The Effectiveness of an AI-infused Music App on 4th Grade Student Motivation

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B.M.E., University of Missouri-Kansas City, 2016

M.Ed., William Woods University, 2021

Submitted to the Graduate Department and Faculty of the School of Education of Baker University in partial fulfillment of the requirements for the degree of Doctor of Education in Instructional Design and Performance Technology

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Date Defended: August 20, 2024

Abstract

The purpose of this study was to determine if the fourth-grade students felt increased motivation towards playing and learning the recorder after experiencing the instructional intervention of a game-based music app called The Magic Flute. Using the ARCS model coined by John Keller (2010), the study examined fourth-grade student feelings of motivation through a survey designed to analyze the attention, relevance, confidence, and satisfaction of students with regard to The Magic Flute. Participants of this study were all fourth-grade students at Ridgeview Elementary in the Liberty Public Schools District No. 53 in Liberty, MO. The results showed an increase in the confidence metric of Keller's ARCS model.

Dedication

I would like to dedicate this dissertation to all of the incredible educators from whom I have had the opportunity to learn. Educators and musicians both stand on the shoulders of those who have come before us. I recognize that I would not be the educator I am today without the guidance of all of those individuals.

Acknowledgements

I would like to first acknowledge my advisor, Dr. Anna Catterson, and my research analyst, Dr. Kyunghwa Cho. Dr. Catterson provided invaluable feedback when helping me to narrow my topic, gave me a starting point for a working framework, and was critical to my success not only during the dissertation process but over the course of working through this program. Dr. Cho helped refine the study and was a tremendous aid during the data analysis phase.

I would also like to acknowledge both of my other dissertation committee members, Dr. Regena Aye and Dr. Tyler Shannon. Dr. Aye provided helpful feedback for my dissertation and offered an exceptional model for an engaging teaching style throughout my coursework. I am grateful for the mentorship of Dr. Shannon on my journey through this doctoral program, and for graciously accepting the offer to serve on my committee.

Finally, I would like to thank Mr. Christopher Hand, Mr. Aaron Money, and Liberty Public Schools for allowing me to carry out this study with the students of Ridgeview Elementary. Without their help and assistance, this study would not have been possible.

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Chapter 1

Introduction

Elementary music class encompasses the bulk of music education for most students in the United States of America (Lowell & Zakaras, 2008). One of the most utilized instruments in the elementary music classroom is the recorder (Günther School, 2024). Despite its widespread use, the excitement and novelty of the recorder still have a hard time standing up to the attention demands of today's youth. Once the initial fire of newness burns away, educators are left with the challenge of sustaining the motivation of their students despite the tediousness of teaching instrument techniques and skill sets. While research has been conducted to determine causes and possible strategies to encourage students, maintain positive feelings, and keep motivation towards instrumental music high, the challenge remains across the field of education to keep students engaged in this field of study (Boaler, 2002; Kumar & Khurana, 2012; Lee & Hammer, 2011). Focused research in recorder music education stands to provide instructional strategies to the public-school educator to meet this challenge (Enrico et al., 2021; Keetman, 1970; Sang, 1987; Warner, 1991).

This study relies on the ARCS model as its theoretical framework. John Keller's ARCS model, depicted below in Table 1 (Keller, 2010, p. 44), is an anagram using the areas of *attention, relevance, confidence,* and *satisfaction.* These areas provide an examination of the components leading to the overall motivation of an individual.

Table 1

John Keller's ARCS Model

Category	Definition
Attention	Capturing the interest of learners; stimulating the interest to learn
Relevance	Meeting the personal needs/goals of the learner to effect a positive attitude
Confidence	Helping the learners believe/feel that they will succeed and control their success
Satisfaction	Reinforcing accomplishment with rewards (internal and external)

The first chapter of this dissertation explores the background of the study. The specific problem and purpose of the study is discussed, along with the significance of the study and relevant delimitations. The chapter concludes with the research questions used in this study.

Background

Educators in all fields face challenges in motivating their students to learn and holding on to their engagement throughout their time working together (Boaler, 2002; Kumar & Khurana, 2012; Lee & Hammer, 2011). Despite possessing many advantages, the current landscape of digital technology has also rendered changes in the attention span, areas of interest, and general motivations of the youth of today (Ross, 1995; Vasil, 2013). These changes require educators to adapt to the advances in technology. Even though this demands instructional reform and a re-framing of the definition of teaching, there also exists opportunities for educators to leverage this technology to better engage and educate their students.

Music encompasses a wide range of benefits for the young student. From development as a human to social-emotional growth to cultural understanding and

beyond, music is an integral part of all human societies (Lehmann et al., 2007; Sooter, 2023). The right to an education in music is equally important as music itself (Cambell & Kassner, 1995). As such, music educators and researchers have an obligation to meet the needs of their learners despite the growing issues presented in the field, particularly concerning the motivation of their students.

Gamification has evoked great interest in the educational community since it broke onto the scene (Rai & Beck, 2016). Its inclusion in educational settings has elicited greater achievement and higher reports of engagement and motivation (Rai & Beck, 2016; Zainuddin et al., 2020; Qiao et al., 2023). Students of gamified education maintain better focus throughout their learning and are inspired to continue pushing themselves through intrinsic and extrinsic motivators. In addition, advances in artificial intelligence technology allow for new possibilities in gamified education. Immediate, accurate feedback from student responses bears the potential to advance learning beyond what a single classroom teacher can accomplish through individualization in the public school system.

Statement of the Problem

The world of education research contains substantial literature on best practices for various desired student outcomes (Butke et al., 2016; Choksy et al., 2001; Gullatt, 2008; Poquette, 2023). At the same time, the landscape of technology changes as the years go by (Wooldridge, 2021). Researchers attempt to study and analyze the new and upcoming applications and concepts for their effect on these student outcomes (Birch, 2013). As a result, gamification is establishing itself as an effective intervention in education (Alhammad & Moreno, 2018). This field is beginning to implement new

developments in artificial intelligence technology, leading to exciting implications for educators (Ross, 2020). However, research on the application of gamification and artificial intelligence remains scarce in elementary music education, especially where instrumental education applying recorder teaching is considered (Aras, 2020; Uludag & Satir, 2023. Simultaneously, the modern student experiences growing motivational challenges in this learning area due to the allure of technological advances (Boaler, 2002; Kumar & Khurana, 2012; Lee & Hammer, 2011). This creates an opportunity for research into the effect of both gamification and artificial intelligence on the motivation of elementary-aged students in their general music class.

Purpose of the Study

In this study, the researcher documented the experiences of elementary students utilizing gamified software employing artificial intelligence technology. The researcher investigated the use of an educational music game as an intervention to analyze the effect of artificial intelligence software on the motivation of elementary-aged students. Participants experienced the music game as part of their recorder unit, and results containing their motivation levels were documented in this quantitative approach. The study hypothesized that there would be a significant increase in the overall motivation of students as measured by the Instructional Materials Motivation Survey (IMMS; see Appendix A), leading to continued participation in instrumental music education. The results of this study will offer insight into the minds of today's youth concerning the recorder, highlight the possibility of this or a similar intervention for the elementary music educator, and encourage future research into this area of music education.

Significance of the Study

With technology development moving exponentially across the digital landscape, researchers must move quickly to update the literature with the latest applications and their benefits and/or disadvantages to keep up. The resulting implications of this research would allow for digital music games to become a staple in elementary education resources, particularly within the instrumental sphere. At the same time, the study would have the potential for additional research into best practices and the most effective strategies for incorporating these concepts in elementary music education. Through the research and application of these tools, educators can apply strategies and resources to fit best the needs of their students and their unique teaching scenario.

Additionally, the differentiated and individualized feedback presented to students through digital music games goes beyond the achievement possible from a classroom experience guided by one or two educators. The results of this study could guide future research into examining the benefit of this feature of music games for inclusion in early instrumental music education, both within the public school system and in private education settings. In the eyes of the game developer, this research offers insight into the components of music games that are the most beneficial to educators and students. Development companies will gain important guidance on the most effective aspects of artificial intelligence to include in their products.

Delimitations

The study took place at one elementary school, and included only the students at that school in fourth grade. Students experienced music class in the same room with the same student cohort. All students had to attend three music classes for their results to be

included in the final analysis. Students also had the same model of recorder with which to participate. Students were allowed to purchase their own or use available school instruments.

All students were required to complete the survey individually. The proctors were not able to help students answer but were able to read the survey to students needing that support as part of their individualized education plan (IEP). All students were surveyed only through a variation of John Keller's Instructional Materials Motivational Survey (IMMS) (Keller, 2010).

Assumptions

Assumptions in a research study refer to the items taken for granted (Roberts, 2004). This study makes the following assumptions:

1. All students have a meaningful understanding of the words used in the IMMS.
2. All students can complete the IMMS without additional help.
3. All students will honestly and accurately represent their feelings based on their experiences without mistakes or outside influences.
4. Each device used was in working order, including the functioning of the device microphone.

Research Questions

The research questions for this study are listed below. The research questions guided the study in its effort to unveil information regarding the relationship between gamified instruction utilizing AI technology and student motivation related to learning and practicing the recorder.

Research Question 1

To what extent is there a significant difference in overall student motivation as measured by the IMMS total score for fourth-grade students before and after participating in instruction using the digital music game “The Magic Flute”?

Research Question 2

To what extent is there a significant difference in attention as measured by the attention subscale of the IMMS for fourth-grade students before and after participating in instruction using the digital music game “The Magic Flute”?

Research Question 3

To what extent is there a significant difference in relevance as measured by the relevance subscale of the IMMS for fourth-grade students before and after participating in instruction using the digital music game “The Magic Flute”?

Research Question 4

To what extent is there a significant difference in confidence as measured by the confidence subscale of the IMMS for fourth-grade students before and after participating in instruction using the digital music game “The Magic Flute”?

Research Question 5

To what extent is there a significant difference in satisfaction as measured by the satisfaction subscale of the IMMS for fourth-grade students before and after participating in instruction using the digital music game “The Magic Flute”?

Definition of Terms

Artificial Intelligence

Artificial intelligence refers to the "capacity of computers or other machines to exhibit or simulate intelligent behavior" (Oxford English Dictionary, 2023).

Elementary-aged students

Elementary education is defined by The Editors of Encyclopaedia Britannica (2024) as the first stage in formal education. The term *elementary-aged students* in the United States of America refers to elementary education students aged five to 13.

Extrinsic motivation

Extrinsic motivation is guided by external rewards or consequences rather than internal satisfaction (Ryan & Deci, 2000).

Gamification

Gamification is the inclusion of "game-design elements in non-gaming contexts" (Deterding et al., 2011, p. 2). Gamification in education refers to using these game-design elements as an instructional strategy to increase student engagement, motivation, enjoyment, and achievement.

Intrinsic motivation

Intrinsic motivation is guided by internal satisfaction rather than external rewards or consequences (Ryan & Deci, 2000).

The Magic Flute

The Magic Flute is a digital music game that utilizes AI technology. The user progresses through a story that follows a young musician in training as they enter a new music conservatory to study the recorder. Musical exercises and full-length songs allow

the player to perform on a recorder as the game monitors pitch and rhythmic timing. The game notates mistakes and provides corrective feedback to the user in real time. The user gains points for correct pitch and rhythm and can progress through the levels of the story.

Recorder

The recorder is an instrument that was first developed in the fourteenth century (Powers, 2003; Lasocki, 2012). It features a whistle mouthpiece and forms a long tube shape. The user blows into the mouthpiece, which creates the sound of the recorder. By covering holes on the instrument, the player can change the pitch of the instrument.

Organization of the Study

The study presented in this dissertation was organized into five chapters. Chapter One serves as an introduction to the study. This chapter includes information surrounding the purpose and significance of the study, considerations taken in the context of the study, and the research questions the study aims to answer. Chapter 2 encompasses the review of literature pertaining to the dissertation. Chapter 3 describes the research design, measurement tools, and data collection and analysis used in the study. Chapter 4 contains an analysis of the results of the study. Chapter 5 concludes the dissertation by discussing the findings, their limitations, and their implications for future research.

Chapter 2

Review of the Literature

The goal of this literature review was to provide context surrounding the purpose of this study. This literature review began with a focus on the role of music education in past and present societies, justifying it as a prominent and important field of study. Tracing this content area to modern times, the researcher laid out current practices in music education. This section also reviewed class requirements and offerings in public school programs nationwide. It concluded with a reflection on current music education theories, ideologies, and practices relating to elementary-aged students, as well as the involvement of the recorder within music education.

The researcher then transitioned into an examination of motivation's role in education. This section on motivation began with an overview of motivation in current literature and gave a synopsis of John Keller's ARCS Model (Keller, 2010). It then transitioned to examining the research on motivation in various applications within education, including specific research covering music education (Keller, 2010). This section reviewed the current challenges in student engagement within music education courses. It led to a review of various shortcomings in music education concerning educator's abilities to influence the motivations of their students. Impacts of motivation on student participation and success within the field of music were also explored.

Examinations of motivations were then followed with a dive into research over gamification, artificial intelligence, and the current practices of both methodologies within education. As demonstrated in this review, these avenues of educational fields offer opportunities to increase student motivation while maintaining effective instruction

and achievement outcomes equal to or greater than traditional educational methods. The review ultimately concluded with the current literature on music-focused educational games and the inclusion of various technological advances within the games.

Music Education

Music education has been a part of civilized human society for centuries, dating back to times in Ancient Greece and earlier (Sooter, 2023). Over the years, music and music education have been seen as integral to the development of human beings. Chinese philosophers believed music brought balance and harmony to the individual's character and promoted self-confidence and self-awareness (Marisi, 2019). Greek philosopher Plato believed it the task and responsibility of the state to educate its citizens, which by necessity should include music (Marisi, 2019). This kind of education promoted achieving important goals and limiting harmful innovations. Woerther (2008) also discussed Plato's outlook on the importance of music education and its effects on social and mental development. This principle of homeopathy was believed to be the connection between the sounds of music and the soul of a human being.

Today, music is seen as something central to the essence of being a human. Lehmann et al. write, "Musical capacity is a universal inherent human capacity: It is part of what it means to be human" (2007, p. 30). It is believed that children, like the right to learn to read and write, also have a right to develop their artistic abilities, including skills related to music performance and comprehension (Cambell & Kassner, 1995). Music also gives therapeutic opportunities for children to regulate intense emotions (Salvetelli, 2019).

At its core, music education provides its learners with advancement in categories relating directly to music and other pathways (Eady & Wilson, 2004; Foster & Marcus Jenkins, 2017; Guhn et al., 2020). Music begets greater understanding in its learners, both within themselves and understanding of others around them (Paige, 2004). Learners garner knowledge and relevance regarding different cultures through participation as performers and listeners. This knowledge promotes a greater appreciation for music and "exalts the human spirit" (Deere, 2010, p. 13). Music also promotes self-discipline, creativity, and compassion in its participants (Lehman, 2019).

Elementary music education today draws its influence from various individuals and their respective methodologies: Orff-Schulwerk, Kodaly, and Dalcroze Eurhythmics (Poquette, 2023). Orff-Schulwerk was born out of the work of Carl Orff Dorothee Günther at the Günther Schule in Munich, Germany (Günther School, 2024). Orff's methodology focuses on the child as the center of learning and music-making (Gullatt, 2008). Students sing, say, dance, and play to experience and grow in music (American Orff-Schulwerk Association, 2024).

The Kodaly method, created by Zoltan Kodaly, began in Hungary (Choksy, 1987). The Kodaly method includes many solfa forms or methods of singing using prescribed syllables for the musical notes to be sung (Choksy et al., 2001). Students become literate in traditional music notation through quality music that includes traditional folk songs from the students' own country and culture (Choksy et al., 2001). Through the Kodaly method, students are encouraged to participate in performing ensembles. One of the main objectives of the Kodaly method is for learners to develop an understanding and appreciation for the quality music taught.

Dalcroze Eurythmics was initially developed for Emile Jacques-Dalcroze's conservatory students (Butke et al., 2016). The methodology was then expanded to include students of all ages. Jacques-Dalcroze grew frustrated with the shortcomings of his students, attributing them to a lack of a structured and comprehensive curriculum (Seitz, 2005). Dalcroze Eurythmics was ultimately conceived to develop musical skills amidst a sense of expressivity, using the body and movement to learn (Seitz, 2005; Juntenen & Hyvönen, 2004). Of the three prominent methodologies in the field of elementary music education outlined above, the Orff-Schulwerk method most thoroughly integrates the use of the recorder (Jorgenson, 2010).

The recorder is an instrument first developed in the 14th century as a member of the flute family (Powers, 2003; Lasocki, 2012). The early instruments functioned much the same way as the recorder of today. Featuring a whistle mouthpiece, the instrument forms a long tube shape. The user blows into the mouthpiece, which creates the sound of the recorder. By using fingers to cover holes drilled into the rest of the instrument, the user can change the pitch of the recorder to create a melody (Hunt, 1962). This instrument was used in various Renaissance and Baroque music during the respective periods and experienced a revival around the 20th century (Lasocki, 2012).

In elementary education, the recorder introduces students to a wind instrument, defined as an instrument that makes sound through the players' breathing (Enrico et al., 2021). The recorder has a higher pitch than other instruments used in the Orff-Schulwerk method, which helps distinguish the sound in an ensemble setting (Jorgenson, 2010). Methods by which the recorder is traditionally taught in the elementary setting include teacher modeling, echo-play, and question-answer format (Sang, 1987; Warner, 1991;

Keetman, 1970). Even outside the Orff-Schulwerk method, the recorder reigns as one of the most proliferous instruments in elementary music education, owing to its simplicity and affordable cost (Hunt, 1962; Powers, 2003). Educators continue to tout the recorder as a useful instrument for teaching a wide variety of elementary music objectives, which is present in countless elementary music curricula throughout the United States.

Lowell & Zakaras (2008) state that the time students spend in public school encapsulates the largest opportunity for most students to gain instruction within the arts, particularly music. When President Obama signed the "Every Student Succeeds Act" as an overhaul to the former "No Child Left Behind" act (ESSA and NCLB, respectively), the measure affirmed music education as essential for a well-rounded education in the eyes of the United States Department of Education (ESSA, 2015). Offering further support, the National Association for Music Education (NAfME) recommends 90 minutes of music education weekly for elementary-aged students (NAfME Council of Music Program Leaders, 2020).

In 2019, the Arts Education Data Project examined music education programs in public school districts across the United States (2019). The study found that 92% of all students have access to music education. Within these school districts, elementary music education ranks the highest in participation out of all grade-level groupings (elementary, middle, high, and mixed). While this data looks favorable in the context of elementary music education, most elementary programs have music as a required subject for all students. This does not necessarily reflect the positive feelings and motivations of elementary and secondary students toward their music education classes, which will be discussed later in this review.

"Determining what really matters to becoming (and sustaining ourselves) as music education researchers and practitioners in the twenty-first century is inspiring but increasingly complex" (Buchborn, 2022, p. 275). Music teachers have discussed the growing importance of an updated, 21st-century curriculum since even before the 21st century began. Ross (1995) wrote about the disenchantment of children in music classes that starts around fifth grade. He discussed student boredom at that age and beyond and also brought up the reduction of students enrolling in music education classes once music becomes an elective opportunity. Boredom has been shown to stem from a feeling of high constraint, low arousal, and high unpleasantness (Geiwitz, 1966). Thus, students with a feeling of boredom with their music classes ultimately will seek constraint reprieve when music becomes an elective offering.

Research from Vasil (2013) added another dimension to the discussion on boredom. This study focused on the extrinsic motivation of fourth-grade students to join an instrumental music program. Through an interview process, the study found that, while intrinsic motivation was present and played a role in the student's decision to participate in an instrumental music program, extrinsic factors also played a large role (Vasil, 2013). Most extrinsic factors were at the integrated regulation stage, which is seen as similar to intrinsic motivation (Ryan and Deci, 2000). This study was one of the first in the field to suggest the importance of extrinsic motivation to engage and retain students within music programs, especially when those programs are elective courses (Vasil, 2013).

Zemke (2002) also called on music educators to explore "other dimensions of teaching music" to better connect with their students and optimize the instruction that

they receive. Zemke goes on to discuss an Academy developed in conjunction with Silver Lake College in Wisconsin designed to expand upon existing music education in the area and offer some music education experiences to students who have none through the public school system at which they attend. These experiences included a combined effort of piano instruction and a youth chorale for elementary-aged students. The program was taught using a Kodaly-inspired method of instruction. At the time of the article's presentation, the program serviced 400 participants, lending a degree of credibility and weight to the program's teaching methods and overall structure.

Woody (2004), similar to Zemke, calls on educators of young musicians to re-frame their goals and objectives for these students. Woody discussed the importance of student self-concept and feelings towards their music class and teacher in building intrinsic motivation towards music. Woody stated that the early influence these factors have on students can last through adolescence into adulthood. Woody also requested educators of this age group align their purpose in teaching to primarily foster a sense of positive feelings about music instead of immediate musical knowledge or skills.

Educators on all fronts continue to fret over the lowered sense of motivation and engagement from their students (Lee & Hammer, 2011; Kumar & Khurana, 2012; Boaler, 2002). Coupled with that, class sizes remain a point of contention for what is considered ideal. According to the Missouri Department of Elementary and Secondary Education (DESE), class sizes within children in kindergarten through fifth grade have a desirable standard of 17-20, with the legal standard being set higher at 25-27 (2023). This data points to an increased need for educational strategies and programs to be put in place that allow teachers and students to succeed in the face of these challenges. On the subject of

motivation, tools exist and continue to be updated and re-made that allow teachers the ability to increase the learning motivations of their students (Keller, 2010; Ryan & Deci, 2017). This increased motivation helps draw their attention to instructional activities, leads to more engagement in the classroom, and thereby increases the potential for learning among their students.

Motivation

Motivation refers to the desires of an individual, as well as the choices and commitments to which these desires ultimately lead (Keller, 2010). Throughout life, people find themselves mixed up in activities due to their motivation towards the given activity. The stronger the motivation, the stronger the chance that the individual will partake in a particular venture and continue to develop in that venture (Keller, 2010; Ryan & Deci, 2017). Motivation within education presents an incredible opportunity and an important responsibility to all educators (Ryan and Deci, 2017). Studies suggest motivation accounts for somewhere between 11 and 27 percent of total student achievement scores (Asmus, 1986; Austin & Vispoel, 1992; Caimi, 1981; Cattell, Barton, & Dielman, 1972; Chandler, Chiarella, & Auria, 1988; Krueger, 1974; Maehr & Archer, 1985; Walker, 1979). The motivation of an educator's students, as evidenced in many studies, has the potential to be leveraged to elicit the most impactful growth from their students.

Within the study of motivational design, Keller proposed four elements through which this study will analyze learner motivation: attention, relevance, confidence, and satisfaction (2010). Attention refers to the focus of the learner; without attention, learning cannot occur. Relevance defines the learner's positive feelings or perceptions about the

learning outcome. Confidence comes into play along with relevance and describes the learner's perceived achievement level concerning the learning outcome. Satisfaction refers to the intrinsic and extrinsic rewards that learners receive upon completion of the learning outcome.

Motivation plays a critical role in a person's selection of tasks upon which to apply themselves and the degree to which they commit themselves (Ryan & Deci, 2017; Zimmerman, 2000; Keller, 2010). This ties strongly to self-efficacy or the belief a person has in their abilities (Zimmerman, 2000; Bandura, 1997). Through stronger self-efficacy, individuals choose loftier goals and solidify their commitment to the achievement of these goals (Bandura, 1991). Motivation and self-efficacy are correlated, and the increase in a student's motivation positively affects their perceived self-efficacy (Zimmerman, 2000). According to Hattie, self-efficacy has an effect size of .63, signifying more than the hinge point of .40, representing a year's growth from a year's worth of input (Hattie, 2008).

Current literature points to motivation as an element influenceable by educators. While embarking on the journey of affecting student motivation can be arduous, there is a benefit to the success of learners to be gained (Turner et al., 2011). This academic motivation refers to the "enjoyment of school learning characterized by a mastery orientation, curiosity, persistence, task-endogeny, and the learning of challenging, difficult, and novel tasks" (Gottfried, p. 525). Motivation within the academic setting is "critical to learning and achievement" (NASEM, 2018, p. 109).

When considering secondary knowledge acquisition, there are ways to preserve learner motivation (Geary & Xu, 2022; Bjorkland, 2022). Secondary knowledge refers

"to the use of domain-specific abilities to create secondary skills and knowledge" (Geary, 2022, p. 2224). In the context of music, this might refer to using music reading knowledge and the technical knowledge of playing an instrument combined in the action of music performance. Bjorkland suggests that, in the case of secondary knowledge acquisition, the integration of guided play helps preserve learner motivation. Lespiau & Tricot (2022) also mention the connection between the primary knowledge base and the desired secondary knowledge. They state the importance of purposefully building from the primary knowledge base to help maintain performance and motivation.

Motivation is important in music learning and performance (Sloboda & Davidson, 1996). To advance in music performance, one must gain proficiency in "a wide range of skills, hearing, motor skills, interpretive, and expressive reading" (Gomes et al., 2014, p. 4). By the same token, motivation must be present in the educational setting for learners to achieve their full potential. Motivation has been shown to increase student achievement within educational settings of music and other fields of study (McPherson & McCormick, 1999; Banikowski & Mehring, 1999; Cogdill, 2015; Woody, 2004).

The demand for learning necessary skills for music education can result in many practice sessions that can seem boring to many aspiring musicians (King, 2016). This rings particularly true when taken in the context of elementary students, who are at the beginning stages of this level of technique acquisition. As Molloy et al. write, "a lack of motivation due to feeling overwhelmed by the amount of skills required to play" can ultimately lead to students becoming disinterested and giving up (2019, p. 1). Through increased levels of internal enjoyment, students report higher levels of motivation. The

higher levels corresponded directly to continuing education among piano students (King, 2016).

To further apply current literature on motivation and learning to music education, Cogdill (2015) detailed several important concepts on motivation and music. Cogdill stated that early musical experiences for students require a positive outlook from the student's perspective to build and improve a child's self-concept (Cogdill, 2015). Research from Woody (2004) supported this claim, stating that "the perception of talent leads to motivation" (2004, para. 8). This self-concept helps students find intrinsic interest in continuing to participate in music activities and classes. Coupled with this idea, Cogdill highlights the importance of educators paying attention to student beliefs (2015). By assessing and building students' growth mindset, educators can help their students build the motivation to continue in music classes.

With regard to how motivation impacts participation in the necessary musical activity of practice (defined as time spent individually honing musical skills, techniques, or specific literature), McPherson & McCormick (1999) administered a self-report questionnaire to 190 pianists on their practices leading up to a formal musical examination. The findings suggested a connection between periods of practice. The musicians reported a greater amount of practice time in the time leading up to the formal examination compared to times of less stress due to no immediate performances. In addition, McPherson & McCormick's findings (1999) suggested that those pianists who practiced more often also found themselves more cognitively engaged during their practice time. The authors postulated that this resulted in a positive feedback loop, where the increased cognitive engagement resulted in more progress during practice time,

leading the pianists to feel more rewarded and increasing their desire to engage in more practice.

Banikowski & Mehring, in their article on enhancing memory, also state the need for student focus of attention on the task at hand to commit the information to long-term memory (1999). This accomplishment again lends itself to that same positive feedback loop discussed in McPherson & McCormick (1999). Motivation concerning music learning is the "driving force that promotes students to participate in music learning activities and to acquire the knowledge or skills" (Asmus, 1994). With its impact on student participation and overall academic achievement, music educators have the potential to impact the overall musical development of their students greatly.

Gamification

Researchers have been exploring the possibilities brought about by gamification since the term was first coined in 2008 (Walz & Deterding, 2014). Gamification refers to "the use of game-design elements in non-gaming contexts" (Deterding et al., 2011, p. 2). By incorporating game-design elements such as competition, challenges, and rewards, educators can bring positive changes in their learners (Alhammad & Moreno, 2018). These elements can be utilized through behavior modification, increased student achievement, engagement, and motivation, as well as promoting a sense of learner agency (Rai & Beck, 2016; Zainuddin et al., 2020; Qiao et al., 2023).

One randomized controlled trial on gamification's efficacy on behavior modification occurred in 2016. Through a study funded by the United States Department of Energy, researchers attempted to quantify what effect gamification methodology would have on consumer energy use (Rai & Beck, 2016). The study employed the Theory

of Planned Behavior (TCB) to examine the influence of gamification. The researchers found that using “serious games” had a significantly consistent effect on both informational gaps and facilitating the desired behavioral change in consumers (Rai & Beck, 2016, p. 11).

Several studies have established and supported the notion that gamification techniques support increased student motivation (Hamari & Koivisto, 2014; Qiao et al., 2023; Sotos-Martinez et al., 2023). Buckley and Doyle showcased a marginal increase in student motivation in their student population (2016). This was shown again in Jurgalaitis et al. (2018), where researchers documented a marginal increase in student motivation in their Unified Modeling Language study. Goksun & Gursoy (2019) revealed increased student engagement when the Kahoot application was used in formative assessments for one of the experimental groups in their study. Bury (2017) further supports this finding, showing students’ desire for the immediate feedback characteristic of gamification elements. Turan & Meral (2018) found that students were more likely to engage with game-based response systems and experience decreased levels of test anxiety. As Day (1968) suggests, low levels of anxiety also correlate with high levels of curiosity, resulting in increased attention to the subject at hand (Keller, 2010).

Gamification is useful in formatively assessing student learning and performance (Zainuddin et al., 2020). In this study, the researchers examined the effect of a gamified formative assessment intervention on two areas of student performance: achievement and engagement. The study showed a significant increase in student engagement within the gamified intervention group compared to the traditional paper-assessment control group.

This demonstrates a positive relationship between gamification methods and student learning and achievement (Sanchez-Martin & Davila-Acedo, 2017).

While some discussion has occurred on digital versus non-digital gamification methods, the current literature shows positive results with both (Qiao et al., 2023). Qiao et al. (2023) utilized two junior high-aged groups of students receiving gamification models of instruction over reading concepts. One group received instruction through a purely non-digital gamified setting, while the other group received a blend of digital and non-digital gamification methods. Both groups reported increased cognitive engagement and improved performance outcomes, in this case reading. Of additional interest, this study also found that through the use of a leaderboard in the mixed instructional group, students were more inclined to "self-regulate their learning" and set individualized instructional goals based on the leaderboard standings (Qiao et al., 2023, p. 406).

Gamification has been linked to an increase in the intrinsic motivation of elementary students in physical education (Sotos-Martinez et al., 2023). Researchers implemented ClassDojo, an educational app, along with gamifying instruction through the use of game points given and/or taken away from students depending on their achievements in various objectives in physical education. Using the motivation questionnaire in physical education, researchers measured and noted a significant increase in student intrinsic motivation (Leo et al., 2016; Sotos-Martinez et al., 2023).

Concerning music education, gamification has fewer results documented in the current literature when compared with education as a whole. Practice and development of musical skills in vocal and instrumental disciplines remains a complex and challenge-prone endeavor (Maria et al., 2016). Through gamification methods, researchers have

attempted to find a way to alleviate the tediousness and monotony of the practice required by musicians to hone their talents (Birch, 2013; Creech et al., 2013; Maria et al., 2016).

A study by Birch (2013) found that applying gamification principles led to increased technical mastery and a more positive attitude in practicing those technical elements in piano students. Gomes et al. examined the benefits of a gamified curriculum teaching recorder, guitar, and "backing vocals" (2014, p. 11). The study utilized three groups: a control group receiving instruction according to education policy and paper materials, an experimental group receiving instruction through multimedia elements, and a second experimental group receiving gamified instruction over the Moodle learning system. Using singing- and play-along, game elements were applied to the course of study for the second experimental group. This, similar to Birch, resulted in a reported increase in motivation compared to the other groups in the study (Birch, 2013; Gomes et al., 2014).

Artificial Intelligence

Artificial intelligence (AI) has existed as an idea since ancient Greek times, when the story of Hephaestus involved the god of blacksmiths creating metal beings and bringing them to life (Wooldridge, 2021). Through the years, AI has existed as an idea in many different realms of fiction. In 1935, Alan Turing became fascinated with the Entsheidungsproblem, which referred to the question of whether "there are mathematical problems that cannot be answered by following a simple recipe" (Wooldridge, 2021, p. 11). With the creation of the Turing machine that answered the Entsheidungsproblem, Turing is credited with the dawn of AI in real-life (Wooldridge, 2021).

From there, AI evolved from the simplistic programming of Turing machines to technology able to process billions of instructions per second (Wooldridge, 2021). Still, this kind of technology was constrained not so much by being unable to make sound decisions but by gathering enough information about a situation to make the correct decision. In this regard, AI development is some time away from developing a machine with "general purpose, human-level intelligence" (Wooldbridge, 2021, p. 31). However, that does not mean that practical applications to the field have not been made concerning the advances made in AI technology.

AI has made intelligent tutoring systems (ITS) possible (Lyu & Wang, 2021). ITS refers to "computerized learning systems that attempt to imitate human tutors and provide personalized instruction to students to enhance the learning process" (Arnau-Gonzalez et al., 2023, p. 1). As one might expect, the ability to give individualized, instantaneous feedback creates a draw towards ITS (Lyu & Wang, 2021). Utilizing an ITS model promotes four aspects of music teaching: "special lecture, vocal singing, solfeggio ear training, and basic music theory" (Wai, 2022, p. 5). Already, developers are incorporating aspects of the ITS model within music games (Birch, 2013; Micheloni et al., 2018; Peppler et al., 2011; Cassidy & Paisley, 2014).

Digital Music Games

"Technology integration does not happen simply by adding technological subjects to the curriculum, but rather by conceiving novel paths to include technology in everyday teaching" (Mandanici & Delle Monache, 2023, p. 7). Effective technology used within the classroom must be purposeful. Technology should act as an educational tool and support system instead of simply solving the question of how to incorporate technology

more fully into the classroom (Ross, 2020). As discussed previously, gamification concepts can be an effective teaching tool. Leveraging available technology, including AI tools, suggests that same level of effectiveness while appealing to today's youth through their design and format.

Games that involve learning musical instruments are effective in teaching concepts associated with learning that instrument (Birch, 2013; Micheloni et al., 2018). Early games with this intention featured a specialized controller meant to emulate an instrument but not enough to be transferable to the instrument in real life (Micheloni et al., 2018). Game designers like Guitar Hero and Rockband had makeshift guitars and drums, which were just enough similar to the real instruments to be convincing. Some experts argue that the notation system and general format held significant transfers toward users learning to play music (Peppler et al., 2011). However, in terms of actually learning to play the instruments, particularly in the case of the guitar, these games fell short.

In the following years, game developers started experimenting with creating a virtual instrument on a touch screen. Games like *Magic Piano* by Smule, *Pianist HD* by Rubycell, and *Piano Notes!* by Visions Encoded all allowed the user to interact with the game in a more immersive fashion but still fell short of tangible learning with regard to the actual instrument. Even so, these games still lacked the ability for the user to create sound from the instrument without being plugged into the game. In other words, the user could not perform on the instrument outside of the confines of the video game.

Micheloni et al. (2018) investigated the use of *Musa* as a piano learning tool. The game featured the ability to use an actual piano as the controller. It relied on a device's

built-in microphone to register the instrument's sound and offered feedback to the player in the form of actions within the game. As the game displayed certain objectives, the player must press certain keys to complete the objective. This game was assessed to be as effective as traditional piano teaching methods, and students were reported as having reduced distractedness while playing (Micheloni, 2018). The game largely focused on scales and technical exercises, leaving something to be desired for students wishing to play complete compositions.

Regarding student motivation, digital music games can attract disengaged learners of the 21st century (Abril & Gault, 2008; Dillon, 2003; Lamont & Maton, 2008). The informal learning environment of music games helps inspire students to embark on and engage with music activities inside and outside the classroom (Missingham, 2007; Peppler et al., 2011). Sung et al. (2016) also suggest using digital mobile games is significantly more effective than traditional classroom approaches in music education. Of the studies conducted in music education and gamification, few apply to the traditional public school education setting, relying on the educator to extrapolate current findings for use within their classroom (Goble, 2009).

One of the most prominent studies on the subject was conducted by Cassidy & Paisley (2014). The study involved one participant in a case study format and utilized the music game *Rock Band* to determine the participant's cognitive and emotional reactions to playing the game. The researchers noted increased engagement and relevance in the participant's feelings towards the game. In this study, relevance in the eyes of the participant referred to the transferability to real-world music-making and general musical

understanding. The participant also experienced peak flow reactions to playing the game (Macdonald et al., 2006).

In a study conducted by Aras (2020), the researcher employed the program *Guitarist* as a potential intervention with six ninth-grade students. The study found increased performance outcomes and documented positive interview reports from the participants on their experience with the game. Other researchers have attempted to include the technological breakthroughs of the modern day in their research on music games (Pitteri et al., 2021). This study utilized a virtual orchestra interface to teach students about various music components while the virtual orchestra performed. Achievement scores by the experimental group were higher than the control (Pitteri et al., 2021). Researchers suggested that this application be used in preparation for a live performance that students would be attending.

A meta-analysis by Uludag & Satir (2023) revealed participants' general positivity towards mobile music games. They cited advantages such as “learning by having fun, learning quickly and easily, willingness to participate in the lesson, effective communication with the teacher, focusing on the lesson, cooperation, willingness to work out of the classroom, and musical development” (Uludag & Satir, 2023). Researchers also found an educational priority in the games included in the meta-analysis. While entertainment was critical in the chosen games, the priority on education was evident (Gomes et al., 2016).

Conclusion

Music education continues its legacy as a subject area of value to societies and cultures worldwide. Much research has been done over the past decade on the benefits of

gamifying instruction, including increased student engagement and motivation. As technology advances, so does the research into available digital games, including AI technology. While the current research includes some references to music-related software, the literature on the potential benefits for elementary music education is scarce. A quantitative research design utilizing a digital music game that includes AI software designed to deliver instantaneous student feedback allowed the researcher to explore the effect of the game on elementary-aged student motivation.

Chapter 3

Methods

This study explored student motivation as it relates to recorder education. An instructional intervention was deployed to examine how the AI feedback provided by the music game app *The Magic Flute* affected student motivation. A quantitative approach allowed the researcher to analyze student motivation towards recorder education before and after engaging in the game. John Keller's ARCS model provided the metric for quantifying student motivation.

This chapter presents the specific design of the study, including the implementation of quantitative methods. The sampling methods and instruments are described, and a discussion of data collection and analysis procedures is provided. Research questions are stated, as well as a section reflecting on the potential limitations of the study.

Research Design

This study employs a quantitative approach based on a quasi-experimental design. Quantitative research refers to research collected and analyzed using numerical data (Creswell & Creswell, 2018). In a quasi-experimental design, the participants are not randomly assigned, and the researcher maintains a limited level of control over the selected participants (Creswell & Creswell, 2018). This provided the researcher to utilize participants from the elementary school at which they taught. The intervention used in this study included the app called *The Magic Flute.* Through the embedded story of a young student transfer into the Mozart Academy, the user performs on a soprano recorder along with real-time music accompaniment as the game analyzes the performed pitches

and rhythms. The game features an adventure mode and an arcade mode, and students receive immediate feedback on their performance. Participants were given the opportunity to describe their state of motivation related to learning the recorder. To this end, John Keller's IMMS survey was adapted to fit the study and measure student motivation (Keller, 2010). Two surveys were created and administered in a pre-test and post-test format (see Appendix A). The pre-test was administered before students began the game-based intervention in order to assess their motivation level with regard to learning the recorder. Students then completed three classes utilizing the intervention. After the third class, students took the motivation post-survey to assess their motivation level after experiencing the game-based intervention.

Selection of Participants

Participants were selected using purposive sampling. Purposive sampling is defined as "selecting a sample based on the researcher's experience or knowledge of the group to be sampled" (Lunenburg & Irby, 2008, p. 175). The participants selected for this study were all students at Ridgeview Elementary in the Liberty Public Schools (LPS) District No. 53, located in Liberty, Missouri. Students were selected using the following criteria:

1. The student was enrolled in the fourth grade at Ridgeview Elementary during the 2023-2024 school year in the LPS District No. 53, and had not experienced recorder instruction before the study.
2. The student and their family signed the Parental Consent Form (see Appendix D).
3. The student participated in three music classes using *The Magic Flute.*

4. The student completed both the IMMS Pre- and Post-Survey.

Purposive sampling was appropriate for this study to identify motivational changes within a population at the beginning of their recorder education. None of the students included in this study had experienced formal learning of the recorder. This allowed the researcher to target how the intervention affected student motivation at the start of their recorder education. All students in this population received recorder instruction through their regularly scheduled music class time. All students experienced the digital music game "The Magic Flute" as the intervention being tested throughout this instructional period.

Measurement

To quantify student motivation in order to compare motivation prior to the intervention with motivation after experiencing the intervention, John Keller's IMMS was employed. This survey consisted of 36 5-point Likert-scale questions belonging to subscales corresponding to the four pillars of the ARCS model. Twelve questions measured attention, nine questions measured relevance, nine measured confidence, and six measured satisfaction (see Appendix A). Keller explained the disparity between attention and satisfaction by saying, "boredom and lack of stimulation are such ubiquitous characteristics in instructional writing, and the satisfaction category does not have as many points of connection to printed writing as the others" (Keller, 2010, p. 282). The survey can be scored according to the four subscales and an overall student motivation score. The survey was designed to analyze student motivation related to a specific course. Because of the subjective nature of motivation, none of the results can be designated with such qualifiers as high, medium, or low. Therefore, it was important to

have preliminary scoring for participants to provide the research with a reference point specific to each individual participant. The post-survey results will be compared to the pre-survey results to analyze the degree of change in the motivation of each student.

The survey was tested for reliability by administering it to 90 undergraduate students at a large Southern university. This reliability test deemed the survey satisfactory through the internal consistency estimates, shown in Table 2, based on Cronbach's Alpha (Keller, 2010).

Table 2

IMMS Reliability Estimates

Scale	Reliability Estimate (Cronbach α)
Attention	.89
Relevance	.81
Confidence	.90
Satisfaction	.92
Total Scale	.96

The survey was validated by Keller through a study utilizing a control group and an experimental group (2010). The control group received what was deemed normal instruction. In contrast, the experimental group received instruction enhanced with stimulatory strategies, satisfying outcomes, and components to establish the relevancy of the lesson and build confidence in the learners. The experimental group scored significantly higher on the survey than the control group. Several other studies provided validation for the IMMS survey (Small & Gluck, 1994; Changeiywo et al., 2011; Zheng et al., 2019).

Data Collection Procedures

Before collecting data, a request was submitted to the Institutional Review Board (IRB) on April 19, 2024, for approval to conduct the research study. The IRB granted approval on May 8, 2024 (see Appendix B). Approval was also sought from LPS through Dr. Tyler Shannon, the principal at Ridgeview Elementary, and Mr. Christopher Hand, the LPS Director of Assessment, Evaluation, and Testing. Communication was sent to Dr. Shannon and Mr. Hand on April 17, 2024. Approval was granted on April 22, 2024 (see Appendix C). As the participants were all under 18, permission was sought from the legal guardian of each student for the students to participate in both the intervention and the survey. A copy of the permission form is included in Appendix D.

Data for the motivation surveys was collected electronically. Students completed the survey through their district-issued device, an Apple iPad. The pre-survey was administered before the first day of recorder lessons in music class. The student's classroom teacher proctored the pre-survey and ensured students completed the survey individually. The post-survey was administered after the recorder unit intervention. The student's classroom teacher again proctored it. Both surveys were conducted using Google Forms, and data was organized using Google Sheets. ID numbers were matched for pre- and post-survey comparison. Both of these programs were encrypted as part of the LPS security protocols.

Data Analysis and Hypothesis Testing

The results of both pre- and post-surveys were analyzed using IBM SPSS 29.0.1.0 (171) to determine the change in student motivation according to John Keller's four pillars of the ARCS model: attention, relevance, confidence, and satisfaction (Keller,

2010). The following research questions guided the study, and the subsequent hypotheses were established. All research questions were measured using the scores from the IMMS pre- and post-survey.

Research Question 1

To what extent is there a significant difference in overall student motivation as measured by the IMMS total score for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H1. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in overall student motivation as measured by the IMMS total score for fourth-grade students at Ridgeview Elementary.

A paired-samples *t*-test was conducted to test **H1**. The IMMS total score of fourth-grade students at Ridgeview Elementary who participated in instruction using the digital music game *The Magic Flute* was compared from the pre-survey to the post-survey. The mean of the IMMS pre-survey total score was compared to the mean of the IMMS post-survey total score. The level of significance was set at .05.

Research Question 2

To what extent is there a significant difference in attention as measured by the attention subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H2. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in attention as measured by the attention subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired-samples *t*-test was conducted to test **H2**. The IMMS attention subscale score of fourth-grade students at Ridgeview Elementary who participated in instruction using the digital music game *The Magic Flute* was compared from the pre-survey to the post-survey. The mean of the IMMS pre-survey attention subscale score was compared to the mean of the IMMS post-survey attention subscale score. The level of significance was set at .05.

Research Question 3

To what extent is there a significant difference in relevance as measured by the relevance subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H3. After participating in instruction using the digital music game *The Magic Flute*, there is a significant difference in relevance as measured by the relevance subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired-samples *t*-test was conducted to test **H3**. The IMMS relevance subscale score of fourth-grade students at Ridgeview Elementary who participated in instruction using the digital music game *The Magic Flute* was compared from the pre-survey to the post-survey. The mean of the IMMS pre-survey relevance subscale score was compared to the mean of the IMMS post-survey relevance subscale score. The level of significance was set at .05.

Research Question 4

To what extent is there a significant difference in confidence as measured by the confidence subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H4. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in confidence as measured by the confidence subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired-samples *t*-test was conducted to test **H4**. The IMMS confidence subscale score of fourth-grade students at Ridgeview Elementary who participated in instruction using the digital music game *The Magic Flute* was compared from the pre-survey to the post-survey. The mean of the IMMS pre-survey confidence subscale score was compared to the mean of the IMMS post-survey confidence subscale score. The level of significance was set at .05.

Research Question 5

To what extent is there a significant difference in satisfaction as measured by the satisfaction subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H5. After participating in instruction using the digital music game *The Magic Flute*, there is a significant difference in satisfaction as measured by the satisfaction subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired-samples *t*-test was conducted to test **H5**. The IMMS satisfaction subscale score of fourth-grade students at Ridgeview Elementary who participated in instruction using the digital music game *The Magic Flute* was compared from the pre-survey to the post-survey. The mean of the IMMS pre-survey satisfaction subscale score was compared to the mean of the IMMS post-survey satisfaction subscale score. The level of significance was set at .05.

Limitations

The limitations of this study refer to "factors that may affect the interpretation of the findings or the generalizability of the results" (Lunenberg & Irby, 2008, p. 133). For this study, students might have experienced a change in motivation simply from the success of learning the instrument, which might have been made possible through several instructional methods. Students who experienced this app towards the beginning of the rotation experienced issues with the microphone sensitivity of their device, which made it difficult for students to be successful even when performing correctly. The sample was also taken from only one elementary school, which reduces the generalizability of the results.

Summary

Through an investigation and analysis of student motivation related to recorder education, this study sought to determine if digital music instruction through software like "The Magic Flute" significantly impacted student motivation. Using a quantitative quasi-experimental research design, the researcher deployed the intervention while collecting participant data regarding their motivation levels through John Keller's IMMS survey before and after their experience with the intervention. Participants were selected

through purposive sampling. Results discussed in the next chapter provide the reader with the degree to which the intervention affected motivation.

Chapter 4

Results

This study examined whether fourth-grade students felt increased motivation towards playing and learning the recorder through the use of a game-based music app called *The Magic Flute.* Motivation was assessed through using John Keller's IMMS, both prior to and after receiving education using *The Magic Flute* (Keller, 2010). Provided in this chapter are the descriptive statistics for the sample and the results of the quantitative analysis for each hypothesis, using paired-sample *t* tests to analyze each of the research questions.

Descriptive Statistics

During the spring of the 2023-2024 school year, 24 students at Ridgeview Elementary agreed to participate in this quasi-experimental study. Before formal education on the recorder, the participants took the IMMS, designed as a pre-survey. After experiencing three music classes utilizing *The Magic Flute*, 23 students took the IMMS again, this time with the design as a post-survey. One of the original 24 students was absent at the completion of the study, so the pre-survey response of that student was omitted from the final results.

The results of the questions on both surveys were compiled and organized according to which of the four categories of Keller's ARCS model they belonged. Twelve of the questions measured attention, nine measured relevance, nine measured confidence, and six measured satisfaction. Each question presented a statement and was answered using a Likert scale of one through five according to how true the statement was for each student. The score of each question was added together to form a score for each subscale, as well as a total score. As a result, attention was scored out of a possible 60 points,

relevance and confidence were both scored out of 45 points, and satisfaction was scored out of 30 points.

The IMMS total motivation score before implementation (M = 118.78, SD = 18.82) resulted in a lower total motivation score than after implementation (M = 123.70, SD = 24.55). The IMMS attention subscale score before implementation (M = 40.70, SD = 5.36) resulted in a lower attention subscale score than after implementation (M = 43.43, SD = 8.39). The IMMS relevance subscale score before implementation (M = 28.91, SD = 7.09) resulted in a higher relevance subscale score than after implementation (M = 28.09, SD = 6.00). The IMMS confidence subscale score before implementation (M = 28.00, SD = 5.16) resulted in a lower confidence subscale score than after implementation (M = 31.96, SD = 7.09). The IMMS satisfaction subscale score before implementation (M = 21.17, SD = 5.28) resulted in a higher satisfaction subscale score than after implementation (M = 20.22, SD = 6.58). Table 3 contains a summary of the IMMS total and subscale scores, the difference between the before and after means, and the maximum score possible for each variable.

Table 3

IMMS Total, Attention, Relevance, Confidence, and Satisfaction Mean Scores

Variable	Before	After	Difference	Max
Total	118.78	123.70	+4.92	180
Attention	40.70	43.43	+2.73	60
Relevance	28.91	28.09	-0.82	45
Confidence	28.00	31.96	+3.96	45
Satisfaction	21.17	20.22	–.95	30

Hypothesis Testing

The research questions of this study examined the difference in fourth-grade student motivation before and after experiencing the game-based music app *The Magic Flute*. Included in this section is each research question, followed by the hypothesis and the results of the data analysis. The results included the *t* statistic, degrees of freedom (*df*), and *p* value. The sample means (*M*) and standard deviation were also included.

RQ1. To what extent is there a significant difference in overall student motivation as measured by the IMMS total score for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H1. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in overall student motivation as measured by the IMMS total score for fourth-grade students at Ridgeview Elementary.

A paired sample t-test was conducted to test H1. The before implementation IMMS total score was compared to the after implementation IMMS total score to assess the change in overall student motivation. The level of significance was set at .05. The results of the paired sample t-test indicated no statistically significant difference between the mean values, $t = -1.10$, $df = 22$, $p = 0.285$. As shown in Table 4, the sample mean for before *The Magic Flute* implementation ($M = 118.78$, $SD = 18.820$) was not significantly different from the sample mean for after *The Magic Flute* implementation ($M = 123.70$, $SD = 24.546$). The hypothesis was not supported by the data.

Table 4

Descriptive statistics for the Results of the Test for H1

	M	*SD*	*N*
Before implementation	118.78	18.820	23
After implementation	123.70	24.546	23

RQ2. To what extent is there a significant difference in attention as measured by the attention subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H2. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in attention as measured by the attention subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired sample t-test was conducted to test H2. The before implementation IMMS attention subscale score was compared to the after implementation IMMS attention subscale score to assess the change in student feelings of attention. The level of significance was set at .05. The results of the paired sample t-test indicated no statistically significant difference between the mean values, $t = -1.67$, $df = 22$, $p = 0.108$. As shown in Table 5, the sample mean for before *The Magic Flute* implementation ($M = 40.70$, $SD = 5.363$) was not significantly different from the sample mean for after *The Magic Flute* implementation ($M = 43.43$, $SD = 8.398$). The hypothesis was not supported by the data.

Table 5

Descriptive statistics for the Results of the Test for H2

	M	*SD*	*N*
Before implementation	40.70	5.363	23
After implementation	43.43	8.398	23

RQ3. To what extent is there a significant difference in relevance as measured by the relevance subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H3. After participating in instruction using the digital music game *The Magic Flute*, there is a significant difference in relevance as measured by the relevance subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired sample t-test was conducted to test H3. The before implementation IMMS total score was compared to the after implementation IMMS relevance subscale score to assess the change in student feelings of relevance. The level of significance was

set at .05. The results of the paired sample t-test indicated no statistically significant difference between the mean values, $t = 0.54$, $df = 22$, $p = 0.593$. As shown in Table 6, the sample mean for before *The Magic Flute* implementation ($M = 28.91$, $SD = 7.090$) was not significantly different from the sample mean for after *The Magic Flute* implementation ($M = 28.09$, $SD = 5.999$). The hypothesis was not supported by the data.

Table 6

Descriptive statistics for the Results of the Test for H3

	M	*SD*	*N*
Before implementation	28.91	7.090	23
After implementation	28.09	5.999	23

RQ4. To what extent is there a significant difference in confidence as measured by the confidence subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H4. After participating in instruction using the digital music game *The Magic Flute,* there is a significant difference in confidence as measured by the confidence subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired sample t-test was conducted to test H4. The before implementation IMMS confidence subscale score was compared to the after implementation IMMS confidence subscale score to assess the change in student feelings of confidence. The level of significance was set at .05. The results of the paired sample t-test indicated there was a statistically significant difference between the mean values, $t = -2.99$, $df = 22$, $p = 0.007$. As shown in Table 7, the sample mean for before *The Magic Flute* implementation

(*M* = 28.00, *SD* = 5.161) was significantly less than the sample mean for after *The Magic Flute* implementation (*M* = 31.96, *SD* = 7.087). The hypothesis was supported by the data.

Table 7

Descriptive statistics for the Results of the Test for H4

	M	*SD*	*N*
Before implementation	28.00	5.161	23
After implementation	31.96	7.087	23

RQ5. To what extent is there a significant difference in satisfaction as measured by the satisfaction subscale of the IMMS for fourth-grade students at Ridgeview Elementary before and after participating in instruction using the digital music game *The Magic Flute*?

H5. After participating in instruction using the digital music game *The Magic Flute*, there is a significant difference in satisfaction as measured by the satisfaction subscale of the IMMS for fourth-grade students at Ridgeview Elementary.

A paired sample t-test was conducted to test H5. The before implementation IMMS satisfaction subscale score was compared to the after implementation IMMS satisfaction subscale score to assess the change in student feelings of satisfaction. The level of significance was set at .05. The results of the paired sample t-test indicated no statistically significant difference between the mean values, $t = 0.731$, $df = 22$, $p = 0.473$. As shown in Table 8, the sample mean for before *The Magic Flute* implementation (*M* = 21.17, *SD* = 5.237) was not significantly different from the sample mean for after *The*

Magic Flute implementation ($M = 20.22$, $SD = 6.578$). The hypothesis was not supported by the data.

Table 8

Descriptive statistics for the Results of the Test for H5

	M	*SD*	*N*
Before implementation	21.17	5.237	23
After implementation	20.22	6.578	23

The results of the study did not reveal a statistically significant difference for the majority of the research questions. The analysis revealed a statistically significant increase in student feelings of confidence from before implementation to after implementation of *The Magic Flute.* The summary of results for RQ1-RQ5 can be found in Table 9.

Table 9

Summary Results of Paired-Samples t Test Analysis by RQ

RQ	Variable	*t*	*df*	*p*
1	Total score	-1.095	22	0.285
2	Attention	-1.674	22	0.108
3	Relevance	0.542	22	0.593
4	Confidence	-2.988	22	0.007*
5	Satisfaction	0.731	22	0.473

Note. * = significant

Summary

Chapter four contained the descriptive statistics for the sample, hypothesis testing, and the data analysis of each research question. The results showed a statistically significant difference in student feelings of confidence after *The Magic Flute* implementation, with no statistically significant differences for the total motivation score or student feelings of attention, relevance, or satisfaction. Chapter five contains a summary of the study and the findings related to the literature. It also concludes the study with implications for action and recommendations for future research.

Chapter 5

Interpretation and Recommendations

The purpose of this study was to determine if game-based music apps, in this case the game *The Magic Flute*, had an effect on student motivation related to learning to play the recorder. This chapter starts with a summary of the study, reviewing the problem and purpose of the study, re-iterating the research questions, and reviewing the methodology and findings. The results of the study as they relate to the current body of literature will be discussed. Implications for action and recommendations for future research will be presented, along with final remarks to conclude this chapter and study.

Study Summary

The following sections provide a general overview of the study. A recapitulation of the problem is discussed, as well as the purpose of the study and the research questions. This section concludes with a review of the methodology and findings of the study.

Overview of the Problem

Music has been, and remains, a central, important, and necessary component of human society (Lehmann et al., 2007; Sooter, 2023). Music educators bear the responsibility of passing this tradition of music to future generations (Cambell & Kassner, 1995). However, music educators are facing the same issues regarding student motivation as educators in all other fields (Ross, 1995; Vasil, 2013). Motivation among students accounts for somewhere between 11 and 27 percent of total student achievement scores (Asmus, 1986; Austin & Vispoel, 1992; Caimi, 1981; Cattell, Barton, & Dielman, 1972; Chandler, Chiarella, & Auria, 1988; Krueger, 1974; Maehr & Archer, 1985; Walker, 1979). Within the realm of music education, those in the field have begun

exploring the idea of teaching music through gamification (Birch, 2013; Creech et al., 2013; Maria et al., 2016). With AI technology progressing and being integrated into these music games, educators have the opportunity to leverage both gamification and AI to illicit greater student engagement and motivation.

Purpose Statement and Research Questions

The purpose of this study was to examine the effect of a game-based music app, *The Magic Flute*, on student motivation as it relates to playing the recorder. Using the ARCS model, the study analyzed student motivation before and after experiencing *The Magic Flute* to determine if there was a difference in their levels of motivation (Keller, 2010). Five research questions were designed through the ARCS model, focusing on total student motivation as well as the four individual pillars of the ARCS model: attention, relevance, confidence, and satisfaction.

Review of the Methodology

This study utilized a quasi-experimental design. Participants were solicited from among the fourth-grade students at Ridgeview Elementary in Liberty, MO using purposive sampling. The study employed a modified version of Keller's IMMS in a pre/post survey method (Keller, 2010). Permission was obtained from the LPS Director of Assessment, Evaluation, and Testing, Baker University's IRB, the participants, and the guardians of the participants. Data was collected from 23 participants. The results were analyzed through a paired-samples *t* test.

Major Findings

Of the five hypotheses in the study, all but one found no significant difference in motivation metrics. The results revealed a significant difference in student feelings of

confidence, showing an increase from before implementation to after implementation. The results revealed no significant differences between total student motivation and student feelings of attention, relevance, and satisfaction.

Findings Related to the Literature

This section compares and contrasts the findings of this study to the current body of literature. The focus of this study was to determine the effect, if any, of game-based music apps on student motivation to assess the effectiveness of these kinds of apps within an educational setting. While the research concerning music, motivation, and gamification was substantial, the inclusion of AI technology in this area was not as comprehensive at the time of this study.

With regard to overall motivation, this study found no significant difference between the before implementation scores and after implementation scores of the participants. This finding contests qualitative findings from Aras (2020). More than half of the participants reported increased motivation when participating in the intervention, a game-based music app called *Guitarist*, in that study. Peppler et al. (2011) reported positive reactions from the participants in that study regarding the game *Rock Band*. It is worth noting that both of these studies took place in a smaller, more specialized setting than a traditional public-school setting.

This study found that *The Magic Flute* had a significantly positive effect on student' feelings of confidence, as measured by the IMMS. This supports the qualitative findings from Peppler et al. (2011), which noted an increase in students continuing to participate in the game *Rock Band* despite their failures. Students described the belief that they would be able to succeed, which serves as one of the defining characteristics of "confidence" within the ARCS model (Keller, 2010).

The literature is currently lacking with regard to the effect of game-based music apps on student attention, relevance, and satisfaction. However, studies have shown that gamification in other fields has a consistently positive effect on these aspects of motivation, and motivation as a whole. Turan & Meral (2018) saw participants with lower levels of test anxiety, thereby increasing their attention. Goksun & Gursoy (2019) reported participants in student engagement through the app *Kahoot*, which relates well to many aspects of motivation. These effects are echoed in many other studies (Hamari & Koivisto, 2014; Qiao et al., 2023; Sotos-Martinez et al., 2023). The findings from this study in the areas of attention, relevance, and satisfaction contrast these results.

Conclusions

This section concludes this study through a discussion of implications for action. Following are the recommendations of this researcher for future research. Final closing remarks are presented to complete this study.

Implications for Action

Findings from this study inform school districts about the potential use of music-based games in music classrooms. This study supports the use of game-based music apps in the effort of establishing and raising student confidence. To that end, these kinds of games carry potential in taking a student with low self-esteem or anxiety concerning their abilities and music and alleviating these barriers to music education. Games such as *The Magic Flute* can also be utilized alongside a curriculum for learning the recorder, in order to foster student confidence. This can be an aid to keep the belief in their own abilities high, in order to withstand the challenges that arise with learning an instrument.

As the technology featured in *The Magic Flute* continues to expand to other apps outside of just the field of recorder, educators should keep an eye on apps that support

their curriculum. With the promise this study has shown, educators may find similar results using differing apps that accomplish the same goal with voice or different instruments. In tandem, developers can look to the features in *The Magic Flute* to identify concepts and programming that can be incorporated into new apps and games.

Recommendations for Future Research

This section details recommendations for future research that have been made apparent to the researcher through the course of this study. These recommendations cover multiple avenues for continued research on the subject of game-based music apps.

As this study was solely focused on the effect of game-based music apps on student motivation, there was no attention within this study given to student achievement and performance on the recorder. While *The Magic Flute* has some potential to influence student motivation according to this study, educators still have a need to know just how effective this game, and other games like it, is on achievement goals.

This study also took a sample from a single elementary school whose participants had not experienced formal education on the recorder. The effect could potentially change, for better or worse, with students who had already experienced the recorder. A sample of students from multiple schools would also give a more accurate picture of the true impact of *The Magic Flute.*

This app was also utilized solely in a typical classroom, meaning students had several other students playing their recorders simultaneously. Several of the students felt this affected their performance due to microphones picking up the instruments of other students. An updated app with a noise gate, which would cancel out noise below a certain threshold, would allow the app to more accurately pick up the intended student.

Finally, this study was done on an app focusing entirely on the recorder. The field of music education would benefit from continued studies on other game-based music apps for other instruments. This research would help inform educators of tools that can be used to combat the challenges of motivating students in the 21st century.

Concluding Remarks

This study was conducted to identify whether the game-based music app *The Magic Flute* has an effect on student motivation as it relates to playing the recorder. This area has limited research in the current body of literature. The findings of this study unveiled that *The Magic Flute* does positively affect student feelings of confidence, supporting the idea that game-based music apps carry some positive influence on student motivation. While this study helped add to the body of literature on game-based music apps and the potential benefits for music education, additional research needs to be conducted to determine the best usage for these educational tools. In addition, research needs to be ongoing in this field to keep pace and reap the benefits of the rapidly changing landscape of technology.

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Appendices

Appendix A – Instructional Motivation Materials Surveys

Pre-Survey

There are 36 statements in this questionnaire. Please think about each statement in relation to the instructional materials you have just studied and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements. Record your responses on the answer sheet that is provided and follow any additional instructions that may be provided in regard to the answer sheet that is being used with this survey. Thank you.

Use the following values to indicate your response to each item.

1 - Not true
2 - Slightly true
3 - Moderately true
4 - Mostly true
5 - Very true

1. When I first looked at the recorder, I had the impression that it would be easy for me.
2. There was something interesting about learning the recorder that got my attention.
3. This material looks more difficult to understand than I would like for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn about the recorder.
5. Completing the exercises on the recorder will give me a satisfying feeling of accomplishment.
6. It is clear to me how the content of this material is related to things I already know.
7. Many of the concepts on recorder have so much information that it is hard to pick out and remember the important points.
8. The recorder is eye-catching.
9. There are stories, pictures, or examples that show me how this material could be important.
10. Completing the recorder exercises successfully is important to me.
11. The quality of the writing will hold my attention.
12. The recorder is so abstract that it is hard to keep my attention on it.
13. As I begin to work on the recorder, I am confident that I can learn the content.
14. The recorder looks so enjoyable that I would like to know more about this topic.
15. The content in the recorder lessons look dry and unappealing.
16. The content in the recorder lessons will be relevant to my interests.
17. The way the information is arranged in the lessons help keep my attention.
18. There are explanations or examples of how people use the knowledge in this lesson.
19. The exercises in the lessons will be too difficult.
20. The recorder has things that will stimulate my curiosity.
21. I will enjoy playing the recorder.
22. The amount of repetition playing the recorder will cause me to get bored sometimes.

23. The content and style of writing in the recorder lessons will convey the impression that its content is worth knowing.
24. I will learn some things that are surprising or unexpected.
25. After I work on the recorder for awhile, I will be confident that I will be able to pass a test on it.
26. This app is not relevant to my needs because I already know most of it.
27. The wording of feedback after the exercises, or of other comments in this app, will help me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc., will help keep my attention on the app.
29. The style of writing will be boring.
30. I will be able to relate the content of this app to things I have seen, done, or thought about in my own life.
31. There are too many words on each page, which will be is irritating.
32. It will feel good to successfully learn about the recorder.
33. The content of this app will be useful to me in learning recorder.
34. I do not think I will understand quite a bit of the material to learn the recorder.
35. The good organization of the content will help me be confident that I can learn this material. 36. It will be a pleasure to work on such a well-designed app.

IMMS Scoring Guide

Attention	Relevance	Confidence	Satisfaction
2	6	1	5
8	9	3 (reverse)	14
11 (reverse)	10	4	21
12 (reverse)	16	7 (reverse)	27
15 (reverse)	18	13	32
17	23	19 (reverse)	36
20	26 (reverse)	25	
22 (reverse)	30	34 (reverse)	
24	33	35	
28			
29 (reverse)			
31 (reverse)			

Instructional Motivation Materials Survey

Post-Survey

There are 36 statements in this questionnaire. Please think about each statement in relation to the instructional materials you have just studied and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements. Record your responses on the answer sheet that is provided and follow any additional instructions that may be provided in regard to the answer sheet that is being used with this survey. Thank you.

Use the following values to indicate your response to each item.

1 - Not true
2 - Slightly true
3 - Moderately true
4 - Mostly true
5 - Very true

1. When I first looked at the app, I had the impression that it would be easy for me to learn the recorder.
2. There was something interesting about learning the recorder using this app that got my attention.
3. The material was more difficult to understand than I would have liked for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn about the recorder.
5. Completing the exercises on the recorder gave me a satisfying feeling of accomplishment.
6. It was clear to me how the content of this material was related to things I already know.
7. Many of the concepts on recorder have so much information that it was hard to pick out and remember the important points.
8. The app made the recorder eye-catching.
9. There are stories, pictures, or examples that show me how this material could be important.
10. Completing the recorder exercises on the app successfully was important to me.
11. The quality of the writing held my attention.
12. The app made the recorder so abstract that it was hard to keep my attention on it.
13. As I worked on this app, I am confident that I can learn to play the recorder.
14. The app made the recorder so enjoyable that I would like to know more about this topic.
15. The content in the app looked dry and unappealing.
16. The content in the app was relevant to my interests.
17. The way the information was arranged in the app helped keep my attention.
18. There are explanations or examples of how people use the knowledge in this app.

19. The exercises in the app were too difficult.
20. The app had things that stimulated my curiosity.
21. I enjoyed playing the recorder with this app.
22. The amount of repetition playing the recorder in this app caused me to get bored sometimes.
23. The content and style of writing in the recorder lessons conveyed the impression that its content was worth knowing.
24. I learned some things that were surprising or unexpected.
25. After working on the app for awhile, I was be confident that I would be able to pass a test on it.
26. This app was not relevant to my needs because I already know most of it.
27. The wording of feedback after the exercises, or of other comments in this app, helped me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the app.
29. The style of writing was boring.
30. I could relate the content of this app to things I have seen, done, or thought about in my own life.
31. There were too many words on each page, which was irritating.
32. It felt good to successfully learn about the recorder using this app.
33. The content of this app was useful to me in learning recorder.
34. I could not really understand quite a bit of the material on this app.
35. The good organization of the content helped me be confident that I would learn this material. 36. It was a pleasure to work on such a well-designed app.

IMMS Scoring Guide

Attention	Relevance	Confidence	Satisfaction
2	6	1	5
8	9	3 (reverse)	14
11 (reverse)	10	4	21
12 (reverse)	16	7 (reverse)	27
15 (reverse)	18	13	32
17	23	19 (reverse)	36
20	26 (reverse)	25	
22 (reverse)	30	34 (reverse)	
24	33	35	
28			
29 (reverse)			
31 (reverse)			

Appendix B

Baker University Institutional Review Board

May 8, 2024

Dear Jeffrey Seba and Anna Catterson,

The Baker University IRB has reviewed your project application and approved this project under Expedited Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.
6. If this project is not completed within a year, you must renew IRB approval.

If you have any questions, please contact me at skimball@bakeru.edu or 785.594.4563.

Sincerely,

Scott Kimball, PhD
Chair, Baker University IRB

Baker University IRB Committee
Tim Buzzell, PhD
Steve Massey, EdD
Jiji Osiobe, PhD
Susan Rogers, PhD

Appendix C

Liberty Public Schools
8 Victory Lane
Liberty, MO 64068
816-736-5300

Subject: Site Approval Letter

To whom it may concern:

This letter acknowledges that I have received and reviewed a request by Jeff Seba to conduct a research project entitled "The effectiveness of an AI-infused music app on student motivation in fourth-grade students" at Ridgeview Elementary and I approve of this research to be conducted at Ridgeview Elementary.

When the researcher receives approval for his/her research project from Baker University's Institutional Review Board, I agree to provide access for the approved research project. If we have any concerns or need additional information, we will contact Dr. Anna Catterson at *217-308-8841* or *anna.catterson@bakeru.edu.*

Sincerely,

Dr. Tyler Shannon
Principal, Ridgeview Elementary
816-522-9825
tyler.shannon@lps53.org

Application to Conduct Research in LPS 53

Name	Organization	Department	
Jeff Seba	Baker University	Instructional Design	
Address	City	State	Zip Code
190 Dykes Lane	Holt	MO	640418
Phone Number	Fax Number	E-mail	
816-853-4117		jeffrey.seba@lps53.org	

I have read and understand the process of application to conduct research in Liberty Public Schools. I also verify that the information provided in this application is accurate to the best of my knowledge.

Signature

X

Date 4-17-24

Is this study part of your work for a degree?

☑ Yes ☐ No

If Yes, complete the following:

☐ Ph.D. ☑ Ed.D. ☐ M.A./M.S

☐ Undergraduate ☐ Other

University or College Baker University

Date of IRB Approval (or date of application if pending) April 18th, 2024

Advisor's Name Dr. Anna Catterson

Advisor's Telephone Number

217-308-8841

anna.catterson@bakeru.edu

Attach a concise, yet thorough, response to each of the following items.

1. **Title and purpose of study**
2. **Timeline**
3. **Benefits to the district**
4. **Research Design Summary**
5. **Assurance of anonymity of Liberty Public Schools students & staff**
6. **Risks of the research**
7. **District involvement**
8. **Funding Sources**
9. **IRB approval**

LIBERTY PUBLIC SCHOOLS

CBT

Research Checklist and Approval

Date: 4/17/24

Submitted to: Christopher B. Hand - Director of Assessment, Evaluation, and Testing

Submitted by: Jeff Seba

Research Proposal Title: The Effectiveness of an AI-infused music app on student motivation in 4th Grade.

Principal Investigator(s): Jeff Seba - Baker University

Checklist

- ☑ Completed "Application to Conduct Research in Liberty Public Schools"
- ☑ Copy of "Informed consent" letter to study population/parents
- ☑ Copies of measurement instruments
- ☑ Approval from university human subjects committee (IRB) if applicable
- ☑ Three (3) copies of your complete application package

Approval of this research is contingent on adherence to district procedures as outlined in the document entitled "Application to Conduct Research" and the information provided with the application. The district must be notified of any substantive changes to the information contained in the application. The district reserves the right to withdraw approval of research if the research is deemed to no longer be in the best interests of the Liberty Public Schools students, staff, or the district.

Research Application: ☑ Approved ☐ Denied Date: 4/22/24

Signatures

Director of Assessment, Evaluation, and Testing

Principal

Principal

LIBERTY PUBLIC SCHOOLS

Appendix D

Principal Investigator: Jeff Seba
Major Advisor: Dr. Anna Catterson
Study Title: The effectiveness of an AI-infused music app on student motivation in fourth-grade students

Dear parents/guardians,

My name is Jeff Seba, the music teacher at Ridgeview Elementary. I am currently in the Doctoral Program in Instructional Design and Performance Technology at Baker University. As part of my dissertation, I am conducting a study on a music app made for learning the recorder called “The Magic Flute.” In this study, I am looking at how student motivation is influenced through instruction using this app. Liberty Public Schools is aware of and has given permission for me to conduct this study. I am writing to ask for your permission for your child to participate in this study.

If you allow your child to participate, we will ask them to complete two short surveys--one before using the app and one upon completion of three class periods. Both surveys contain similar questions about your child’s thoughts on the app and learning the recorder. Each survey will take no more than 10 minutes, and students will not miss any instruction time in order to participate. If a child indicates at any time that they do not want to participate, they will be thanked and will receive alternative recorder instruction.

There are no known risks to your child from participating in this study. Their grades and class standing will not be affected in any way if they do or do not participate. Your child will not directly benefit from this research. However, their participation may benefit others by informing the development of future instructional materials and processes designed to increase enjoyment and satisfaction when learning a musical instrument.

This research is anonymous. Each student will receive a randomized ID number in order to connect their pre-survey results with their post-survey results. No names will be collected. If a report of this study is published or presented at a professional conference, only group results will be communicated and not individual responses.

If you would like your student to participate, please fill out the below form and return it to your child’s classroom teacher. I am happy to answer any questions or concerns you have about the study. Please contact me at jeffrey.seba@lps53.org or 816-736-5450.

Thank you for your time!

Jeff Seba
Ridgeview Elementary Music Teacher
Baker University IDPT Doctoral Candidate

Parent Permission Form

If you wish for your child to participate in the research study titled “The effectiveness of an AI-infused music app on student motivation in fourth grade students” please sign and date the form below and return to your child’s classroom teacher. Please note that both you and your child must sign and date the form.

Principal Investigator: Jeff Seba
Major Advisor: Dr. Anna Catterson
Study Title: The effectiveness of an AI-infused music app on student motivation in fourth grade students

Notification of permission:

I am willing to participate in the study described above.

_____ _____

Student Name *Date*

_____

Student Signature

I give permission for my child to participate in the study described above.

_____ _____

Parent/Guardian Name *Date*

_____

Parent/Guardian Signature

Appendix E

BAKER UNIVERSITY

IRB Request

Date 4-19-24

IRB Protocol Number _____ (IRB use only)

I. Research Investigator(s) (students must list faculty sponsor)

Department(s) Instructional Design and Perfo

	Name	Signature	
1.	Jeff Seba		Principal Investigator
2.	Anna Catterson	Anna Catterson	☐ Check if faculty sponsor
3.	Kyunghwa Cho	Kyunghwa Cho	☐ Check if faculty sponsor
4.			☐ Check if faculty sponsor

Principal investigator contact information

Note: When submitting your finalized, signed form to the IRB, please ensure that you cc all investigators and faculty sponsors using their official Baker University (or respective organization's) email addresses.

Phone 816-853-4117

Email jeffreyteseba@stu.bakeru.edu

Address 190 Dykes Lane

Holt, MO 64048

Faculty sponsor contact information

Phone 217-308-8841

Email anna.catterson@bakeru.edu

Expected Category of Review: ☐ Exempt ☐ Expedited ☑ Full ☐ Renewal

II. Protocol Title

The effectiveness of an AI-infused music app on student motivation in fourth grade stud

III. Summary:

The following questions must be answered. Be specific about exactly what participants will experience and about the protections that have been included to safeguard participants from harm.

A. In a sentence or two, please describe the background and purpose of the research.

Artificial intelligence (AI) is an emerging tool in the field of education. Through the use of AI, educators can maximize feedback given to students, which helps promote student engagement. The purpose of this study is to examine the effects of a music app utilizing AI technology on student motivation as it relates to learning a musical instrument - the soprano recorder.

B. Briefly describe each condition, manipulation, or archival data set to be included within the study.

This study will use one intervention. Subjects will utilize the music app designed by ClassSplash called 'The Magic Flute' to learn to play the recorder. The app employs artificial intelligence to recognize and give feedback on the pitch and rhythm played on the recorder by the student. The app facilitates learning through a story-like element.

The intervention will take place over three regularly scheduled music classes.

IV. Protocol Details

A. What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

Student motivation will be collected using a variation on John Keller's Instructional Materials Motivation Survey (IMMS). The IMMS contains 36 Likert-style questions. Each question pertains to one of the four pillars of John Keller's ARCS model, as they relate to learning the recorder. Twelve questions pertain to attention, nine to relevance, nine to confidence, and six to satisfaction. Students will be surveyed before and after experiencing the intervention. Both the pre- and post-surveys will be administered through Google Forms.

B. Will the subjects encounter the risk of psychological, social, physical, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

Subjects will not be at psychological, social, physical, or legal risk. The app will be purchased from the developers through the Apple app store, and all students will have a license for the app.

C. Will any stress to subjects be involved? If so, please describe.

The subjects will not experience any stress during the intervention or data collection process.

D. Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

The students will not be deceived or misled in any way. All students will be given explanations of the study, the acp, and the data collection processes. Each subject's guardian will also be given this information, and both student and guardian asked to approve via written signature.

E. Will there be a request for information which subjects might consider to be personal or sensitive? If so, please include a description.

There will not be a request for information which subjects might consider to be personal or sensitive. Subjects will receive a randomized ID number, to match pre- and post-survey data. This will be the only method for tracking student answers, and the ID number will not be linked to individual subjects.

F. Will the subjects be presented with materials which might be considered to be offensive, threatening, or degrading? If so, please describe.

Subjects will not be presented with materials which might be considered to be offensive, threatening, or degrading.

G. Approximately how much time will be demanded of each subject?

Each intervention will last approximately 30 minutes. Each survey will take between 3-7 minutes to complete. This will result in a total time demanded of 96-104 minutes. It should be noted that the interventions will take place during the subjects' regularly scheduled music classes.

H. Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

The subjects in this study will be comprised of willing fourth-grade students at Ridgeview Elementary in Liberty, MO, where the principal investigator works as the school's music teacher. Subjects will be given an overview of the purpose and contents of the study, and will receive a written permission form (attached) to be signed by themselves and their parents. The students will not experience harm or disadvantage in continuing music classes with the principal investigator should they choose not to participate.

I. What steps will be taken to insure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

Each student will be given the choice whether or not to participate in the study. If they choose not to participate in the study, they will still be able to participate in the app. If they do not want to participate in the app, alternative recorder instruction will be provided.

J. How will you insure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

A written consent form will be given to the subjects and their guardians prior to participating.

K. Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

All students will receive a randomized ID number, which will serve as their only method of identification. None of the data collected will be identifiable with the subjects, only the ID number. The ID numbers will not be made a part of any permanent record.

L. Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher, or employer? If so, explain

In this study, the fact that a subject did or did not participate in the study will not be made part of any permanent record available to a supervisor, teacher, or employer.

M. What steps will be taken to insure the confidentiality of the data? Where will it be stored? How long will it be stored? What will be done with the data after the study is completed?

The data collected in this study will be stored on a password protected Google Drive account monitored and secured by Liberty Public Schools in Liberty, MO. The data will be stored up to one year after completion of the study. Upon the date of one year after completion of the study, the data will be deleted from the password protected Google Drive account.

N. If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks associated with this study. Participants will not receive any benefits.

O. Will any data from files or archival data be used? If so, please describe.

There will be no data from files or archival data used.