimicking the motions. The sequence started at two and went to 20, while the numbers were presented on the screen in tandem with the counting. The music video included an exercise after two numbers within the sequence, “2, 4, cha cha cha, 6, 8, cha cha cha, 10, 12, cha cha cha…” The next portion of the video instructed students to count by 10s to 100 while engaging in a different exercise. Again, the numbers were visible on the screen while the students were skip-counting.

The second video, *Count Back Cat* by Mr. R, focused on skip-counting backward (i.e., decreasing arithmetic sequence). The song began with the chorus, where the main subject of the video, a cat that spent his money while counting backward by 2s, 5s, and 10s. This video contained no motions for the students to follow but gave direct instructions for the students to follow, “Everybody help count back. Count back from 50 by 5s.” The video counted each sequence with a slight pause between each number. Like the previous video, numbers flashed on the screen when students were skip-counting. The video presented students with two opportunities to count backward by 5s. Following the first skip-counting pattern, the chorus repeated. The sequence of 10s followed the same presentation as the 5s. The skip-counting backward by 2s section of the video invited students to start at the number 30.

For the non-musical learning activities, I used four different teaching activities that required students to interact with and manipulate Unifix cubes, use a hundreds chart, and count using blank number lines. These hands-on activities allowed me to observe the student's behaviors, dispositions, and overall understanding of the same skip-counting concept without music. Examples of the non-music learning activities are shown in Figures 1, 2, 3, and 4.

Figure 1

Example of Skip-Counting Forward by 2s Using Number Line



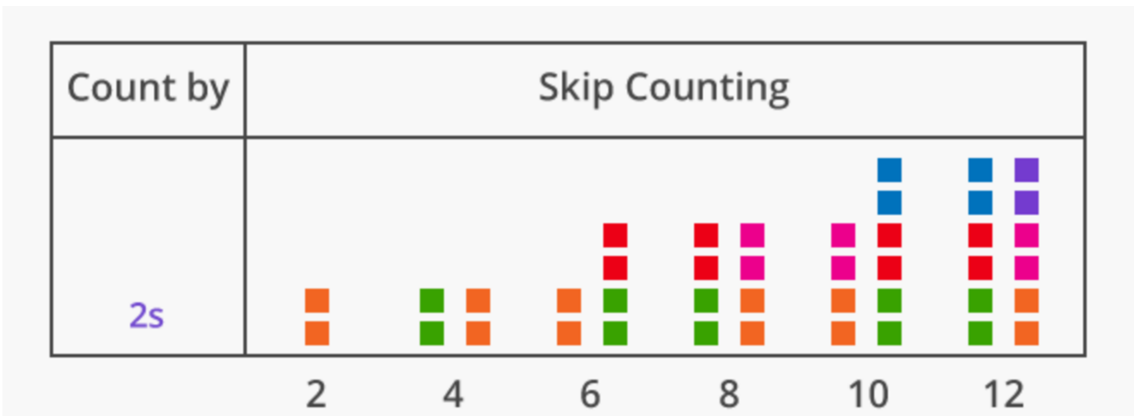
Note. From *What is skip count?*. (n.d.). Retrieved December 12, 2021, from https://www.splashlearn.com/math-vocabulary/number-sense/skip-count.

The number line activity (shown in Figure 1) allowed students the opportunity to conceptualize that skip-counting is about making equal sized "jumps" on the number line and that skip-counting with larger number means the "jumps" on the number line are bigger. In addition, students could count the number of "jumps" to help build the foundation for multiplication. The blank number line activity modeled addition and subtraction by moving forward (addition) and backward (subtraction) on the number line.

Two other non-music activities involved Unifix cubes. These two activities were designed to reinforce quantity, equal groups, and skip-counting. One activity I performed with the students was to make equal groups with different colors of Unifix cubes. For example, when working with reinforcing the concept of 2s, students locked together two orange Unifix cubes, two green Unifix cubes, two red Unifix cubes, two blue Unifix cubes, etc. This helped reinforce the meaning of the quantity of two. Once the groups of 2s were created, I had them place one group of two on their desk and say "two". Then, I had them place another set of two locked Unifix cubes next to the first set and say "four". We continued this pattern of placing down a set of two Unifix cubes and then saying the total number of cubes until they modeled a set number of groups. A picture of this first Unifix cube activity is shown in Figure 2.

Figure 2

Example of Equal Groups in Skip-Counting Forward by 2s Using Unifix Cubes

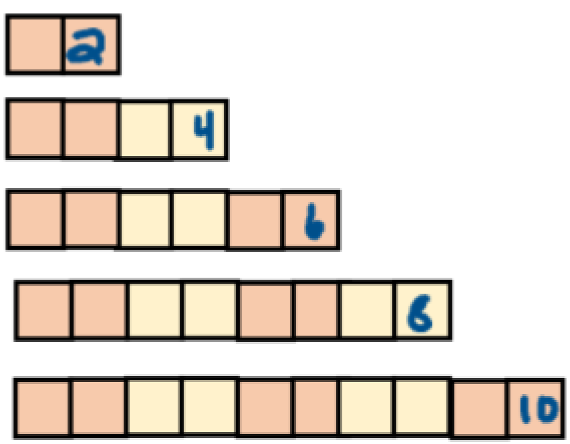


Note. From *What is skip count?*. (n.d.). Retrieved December 12, 2021, from https://www.splashlearn.com/math-vocabulary/number-sense/skip-count.

In the second Unifix cube activity, I had students use groups of Unifix cubes to make "trains" that modeled each step in skip-counting. In this activity I required students to build "trains" with Unifix cubes that used groups of different colored cubes to a final number I gave them. For example, I would tell the students to build "trains" that showed skip-counting by 2s until they got to the last "train" that showed the number twenty. To model this, the students first took two Unifix cubes, locked them together, and place them on their desk. Then the students would take four Unifix cubes, lock them together, and place them on their desk right below the "train" that modeled two sets of two (i.e., skip-counting to four by 2s). They would perform this task until they modeled the last number, or longest "train", I instructed them to build. In the end, the students would have an array of Unifix "trains" (as shown in Figure 3) and then would have to verbally say the number of Unifix cubes in each "train". As the students verbalized the number of Unifix cubes in each "train", I asked the students to write the total number of Unifix cubes in the "train" on the end with an Expo marker. Next, I had the students skip-count forward and backward by 2s, looking at the numbers they wrote on the cubes with the marker. Lastly, I had students write the numbers they verbalized in a written sequence of numbers. I also used this activity for groups of five and ten.

Figure 3

Example of Skip-Counting Forward by 2s Using Unifix Cubes



The last non-musical activity I implemented during the intervention was a hundreds chart activity. For this activity, I had students circle groups of two on the hundreds chart until they reached the number twenty. The students used different colored markers to circle the groups in increments of 2s, 5s, and 10s. I asked students to observe the patterns of the number sequences. During this activity, the students and I discussed the conceptual difference between the number of groups and the total number. After students filled in their chart (as shown in Figure 4) I asked students questions regarding their number of groups. For example, “How many groups of 2 make 18?” “If I have six groups of two, what is the total?”

Figure 4

Example of Skip-Counting Forward by 2s Using Hundreds Chart

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

In a qualitative study, a researcher's personal views and beliefs are important to their research. A researcher's personal views significantly affect how research is created and presented to participants (Hara, 1995; O'Brien et al., 2014; Queiros et al., 2017; Sahin & Ozturk, 2019). The qualitative research design is built around the author's personal views, which allows their beliefs to direct the research (Hara, 1995; O'Brien et al., 2014; Yilmaz, 2013). The intimate connection between the researcher and the research allows the researcher to qualitatively measure the events that each participant experiences subjectively (Lowhorn, 2007; Queiros et al., 2017). Qualitative research is comprehensive, and the target is to gain perspectives from participants, not make predictions about behavior.

Employing qualitative research can provide perspective and understanding into the psychosocial and interpersonal aspects of subjects using close observation, interviews, and analysis of participant responses to questions asked by the researcher to formulate problems or issues into research questions that can be answered. (Arghode, 2012; Bloomfield & Fisher, 2019; Indu & Vidhukumar, 2020; Lowhorn, 2007; O'Brien et al., 2014; Queiros et al., 2017; Ramani & Mann, 2016; Sahin & Ozturk, 2019; Sergeant, 2012; Yilmaz, 2013). The researcher's bias and participants will affect the data, which are needed to categorize results from a study as qualitative (O'Brien et al., 2014; Tomaszewski et al., 2020). The entire framework behind the design of a qualitative method relies on the differences and biases of participants to create the range of data to answer and represent all sides of a research question fully.

Data Collection Methods

There were five data collection instruments used for the study. The first instrument was a disposition pretest containing questions that allowed students to reflect on their feelings about learning math and listening and singing to songs. Students chose a colored emoji that represented their feelings about the question I asked them. The following questions were used for data collection for the disposition pretest:

1. Which emoji below best shows your feelings about learning math?
2. Which emoji below best shows your feelings about listening to songs?
3. Which emoji below best shows your feelings about singing songs?

Appendix B contains the interview sheet used for the study.

The second data collection instrument was a concept pretest consisting of an interview with each student to skip-count forward and backward by 2s, 5s, and 10s. After students were instructed in the skip-counting task, I noted their verbal response. I recorded their accuracy and how long it took the student to complete each portion. If the student could not perform the given task, I stopped the timer not allowing the participant to continue.

The third data collection instrument was a daily exit ticket. To collect this data, I showed students emoji stickers that had colored faces, and I asked them to choose the one that represented how much they liked the learning activity that day. They chose their appropriate emoji sticker for that day, and I placed it on a class chart (see Appendix C). The class emoji chart was not visible to the students but was retained for data analysis purposes. Data collection instruments four and five consisted of posttest interviews that repeated the same processes used in the disposition and concept pretest. This repeated measure was used to help determine changes in disposition and skip-counting accuracy of students throughout the length of the study.

To help record and document data not captured in the five data collection instruments, I kept daily notes and videotaped the activity sessions. Filming the activity sessions allowed me to watch sessions repeatedly and was particularly helpful at capturing nonverbal interactions, which were more difficult to record in conventional field notes. After the video capture, the recordings were transcribed to help verify the notes taken during the time of the activity. Doing this helped me triangulate data and protect against validity and reliability concerns. Researchers in qualitative studies often triangulate the data collected, which helps promote comprehension of the central themes within the research (Hara, 1995; Ramani & Mann, 2016; Tomaszewski et al., 2020). Researcher notes consisted of observations of students' behaviors during each intervention session, observations of common errors displayed by individual students, a record of the conversations that took place during the activities, and documentation of the implementation of the lesson plans for each of the skip-counting learning activities.

Data Analysis Strategy

During my ROS, I chose to use the case studies of three students. The case study method allows researchers to find correlations between aspects reported by participants in a qualitative study and evaluate them to determine the shared problems in a population. Case studies allow researchers to find the problem, create the context, and develop solutions for a population's issues (Williams, 2007). The applied sciences: social sciences, education, and health fields use case studies to modify their practices when problems arise (Tomaszewski et al., 2020; Williams, 2007). Field research is imperative when conducting a case study, as it allows for data to be collected to create innovative solutions (Queiros et al., 2017; Tomaszewski et al., 2020; Williams, 2007). Case studies allow researchers to experience an in-depth understanding of how people perceive events by using field research.

For each case study, I employed descriptive statistics to analyze data obtained from the five data collection instruments. The first pretest and posttest, containing the emoji emotion questions, were analyzed with descriptive statistics by examining differences from pretest to posttest to measure any change in students' disposition. For the second pretest and posttest, I examined the differences in concept attainment by measuring skip-counting accuracy and the amount of time used to complete the skip-counting activities. This repeated measure technique helped to gauge improvements in skip-counting by each of the three participants in the intervention. Frequency counts of each emoji for the daily exit ticket sticker activity were recorded, and the relationships between how these emojis correlated to different activities were noted.

The analysis of the transcribed video data closely relates to the elements of the work of Burnard (1991), an inductive approach to qualitative analysis. This method uses a stage-by-stage method of data analysis, where interviews are recorded in full, and the whole recording is transcribed. Then the researcher combs through the transcripts, line by line, and identifies patterns and themes that emerged during all skip-counting activities: both musical and non-musical. When I engaged in the inductive approach outlined by Burnard, I created initial codes, read line by line through transcripts, decided on a coding scheme that described the data by looking for recurring patterns, and applied the coding scheme to the data. Next, I collated codes with excerpts and then grouped the codes into themes, looking for relationships across the data instruments. The themes connected multiple codes. Lastly, I evaluated and revised the themes and made final decisions that are presented in the results and analysis chapter.

The researcher transcribed the notes of her observations. The transcriptions were loaded into a coding software program, Atlas.ti, to assist with the qualitative data analysis. The coding software program helped the researcher identify common themes by sorting, organizing, and grouping the codes based on commonalities. The software also allowed the researcher to search all transcriptions at once because all data were aggregated in one place.

As previously stated, I did not elect to perform a case study for all seven participants. While analyzing data, I based the selection of students in the case studies by determining the students who had a complete set of data collection points. Only three of the seven participants had no missing data points, so I chose to describe the individual cases of these three participants.

Timeline

The data collection process for this study started in January 2022 an ended in March 2022. Each activity was implemented approximately five times except for the hundreds chart activity, which was enacted only four times due to campus activities. The timeline in Table 1 displays the dates of each learning activity session. Each activity was rotated through the participants' sessions giving them equal opportunity to experience each learning activity to gauge understanding.

Table 1

Timeline for Implementation of Learning Activities

Week	Monday	Tuesday	Wednesday	Friday
Jan 4-7	Winter break	Winter break	Pretests 1. Disposition pretest 2. Concept pretest	Music act. #1: 1. Skip-count songs 2. Exit emoji ticket
Jan 10-14	Researcher absent due to illness	Researcher absent due to illness	Researcher absent due to illness	Researcher absent due to illness
Jan 17-21	School holiday	Campus activity	Non-music act. #1a: 1. Number line 2. Exit emoji ticket	Non-music act. #1b: 1. Unifix cubes 2. Exit emoji ticket
Jan 24-28	Non-music act. #1c: 1. Hundreds chart 2. Exit emoji ticket	Music activity #2: 1. Skip-count songs 2. Exit emoji ticket	Non-music act. #2a: 1. Number line 2. Exit emoji ticket	Non-music act. #2b: 1. Unifix cubes 2. Exit emoji ticket
Jan 31-Feb 4	Non-music act. #2c: 1. Hundreds chart 2. Exit emoji ticket	Music activity #3: 1. Skip-count songs 2. Exit emoji ticket	Non-music act. #3a: 1. Number line 2. Exit emoji ticket	Bad weather day
Feb 7-11	Researcher not on campus	Campus activity	Non-music act. #3b: 1. Unifix cubes 2. Exit emoji ticket	Non-music act. #3c: 1. Hundreds chart 2. Exit emoji ticket

Feb 14-18	Campus activity	Non-music act. #4c: 1. Hundreds chart 2. Exit emoji ticket	Music activity #4: 1. Skip-count songs 2. Exit emoji ticket	Student holiday
Feb 21-25	Student holiday	Researcher not on campus	Non-music act. #4a: 1. Number line 2. Exit emoji ticket	Non-music act. #4b: 1. Unifix cubes 2. Exit emoji ticket
Feb 28-Mar 4	Music activity #5: 1. Skip-count songs 2. Exit emoji ticket	Non-music act. #5a: 1. Number line 2. Exit emoji ticket	Non-music act. #5b 1. Unifix cubes 2. Exit emoji ticket	Posttests 1. Disposition posttest 2. Concept posttest

Closing Thoughts

The goal of my problem of practice was to reflect on the effect that musical learning activities and required lessons from the math intervention curriculum had on second-grader's understanding of and motivation to learn skip-counting patterns during Tier III instruction. By using a pretest-posttest and repeated measures design, I aimed to analyze the effectiveness of using music and movement to develop student understanding and motivation and analyzed this by triangulating the data I collected to answer my research question. Student growth was observed using descriptive statistics between pretest and posttest disposition and content tests which measured accuracy and completion time for each student while they counted forward and backward by 2s, 5s, and 10s. I used an array of tools to help me analyze data. Some of those tools included disposition scores, frequency counts, video-recorded sessions, and pretest/posttest data which allowed me to investigate changes in student understanding and motivation across the length of the study. The artifact I developed from this study could be used for future Tier III students in their understanding of and motivation to learn skip-counting patterns.

CHAPTER IV

ANALYSIS AND RESULTS

Introducing the Analysis

The purpose of conducting my research study at GPES was to answer the following research question:

1) When integrated into the second-grade intervention curriculum, what effects do musical learning activities, specifically songs and videos, have on students' understanding of and motivation to learn skip-counting patterns?

When attempting to attain evidence of student understanding of skip-counting patterns, students had to exhibit some of the following characteristics: greater comprehension and articulation of what they learned and why. The researcher observed higher levels of engagement and an increase in confidence when looking for characteristics of student motivation.

I implemented a four-step process to investigate my research question. For the first step, I administered an initial cognitive interview with seven students. I sought to collect my students' initial perspectives and dispositions about learning math, listening to songs, singing songs, and gauge how they performed on initial skip-counting forward and backward by 2s, 5s, and 10s, without any assistance or manipulatives. My second step involved four different learning activities, all targeted to help engage students in learning concepts and sequences related to skip-counting during their daily intervention times for five weeks. After each intervention session from step two, I activated the third step where I gave each student an exit ticket to document their perceptions and general disposition of the day’s lesson. Finally, in step four, students participated in a posttest cognitive interview identical to the initial one administered in step one. I analyzed the data using a coding software program, Atlas.ti, which helped me identify emerging themes throughout the data collection.

Presentation of Data

In this chapter, I discuss and explain the representation of the data that depict the findings of this research. The themes will be discussed through the implications of my research question. I noted the significant context found when coding and analyzing the data. All data were collected within my office during regular school hours during the data collection period. The participants were chosen through a convenience sampling method, allowing me to use students already served through the leveled Tier III mathematics instruction. The groups to which the participants were assigned depended on the general education teacher's schedule and grade level. Thus, the groups were predetermined and could not be modified. Generally, these Tier III students attend intervention sessions four times a week, 30 minutes per session on average. I am the instructor of record for these intervention sessions and am responsible for implementing the intervention learning activities. Due to outside circumstances, such as COVID-19 policies and other campus activities, these days and times for intervention sessions fluctuated.

There were three predetermined groups of participants. Group one consisted of three participants who were all in second grade. Throughout the study, two of the three students in group one were missing data points and thus I eliminated them from my case studies. Group two had three participants and one of these three participants had missing data points which led to dismissing that one participant from the study. The last group consisted of only one participant, who was also eliminated due to frequent absences and missing data. These eliminations left me with three participants who had full data points and did not miss a learning session. I assigned each participant a pseudo name to further protect their identity.

The first step I performed with the case study participants included an initial interview that gauged their perceptions regarding their feelings toward mathematics and music. The interviews were conducted where the participant was evaluated alone in my office with no other students or distractions. After the initial questions containing the emojis were asked, the rest of the questions evaluated students' knowledge of skip-counting before any intervention activities. As the students were verbally responding to the prompts of the interview, I notated their skip-counting accuracy and recorded the amount of time it took each student to complete the task.

After administering the pretest interviews, students participated in a series of music and non-music-based learning activities with their group during their specified intervention time throughout the following weeks of data collection. Music was the first activity I introduced to the participants. In the music videos I chose, both were on Youtube, and skip-counting forward and backward was modeled. When the songs were first introduced, students were instructed that they did not have to participate with the music and movements that went along with each video but were asked to join in the skip-counting portions. Jack Hartmann's *Workout and Count* video had students engage in different physical activities while they skip-counted forward by 2s, 5s, and 10s. In the second video, created by Mr. R. named *Count Back Cat*, students listened to a musical story about a cat that spent money and counted backward by 2s, 5s, and 10s while singing.

During the non-music lessons, I used an array of manipulatives to teach skip-counting procedures. I introduced skip-counting to the groups using a number line throughout the second lesson. The students and I used number lines with moveable cursors, which went to 20, so they could physically model jumps of 2s, 5s, and 10s. During this lesson, the students and I discussed how each jump was a different size because each jump was moving a different number of ticks. The students recognized that a jump of 10 was the greatest, a jump of 5 was medium-sized, and a jump of 2 was the smallest. To physically move their bodies, I printed out large number lines, which went up to 100 and were placed on the floor. Students walked out the jumps during a number line lesson and could see their feet move in different increments based on the number they were skip-counting. In later sessions, after many practice sessions where students became comfortable with number lines, I had students fill in empty number lines with tick marks and jumps of 2s, 5s, and 10s.

Unifix cubes, used in many different settings within a school, are familiar to my participants. I used these cubes to allow my participants to model and create groups while combining groups to make “trains”. “Trains” allowed separate groups to be connected, showing the relationship between creating groups of the same number, which helped them understand the concept of skip-counting. Unifix cubes come in many different colors and can be used to show and model separate groups. The students were asked questions and learned differentiation between what constitutes a group and a total.

Participants were also encouraged to assist in developing skip-counting skills using a hundreds chart. A hundreds chart lists the numbers in ten columns and ten rows in numerical order. With different colored dry-erase markers, students circled different groups of multiples of 2, 5, and 10. The participants found patterns in the skip-counting numbers, where the 2s ended in 2, 4, 6, 8, or 0; 5s ended in 5 or 0; multiples of 10 ended only in 0. These patterns assisted students when skip-counting because they allowed them to figure out which number came next in a skip-counting sequence.

After the initial questions which measured students' dispositions toward music and math were asked, the researcher presented the task of skip-counting forward and backward by 2s, 5s, and 10s to measure students understanding of skip-counting patterns. At the same time, as the researcher, I notated their accuracy and timed their task.

The participants in this case study engaged in four different lessons that influenced their skip-counting abilities. All four of these activities were given the same amount of time within each session, and the participants all had the ability during each session to express what they were learning to the researcher. The first lesson was a musical activity. In this activity, the participants were instructed to stand in front of the projected screen and watch a video the researcher chose, modeling skip-counting forward and backward. The researcher informed the students they would not know the words to the songs but were asked to participate with the video performer while they were skip-counting. The researcher videoed each session and checked for the accuracy of the student's skip-counting patterns. The data analyzed from each music activity session were grouped into a category to measure understanding of and motivation to learn skip-counting patterns using musical activities.

The remaining three learning activities involved using manipulatives, non-music activities, to teach skip-counting patterns. One manipulative used was a hundreds chart where students were asked to circle groups of 2s, 5s, and 10s while answering various questions about forward and backward sequences of numbers. Number line activities consisted of modeling jumps with their fingers, markers, and bodies to show the different distances of each skip-count interval. The final manipulative used was Unifix cubes. Students created "trains" where students added intervals of the specific number to the end of their "train"; effectively showing them the pattern that skip-counting follows. To answer the research question, the three manipulative activities were grouped in a category of non-musical activities. These activities allowed the researcher to generate an overall percentage of each participant's comprehension and motivation.

After the data collection was completed, the researcher listened to the audio recording and transcribed all communication between the participants and the researcher verbatim. After creating the initial report, the researcher viewed each videotaped session and transcribed all nonverbal communication into one complete document. The transcriptions were sorted by date, activity, and group number. The transcriptions were then uploaded to the computer software program. After uploading all transcripts, pretest/posttest results, and exit ticket data into Atlas.ti, the researcher used a tool within the program to create a word cloud and observe a word list sorted by the number of times a word appeared within the documents. Seeing these words allowed the researcher to develop initial codes from the patterns seen throughout the data. The researcher created some initial codes: correct and incorrect response, modeled correctly and incorrectly, does not participate, off-task behavior, echoing, and self-correction. As the researcher began to look closer at the data, more codes needed to be created to represent different responses seen within the sessions. To better answer the research question between music and non-music activities, codes depicting the type of activity, such as number line, hundreds chart, Unifix cubes, or songs were added to the transcriptions. The codes created by the researcher measured the correctness and incorrectness of each participant on the tasks they were asked to perform for both music and non-music learning activities. The researcher was able to group the codes by looking at recurring patterns. Keeping the research question in mind, the codes were sorted into themes to develop better information that could be used to answer the research question. The two themes developed were participant understanding of and motivation to learn skip-counting patterns.

Each verbal and nonverbal response was coded to fall under four categories within the themes: evidence of understanding and misunderstanding and evidence of positive and negative behavior. The first category falls under the theme of student understanding. To capture the participant's understanding of learning skip-counting patterns, the researcher grouped several codes to track the occurrences of student retention, comprehension, and improvement in assessments. The codes grouped for non-music activities were correct response, echoing, self-correction, and modeled correctly. The researcher's codes for the music activity were correct response and echoed response. The researcher decided to include echoing as a correct response because the participants were learning the patterns and attempting to count along with the videos. Each of these codes represented a student's proof of understanding.

The second category within the understanding theme was evidence of misunderstanding. For non-music activities, the researcher grouped multiple codes to track the frequency of student responses, including incorrect responses, correction after observation of peers, counted with assistance, or modeled incorrectly. Each of these codes represented student responses when tasks were not followed correctly. When finding instances of student misunderstanding in music activities, the researcher knew there would only be eleven instances of skip-counting through both songs, which she grouped into one frequency score. If the student did not achieve success during the sequence, the researcher noted an incorrect response.

The last two categories fell under the theme of participant motivation to learn skip-counting patterns with music and non-music activities. Motivation seen within student responses attempted to measure levels of engagement, disposition toward the activity, and confidence level. When coding, the researcher saw two different categories of motivation develop between student responses, evidence of positive and negative behavior. To measure positive behavior of non-music activities, the researcher tracked the codes of counted confidently and needed clarification. Codes for the music activity measurements were counted confidently, sang along, and performed motions with video.

For evidence of negative behavior in non-music activities, the following codes were used: off-task behavior, needed time to think, and did not participate. Music activities used the code: does not participate.

Case Study 1 (Julie)

The participant selected out of the first group of intervention students, Julie, is a nine-year-old white female whose home and native language is English. She is considered at-risk for retention or not meeting standards. The student was retained in the first grade after not achieving adequate growth and development of grade-level objectives. A 504 plan is currently in place for Julie, diagnosed with ADHD. Also, she is categorized under specific guidelines as economically disadvantaged because she receives free meals through the school district because of the low-income level of her family. Julie has good attendance and no tardiness. She has no documented disabilities but has been previously evaluated in a full individual evaluation (FIE) for learning disabilities in the subjects of reading and math. The campus diagnostician concluded that she did not qualify for any Special Education support or programs within the district. Julie’s home life has played a direct role in her placement within Tier III intervention for reading and mathematics. As a newborn, Julie was born drug-dependent and was placed into the custody of Child Protective Services and then transferred into foster care, where she was eventually adopted when she was four years old.

The first data collection task for Julie was the perception interview. I asked Julie the three questions outlined, and Julie responded with a green smiley face in response to the question about her feeling about math, a yellow straight face in response to the question about her feelings about listening to songs, and a green smiley face in response to the question about her feeling about singing songs. Julie had an additional comment for each question asked. When asked the first question, she pointed to the smiling face and commented, “I love math.” When asked how she felt about listening to songs, she chose the straight face and stated, “They are okay.” “I like it,” was her response as she pointed to the smiling face for question 3.

During the disposition posttest, Julie made one comment for the first question regarding her feelings about learning math when she pointed to the smiling face, “A happy face.” She did not have as many comments during the posttest as she did the pretest. Julie’s disposition posttest consisted of all green smiley faces to the questions about her feelings toward math, listening to music, and singing along with music. Julie’s disposition regarding the interview questions was more positive after the implementation of all the learning activities. The results of Julie’s disposition pretest and posttest are shown in Table 2.

Table 2

Disposition Pretest and Posttest Results for Julie

	Question 1: Which emoji below best shows your feelings about learning math?	Question 2: Which emoji below best shows your feelings about listening to songs?	Question 3: Which emoji below best shows your feelings about singing songs?
Pretest			
Response			
Score	3/3 (100%)	2/3 (66.67%)	3/3 (100%)

Posttest			
Response			
Score	3/3 (100%)	3/3 (100%)	3/3 (100%)

For the concept pretest, when counting forward by 2s to 20, the student responded, "2, 4, 6, 8, 10," then the student paused while trying to figure out what number came next. "10, 20, 30, 32, 31," Julie continued. I stopped the timer at 7.74 seconds because the student was unsuccessful with the given task. Because the student was only successful with the first five numbers in the 2s skip-counting sequence, I scored her accuracy as five out of ten, or 50%. When asked to skip-count backward by 2s, the student hesitated more when giving her answers. The completion time for this task was 20.18 seconds but had no relevance to her knowledge because her accuracy was very low. "20, 10, 11, 12, 10, 4, 3, 2." Therefore, the student scored 10%, or one out of ten.

The student began the next task of counting forward by 5s. "5, 10, 15, 20, 25, 30, 35, 30." The clock was visible to the student, and she got distracted, so I placed it out of sight and made the student start again from the beginning. Julie answered, "5, 10, 15, 20, 25, 30, 35, 45, 60, 65," in 13.78 seconds. The student omitted numbers 40, 50, and 55, resulting in an accuracy score of 70%. When counting backward by 5s, the researcher stopped the task at 18.54 seconds because she only knew the first number of the sequence, 50. She got visibly frustrated when unsure of her answers and put her head down when asked to perform the skip-counting tasks.

Julie was only successful in one area of the third part of the pretest, counting forward by 10s. She had no hesitation and counted confidently in 5.10 seconds. For counting backward by 10s, the participant's accuracy score was one out of ten. Also, the completion time of 30.93 seconds was the highest for this task. The researcher ended the task after the student continued to be unsuccessful: "100, 99, 10, 11, no…, 100, 99, 98, 97, 96, no." The descriptive statistics for Julie's concept pretest are displayed in Table 3.

For the concept posttest, when asked to count forward by 2s to 20, the student responded, "2, 4, 6, 8, 10, 12, 13, 14, 15, oh." The student immediately stopped and realized she had skip-counted incorrectly. I asked the student to start over. She replied, "2, 4, 6, 8, 10." Julie noticed the timer, and I assured her the time was unimportant. She continued, "12, 13, 14, 16, 18, 20," therefore, receiving a score of 90% accuracy in 32.47 seconds for completion. The student began with the first term, twenty, of the skip-counting sequence when counting backward by 2s. The student paused for a lengthy amount of time. I prompted Julie, "go backward. What would be before 20?" The student responded, "18." She continued to pause for another extended period, and the researcher had to prompt her by asking what number came next in the sequence. The student did not exhibit automaticity with the task, taking two minutes and twenty seconds to complete. Although the student produced the correct number in the sequence, the score of ten out of ten does not accurately depict the student's comprehension.

When asked to skip-count forward by 5s, the participant had no hesitation and counted correctly and confidently in 4.05 seconds. Counting backward by 5s, the student started the sequence with "50, 55." I reminded Julie that the task required her to count backward. After taking this correction, she responded with the correct skip-counting pattern in 59.37 seconds. This extended amount of time when giving her answer was because I had a visitor walk into my office while timing her response and didn't pause the timer while tending to the situation.

The participant skip-counted forward by 10s accurately and confidently in 3.27 seconds. While attempting the task of skip-counting backward by 10s, Julie speedily counted "100, 90, 80, 70, 60, 50, 40, 20." After hearing her mistake due to the speed of her answer, I stopped her and asked her to slow down while giving her answer and try again. On the second attempt, the participant counted in sequential order, not hesitating in her correct responses resulting in a 100% score in 8.01 seconds. The results of Julie's concept posttest are shown in Table 3.

Table 3

Concept Pretest and Posttest Results for Julie

Skill Assessed	Accuracy	Completion Time
Pretest		
Counts forward by 2s from 2 to 20	5/10 (50%)	Stopped at 7.74 sec
Counts backward by 2s from 20 to 2	1/10 (10%)	20.18 sec
Counts forward by 5s from 5 to 50	7/10 (70%)	13.78 sec
Counts backward by 5s from 50 to 5	1/10 (10%)	Stopped at 18.54 sec
Counts forward by 10s from 10 to 100	10/10 (100%)	5.10 sec
Counts backward by 10s from 100 to 10	1/10 (10%)	30.93 sec
Posttest		
Counts forward by 2s from 2 to 20	9/10 (90%)	32.47 sec
Counts backward by 2s from 20 to 2	10/10 (100%)	2:20.20 min
Counts forward by 5s from 5 to 50	10/10 (100%)	4.05 sec
Counts backward by 5s from 50 to 5	10/10 (100%)	59.37 sec
Counts forward by 10s from 10 to 100	10/10 (100%)	3.27 sec
Counts backward by 10s from 100 to 10	10/10 (100%)	1st attempt: 9.37 sec 2nd attempt: 8.01 sec

Table 4 is organized by session number, with each session including the first lesson for each non-music learning activity: number line, Unifix cubes, and hundreds chart. The instances of understanding and misunderstanding, as well as evidences of positive and negative behaviors were averaged together to get an overall score for the amount of times each learning activity was implemented. Julie was observed during the implementation of all the non-music learning activities during each session, and her responses and behaviors were analyzed using coding data. The non-musical activities yielded a 64.92% rate of understanding in her responses. Her incorrect responses during non-musical activities were very high. At 35.08%, her incorrect answers showed a lack of understanding when using manipulatives to learn skip-counting patterns. When looking at her motivations toward learning skip-counting with non-music learning activities, Julie showed a higher percentage, 66.67%, of negative behaviors toward the activities than positive ones. Her daily exit ticket data showed positive regard for non-music lessons when learning skip-counting patterns. Her frequency score was thirty-one out of thirty-six.

While she participated in the musical activities, Julie had a 77.27% score for student understanding which was present within the codes. Her score was 22.73% for misunderstanding during music learning activities. Contrary to Julie's behavior toward non-music activities, the participant portrayed evidence of positive behavior toward the music activity 95.66% of the time. Julie's evidence of negative behaviors observed during music learning activities were averaged to 4.44%. While she showed positive behaviors during the music activities, her exit ticket data does not reflect these behaviors. Her disposition score was only seven out of twelve points. Table 4 displays the results of Julie's non-music and music related scores.

Table 4

Frequency Chart for Non-Music and Music Activities for Julie

Session Number	Evidence of Understanding	Evidence of Misunderstanding	Evidence of Positive Behavior	Evidence of Negative Behavior	Disposition Score
Non-Music Activities					
1	112/161 (69.57%)	49/161 (30.43%)	2/14 (14.29%)	12/14 (85.71%)	8/9 (88.89%)
2	58/102 (56.86%)	44/102 (43.14%)	8/21 (38.1%)	13/21 (61.9%)	8/9 (88.89%)
3	81/133 (60.9%)	52/133 (39.1%)	4/4 (100%)	0/4 (0%)	7/9 (77.78%)
4	58/80 (72.5%)	22/80 (27.5%)	0/1 (0%)	1/1 (100%)	8/9 (88.89%)
All Sessions	309/476 (64.92%)	167/476 (35.08%)	14/39 (33.33%)	26/39 (66.67%)	31/36 (86.11%)
Music Activities					
1	9/11 (81.82%)	2/11 (18.18%)	14/15 (92.86%)	1/15 (7.14%)	3/3 (100%)
2	9/11 (81.82%)	2/11 (18.18%)	15/16 (93.33%)	1/16 (6.67%)	1/3 (33.33%)
3	9/11 (81.82%)	2/11 (18.18%)	28/29 (96.43%)	1/29 (3.57%)	2/3 (66.67%)
4	7/11 (63.64%)	4/11 (36.36%)	29/30 (96.55%)	1/30 (3.45%)	1/3 (33.33%)
All Sessions	34/44 (77.27%)	10/44 (22.73%)	86/90 (95.66%)	4/90 (4.44%)	7/12 (58.33%)

Case Study 2 (Cara)

Cara, the first participant, selected out of the second group, is an eight-year-old white female who speaks English at home and school. She receives free meals through the school district because she qualifies as economically disadvantaged. Cara has been sent a letter for truancy because she has multiple unexcused absences and is always coming into school after the school day has already begun. The SIT committee, which consists of her classroom teachers, school administration, math interventionist, and a school counselor, has met and decided that Cara needs a full FIE to determine if she meets any qualifications for SPED services provided by the district. She is scheduled to have the evaluation at the beginning of her third-grade year. Child Protective Services has actively investigated the student and their family three times during the 2021-2022 school year over neglect claims and unexplained physical signs of abuse on her body, visible to her teacher.

During Cara's initial disposition pretest, the first data collection task, I asked Cara the three questions outlined. When asked about her feelings of learning math, she responded with a green smiley face. She chose a yellow straight face in response to the question about her feelings about listening to songs, and a green smiley face in response to the question about her feeling about singing songs. I noted that she did not verbally respond or have any comments for this portion. She only pointed to the emoji she felt best represented her feelings toward the question asked. I did not probe further for an explanation as to why Cara chose a specific sticker.

During the disposition posttest, Cara made no comments regarding the questions she was asked. Her answers to the questions about learning math, listening to music, and singing songs were all given a green smiley face. Cara's disposition regarding the interview questions was more positive after the implementation of all the learning activities. Cara's disposition results for her pretest and posttest are reflected in Table 5.

Table 5

Disposition Pretest and Posttest Results for Cara

	Question 1: Which emoji below best shows your feelings about learning math?	Question 2: Which emoji below best shows your feelings about listening to songs?	Question 3: Which emoji below best shows your feelings about singing songs?
Pretest			
Response			
Score	3/3 (100%)	2/3 (66.67%)	3/3 (100%)

Posttest			
Response			
Score	3/3 (100%)	3/3 (100%)	3/3 (100%)

For Cara's concept pretest, the student began counting by ones, but I redirected Cara. She had no hesitation and counted confidently after being corrected, resulting in 100% accuracy in 6.71 seconds. Cara successfully performed skip-counting backward by 2s with a ten out of ten score but hesitated between the transition from ten to eight, for a total completion time of 11.59 seconds. The student counted confidently with no hesitation when asked to skip-count forward by 5s and finished the task in 5.79 seconds. The score for this task was 100%. The next task, counting backward by 5s, was the only area where the participant struggled. The student began, "50, 55," and the researcher redirected the student to count backward. The student attempted "50, 45, 40, 35, 30, 20, 25, 10… I don't know." This task took the participant the longest time, 39.42 seconds, and gave her a five out of ten accuracy. When skip-counting by 10s, Cara completed the forward sequence in 6.60 seconds with an accuracy of 100% and the backward sequence with a score of ten out of ten in 8.55 seconds.

During the concept posttest, Cara had no hesitancy and assuredly skip-counted forward and backward by 2s and 10s, resulting in 100% accuracy in 4.43, 7.57, 4.03, and 6.92 seconds, respectively. Likewise, the participant scored ten out of ten when skip-counting forward by 5s, completing the task in 6.47 seconds. The task, counting backward by 5s, was the only area where the participant made any mistakes. The student said, “50, 45, 40, 35, 30, 25, 20, 20, 15, 10, 5, 0.” I was unsure if the student had accidentally repeated the number twenty, so I asked her to repeat the sequence. The student responded with the same set of numbers giving her an accuracy of 90% in 21.09 seconds. The results of Cara’s concept pretest and posttest are shown in Table 6.

Table 6

Concept Pretest and Posttest Results for Cara

Skill Assessed	Accuracy	Completion Time
Pretest		
Counts forward by 2s from 2 to 20	10/10 (100%)	6.71 sec
Counts backward by 2s from 20 to 2	10/10 (100%)	11.59 sec
Counts forward by 5s from 5 to 50	10/10 (100%)	5.79 sec
Counts backward by 5s from 50 to 5	5/10 (50%)	39.42 sec
Counts forward by 10s from 10 to 100	10/10 (100%)	6.60 sec
Counts backward by 10s from 100 to 10	10/10 (100%)	8.55 sec
Posttest		
Counts forward by 2s from 2 to 20	10/10 (100%)	4.43 sec
Counts backward by 2s from 20 to 2	10/10 (100%)	7.57 sec
Counts forward by 5s from 5 to 50	10/10 (100%)	6.47 sec
Counts backward by 5s from 50 to 5	9/10 (90%)	1st attempt: 8.86 sec 2nd attempt: 21.09 sec
Counts forward by 10s from 10 to 100	10/10 (100%)	4.03 sec
Counts backward by 10s from 100 to 10	10/10 (100%)	6.92 sec

There were areas within the skip-counting patterns where Cara could still make improvements, which is another reason she remained a participant in the case study. Her percentage of understanding skip-counting patterns during lessons with non-music manipulatives was the highest percentage at 82.95%. Her evidence of misunderstanding scores while implementing non-musical activities, resulted in a frequency of sixty-six out of three hundred eighty-seven responses. Her answers did not require much time to formulate as the other participants. Her automaticity was evident in her responses to questions asked by the researcher. The participant had a higher percentage of negative behaviors during lessons with non-musical activities. When asked to choose her emoji sticker regarding the lessons without music, she always chose the smiley-face sticker, which gave her the maximum number of points for her disposition score, 100%. The session numbers in Table 7 refer to each learning activity implemented. Session 1 consists of the first activity for number lines, Unifix cubes, and hundreds chart. Likewise the remaining sessions include all three non-music learning activities in the data presented and averaged together to portray overall scores for Cara.

Cara had the highest frequency of evidence of understanding during the music lessons of 88.64% as opposed to her score for evidence of misunderstanding, 11.36%. Her positive feelings were higher in the music lessons, scoring at 94.29%, while her negative behaviors represented a low frequency of only 5.71%. Her disposition score on the music activities was 100%, just like the non-music activities. The descriptive statistics for Cara's understanding and evidence of behaviors during music activities are displayed in Table 7.

Table 7

Frequency Chart for Non-Music and Music Activities for Cara

Session Number	Evidence of Understanding	Evidence of Misunderstanding	Evidence of Positive Behavior	Evidence of Negative Behavior	Disposition Score
Non-Music Activities					
1	136/141 (96.45%)	5/141 (3.55%)	0/1 (0%)	1/1 (100%)	9/9 (100%)
2	85/112 (75.89%)	27/112 (24.11%)	1/4 (25%)	3/4 (75%)	9/9 (100%)
3	63/93 (67.74%)	30/93 (32.26%)	0/1 (0%)	1/1 (100%)	9/9 (100%)
4	37/41 (90.24%	4/41 (9.76%)	1/2 (50%)	1/2 (50%)	6/6 (100%)
All Sessions	321/387 (82.95%)	66/387 (17.05%)	2/8 (25%)	6/8 (75%)	33/33 (100%)
Music Activities					
1	8/11 (72.73%)	3/11 (27.27%)	10/12 (83.33%)	2/12 (16.67%)	3/3 (100%)
2	10/11 (90.91%)	1/11 (9.09%)	19/20 (95%)	1/20 (5%)	3/3 (100%)

3	10/11 (90.91%)	1/11 (9.09%)	16/17 (93.75%)	1/17 (6.25%)	3/3 (100%)
4	11/11 (100%)	0/11 (0%)	21/21 (100%)	0/21 (0%)	3/3 (100%)
All Sessions	39/44 (88.64%)	5/44 (11.36%)	66/70 (94.29%)	4/70 (5.71%)	12/12 (100%)

Case Study 3 (Laci)

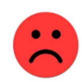
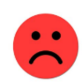
Laci is a nine-year-old American Indian – Hispanic female whose native and home language is Spanish. Due to her language barrier, she receives ESL services from the ESL teacher on campus through the school district. Laci is not considered economically disadvantaged, but she is coded as at-risk for failure or retention. During the 2021-2022 school year, her family visited relatives in Mexico during winter break. Before their departure, her guardians withdrew her from GPES to ensure her absences would not accumulate while abroad. Upon their return, she was reenrolled to her previous classroom and services. While under the observation of the SIT committee, it was determined that Laci's deficits in reading and mathematics were not due to a disability but rather the gap between her native language (Spanish) and the language spoken within the school (English).

During Laci's initial disposition pretest, she did not ask any questions or make any comments regarding the questions she was asked by the researcher about her feelings. Laci chose the yellow straight face when asked about her feelings toward learning math. When asked how she felt about listening to songs, she chose the green smiley face. In contrast, Laci chose the red frown face when asked her feelings about singing songs. I did not ask any questions about her feelings or ask why she chose the emojis. The results of the disposition pretest are recorded in Table 8.

For the concept posttest, Laci's response to the question of how she felt about learning math was a green smiley face. When asked about her feelings toward listening to music, Laci chose the yellow straight face. The last question how she felt about singing songs, Laci, again, chose a red frown face. Laci did not make any additional comments, and I did not ask her to elaborate on her choices. The results are displayed in Table 8 below.

Table 8

Disposition Pretest and Posttest Results for Laci

	Question 1: Which emoji below best shows your feelings about learning math?	Question 2: Which emoji below best shows your feelings about listening to songs?	Question 3: Which emoji below best shows your feelings about singing songs?
Pretest			
Response			
Score	2/3 (66.67%)	3/3 (100%)	1/3 (33.33%)
Posttest			
Response			
Score	3/3 (100%)	2/3 (66.67%)	1/3 (33.33%)

Laci was very uninterested in answering my questions during the concept pretest and seemed to shut down when asked to do something she was unsure how to complete. I asked her to skip-count forward by 2s from two to twenty, and she presented a look of confusion. I asked, "Do you understand?" The student shook her head no. I asked her to attempt the skill, and the student responded, "2." No other numbers were said, so I stopped the timer at 32.04 seconds and scored her attempt with 10% accuracy. When given the second task, the student did not attempt it, so I gave her a zero out of ten score, stopped the timer, and did not record the time due to its irrelevancy.

Laci, when skip-counting forward by 5s, uttered, “5…15…20,” giving a score of one out of ten. The student chose not to continue, so I stopped the timer at one minute and three seconds. She did not attempt the task of counting backward by 5s, so she scored 0% for accuracy, and the time was not recorded. She was familiar with counting forward and backward by 10s. The participant counted confidently, scoring 100% for both tasks and completion times of 10.42 seconds for the forward sequence and 23.84 seconds skip-counting backward. The results are displayed in Table 16.

Laci was the only participant that scored 100% on all tasks during the concept posttest. When asked to skip-count forward by 2s, Laci completed the task correctly in 11.65 seconds. Laci counted backward by 2s successfully in 18.38 seconds. She confidently skip-counted forward by 5s and 10s in the least amount of time, 3.92 and 4.15 seconds, respectively. She showed slight hesitation while counting backward by 5s and 10s but did not need any assistance producing the next numbers in the sequences. The only correction I made was her pronunciation within the 10s pattern from “teen” to “ty.” Her native language of Spanish played a role in her dialect while counting. The results of the concept posttest are in Table 9.

Table 9

Concept Pretest and Posttest Results for Laci

Skill Assessed	Accuracy	Completion Time
Pretest		
Counts forward by 2s from 2 to 20	1/10 (10%)	Stopped at 32.04 sec
Counts backward by 2s from 20 to 2	0/10 (0%)	Does not attempt
Counts forward by 5s from 5 to 50	1/10 (10%)	Stopped at 1:03.89 min

Counts backward by 5s from 50 to 5	0/10 (0%)	Does not attempt
Counts forward by 10s from 10 to 100	10/10 (100%)	10.42 sec
Counts backward by 10s from 100 to 10	10/10 (100%)	23.84 sec
Posttest		
Counts forward by 2s from 2 to 20	10/10 (100%)	11.65 sec
Counts backward by 2s from 20 to 2	10/10 (100%)	18.38 sec
Counts forward by 5s from 5 to 50	10/10 (100%)	3.92 sec
Counts backward by 5s from 50 to 5	10/10 (100%)	16.24 sec
Counts forward by 10s from 10 to 100	10/10 (100%)	4.15 sec
Counts backward by 10s from 100 to 10	10/10 (100%)	12.46 sec

Laci's understanding scores of the non-musical learning activities were high, which showed she had some conceptual knowledge learned from manipulatives while learning skip-counting patterns. The results are displayed in Table 10. The score for Laci's evidence of understanding in non-musical activities was 82.17%, and her misunderstanding responses were 17.83%. With a score of 0%, it was evident that she had no positive behaviors observed during non-musical activities. Still, her disposition score reflected a high positive attitude toward the learning activities, with thirty-two out of thirty-three.

Laci's frequency chart for musical activities, as displayed in Table 10, depicted evidence of understanding during music-implemented learning activities. Her score for understanding was thirty-eight out of forty-four, leaving her evidence of misunderstanding at 13.64%. Positive behavior was observed more frequently, 94.2%, while participating in the music activity, supported by her exit ticket disposition score of ten out of twelve.

Table 10

Frequency Chart for Non-Music and Music Activities for Laci

Session	Evidence of	Evidence of	Evidence	Evidence	Disposition

Number	Understanding	Misunderstanding	of Positive Behavior	of Negative Behavior	Score
Non-Music Activities					
1	103/113 (91.15%)	10/113 (8.85%)	0/2 (0%)	2/2 (100%)	9/9 (100%)
2	83/104 (79.81%)	21/104 (20.19%)	0/13 (0%)	13/13 (100%)	9/9 (100%)
3	49/70 (70%)	21/70 (30%)	0/0 (0%)	0/0 (0%)	8/9 (88.89)
4	60/72 (83.33%)	12/72 (16.67%)	0/0 (0%)	0/0 (0%)	6/6 (100%)
All Sessions	295/359 (82.17%)	64/359 (17.83%)	0/15 (0%)	15/15 (100%)	32/33 (96.97%)
Music Activities					
1	9/11 (81.82%)	2/11 (18.18%)	9/10 (90%)	1/10 (10%)	2/3 (66.67%)
2	10/11 (90.91%)	1/11 (9.09%)	19/20 (95%)	1/20 (5%)	2/3 (66.67%)
3	10/11 (90.91%)	1/11 (9.09%)	18/19 (94.74%)	1/19 (5.26%)	3/3 (100%)
4	9/11 (81.82%)	2/11 (18.18%)	19/20 (95%)	1/20 (5%)	3/3 (100%)
All Sessions	38/44 (86.36%)	6/44 (13.64%)	65/69 (94.2%)	4/69 (5.8%)	10/12 (83.33%)

Interaction between the Research and the Context

How the Context Impacted the Results

The second-grade students chosen as participants for the case study are categorized as needing Tier III intervention in mathematics. Students are selected for Tier III instruction according to campus protocol and levels of student achievement. These participants within Tier III are one to two grade levels behind their peers and receive intense individualized instruction in mathematical areas where they show deficits. These students lack conceptual knowledge of basic mathematical skills. One area of low conceptualization with the students when administered a district progress monitoring assessment was gaps in skip-counting patterns relative to a first-grade state-mandated student expectation. More specifically, TEKS 1.5B states students should be able to skip-count by 2s, 5s, and 10s.

Although the students were willing to participate in the study and showed excitement when given different learning activities and tasks, several limitations arose throughout the data collection process. These participants were chosen from a convenience sample, limiting the potential pool of participants for the case study. The socio-economic grouping of the demographics of CSISD was already predetermined, creating a non-random environment where the researcher had to implement the case study. Another limitation faced was the researcher had prior relationships with all three participants, introducing bias because the researcher knew the strengths and weaknesses of each student. The researcher possessed a unique skill set, allowing them to understand how participants reacted in specific situations. Then, the researcher counteracted and changed the outcome. Lastly, it was difficult for the researcher to keep lessons and models the same, remaining consistent across lessons using the same vocabulary and questions because there was no set script to follow. The researcher also has a background in education and changed and adjusted the lessons based on the previous group's achievements.

Many challenges were out of the researcher's control during the case study's data collection and analysis period. Student absences removed participants from the case study and created a different learning environment for the groups during observations. Absences from both participants and the researcher due to COVID-19 and other illnesses were not the only disruptions. Intercom messages, visitors, phone calls, technology malfunctions, and being in a heavy-trafficked area of the school all contributed to distractions that the researcher and participants faced during intervention. Students who chose to wear masks during the lessons contributed to the researcher's challenges when they tried to hear the participant's responses. The researcher's timeline was disrupted due to grade-level activities and unexpected bad-weather days, preventing students and teachers from attending school. The data collection occurred in a small window of time that severely limited the amount of data the researcher was able to collect, which presented another challenge.

Regarding the study participants, the researcher faced challenges such as the exit ticket data. Students' sticker choices might not have reflected their attitude toward the activities. Instead, it could have resulted from their mood, favorite color, or not wanting to choose a sticker with a negative connotation. Furthermore, the participants were apprehensive about listening and singing to music in front of their peers.

How the Research Impacted the Context

The results of the interviews and themes found while conducting the case study were condensed and shared with the participant’s classroom teachers. These findings allowed the teachers to understand different activities and methods that they could introduce within their small-group Tier II instruction within the classroom to bridge the gap that other students experience within their learning of skip-counting patterns. Also, the researcher presented the findings to other math interventionists across the district and discussed the possible advantages of how integrating music into math intervention can assist students who need to master skip-counting.

The researcher found several suggestions for further study. One suggestion is to conduct a random sample of students who have not yet learned skip-counting to see if using musical learning activities affects motivations and understanding of skip-counting patterns. Another potential research area is moving the focus from intervention groups to regular general education classrooms whose teachers teach students how to skip-count.

Summary

Three case study participants were taken through the intervention program through their school, GPES. Through this ROS study I provided tools to help with these three student's individual development of necessary skills to understand and show their understanding of skip-counting patterns. According to TEKS 1.5B, skip-counting patterns are an essential skill for Texas students to master. Participant progression was observed, videotaped, and documented through different measurement instruments: pretest/posttest and exit ticket data. The information gathered within the data collection instruments was coded and developed into themes. The qualitative results of this research were then put into frequency tables and analyzed, grouped by the participant, to check for evidence of themes throughout their time spent within the case study. The two themes, understanding of and motivation to, were found in all participants when using music activities to learn skip-counting patterns. However, non-music activities only showed comprehension but not motivation to learn.

CHAPTER V

CONCLUSIONS

Summary of Findings from Chapter 4

The analysis of this qualitative study allowed me to deeply explore the impact of using music to teach mathematic skills, specifically skip-counting patterns, to second-grade Tier III intervention students. Using non-music and music activities, I was able to track the progress of state objective, TEKS 1.5B, which says students are expected to acquire the skill of skip-counting forward and backward by 2s, 5s, and 10s by the end of first grade.

The following research question guided the present study:

1) When integrated into the second-grade intervention curriculum, what effects do musical learning activities, specifically songs and videos, have on students' understanding of and motivation to learn skip-counting patterns?

The research question that fueled this case study found data surrounding the three participants' understanding of and motivation to learn skip-counting patterns. The qualitative framework allowed individual feelings and the progression of the two themes to be revealed throughout the study.

The qualitative data collection instruments within the case study included a pre and posttest and an exit ticket. The pre and posttest were identical and consisted of two parts. The first part of the pre and posttest was an interview asking students their feelings toward learning math, listening to songs, and singing to songs. The second part, a timed accuracy test, was administered to students to assess their ability to skip-count forward and backward by 2s, 5s, and 10s. The exit ticket data instrument kept track of participants' daily feelings about the lesson. Different learning activities, including music and non-music activities, were presented to assist students in developing skip-counting patterns. During all sessions I, as the researcher, took copious notes which were recorded and transcribed before data analysis.

After the data were collected, the analysis process started. The transcripts from the video-recorded sessions were reviewed multiple times before being analyzed and coded. Codes were created and translated into two themes containing subcategories: understanding, with the subcategories of evidence of understanding and misunderstanding, and motivation, with the subcategories of positive and negative behavior. Results from the data analysis helped confirm that the participants learned skip-counting patterns using non-music activities but had lower positive behaviors scores while doing so. When participating in musical activities, scores in the evidence of positive behaviors was higher than in non-music activities. Results from all three case studies were analyzed together, inferences were made, and conclusions were drawn to help answer the research question. Each data collection instrument was developed to gauge student understanding and/or motivation to learn throughout the study.

Disposition Pre and Posttest

The disposition pre and posttest was used to help measure students' motivation toward learning and music. I chose the different colors for the faces because of student familiarity and knowledge of what feeling each different colored face represented. When tabulating the disposition score, I assigned each face a different point value that was repeated in the exit ticket data. The green smiley face was worth three points, the yellow straight face represented two points, and the red face only worth one point.

The questions chosen for the disposition pre and posttest were created to gauge student's initial perceptions about the overall components of the study. These questions would allow the researcher to gain insight into student motivation. Through repeated measures, the posttest was designed to measure change in student motivation after participating in the study.

The first question showed the researcher the students' growing confidence with learning math. The pre and posttest results reveal a more positive disposition of students wanting to learn math over the course of the study. The dispositions of Julie and Cara remained unchanged with a score of three out of three for both pre and posttest results, indicating positive disposition toward learning math. The third participant, Laci, chose a yellow straight face for the pretest giving her disposition of learning math a score of 66.67%. Laci's posttest showed a higher score for disposition with a green smiley face sticker, increasing her score for disposition by 33.33%.

When creating the second question asking students to rate their feelings about listening to songs, I did not go into detail about the specifics of what songs I was referencing in my question. Students answered the question according to their own definition of what listening to songs was. Julie's and Cara's scores increased from the pre to the posttest, showing more positive disposition about listening to songs. Both scores rose from two out of three to three out of three points. Laci showed a decrease in her score for disposition about listening to songs, 33.33%, reflecting negative motivation. There are no data to help explain the decrease in Laci's disposition score, but it could be that Laci misinterpreted the question asked within the initial disposition pretest.

Again, I did not go into detail when creating question three, and students answered based on their own interpretation of the question. Although I did not give any explanation about specifics, there were no changes in disposition from pre to posttest for any participant. Julie and Cara chose a green smiley face, keeping their disposition score at 100% through the study. In contrast, Laci chose red frown faces when answering the question on the pre and posttest, giving her a maintained score of 33.33%.

Concept Pre and Posttest

The concept pre and posttest was not designed to measure student motivation. The skills assessed in the concept pre and posttest were presented in the following order: skip-count forward by 2s, skip-count backward by 2s, skip-count forward by 5s, skip-count backward by 5s, skip-count forward by 10s, skip-count backward by 10s. The order was chosen at random, and the researcher had no specific reason for the order when creating the concept pre and posttest. Understanding of the skip-counting patterns was measured by accuracy scores for each participant. Accuracy was recorded for each task. Points were not deducted from a participant's score if they made a self-correction or hesitated when counting. I gave full points if students started counting an incorrect sequence, and I had to redirect them to perform the task correctly. Understanding could be measured if accuracy increased, or if the accuracy score remained the same and the speed decreased.

Two of the three participants displayed an increase in accuracy in skip-counting forward by 2s from two to twenty. The results show comprehension of the 2s number sequence. Julie’s score reflected a 40% improvement while Laci increased her accuracy by 90% from pre to posttest. Cara’s concept pre and posttest results remained at 100%, but her completion time decreased from 6.71 to 4.43 seconds, resulting in proof of her retention of skip-counting patterns when counting forward by 2s.

For the second skill, skip-counting backward by 2s, Julie’s accuracy displayed a growth of 90%. Although she took an extended amount of time, two minutes and twenty seconds, I still consider this an increase in her understanding from pre to posttest. Laci did not attempt the skill on her pretest, resulting in an accuracy score of 0%. However, she successfully completed the sequence of skip-counting backward by 2s on the posttest, scoring ten out of ten. Cara had 100% accuracy scores on the skill of skip-counting backward by 2s on the pre and posttest. Still, I was able to identify growth in her comprehension because her completion time decreased by 4.02 seconds between the pre and posttest.

Skip-counting forward by 5s was the next skill on which the participants were assessed. When comparing Julie’s results from the pre to posttest, I measured 30% growth in her accuracy. Laci’s comprehension showed growth from 10% to 100%. These two results show understanding of skip-counting patterns. When skip-counting forward by 5s, Cara had the same level of accuracy across the pre and posttest. Although her time increased, her level of understanding is reflected by her 100% score. The retention of the skill of skip-counting backward by 5s is visible in the results from all participants, depicting comprehension of the skip-counting pattern. All three participants made gains in their accuracy score: Julie – 90%, Cara – 40%, and Laci, 100%.

For the fifth skill, skip-counting forward by 10s, comprehension was demonstrated from the pre to the posttest. All students scored 100% accuracy, but evidence of understanding was noted in a decrease of their completion time. Julie's difference in completion time from pre to posttest was 1.83 seconds. Similarly, Cara showed a difference of 2.57 seconds when completing the task. Lastly, Laci exhibited the greatest difference in time, 6.27 seconds. When skip-counting backward by 10s, the only participant who had a change in accuracy score was Julie, resulting in a 90% increase. Although there was no growth in scores for Cara and Laci from pre to posttest, because both scored 100%, their completion times decreased showing evidence of understanding according to standards set by the researcher.

When observing all data, between pre and posttest, I concluded there was more comprehension of skip-counting patterns. The concept pre and posttest did not measure which learning activity contributed to these results, they just represented student growth in the learning of skip-counting skills and patterns. The result from this data collection instrument was that understanding was evident for all skip-counting skills for every participant, as shown in their accuracy scores or completion time.

Understanding of Non-Music Learning Activities

When trying to figure out how to measure the evidence of understanding in non-music learning activities, I had to group four codes that I assigned to the data to obtain a final frequency. The four codes grouped were correct response, echoing, self-correction, and modeling correctly. A correct response was noted when I asked any individual a question and their response was accurate during a learning session or when a student skip-counted forward or backward by 2s, 5s, or 10s successfully. When students skip-counted forward or backward for the number sequences, echoing was included in evidence of their understanding because although they understood the patterns, they waited for their peers to say the number first.

Also, self-correction, with no redirection from the researcher, was noted and coded as evidence of comprehension during all non-music activities. If there was evidence of a student modeling a task correctly with Unifix cubes, number lines, or a hundreds chart, they received another occurrence of understanding of skip-counting patterns. If students created a "train" successfully with Unifix cubes, modeled the correct spacing of jumps on a number line, or circled the correct groups of 2s, 5s, or 10s on a hundreds chart, they received a correct response instance.

Evidence of misunderstanding during non-music activities also had specific codes assigned to measure the data point. Incorrect responses, correction after observation of peers, counting with assistance, and modeling incorrectly attributed to the participant's score for misunderstanding. If students gave an incorrect response when asked any individual question or made a mistake when skip-counting forward or backward, I noted the occurrence as evidence of misunderstanding. The "correction after observation of peers" code was assigned to tasks involving all non-music activities. When asked to create a "train" of Unifix cubes, model a jump on the number line, or circle a group of 2s, 5s, or 10s on the hundreds chart, if the student observed their peers to replicate their model, I did not code this as evidence of understanding because the initial task was incorrect. Also, it was not a self-correction because the student's needed their peer's model to correct their mistake. Therefore, this is another code included in evidence of misunderstanding.

Several instances were coded as counting with assistance because of one or more of the following characteristics. When orally skip-counting forward or backward by 2s, 5s, or 10s, if students were unable to produce the next number in the sequence, and I provided them with the correct response, I assigned the counting with assistance code. More documentation of counting with assistance occurred during the non-music learning activities when I would point to the numbers written on the cubes, number line, or hundreds chart as the student skip-counted. Counting with assistance examples were grouped into evidence of misunderstanding because students were not producing answers on their own. If a student modeled a task incorrectly during the non-music activities, they received a code of modeled incorrectly which is categorized under evidence of misunderstanding.

When interpreting the results, it is imperative that the sessions of the learning activities be explained. Session 1 of non-music activities included number line activity #1a, Unifix cubes activity #1b, and hundreds chart activity #1c. Sessions 2, 3, and 4 follow the same framework as Session 1, using the number line, Unifix cubes, and hundreds chart activities. The percentages for the evidence of understanding across all three non-music learning activities were combined to represent one session. After evidence of understanding and misunderstanding occurrences were combined, each participant had a total number of responses to allow the researcher to create percentages. All session data were compiled over the course of the study to generate an overall percentage of understanding for each participant. Julie had a total number of 476 responses that were coded with evidence of understanding or misunderstanding during non-music learning activities. Julie's evidence of understanding when participating in the learning activities was 64.92%. On the other hand, she had 167 out of 476 instances of misunderstanding. Cara's total occurrence for all sessions was out of a possible 387 responses and Laci's presented a combined total of 359. Cara and Laci had similar results and displayed a higher percentage for evidence of understanding of skip-counting patterns, with scores of 82.95% and 82.17%. The findings presented the students' evidence of misunderstanding of skip-counting patterns in non-music activities is lower than their levels of understanding because each student had higher occurrences of the codes assigned by the researcher for evidence of understanding.

Motivation for Non-Music Learning Activities

When discussing students' motivation to learn skip-counting patterns, I included codes that helped establish the positive and negative behaviors seen in non-music learning activities. The two positive behavior examples seen by the researcher were confidence when counting and needing clarification. Confidence in counting demonstrates automaticity when counting. When students needed clarification, I decided this was a positive behavior because they were inquiring to ensure they understood the question to provide correct responses which exemplifies motivation and willingness to learn. After the researcher reworded the question, students were able to answer correctly and with confidence.

The negative behavior codes I included to support the theme of motivation to learn skip-counting patterns were off-task behavior, time to think, does not participate, and does not attempt. Students who demonstrated off-task behaviors were not focused on the lesson, distracted by outside influences, or needed to be redirected presented a negative attitude toward learning. Also, I can infer students were not confident in performing the tasks which led to moments of hesitation, time to think, when answering. Therefore, these instances were coded as evidence of negative behavior. Initially, the codes of does not participate and does not attempt were separated. As codes were analyzed, I combined the codes and saw them being used interchangeably as evidence of negative behavior toward learning. Students who were assigned these codes refused to participate in activities, could not produce answers because they did not understand, or did not show motivation to learn.

Analysis of the data revealed a greater number of occurrences that showed negative behavior during non-music learning activities by each participant throughout the length of the study. Laci showed no evidence of positive behavior during the non-music learning activities, and 100% negative behaviors. Cara’s evidence of negative behavior was scored at 75%, leaving her positive behavior occurrences at 25%. Julie had the lowest occasions of negative behavior, but it was still higher than her percentage of positive behaviors. Although the students were successful in learning skip-counting patterns in non-music activities, I interpreted from the results that students were not motivated to learn in the non-music settings because of the evidence of negative behaviors found within the data.

The disposition score for non-music learning activities was originally going to be used as evidence of their motivation toward the activity they were completing. The reason I decided not to include the disposition scores in the interpretation of the data was because their exit ticket data did not accurately reflect the behaviors observed by the researcher during the non-music activities. Each participant had a high disposition score for the non-music activities, and evidence of more negative behavior, which does not give an exact reflection of student perception. Julie had a combined disposition score of 86.11%, which portrays positive feelings toward the learning activity. However, her evidence of negative behaviors (66.67%) was seen more frequently than her positive behaviors (33.33%). Similarly, Cara’s evidence of negative behaviors was represented 75% of the time during non-music activities whilst her disposition score was a 100%. Laci, who exhibited 100% negative behaviors during the non-music learning activities had a more positive disposition score of 96.97%. I infer the results are not accurate and do not genuinely represent the student’s motivation. Students associate negative connotations toward the yellow straight face and the red frown face. Another inference I made about the student’s choice of sticker was possibly they did not want to hurt my feelings by choosing the red frown face or the yellow straight face because the green smiley face has a more positive effect.

Understanding of Music Learning Activities

Evidence of understanding was visible in the music activities the students participated in throughout the study. To help support the improvement in comprehension for all students, two codes present in the data were grouped under the understanding theme. The music activities consisted of two songs that modeled skip-counting forward and backward by 2s, 5s, and 10s. If students skip-counted along with the video, the answers were noted as correct responses. Also, echoing was included as evidence of understanding because the students knew the next number in the sequence, but did not have the confidence to respond without hearing or seeing the correct answer from the video first. Evidence of misunderstanding was not noted during the initial observations. For each music session, the students had eleven opportunities between both videos to display their skip-counting abilities. Evidence of understanding was noted, so evidence of misunderstanding was calculated after the result was found.

Each session displayed in the findings for music activities only included one day of implementation and observations of both skip-counting songs. All four music activity sessions were combined for an overall percentage portraying evidence of understanding and misunderstanding. Each participant had forty-four opportunities to demonstrate their level of understanding during all music activities. Similar to the non-music activities, all three participants had a higher percentage of moments of comprehension compared to times of misunderstanding. Again, Cara and Laci had similar percentages for their comprehension, 88.64% and 86.36%. Julie's percentage was not far behind the other participants at 77.27%. All participants showed a clear understanding during the music learning activities.

Motivation for Music Learning Activities

While analyzing the data for student motivation to learn skip-counting patterns, I included codes assisting me in deducing the differences between instances of positive and negative behaviors. The three positive behavior examples seen by the researcher were confidence when counting, singing along with the songs, and completing motions with the video. When students display confidence while skip-counting, the students did not wait for numbers to flash across the screen, showing their automaticity when skip-counting. I noted this as a positive behavior because students were comfortable while counting. Students showed evidence of their motivation to learn by singing along with the music learning activity. I considered this a positive behavior because the student was participating and showed interest when listening to the songs. Also, I observed the students' happy dispositions while singing along to the songs. Similar to singing along, if the students attempted to follow along with the motions, I included their actions as an example of motivation to learn skip-counting patterns because they were engaged and willing to follow along with the instructions provided in the video.

I combined "does not participate" and "does not attempt" into one category, reflecting the change I made also in the non-music motivation section. I included the following behaviors under the code of "does not participate": not looking at the board, not paying attention to the video, no participation from the student even after I encouraged them. The student's lack of motivation was noted as a negative behavior.

All positive motivation scores for all participants across the music activities were higher than the negative behavior scores. Julie's evidence of understanding was the lowest, but her positive behaviors toward the activity were the greatest across the participants at 95.66%. Cara and Laci, again, had very similar scores in their positive and negative behaviors. The behavior percentages for Cara are 94.29% of positive behaviors, and 5.71% of negative behaviors observed throughout the study. Likewise, Laci's scores of 94.2% for positive motivation for learning and 5.8% for negative motivation to learn are similar to the scores of Cara.

The disposition scores of the participants for the music learning activities, recorded on their exit ticket data chart, coincide with the researcher's observations of positive behaviors. Although Julie seemed to enjoy the music learning activities more than half the time, her evidences of positive behaviors were visible at 95.66%, while her disposition score was 58.33%. Cara's disposition score (100%) reflects her evidence of positive behaviors (94.29%) during music activities. The disposition score for Laci, 83.33%, supported the data of positive behavior occurrences at 94.2%. The results of the disposition score for music activities present a connection between student's understanding and motivation to learn skip-counting patterns.

Findings

Results indicate that levels of comprehension increased in both music and non-music learning activities. The scores in the evidence of understanding exceeded the scores in the evidence of misunderstanding during all activities for all participants as demonstrated above. Examining across the data from non-music to music activities, the results indicate that student's evidence of understanding occurred more in music learning activities than in non-music learning activities. Julie had a non-music learning activity understanding score of 64.92%. Her music learning activity score was 77.27%. Although Cara's increase was not as large as Julie's, a growth was still visible in the data reflected in her scores of understanding in non-musical (82.95%) and musical (88.64%) activities. Similar to Cara, Laci exhibited greater levels of understanding in music activities, 86.36%, compared to non-musical activities, 82.17%. The results of the data presented help support the research question when discussing student understanding of learning skip-counting patterns.

Discussing student motivation, evidence of negative behavior occurrences in non-music activities was higher than negative behaviors observed in music activities for all three participants. The positive behaviors tied to student motivation were observed more often in music activities. Julie's positive behavior scores from non-music activities to music activities were 33.33% and 95.66%, respectively. Cara's scores also demonstrated an increase in positive behaviors from non-music (25%) to music (94.29%) activities. Laci, who showed no positive behaviors when participating in non-music activities had a score of 94.2% of positive behaviors seen in music learning activities.

Discussion of Results in Relation to the Extant Literature

A qualitative approach was chosen for this study to gauge participant understanding and motivation toward the integration of musical learning activities in mathematics lessons. When attempting to attain evidence of student understanding of skip-counting patterns, students had to exhibit some of the following characteristics: greater comprehension, articulation of what they learned and why, higher levels of engagement, and an increase in confidence. Qualitative research aims to develop comprehensive overviews of participant perspectives while ensuring that no predictions are made regarding behavior or performance. Using this type of study allows researchers to understand aspects relative to participants, including psychosocial and interpersonal relationships, which are unique to each participant and affect the way they think, develop knowledge, and understand the world around them. Researchers who utilize qualitative research studies have many tools available to study participants, such as close observation, interviews, and analysis of participant responses, which allow the researcher to create hypotheses and research questions to answer common problems seen in specific fields (Arghode, 2012; Bloomfield & Fisher, 2019; Indu & Vidhukumar, 2020; Lowhorn, 2007; O'Brien et al., 2014; Queiros et al., 2017; Ramani & Mann, 2016; Sahin & Ozturk, 2019; Sergeant, 2012; Yilmaz, 2013).

The researcher's transcripts, videos, and notes were condensed into one comprehensive document. Having three methods of observation allowed the researcher to triangulate the data before being analyzed. Triangulation is an essential tool for researchers when conducting qualitative research because it enables them to gain aspects of reliability and validity to strengthen the themes and findings of their research (Hara, 1995; Ramani & Mann, 2016; Tomaszewski et al., 2020).

Off-task behaviors were present in non-music learning activities more frequently than in lessons that utilized music activities. Confidence and student engagement were also noted more during music than in non-music activities. These findings align with prior researchers who say allowing students to utilize creative outlets while learning mathematics concepts has been shown to boost confidence in their abilities and help them stay engaged while learning (Annarella, 2000; Baravalle, 1944; Biller, 1994; *Creative Teacher Exchange*, 1954; Ediger, 2000; Rajan, 2016; Sullivan & Bers, 2108; Todhunter-Reid, 2019; Ufuktepe & Ozel, 2002).

The differences between participants' attitudes were evident during musical learning activities, which had a higher percentage of positive behaviors than in non-music activities. The student's increase in willingness to participate was seen throughout the data as students began to feel comfortable with singing and performing motions along with the music videos in front of their peers. Music that contains an upbeat tempo and rhythm captures students' attention, keeping them engaged and helping them retain concepts related to mathematics skills. Integrating music and mathematics has many benefits for students, such as increased achievement by strengthening memory and recall, increased levels of engagement and participation, and creating a positive environment for students to learn (An et al., 2013).

Throughout all music and non-music activities, the accuracy of skip-counting forward and backward, evident in the posttest results, increased for all participants within the case study. Student mastery of skip-counting patterns directly affects their ability to learn foundational mathematical skills: addition, multiplication, pattern recognition, and composing and decomposing numbers (Bray & Blais, 2017; Hazen, 1996; Fernandez, 2008).

Discussion of Personal Lessons Learned

Conducting this case study taught me a few lessons. Some students could skip-count by 2s, 5s, and 10s but did not understand the concept that skip-counting increases by equal increments while counting. I found that skip-counting can be taught using many different methods such as music, blank number lines, Unifix cubes, and a hundreds chart. This research study was my first qualitative study. I learned to use coding software to code and analyze the data, using all of the functions such as the word cloud, code manager, and linking tools to explore the themes and ideas found within the data. Finding themes and patterns in the coded data was a learning experience because I had to find a way to look at the data from an angle where significance could be seen in the results.

Also, throughout the processes of creating the data collection instruments, implementing the activities, and analyzing the data, I had to ensure that each step was justified by research from my literature review. During the analysis period specifically, I had to be sure that the findings supported the research question. I had to make adjustments and eliminate extraneous information several times because it was not relevant to the research. I learned the importance of remaining consistent across each session because a qualitative study requires that a researcher's data collection instruments and methods are duplicated for all participants.

Time management is a lesson I learned during the implementation of this case study. I found that triangulating my data between notes, videos, and transcripts took time. Although necessary for my research, I should have given myself more time to analyze my data before coding and creating themes. It would have been beneficial to transcribe after each activity session with students, so the observations were current and fresh on my mind.

Implications for Practice

Through examining the data and results from the study, it is apparent that adding music to the curriculum has a positive effect on student's motivation and understanding and I recommend that it be added as an instrument to teach skip-counting skills. Classroom teachers should be encouraged, and maybe mandated, to utilize music activities during their Tier II small-group instruction sessions. As the campus math interventionist, my role should take the lead and support teachers by working in tandem and modeling lessons within the classroom. Vocabulary and activities will need to refrain from variation across grade-level classrooms.

Professional development opportunities need to be provided to allow teachers who have Tier II student intervention groups deficient in skip-counting patterns to successfully implement different learning activities during instruction. Research validates a requirement for music learning activities in the district math curriculum and the CSISD RtI framework. Also, an amendment to the campus improvement plan within the category for small-group instruction should include multiple learning activities to teach skip-counting patterns.

Connect to Context

The research and findings had an impact on the participants in the case study because they provided them a voice and opportunity to overcome their deficiencies and discuss their feelings toward the different learning activities presented. Tier III students typically learn better with repetition of tasks to retain information, which is a characteristic that our district incorporates in the intervention curriculum. The repetition of the music and non-music activities affected the participant's results of increased accuracy and positive motivation when learning skip-counting patterns. This action research familiarized the researcher with multiple examples of learning activities to inform and teach classroom teachers different opportunities to improve comprehension of skip-counting patterns.

Lessons Learned

My personal experiences in teaching mathematics allowed me to see the need for engaging and intense intervention. As a classroom teacher, I realized that using music could help student engagement and focus. My classroom students and I used popular songs to create lyrics to help retain difficult math concepts. I used music not only during academic times but also during transitions. Music is an accessible tool for all classroom teachers to use.

When I first proposed my study to my committee chair, I attempted to create a research question that studied how music affected math learning. After discussing with my committee and looking at my timeline, it was evident that I needed to narrow my focus from general mathematics to a particular math skill. My current role as a math interventionist allowed me to have a place on the SIT committee, where recommendations were made to help the struggling Tier III students. In reviewing campus assessment data during the meetings, a common area of deficiency in the second-grade population was noted. The area stated that students were ready to develop the first-grade skill of skip-counting, meaning they had a gap in their learning within this concept.

Recommendations

This study incorporated literature elements that already exist regarding the benefits of implementing music to teach mathematics skills. Although my data analysis showed an increase in understanding and motivation to learn skip-counting patterns, a few areas would benefit from further investigation to comprehend the effects of music on mathematics. One suggestion is having a more extended period for data collection to give better opportunities for students to express understanding of and motivation to learn skip-counting patterns. The present study, despite all the aspects outside of the researcher's control, such as absences and quarantines, allowed a data collection period of approximately five weeks. Giving more time for participants to be exposed to skip-counting procedures and activities would potentially allow them to develop the necessary skip-counting skills to cover the deficit fully. A future study could follow the same procedures, data collection instruments, and methodology with a different concept that second-grade Tier III students struggle with learning math. Conducting a similar analysis could support or negate the findings throughout literature that discuss the relationship between music and allowing students to become successful when learning necessary math skills.

Also, a different student population could be positively affected by utilizing a random selection process of participants. The present study's participants were known to the researcher and introduced bias into the study. A completely random, bias-free study would be a good future opportunity to explore the relationship between math and music further. The final recommendation would be to expand the case study from one school to include schools across the state of Texas. A study could start small, testing all elementary schools within the district and work up in size to have a range of demographics and socio-economic areas in Texas schools. Including all of these different regions would hopefully corroborate the data and results collected within the present study.

Closing Thoughts

As I have conducted this research, I have had the opportunity to measure student achievement and growth. Following this idea from beginning to end has allowed me to grow as a researcher and an educator. By understanding my students' needs to be successful, I have developed a researcher's view regarding a student's desires, strengths, and weaknesses. Conducting an action research study has allowed me to see situations as both a teacher and a researcher. I have developed and mastered observation skills by utilizing triangulation between observation of student behavior and my notes to document the way students conceptualize and understand math concepts. Now that I know the necessary methods to observe my students, I can tailor lessons or content to their specific learning strategies. As I stated earlier, I did not choose education, but education chose me, and this study has reminded me of this critical fact. This study has helped me solidify my love for learning and having an impact on the learning of my students. After conducting this ROS study, I have developed additional tools, my artifact, to include in my toolbox to help better teach my students and to share these materials with our district's teachers.

REFERENCES

Alkhatib, O. J. (2019, March). A framework for implementing higher-order thinking skills in Engineering & Humanities. *2019 Advances in Science and Engineering Technology International Conferences (ASET)*, 1-8. https://doi.org/10.1109/ICASET.2019.8714232.

An, S., Capraro, M. M., & Tillman, D. A. (2013). Elementary teachers integrate music activities into regular mathematics lessons: Effects on students' mathematical abilities. *Journal for Learning Through the Arts, 9*(1).

An, S. A., Ma, T., & Capraro, M. M. (2011). Preservice teachers' beliefs and attitude About teaching and learning mathematics through music: An intervention study. *School Science and Mathematics, 111*(5), 236–248.

An, S. A., Tillman, D., Shaheen, A., & Boren, R. (2014). Preservice teachers' perceptions about teaching mathematics through music. *Interdisciplinary Journal of Teaching and Learning, 4*(3), 150–171.

Annarella, L. A. (2000). *Theatre in the classroom--a creative way to teach and learn* (ED445357). ERIC. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED445357

Arghode, V. (2012). Qualitative and quantitative research: Paradigmatic differences. *Global Education Journal*, *2012*(4). 155-163.

Ayele, M. A. (2016). Mathematics teachers' perceptions on enhancing students' creativity in mathematics. *International Electronic Journal of Mathematics Education, 11*(10), 3521-3536.

Azaryahu, L., Courey, S. J., Elkoshi, R., & Adi-Japha, E. (2020). "MusiMath" and "Academic Music" - Two music-based intervention programs for fractions learning in fourth grade students. *Developmental Science, 23*(4).

Baravalle, H. V. (1944). Psychological points of view on the teaching of arithmetic. *The Mathematics Teacher*, *37*(8), 341.

Baroudi, Z. M. (2007). Formative assessment: Definition, elements, and role in instructional practice. *Post-Script (1444-383X), 8*(1), 37–48.

Biller, J. (1994, October). *A creative concept in teaching math to art students: Make-a-problem.* Paper presented at the annual National Conference on Liberal Arts and Education of Artists. New York, NY.

Biller, J. (1995, October). *Math in art or art in math.* Paper presented at the annual National Conference on Liberal Arts and Education of Artists. New York, NY.

Bloomfield, J., & Fisher, M. J. (2019). Quantitative research design. *Journal of the Australasian Rehabilitation Nurses' Association (JARNA), 22*(2), 27–30. https://doi.org/10.33235/jarna.22.2.27-30

Bray, W. S., & Blais, T. V. (2017). Stimulating base-ten reasoning with context. *Teaching Children Mathematics, 24*(2), 120-127.

Briand, C. (2013). *Add+VantageMR® assessments: A case study of teacher and student gains* (Doctoral dissertation, University of New Mexico).

Bridges Intervention. Bridges in mathematics | The math learning center. (2021). Retrieved from https://www.mathlearningcenter.org/curriculum/bridges.

Burton, J. M., Horowitz, R., & Abeles, H. (2000). Learning in and through the arts: The question of transfer. *Studies in Art Education, 41*(3), 228–257. https://doi.org/10.2307/1320379

Cartwright, K. (2018). *Exploring mathematical fluency: Teachers' conceptions and descriptions of students*. (ED592432). ERIC https://files.eric.ed.gov/fulltext/ED592432.pdf.

Choy, L. T. (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR Journal of Humanities and Social Science*, *19*(4), 99-104.

Colwell, R., & Davidson, L. (1996). Musical intelligence and the benefits of music education. *NASSP Bulletin, 80*(583), 55–64. https://doi.org/10.1177/019263659608058310

Costley, K. C. (2011). *The link between musical achievement and academic achievement of young children* (ED513911). ERIC. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED513911

Creative teacher exchange: It all depends on the teacher. (1954). *Educational Horizons, 33*(2), 116.

DiDomenico, J. (2017). Effective integration of music in the elementary school classroom. *i.e.: Inquiry in Education, 9*(2).

Dixson, D. D., & Worrell, F. C. (2016). Formative and summative assessment in the classroom. *Theory Into Practice, 55*(2), 153-159.

https://doi.org/10.1080/00405841.2016.1148989

Edelson, R. J., & Johnson, G. (2003). Music makes math meaningful. *Childhood Education, 80*(2), 65–70. https://doi.org/10.1080/00094056.2004.10521259

Ediger, M. (2000). *The creative mathematics teacher* (ED436375). ERIC. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED436375

Egger, J. O. (2019). Effects of cooperative learning on preservice elementary teachers' interest in and integration of music into core academic subjects. *International Journal of Music Education, 37*(4), 608–621. https://doi.org/10.1177/0255761419852173

Fattal, L., & An, H. (2019). STEAM: Choreographing the phases of the moon. *Journal of Dance Education, 19*(4), 178–182.

Fernàndez, E. (2008). Early childhood corner: Taking advantage of everyday activities to practice math every day. *Teaching Children Mathematics, 15*(3), 174-177.

Finnerty, D. C. (2018). *The predictive utility and longitudinal student growth of NWEA Map interim assessments in two Pennsylvania middle schools* (Doctoral dissertation, Lehigh University).

Fiore, G. (1999). Math-abused students: Are we prepared to teach them? *The Mathematics Teacher, 92*(5), 403-405.

Forseth, S. D. (1980). Art activities, attitudes, and achievement in elementary mathematics. *Studies in Art Education, 21*(2), 22–27.

Frank, A. R. (1989). Counting skills–A foundation for early mathematics. *The Arithmetic Teacher, 37*(1), 14-17.

Froschauer, L. (2016). STEAM: Beyond the acronym. *Science & Children, 53*(6), 5.

Fuchs, L. S., Schumacher, R. F., Long, J., Namkung, J., Hamlett, C. L., Cirino, P. T., Siegler, R., & Changas, P. (2013). Improving at-risk learners' understanding of fractions. *Grantee Submission, 105*(3), 683–700. https://psycnet.apa.org/doi/10.1037/a0032446

Garrett, R., Dawson, K., Meiners, J., & Wrench, A. (2018). Creative and body-based learning: Redesigning pedagogies in mathematics. *Journal for Learning through the Arts, 14*(1).

Geist, K., Geist, E. A. & Kuznik, K. (2012). The patterns of music: Young children learning mathematics through beat, rhythm, and melody. *Young Children, 67*(1), 74.

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.

Gerretson, H., Bosnick, J., & Schofield, K. (2008). A case for content specialists as the elementary classroom teacher. *Teacher Educator, 43*(4), 302–314.

Gibbs, A. S., Hinton, V. M., & Flores, M. M. (2018). A case study using CRA to teach students with disabilities to count using flexible numbers: Applying skip counting to multiplication. *Preventing School Failure, 62*(1), 49–57. https://doi.org/10.1080/1045988X.2017.1342218

Greens Prairie School Improvement Committee. (2019). *Annual campus improvement plan for Greens Prairie Elementary 2020-2021*. Retrieved from http://web.csisd.org/school_board/agendas/2020-2021/September/GreensPrairie-2020-21-CIP.pdf

Hall, C., & Thomson, P. (2017). Creativity in teaching: What can teachers learn from artists? *Research Papers in Education, 32*(1), 106–120.

Hara, K. (1995). Quantitative and qualitative research approaches in education. *Education,115*(3), 351-356.

Hazen, B. (1996). Elementary math part 2. *Practical homeschooling, 13*. Retrieved from https://www.home-school.com/Articles/elementary-math-part-2.php

Hetland, L. (2000). Listening to music enhances spatial-temporal reasoning: Evidence for the "Mozart Effect". *Journal of Aesthetic Education, 34*(3/4), 105-148. https://doi.org/10.2307/3333640

Indu, P. V., & Vidhukumar, K. (2019). Research designs-an overview. *Kerala Journal of Psychiatry*, *32*(1), 64-67. https://doi.org/10.30834/KJP.32.1.2019.179

James, F. (2004). Response to intervention in the individuals with disabilities education act (IDEA), 2004. *International Reading Association*, 1-5.

Jones, S. M., & Pearson Jr., D. (2013). Music: Highly engaged students connect music to math. *General Music Today, 27*(1), 18–23.

Jordan, N. C., Kaplan, D., Locuniak, M. N., & Ramineni, C. (2007). Predicting first-grade math achievement from developmental number sense trajectories. *Learning Disabilities Research & Practice*, *22*(1), 36-46.

Kaboub, F. (2008). Positivist paradigm. *Encyclopedia of Counselling*, *2*(2), 343.

Krishnan, R. (2020). *The functional relationship between music and math.* Retrieved from https://blog.discmakers.com/2020/07/the-functional-relationship-between-math-and-music/

Lampert, M. (1986). Knowing, doing, and teaching multiplication. *Cognition and Instruction*, *3*(4), 305-342.

Leandro, C. R., Monteiro, E., & Melo, F. (2018). Interdisciplinary working practices: Can creative dance improve math? *Research in Dance Education, 19* (1), 74–90. https://doi.org/10.1080/14647893.2017.1354838

Lunde, H. (2021). *Does the implementation of Bridges math intervention show growth in student learning?* (Masters thesis, Minnesota State University Moorhead).

Maker, C. J. (2003). Developing scope and sequence in curriculum. *Curriculum for Gifted and Talented Students, 30*(4), 25-35.

Marshall, C. (2016). *The math behind Beethoven's music.* Retrieved from https://www.openculture.com/2016/04/the-math-behind-beethovens-music.html

Marasco, E., & Behjat, L. (2014). Changing gender perceptions in elementary stem education. *2014 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--20162

Martinie, S. (2006). Families ask: Some students do not like mathematics. *Mathematics Teaching in the Middle School, 11*(6), 274-275.

Math anxiety causes trouble for students as early as first grade. (2012, September 28). *Health & Medicine Week*, 1130. https://link.gale.com/apps/doc/A304105868/HRCA?u=txshracd2898&sid=HRCA&xid=05364828.

Math deficits: Why do students struggle? (2017). *2e: Twice-Exceptional Newsletter, 83*, 6.

May, B. N. (2018). Meaningful music learning through integration. *General Music Today, 32*(1), 23–25. https://doi.org/10.1177/1048371318793150

Morgan, P. L., Farkas, G., & Maczuga, S. (2015). Which instructional practices most help first-grade students with and without mathematics difficulties? *Educational Evaluation and Policy Analysis, 37*(2), 184–205. https://doi.org/10.3102/0162373714536608

Mutlu, Y. (2019). Math anxiety in students with and without math learning difficulties. *International Electronic Journal of Elementary Education, 11*(5), 471–475.

National Center for Education Statistics. (2019). *NAEP report card: Mathematics.* https://www.nationsreportcard.gov/mathematics/nation/groups/

National Center on Intensive Intervention. (Nd). *Teaching counting: Consideration for instruction*. Retrieved from https://intensiveintervention.org/sites/default/files/ TeachingCounting_Considerations_Instruction.

Nelson, G., & Powell, S. R. (2018). A systematic review of longitudinal studies of mathematics difficulty. *Journal of Learning Disabilities, 51*(6), 523–539.

Northwest Evaluation Association. (2020). *2020 NWEA MAP growth normative data overview.* https://teach.mapnwea.org/impl/MAPGrowthNormativeDataOverview

Perger, P., Major, K., & Trinick, R. (2018). Adding to, not taking away: Mathematics and music in the primary classroom. *Teachers and Curriculum, 18*(1), 19–25.

PQ, R. (2016). *Music and the Fibonacci sequence.* Retrieved from http://blog.dubspot.com/fibonacci-sequence-in-music/

Preston, A. I., Wood, C. L., & Stecker, P. M. (2016). Response to intervention: Where it came from and where it's going. *Preventing School Failure: Alternative Education for Children and Youth, 60*(3), 173-182.

Programme for International Student Assessment. (2018). *PISA 2018 results.* https://www.oecd.org/pisa/publications/pisa-2018-results.htm

Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*, *3*(9), 369-387. https://doi.org/10.5281/zenodo.887089

Rajan, R. (2016). Beyond broadway: Connecting musical theater and academic learning. *Childhood Education, 92*(2), 118–125. https://doi.org/10.1080/00094056.2016.1150743

Rauscher, F. H., Shaw, G. L., & Ky, C. N. (1993). Music and spatial task performance. *Nature 365*, 611 (1993). https://doi.org/10.1038/365611a0

Rothstein, E. (1982, August 29). *Math and music: The deeper links.* NY Times. https://www.nytimes.com/1982/08/29/arts/math-and-music-the-deeper-links.html

Rufo, D. (2017). Math hater: How one child overcame her math anxiety through self-administered art therapy. *Art Education, 70*(5), 6–10.

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

Schmidt-Jones, C. (2019). Integrating math and music. *Delta-K, 55*(2), 12–14.

Shah, S. (2010). *An exploration of the relationship between mathematics and music* (Doctoral dissertation, Manchester Institute for Mathematical Sciences, The University of Manchester).

Simpson Steele, J., Fulton, L., & Fanning, L. (2016). Dancing with STEAM: Creative movement generates electricity for young learners. *Journal of Dance Education, 3*, 112.

Sullivan, A., & Bers, M. U. (2018). Dancing robots: Integrating art, music, and robotics in Singapore's early childhood centers. *International Journal of Technology and Design Education, 28*(2), 325. https://doi.org/10.1007/s10798-017-9397-0

Texas Education Agency. (2020). *STAAR statewide summary reports.* https://tea.texas.gov/student-assessment/testing/staar/staar-statewide-summary-reports

Texas Education Agency. (2022). *Section 504.* https://tea.texas.gov/academics/special-student-populations/section-504

Tillman, D. A., An, S. A., & Boren, R. L. (2015). Assessment of creativity in arts and STEM integrated pedagogy by preservice elementary teachers. *Journal of Technology and Teacher Education, 23*(3), 301–327.

Tinh, T., & Quang, L. (2019). Integrating art with STEM education - Steam education in Vietnam high schools. *Annals. Computer Science Series, 17*(1), 203–213.

Todhunter-Reid, A. (2019). In-school arts education and academic achievement: A child fixed effects approach. *Arts Education Policy Review, 120*(2), 112–119.

Tomasetto, C., Morsanyi, K., Guardabassi, V., & O'Connor, P. A. (2020). Math anxiety interferes with learning novel mathematics contents in early elementary school. *Journal of Educational Psychology*. https://doi-org.srv-proxy2.library.tamu.edu/10.1037/edu0000602.supp

Ufuktepe, U., & Ozel, C. T. (2002, July). *Avoiding mathematics trauma: Alternative* *teaching methods.* Paper presented at the annual International Conference on the Teaching of Mathematics. Crete, Greece.

U.S. Department of Education. (2004). *Introduction: No child left behind.* https://www2.ed.gov/nclb/overview/intro/index.html

Vaughn, K. (2000). Music and mathematics: Modest support for the oft-claimed relationship. *Journal of Aesthetic Education, 34*(3/4), 149. https://doi.org/10.2307/3333641

Vitale, J. L. (2011). Music makes you smarter: A new paradigm for music education? Perceptions and perspectives from four groups of elementary education stakeholders. *Canadian Journal of Education / Revue Canadienne de l'éducation, 34*(3), 317.

Wallace, C. E., & Russ, S. W. (2015). Pretend play, divergent thinking, and math achievement in girls: A longitudinal study. *Psychology of Aesthetics, Creativity, and the Arts, 9*(3), 296–305. https://doi-org.srv-proxy2.library.tamu.edu/10.1037/a0039006

Waller, L. I. (2012). *Math intervention teachers' pedagogical content knowledge and student achievement* (Order No. 3506346). Available from ProQuest Dissertations & Theses Global. (1015169915). http://proxy.library.tamu.edu/login?url=https://www.proquest.com/dissertations-theses/math-intervention-teachers-pedagogical-content/docview/1015169915/se-2?accountid=7082

Wildridge, J. (2019). *Classical music and mathematics.* Retrieved from https://www.cmuse.org/classical-music-and-mathematics/

Wilkins, J. L. M., & Ulrich, C. (2017). The role of skip counting in children's reasoning. *Virginia Mathematics Teacher, 43*(2), 8-14.

Williams, C. (2007). Research methods. *Journal of Business & Economics Research (JBER)*, *5*(3), 65-72. https://doi.org/10.19030/jber.v5i3.2532

Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European Journal of Education*, *48*(2), 311-325. https://doi.org/10.1111/ejed.12014

APPENDIX A

IRB DETERMINATION LETTER

NOT HUMAN RESEARCH DETERMINATION

February 22, 2021

Type of Review:	Initial Review Submission Form
Title:	CLOSING THE GAPS IN MATHEMATICS FOR ELEMENTARY-AGED STUDENTS USING VARIOUS MUSICAL INTERVENTIONS
Investigator:	Mary Margaret Capraro
IRB ID:	IRB2021-0162
Reference Number:	121572
Funding:	N/A
Documents Received:	IRB Application (v1.0)

Dear Mary Margaret Capraro:

The Institution determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

Further IRB review and approval by this organization is not required because this is not human research. You have indicated that the results of the activities described in the application will not be generalized beyond a single school system and will not be published. This determination applies only to the activities described in this IRB submission and does not apply should any changes be made. If changes are made you must immediately contact the IRB about whether these activities are research involving humans in which the organization is engaged. You will also be required to submit a new request to the IRB for a determination.

Please be aware that receiving a 'Not Human Research Determination' is not the same as IRB review and approval of the activity. IRB consent forms or templates for the activities described in the determination are not to be used and references to TAMU IRB approval must be removed from study documents.

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration

APPENDIX B

DISPOSITION PRETEST/POSTTEST

Student Name: Date:

Ask the student the following questions listed below. Circle the face that corresponds to their answer. (red face – no; yellow face – I don't know or I'm not sure; green – yes)

1. Which emoji below best shows your feelings about learning math?

2. Which emoji below best shows your feelings about listening to songs?

3. Which emoji below best shows your feelings about singing songs?

APPENDIX C

EXIT TICKET

How did you feel about your learning of skip-counting today?

Student Name	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Julie					
Cara					
Laci					

APPENDIX D

ARTIFACT

1. Introduce findings of research study to the district math coordinator – August 2022
   a. Share results of research
   b. Ask permission to share with the district elementary math interventionists
2. Present to math interventionists – September 2022
   a. Share results of research
   b. Explain music activities
   c. Give examples of non-music learning activities (videos from my study)
      1. Number line
      2. Unifix cubes
      3. Hundreds chart
   d. Create a window for interventionists to implement the activities at their home campus.
3. District math interventionist meeting – January 2023
   a. Interventionists share results and recommendations
   b. Complete a teacher survey developed by me to gauge perceptions of study
   c. Open a time for questions
4. District math interventionist meeting – April 2023
   a. Create a plan for the 2023-2024 school year
   b. Agree on a different mathematical concept to focus on teaching

c. Decide on music and non-music learning activities to implement