COMPARING NOVEL AND ESTABLISHED TECHNOLOGY IN AN ELEMENTARY MUSIC CLASSROOM

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Master's Thesis

Music, Mind, and Technology

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30 June 2020

University of Jyväskylä

JYVÄSKYLÄN YLIOPISTO

Tiedekunta – Faculty Humanities and Social Sciences	Laitos – Department Music, Art, and Cultural Studies
Tekijä – Author Kalli Bankston	
Työn nimi – Title Comparing novel and established technology in an elementary music classroom	
Oppiaine – Subject Music, Mind & Technology	Työn laji – Level Master's Thesis
Aika – Month and year May 2020	Sivumäärä – Number of pages 61

Tiivistelmä – Abstract

Students currently enrolled in school are accustomed to a world filled with technology. When utilized correctly, technology has the potential to greatly support student learning throughout all areas of education. This study aimed to investigate student learning as compared between two pieces of music technology: the iPad and the KAiKU Glove. The iPad is an established piece of music technology, whereas the KAiKU Glove is a newly-developed, touch-based electronic glove designed for music education. Two groups of Finnish students participated in the study during their elementary music classes, one class learning with the iPad and the other class learning with the KAiKU Glove. Knowledge retention and knowledge growth were assessed through quantitative measures. The students' perceptions of the two technologies were also compared between the classes using Likert scale self-reports, which examined each technology's ease of use and association with a traditional classroom instrument. The study found that while both classes experienced knowledge growth, the iPad scored slightly higher on a post-intervention test of musical knowledge when compared to the KAiKU Glove class. The study also revealed nonsignificant data indicating students in the iPad class found their technology easier to use than students in the KAiKU Glove class, as well as significant data that the iPad users felt a greater association between their technology and traditional classroom instruments. While this study showed more slightly positive results for the iPad class, the positive results also experienced by the students using the KAiKU Glove suggest that new music technology can be comparable to existing music technology. The study provides supporting evidence for the inclusion of new music technology in the elementary music classroom.

Asiasanat – Keywords

Music education, music technology, music education technology, iPad, KAiKU Glove

Säilytyspaikka – Depository	
Muita tietoja – Additional information	

Acknowledgements

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There are a few people that need to be acknowledged for their roles in making my time in Finland successful. Thank you to my program coordinator, Marc Thompson, for providing me a wonderful, challenging opportunity to study and learn; and grow as a person. For that I am forever grateful.

Thank you to my supervisor, Jukka Louhivuori, for providing all of the materials necessary to complete the study, and for connecting me with Henna Mikkonen. Many thanks to Henna for welcoming me into her classroom and allowing an interrupt to her school year. Thank you for planning lessons and designing tests for your students so that the experiment could be successful. I am very glad I got to spend time in a Finnish elementary music class.

Johanna Wilson, thank you for providing me with motivation to write. You really helped my creativity. Andy Danso, thank you for being my research partner. There is no way that I could have done this without you and I will always be thankful for your help. You kept me on track and always supported a venting session. Also…you were definitely a member of thesis club.

THESIS CLUB!! The biggest thank you to my friends in thesis club. They held me accountable, made me go to school on a daily basis, made me laugh, and most importantly, kept me sane. Thesis club was hands down the best part about writing a thesis and I would write a thousand more if it meant I got to be surrounded by them.

And finally, thank you to my family for supporting me on this adventure!

CONTENTS

1 INTRODUCTION

Technology is an ever-evolving field that is constantly shaping the way people live their lives. It is no longer viewed as a luxury for the wealthy but is now readily accessible and an integral part of everyday life. As few as fifteen years ago it was unheard of for a toddler to be playing with an expensive electronic device, but in today's world many children are capable of working electronics before they are able to form complete sentences. In a survey commissioned by the American Speech-Language-Hearing Association, 68% of U.S. parents said their 2-year old children use tablets, and 59% of those 2-year olds also use smartphones (New ASHA Survey, 2015). These children are growing up in a world that revolves around technology. Living without it is a foreign thought for children in today's society.

Just as technology is progressing, so is the field of education. The classroom days of the past are rapidly coming to an end (Konstantinou, 2016). Chalk boards are being replaced by state of the art, touch screen smart boards, and heavy textbooks have turned to tablets, all course materials downloaded in one convenient location. To stay relevant with the ever-changing times, all classrooms, including music classes, must adapt and embrace technology or risk being left behind. According to one study, children spend two hours and thirty-one minutes a day listening to music (iPod/MP3 device) and at least another two hours and thirty-two minutes on an additional electronical device (Rideout, Foehr, & Roberts, 2010). Technology is present in all aspects of people's lives, including music consumption.

Children crave technology, and students who are currently entering school are unaware of a world without it. Wise, Greenwood and Davis (2011) state that students who are in school now are "products of the digital age in that they have spent their lives surrounded by and using computers, video games, digital music players, mobile phones and all the other tools and paraphernalia of what is also called the information age" (p. 118). These students' whole existence has evolved around technology. According to Webster (2002), these students are "unaware of a world without computers, personal digital assistants, portable CD and MP3 players, digital keyboards and the Internet with its connection to vast amounts of information" (p. 38). The students we teach today are members of the digital age, and the way they are taught must be adapted to fit their learning styles.

The educational approaches of the past will not continue to be successful with the digital age student. For music education classrooms to stay relevant and allow for the teachers to continue capturing the attention of students, educators must incorporate music technology into their curricula. By utilizing music technology as part of teaching and music learning, Konstantinou (2016) states that teachers are able to "connect students' out-of-school music lives to their in-school music ones" (p. 177).

Current technology affords the ability to create, record, watch, share, buy, and stream any type of music with the press of a button. By bridging out-of-school music consumption with in-school music learning, teachers can make music relevant to all aspects of students' lives. If utilized properly, music technology can be beneficial for all levels of music education. It has the potential to supplement student learning in many ways. For example, music technology affords students the ability to produce quality sounds from the first attempt, compose their own music, and play and hear instruments otherwise not accessible in the music classroom.

This study aims to investigate students' perceptions of two pieces of music technology, the iPad and the KAiKU Glove, in an elementary music classroom. The iPad is commonly used in music classrooms and was familiar to the students while the KAiKU Glove was an unfamiliar piece of new music technology. Themes investigated include the both technologies ease of use and their respective associations with traditional classroom instruments as seen by the students. In addition to investigating the students' perceptions of both pieces of technology, the students' knowledge retention and knowledge growth were compared between the two technologies.

As an elementary music teacher, using new technology in the classroom is of particular interest to me since the field of music education technology is rapidly evolving. I have observed my own students' technology usage and seen how my students crave learning and creating beyond paper and pencil or traditional music making. By investigating the way students learn musical concepts and music theory, educators like me can adapt my own teaching practices to better suit the needs of my students. Through this study, I also hope to find supporting evidence for the use of new music technology in the elementary music classroom.

Through the action research data collection process and the data analysis, different research questions and hypotheses arose. After having narrowed down the focus to three main topics (ease of use, musical instrument association, and knowledge retention/knowledge gained), I will attempt to support the hypotheses that, when used in a Finnish elementary music classroom, (1) the KAiKU Glove is easier to use than the iPad, that (2) the iPad has a greater association with traditional instruments than the KAiKU Glove, and that (3) the KAiKU Glove class supports greater knowledge retention and knowledge growth than the iPad.

2 LITERATURE REVIEW

2.1 Music Education

2.1.1 Finnish Elementary Music

In a study conducted by Ruismäki and Tereska (2007), when discussing music education and the Finnish school system, it is stated that "music has had an important role in the curriculum since the founding of the elementary school system" (p. 127). Students in Finland attend comprehensive schools from the ages of 7-15. The main goal of comprehensive school in Finland "is to make pupils active members of society and develop in them a strong cultural identity" (Anttila, 2010, p. 242). It is uncommon for elementary-level music to be taught by a music specialist; instead, music is commonly taught by the classroom teacher. Educators with training in music education are employed as music teachers at upper level and secondary schools. In some instances, however, such as at the Jyväskylän normaalikoulu (a comprehensive elementary school located in Jyväskylä, Finland), a music specialist is employed to teach music education to the students, with music being the only subject the specialist teaches (H. Mikkonen, personal communication, February 13, 2018).

Music is a required subject of study for the first seven years of comprehensive school education. The National Board of Education outlines the aims of Finnish music education to include "helping pupils to identify their musical interests; encouraging them to become involved in musical activity, providing them with the means of expressing themselves through music, and supporting their holistic development" (Anttila, 2010, p. 243). Finland's National Core Curriculum gives both broad and vague descriptions as to what should be taught in music classes. The National Core Curriculum consists mostly of "singing, playing instruments and listening to music of various styles and genres" (Anttila, 2010, p. 243). The curriculum does state the need for students to experiment with their own musical ideas by composing, arranging, and improvising using instruments, singing, dancing and music technology. Music education is considered important because it helps students to understand music's ability to connect to a time and place. Music changes as cultures and societies evolve, and can mean different things to different listeners (Anttila, 2010; Elliott, 2009; Ruismäki & Tereska, 2007).

Finnish music education does not focus solely on mastering musical concepts and theories, but also incorporates music appreciation in the students' education (Anttila, 2010).

Finnish music education is approached from a praxial viewpoint, meaning that the development of musicianship is one of the primary goals. Praxial music education sees music as something that is available for everyone, regardless of their level. This approach to music education is rooted in practice, rather than theory, and is a collaborative process between the educator and student (Thorgersen, Johansen, & Juntunen, 2016). Anttila (2010) describes praxial music education "as something that people do – as goal-directed human activity" (p. 243). It is believed that musical ability is present in all students; therefore, praxial music education serves all students, with varying needs and purposes (Anttila, 2010). Praxial music education in a comprehensive school setting should cultivate student growth and nurture the student's musical development, regardless of their ability (Anttila, 2010).

Finland's core curriculum is based on constructivist views of knowledge and learning. Constructivist learning produces a student-centered learning environment (Webster, 2002b). Jean Piaget's research into the development of one's cognitive processes is the basis behind the constructivist learning theory. His research brought forth the notion that "intelligence is shaped by experience" (Kolb, 2014, p. 12). The student must experience to learn, as learning does not happen because the teacher gives students thoughts. Learning is individual to the child and is viewed as a social activity that best takes place among groups of children (Scott, 2006; Webster, 2002b). The goal of music education is not to teach music to the student, but to teach the student how to cultivate and develop their own musical abilities and appreciation for music (Scott, 2006).

2.1.2 Guidonian Hand and Solfege

The idea of using one's hand to learn music and assist in making music is not novel (Magnusson, 2011; Miller, 1973). The "pedagogical concept of 'musical hand' has existed nearly 1000 years through the work of Guido of Arezzo (Guidonian hand)" (Myllykoski, Tuuri, Viirret, & Louhivuori, 2015, p. 182). The Guidonian hand is a hand-based notation system that dates back to the 11th century. Guido of Arezzo used the hand-based notation system to teach medieval singers the hexachord (six-note scale) by using the palm of their hand as a guide to the notes. According to Magnusson (2011), the Guidonian hand is "a

system of prescriptive instructions for conducting music, where each part of the hand's digits represents a musical note for the performers (p. 19). As a monk, Guido of Arezzo assisted the singers in remembering the Gregorian chants that they performed in the monasteries (Magnusson, 2011; Miller, 1973). Miller (1973) describes how the hand was used to remember notes, stating that "the entire gamut of tones from G to e'' were assigned palm and finger locations on the left hand, and the index finger of the ring hand touched these to indicate the exact tones to be sung" (p. 244).

Guido's music theory system (also known as Guidonian music theory) proved effective in learning and memorizing musical structures (Myllykoski et al, 2015). Guido of Arezzo is attributed with the invention of the modern music score as well as with the creation of solfege (Magnusson, 2011). Solfege is a commonly used tool in elementary music where each pitch is assigned a name. Each note of the scale is assigned a syllable (do, re, mi, fa, so la, ti, do).

Magnusson (2011) states that "the great success of the traditional score as musical technology has established it as the fundament on which our musical education is built" (p. 19). The creation of the traditional music score led to continued developments in the way people learn music. It has also led to the development and growth of devices used to aid in music education and music learning.

The Guidonian hand, combined with the commonly used Kodaly method (solfege) were the driving ideas for the creation of the KAiKU Glove (Myllykoski et al., 2015). The KAiKU Glove is a new, functional prototype of a touch-based musical glove designed for music education. The palm of glove contains sensors, that when pressed, produce high quality musical sounds. While the mapping of the sensors on the glove is different than tone placement on the Guidonian hand, Guido's hand inspired the idea to project music theory onto one's hand in form of a wearable piece of music technology (J. Louhivuori, personal communication, March 22, 2018).

2.2 Music Technology

Music technology is a broad concept with a variety of applicable components. To properly discuss what encompasses music technology, the term must be defined. Pitts and Kwami (2002) define music technology as "any situation in which electronic technology is used to control, manipulate or communicate musical information" (p. 61). Byrne and MacDonald (2002) have a more detailed definition that catalogs many components of music technology. Wise et al. (2011) summarize the components by stating that music technology encompasses "…electronic keyboards, sound modules, multi-track recorders, synthesizers, hardware sequencers (such as those contained in the on-board sequencers in keyboards), and a wide range of software applications that allow sequencing, notation, editing and recordings through MIDI-based and acoustic means" (p. 119).

Music technology can be a very important tool for teaching musical concepts to students of all ages. The ultimate goal of educators when using music technology is to integrate it into the curriculum rather than it being an additional resource used just for teaching (Wise et al., 2011). Integration is important as "the effectiveness of music technology serves to provide a means of enhancing and expanding educational opportunities for the students, as well as enrich learning content and knowledge" (Wai-Chung, 2007, p. 701). The goal of present day music education technology is not to replace real music making, learning, or teaching, but it is a way of developing, researching, and advancing new methods in the music classroom (Pitts & Kwami, 2002) while integrating technology into the day by day routine (Sastre et al., 2013). Students should learn with music technology, not from it.

2.2.1 History of Music Technology

Using technology to assist music education is not a new concept, but the availability and complexity of the devices used is. In 1877, Thomas Edison invited the phonograph (sometimes called the gramophone), a device that first made possible the use of technology in music education. The phonograph not only allowed for sound to be recorded, but also for it to be reproduced, which was novel. While at the time the phonograph was expensive and uncommon, it began an evolution of music technology in the twentieth century.

The creation of the Theremin brought electronic music to the forefront of musical consciousness. The early- to mid-twentieth century saw the development of technologies such as amplifiers, tape recorders, jukeboxes and early electric guitars. Classical composers began to use electronic instruments in their compositions (Webster, 2002a). Beckstead (2001) quotes Edgard Varèse, an avid user of electronic instruments referred to as "the father of electronic music," as stating he has "been waiting a long time for electronics to free music from the tempered scale and limitations of musical instruments. Electronic instruments are the portentous first step toward the liberation of music" (p. 45). Varèse made this statement in 1931, just as using electronics to create music was beginning to flourish. Electronics and electric instruments eventually made their place in music classrooms.

By the mid- to late-twentieth century, cassette tape recorders were available for everyday use and were considered the main technology available for music education. Around the same time, computers began their big entrance into the world. In the mid 1980s, the development of micro-technology helped to bring more relevance to electronic instruments. Wise et al. (2011) states this "development marks a defining point in music education" (p. 119) as electronic instruments in the classroom allowed for different sounds and musical styles to be produced. Toward the end of the twentieth century, computer technology started to become more affordable and as a result, more available for purchase by educational institutes. With the availability of the computer came the development of faster and more readily available internet.

Presently, students use music technology, both inside and outside, of school on a daily basis. These daily uses, according to Konstantinou (2016) include "…computers, tablets, smartphones with applications, iPods, websites and music software programs, that allow them not only to listen to music but also learn music and even compose and share their own music pieces" (p.177). Music technology has allowed music education to become learner centered, allowing the student to create and explore their interests in depth.

Music technology in the classroom, including the iPad, can be utilized as a part of a social constructivism approach in the music classroom (Williams, 2014). The technology has "the potential to fundamentally change the ways that learning and teaching are carried out, greatly favoring constructivist and collaborative approaches to learning" (Manuguerra & Petocz,

2011, p. 61). Furthermore, music technology allows for greater accessibility when compared to traditional classroom instruments.

The goal of present day music technology is not to replace acoustic music making, learning, or teaching but instead to develop, research, and advance new methods in the music classroom (Juvonen & Ruismäki, 2009). Carlisle (2014) states that "technology can function as a tool to "fill" in areas where there are technical limitations with the classroom instruments, physical limitations experienced by students, or a lack of access to acoustic instruments and timbre diversity" (p. 16). These tools and instruments "can be seen as body-extensions that allow the mind to operate within a musical reality that is otherwise not accessible" (Leman, Lesaffre, Nijs & Deweppe, 2010, p. 205).

2.2.2 iPads in the Classroom

The iPad, a hand-held touch-based device, was released in April 2010 and has since integrated into today's society (Dhir, Gahwaji, & Nyman, 2013; Manuguerra & Petocz, 2011; Randles, 2013; Ruismäki, Juvonen, & Lehtonen, 2013). Due to its relatively low cost, the iPad is a staple in many classrooms. The iPad's interface is very intuitive and easy to use (Culén & Gasparini, 2011), which helped the device make an easy transition into education. It is thought of as "an ideal tool for performing different actions required in any education system due to its screen size, multimedia support, lightweight, and long battery life" (Dhir et al., 2013, p. 707). Previous studies have shown that students view the iPad as an engaging and enjoyable way to experience learning (Dhir et al., 2013; Manuguerra & Petocz, 2011).

The iPad is also seen as a device that can assist in making learning seamless. It allows for the student to easily switch between learning contexts (formal and informal learning), as well as supplementing what the students are already learning (Clark & Luckin, 2013). In special needs education, the iPad has the ability to reach students with learning disabilities, special accommodations and/or physical limitations (Carlisle, 2014; Williams, 2014).

The iPad has many implications, not only in the general and special education curriculums, but also in music education. It has changed pedagogical approaches in music education (Manuguerra & Petocz, 2011) by making the learning experience simpler but deeper by allowing customizations for students based on abilities and learning rates. Carlisle (2014)

states that the iPad also allows an opportunity to scaffold students' musical learning, enhance self-expression, and explore timbral relationships. The device assists in scaffolding the students learning by immediately providing feedback as the students engage with the technology. The tactile feedback from the iPad can assist students who have difficulty keeping the steady beat. Tactile feedback also allows for exploration and expression through tone relationships. iPads provide the ability to easily change modes, instruments, and scales of traditional instruments without actually having those instruments present in the classroom. With the iPad, pitch modulation can occur, which allows for students to explore music of different cultures. For example, the East Indian raga modes, which would not be easily accessible on a traditional Western elementary music classroom instrument, are achievable using apps on the iPad; Carlisle (2014) discusses the way "the performer bends a sustained pitch after the initial attack as a way to develop the mood of the raga" (p.14).

Exploring chord progressions can be easily done by using an iPad, allowing for the development of tone relationships. When attempting to perform chords on classroom barred instruments, students must have the ability to perform with more than two mallets to play a traditional three note chord. The skill of performing multiple grip mallet techniques is often taught in advanced upper level music classes (middle school/high school level) thus making it difficult to perform with elementary aged students. The iPad allows the students the ability to perform three (or more) note chords with the press of a finger.

Williams (2014) outlines ways the iPad and classical instruments are similar. While students can produce high quality sounds on both, students can also produce poor quality sounds without the instruction of a teacher. The iPad and traditional instruments also both require practice to be successful. Improving upon technical proficiency helps the student develop musicianship on both the iPad and a classical instrument. Williams (2014) also makes note that there are limitations on who can be successful on both types of instruments and finally, most basically, both require human interaction to produce music.

2.2.3 KAiKU Glove

As previously discussed, the KAiKU Glove is a piece of hand-based, wearable music technology created and designed for music education. Hand-based music technology has previously been used for things such as stroke rehabilitation and gesture based music

performance (Friedman et al., 2014; Mi.mu: story, 2018) but the KAiKU Glove is one of the first pieces designed specifically for music learning. One of the main ideas behind the conception of the KAiKU Glove is to bring the musical instrument physically closer to the player's body, thus allowing for the player's body to essentially become the instrument. By having the instrument closer to the body, the creators believe that it "potentially enables the utilization of already familiar sensory-motor skills in music making" (Myllykoski et al., 2015, p. 182). Since the player is very familiar with their hand, the KAiKU Glove builds upon that instinctive knowledge to create a musical instrument that is natural.

Cognitive theoretical approaches to education state that new knowledge is compounded with existing knowledge to create learning (Bandura, 1986). By scaffolding learning, students build upon existing knowledge with new knowledge. When a student is active in a lesson, more learning occurs. Leman (2008) makes note that many cognitive theorists, including Jean Piaget, have generated the idea that "the link between mind and matter is based on the role of the human body as mediator between physical energy and meaning" (p. 43). The KAiKU Glove was created to take something innate to the user, their hand, and build upon that to support and encourage music learning. This is both compounding new knowledge with existing knowledge as well as using the human body as a mediator to create music. With the KAiKU Glove, instead of using one's hand to play the musical instrument, the glove transforms the user's hands into the instrument.

As previously mentioned, the Guidonian hand, combined with the commonly used Kodaly method (solfege) were the ideas behind the development of the KAiKU Glove. The developers wanted to find a very concrete, physical way to help children learn theoretical musical concepts. They believed that it is important to link theory with sound, that quality sounds help motivate students, and that the combination helps promote embodied cognition. The KAiKU Glove provides students with a concrete musical link to the body, since the instrument is worn on the student's hand (J. Louhivuori, personal communication, March 22, 2018).

Tactile and kinesthetic learning are involved when beginning and mastering any type of musical instrument. Music learning is action-oriented and multimodal in nature. The KAiKU Glove allows students to "learn music through different modalities: visually, auditorily and

kinesthetically" (Myllykoski et al., 2015, p. 182) as well as through any combination of these modalities. When a student touches a sensor on the glove, they receive tactile feedback. Using the argument that not just one modality can thoroughly teach music, the glove combines different "sensory modalities, kinesthesia and motor actions" to allow for "embodied musical interaction for music learning" (Myllykoski et al., 2015, p. 182). Some of the potential benefits of using the KAiKU Glove in music learning "include music playing, digital instrument control, arranging, composing and sound morphing" (Myllykoski et al., 2015, p. 183).

The KAiKU Glove is made to be played with both hands. Touch interaction between hands is a guiding force behind the idea of success for the glove in a music education setting. One hand works as the instrument by wearing the glove and the other hand plays it. It is "intended to be played with palms facing each other and every finger facing its equivalent" (Myllykoski et al., 2015, p. 183). This allows for the student to play the instrument without having to look at it as a result of the kinesthetic familiarity between the user's two hands. The glove also allows for the reversal of the roles of the two hands, as the hand that wears the glove can touch the other hand and still produce sound. The sensors are sensitive to pressure and type of touch, allowing for many different effects, including attack of note (potential to teach articulation), dynamics, and manipulation of pitch (also referred to as a pitch bend). The sensors on the glove can be assigned any note, allowing freedom for the educator and student. Sensor note assignment used in this study can be seen in Figure 1. In 2018, Taction Enterprises, the company behind the creation of KAiKU Glove, received both United States and European patents for the mapping of the notes.

FIGURE 1. Fingerless KAiKU Glove with corresponding notes labeled on sensors.

2.2.4 Benefits of Technology

The lives of today's students are centered around technology. By using technology in the music classroom, teachers are able to bring the student's world into the class. As a result, this makes learning more attractive for the students by making real world connections. Konstantinou (2016) believes that "technology has the potential to bridge the gap between students' musical lives and their experiences in and out of school" (p. 117). Burnard (2007) states that by bridging the gap, it allows for increased "collaboration within and beyond the formal school setting" (p. 41).

By using technology in the classroom, learning becomes more student-centered and less teacher-led, allowing the students to be more in control of what and how they are learning. Technology also has the possibility of making lessons run smoother and more efficiently, thus freeing up time to allow for creative development within the students (Burnard, 2007). Using the appropriate music technology can be of benefit for children to help them develop musical and social skills (Charissi & Rinta, 2014). Music technology also allows for students to engage as a DJ by choosing their own songs, beats, rhythmic structures and instruments (Crow, 2006). The KAiKU Glove has the potential to be used in a DJ setting as it allows the user to change instrument sounds, alter notes, record their own sounds, and play their own

rhythmic structures. According to Webster (2012a), music technology also has the "power to re-conceptualize the traditional roles of composer, listener, and performer" (p. 117). By utilizing music technology, students have the ability to easily compose their own piece of music while producing quality sounds, with or without the technical skills to actually play the instrument.

According to Crow (2006), music "technology's ability to manipulate audio has meant that many people, who up until now did not perceive themselves to be musicians, can handle, create and communicate music using their computers" (p. 123). Students can use music software and technology that is simple to operate and easy to create with, thus allowing music to influence and reach more students. This can be helpful for building relationships with "hard to reach" students who use the excuse that they are "not good at music because it is too hard" as a reason not to participate.

Music technology allows for people with or without musical training to become musicians. Since the proper playing technique needed for a traditional instrument is not necessary when performing with music technology, people who lack formal musical training are still capable of producing quality musical sounds (Webster, 2011). The experience of composing and creating music is easily attainable to all levels and ages of students because there are resources available that allow "individuals at a very young age to manipulate sound and create compositions" (Webster, 2002a, p. 117). Novel music technology used in this study, the KAiKU Glove, requires minimal skill to produce quality sounds, which allows music to reach a larger population of students, including those with special needs or limited mobility (J. Louhivuori, personal communication, March 22, 2018).

Adaptive music technology includes tools offering the potential to serve more disabled students and provide musical opportunities for those students akin to their non-disabled peers (Carlisle, 2014; Williams, 2014). It affords educators the ability to connect with students who otherwise may be unable to participate in traditional music classes (Peters, 2018). The technology supports a multisensory approach to music learning by providing visual stimuli, auditory stimuli, kinesthetic activity (movement), and tactile touch.

Students enjoy using technology, and it has the ability to boost things such as participation, motivation, engagement, and creativity. In a study conducted by Konstantinou (2016), data from student questionnaires showed that the students were very excited about the use of technology in the music classroom. Konstantinou (2016) found that "students' excitement, engagement and motivation when using technology was more than evident during the lessons and relevant comments were recorded in their questionnaires" (p. 183). The study investigated the use of music technology in three separate primary schools' music classes, with the most common music technology represented in the study being computers, laptops, music software, and projectors. The students were provided one-to-one technology, meaning each student was in possession of their own device. Students were motivated and excited during the lessons because they were using technology. Konstantinou (2016) found that the students were especially excited "when they were given the opportunity to be more creative by creating something, adding music to a scene, or composing their own melodies" (p. 184).

2.3 Action Research

Action research is a practical and systematic research method that allows for evaluation of teaching and educational practices, as well as investigation into students' learning. It can be defined as "a process of systematic reflection, enquiry and action carried out by individuals about their own professional practice" (Frost, 2002, p. 25). It is ongoing as the researcher plans, acts and observes, and then reflects. During the reflection, the researcher is evaluating the data and determining the best plan to move forward. The revised plan moving forward begins the cycle again. The methodology was first introduced in the mid-twentieth century and came as a result for the need for more relevant and practical knowledge in fields of social sciences (Nolen & Vander Putten, 2007).

Action research combines theory and research to create an evaluation tool to ensure best educational practices in the classroom. In a school setting, action research is used to improve upon educational practices as well as to understand, evaluate, and change practices. Educational action research takes place in a common, normal setting where the students feel comfortable. By observing the students in their natural school setting, researchers are able to gather ecologically valid data from their observations. Ecologically valid data allows for the findings to be generalized to the real world because the data was collected in a natural setting.

In a classroom, the educator may be the only observer of the action research while it is taking place, or it may be a collaboration between the educator and an outside researcher.

Action research is cyclical in nature (Bassey, 1998; Cain, 2008; Costello, 2003): plan, act, observe, reflect, move forward. In using action research, there is an emphasis on practicality and problem solving by identifying an issue, and implementing a practical solution. Michael Bassey (1998) elaborates on the action research model to include eight stages. Costello (2003) summarizes the eight stages:

> Stage 1: Defining the enquiry.
>
> Stage 2: Describing the educational situation.
>
> Stage 3: Collecting and analyzing evaluative data.
>
> Stage 4: Reviewing the data and looking for contradictions.
>
> Stage 5: Tackling a contradiction by introducing some aspect of change.
>
> Stage 6: Monitoring the change.
>
> Stage 7: Analysing evaluative data concerning the change.
>
> Stage 8: Reviewing the change and deciding what to do next. (p.8)

Bassey's (1998) framework was created to answer three main questions: "what is happening in this educational situation of ours now? (Stages 1-4); what changes are we going to introduce? (Stage 5); what happens when we make the changes? (Stages 6-8)" (Costello, 2003, p. 9). Stages 1-4 address determining the problem, evaluating the situation and observing what already exists. Stage 5 has the researcher introducing some type of change. Stage 6-8 observes and analyzes the change, including data collected. Stage 8 ends with the researcher reviewing all knowledge gained and deciding the best way to move forward.

When analyzing action research data, four key terms emerge as guides. Macintyre (2000, p.91) describes the four terms as themes, incidence, patterns, and trends. Themes includes "the consistent ideas which emerged," incidences meaning "how often something occurred," patterns are defined as "the timing of the occurrences – whether they were single or in a cluster" and trends are "the frequency of the patterns" (Macintyre, 2000, p. 91).

In a review of music education literature utilizing action research, Cain (2011) found that while “the most common data collection methods were qualitative, including reflective journals, interviews, and participant observations, some studies employed quantitative methods” (p. 287). Both qualitative and quantitative data collection measures were found to be used in the music education studies depending on what was most appropriate for the study. In regard to the data analysis, music education action research was also found to be both inductive and deductive, meaning that sometimes the themes discovered came from the data collected, and other times the data collected was used to guide the themes found (Cain, 2011; Davidson, 2004; Miller, 2004). Action research was used in a way that best fit the topic to be discovered.

3 RESEARCH DESIGN

Literature shows that the technique of using one's hand to assist in learning music has been around for thousands of years (Miller, 1973; Myllykoski et al., 2015). While that teaching technique predates the scientific term "embodied cognition," embodied cognition is a driving idea behind utilizing one's hand as a learning tool. Embodied cognition theorizes that the body influences the mind, just as the mind influences the actions of the body.

The KAiKU Glove was developed using the theological framework of embodied cognition (Leman, 2008), which supports the concept of using one's hand to create and learn music theory. When using the KAiKU Glove to create music, the instrument is worn on the hand like to a traditional glove. As a result, it acts as an extension of the performer's body. Furthermore, the KAiKU Glove has the ability to produce quality musical sounds without the years of training required to produce an equivalent sound on a traditional instrument.

The iPad, a piece of technology commonly found in many classrooms (Dhir, Gahwaji, & Nyman, 2013; Manuguerra & Petocz, 2011; Randles, 2013; Ruismäki, Juvonen, & Lehtonen, 2013), is utilized as music technology in music education classrooms. The KAiKU Glove is comparable to the iPad in sound production and sound quality, which prompted the decision to compare two pieces of music technology in this study. Unlike the KAiKU Glove, the iPad is not an extension of the performer's body, but rather a technological tool that is used to create and learn music.

This study aims to investigate ease of use, association with a traditional classroom instrument, and knowledge retention/knowledge growth as compared between a common piece of music technology, the iPad, and a novel music technology, the KAiKU Glove. I conducted the study alongside fellow graduate student Andrew Danso at a Finnish elementary school. A team of two researchers was necessary for setting up and troubleshooting both music technology and video cameras for observing the lessons. An additional researcher also strengthens the validity of observations made during the lessons. The content of the lessons was developed and taught by the school's music teacher, a native Finnish speaker who was familiar with the students and who also administered the experiment. It was determined that a native Finnish speaker

should be involved to properly conduct the study within the context of Finnish music education.

3.1 Aims

As the KAiKU Glove is a relatively new piece of music technology still in the developmental phase, no prior research exists with the KAiKU Glove in an elementary school setting. This study aimed to introduce the KAiKU Glove to elementary-aged students while comparing student learning with it versus student learning with the iPad, a commonly used piece of music technology. The study looked at knowledge gained and knowledge retained using both technologies. An additional aim of the study was to compare the students' perception of ease of use of the technology, as well as the students' views on the technology as a musical instrument.

3.2 Hypotheses

For this study, three hypotheses were developed through a combination of real world teaching experience and research into the constructivist learning theory. My experience as an elementary music teacher has provided me first hand views on student interest and ability to use technology in the classroom. Constructivism states that students learn by engagement (Kolb, 2014; Scott, 2006; Webster, 2002b) and my personal experience as a teacher has suggested that students can be engaged by technology.

Each of this study's hypotheses addresses the students and their respective assigned piece of musical technology. The first hypothesis aims to investigate the students' perception of ease of use with their respective technology. This was explored by analyzing and comparing the students' responses on self-report Likert scales they filled out pre- and post- lesson. The second hypothesis aims to investigate which piece of technology has a greater association with a traditional musical instrument (e.g. recorder, piano). This hypothesis was also explored by analyzing and comparing the students' responses to the corresponding self-report Likert scale question that they filled out pre- and post- lesson. The final hypothesis aims to investigate the association of each music technology with the students' retained knowledge of

music theory. This was analyzed by the student's scores on the pre- and post- study baseline test of musical knowledge. The three hypotheses are as follows:

H1: Students in the KAiKU Glove class will find their technology easier to use than students in the iPad class as operationally defined by overall higher ratings in the post-lesson self-report Likert scale statement, "Today, I found the glove easy to use."

H2: Students in the iPad class will have a greater association between their technology and musical instruments (e.g. recorder, piano) than students in the KAiKU Glove class, as operationally defined by overall higher ratings in the post-lesson self-report Likert scale statement, "Today, I viewed the iPad as a musical instrument just like the recorder and piano."

H3: Students in the KAiKU Glove class will develop a better knowledge of music theory than students in the iPad class, as operationally defined by overall test scores on the pre- and post-study baseline test of musical knowledge.

3.3 Setting

The location of the study was Jyväskylän normaalikoulu. Jyväskylän normaalikoulu (normal school) is a primary (elementary) school that provides basic education and collaborates with the University of Jyväskylä to provide teacher training. Jyväskylän normaalikoulu conducts experimental and collaborative research with departments and facilities of the university. Henna Mikkonen, the music teacher at Jyväskylän normaalikoulu, taught the lessons for this study. In an attempt to achieve ecological validity (Chaytor, Schmitter-Edgecombe, & Burr, 2006) by not altering the environment in which the students normally learn, this study took place during their normal music class, and was taught by their normal music teacher.

3.4 Participants

Participants in this study were third grade students who attend Jyväskylän normaalikoulu. Since the University of Jyväskylä partners with Jyväskylän normaalikoulu, no additional paperwork was needed for student consent. The students were aged between 8 and 9 years.

There were two classes of 21 students each, totaling in 42 participants. One class was assigned the iPad (Male=10, Female=11) and the other class was assigned the KAiKU Glove (Male=9, Female=12). All participants were asked to complete a Likert scale before and after each lesson to gage motivation, as well as a pre- and post- study baseline test of basic musical knowledge. The pre-test was conducted before the study began, and the post-test concluded the final lesson of the study. All lessons were taught by Henna Mikkonen, the music teacher at Jyväskylän normaalikoulu.

3.5 Materials

For this study, the technology used included iPads, KAiKU Gloves, headphones, stereo (speakers), projector, an electronic keyboard, and a video camera. Other non-technological materials used include pre- and post- lesson self-report Likert scales and the pre- and post-study baseline test of musical knowledge. The materials used to complete the study are discussed in depth in the sections to follow.

3.5.1 Self-Report Likert Scale

All participants completed a self-report Likert scale prior to the start and at the completion of each lesson. The self-report Likert scales were conducted in the student's native language, Finnish. Questions asked were the same for the iPad class and KAiKU Glove class. Prior to the start of each lesson, the students completed the pre-lesson self-report which contained three questions. Those questions measured excitement, ease of use, and views on the technology's ability to be seen as a traditional instrument. The self-report Likert scale (English translation) can be seen in Appendix A. All student responses were recorded on a five-point scale. It is to be noted that the self-report Likert scale in Appendix A is the one used by the iPad class. The KAiKU Glove's version was identical, except for the replacement of the word "iPad" with "glove".

The post-lesson self-reports contained six questions, measuring excitement, ease of use, the technology's ability to be seen as a traditional instrument, and teacher/student interaction. The post-lesson self-reports were completed at the end of each lesson. The self-report Likert scale (English translation) is included in Appendix B. It is to be noted that the self-report Likert

scale in Appendix B is the one used by the iPad class. The KAiKU Glove's version was identical, except for the replacement of the word "iPad" with "glove". All student responses were recorded on a five-point scale.

In order to validate the reliability of the self-report Likert scale, a reliability analysis was carried out on the data (Fields, 2009; Hall, Hume, & Tazzyman, 2016; Laerhoven, Zaag-Loonen, & Derkx, 2004; Reynolds-Keefer & Johnson, 2011). Cronbach's alpha was chosen as it is a measurement of internal consistency and shows how closely the statements are related using a 0 to 1 scale. The self-report Likert scale was found to be highly reliable (27 items; α = .94). Cronbach's alpha indicates a high level of internal reliability for the self-report Likert scale questions suggesting the statements have a relatively high internal consistency. It should be noted that there is an effect on the reliability since the value of α is dependent on the total number of items (Fields, 2009).

Table 1 highlights the Inter-Item Correlation Matrix scores as reported from Cronbach's alpha between the pre-lesson question, "I think the iPad/glove will be easy to use today" and its corresponding post-lesson question, "Today, I found the iPad/glove easy to use".

TABLE 1. Inter-Item Correlation Matrix scores for questions pertaining to the technologies' ease of use.

	"I think the iPad/glove will be easy to use today."			
		Week 1	Week 3	Week 6
"Today, I found the iPad/glove easy to use."	Week 1	.73		
	Week 3		.80	
	Week 6			.78

Table 2 highlights the Inter-Item Correlation Matrix scores as reported from Cronbach's alpha between the pre-lesson question, "I view the iPad/glove as a musical instrument, just like the recorder and piano" and its corresponding post-lesson question, "Today, I viewed the iPad/glove as a musical instrument, just like the recorder and piano".

TABLE 2. Inter-Item Correlation Matrix scores for questions pertaining to the technological instrument association.

		"I view the iPad/KAiKU Glove as a musical instrument, just like the recorder and piano."		
		Week 1	Week 3	Week 6
"Today, I viewed the iPad/KAiKU Glove as a musical instrument just like the recorder and piano. "	Week 1	.73		
	Week 3		.80	
	Week 6			.78

These two questions were highlighted as they closely corresponded with two of this study's hypotheses. The relatively high and consistent correlation scores throughout weeks one, three, and six for both ease of use and technological instrument association indicate that the questions asked in the pre- and post- lesson self-report Likert scales are reliable.

3.5.2 Baseline Test of Musical Knowledge

Prior to the start of the study, the students took a test to establish a baseline of their musical knowledge. At the completion of the study, students took the same test so that scores could be used to compare what the students knew when the study began and what the students knew when the study was complete. The baseline test of musical knowledge was created by Henna Mikkonen, Jyväskylän normaalikoulu music teacher, and tested musical concepts such as note names, rhythms, aural skills, and pitch identification. Since the baseline test of musical knowledge was created by the classroom teacher, a test was formulated that could accurately measure the students' knowledge in terms of the curriculum. Henna Mikkonen was aware of the students' prior musical knowledge as well as the previous content covered in her music classes. Students completed the test in Finnish. The full test (Finnish translation) can be found in Appendix C.

3.5.3 Technology

The study was completed using two types of music technology; the KAiKU Glove and the iPad. The KAiKU Glove is a new functional prototype of a touch-based musical glove

designed for music education. For this study, four different variations of the KAiKU Glove were used. Each glove used had wires connecting the glove to the glove's control board. The control board was worn around the students' wrist similar to a watch strap and provided the power source for the glove.

The four different types of KAiKU Gloves used include: wired gloves, wireless gloves, full finger gloves, and fingerless gloves. The wired gloves connected to the iPads via Micro USB cord, while the wireless gloves used Bluetooth to connect to the iPads. The full finger KAiKU Gloves covered the entire hand, and the fingerless KAiKU Gloves ended at the first joint (finger tips remain uncovered). The wired gloves were both full finger and fingerless, and the wireless gloves were solely fingerless.

The music class at Jyväskylän normaalikoulu is equipped a class set of iPads that were used for this study. Both KAiKU Gloves and iPads produced sounds using the Apple app Garageband. While the KAiKU Glove was the interface that the students interacted with to create sounds, the glove used Garageband as a facilitator for those sounds. The KAiKU Glove class did not interact with the iPads but used them solely as sound facilitators. All students wore headphones during the lessons.

The music teacher used a projector to display content for the lessons and the stereo (speakers) in the classroom to project audio. She also used an electric piano to assist the students. To assist in further analysis, a standard video camera was positioned in the classroom to record the students during each lesson. The video camera recorded audio and video to MiniDV tapes. During the study, the researchers provided technical assistance.

3.6 Procedure

This study was conducted over eight weeks. Students in each class were assigned a number from 1-21. The students wore their numbers around their necks every week for identification purposes. The first week of the study was an observation of a typical lesson for both classes and the second week consisted of familiarization sessions with the classes using their assigned technology. After the observation week and familiarization week, six weeks of lessons took place. The following subsections will describe the familiarization sessions, the six weekly lessons for the study, and the musical goals for each lesson.

3.6.1 Familiarization Sessions

Each class participated in a familiarization session for their technology. Familiarization sessions took place for the iPad and KAiKU Glove during normal class times a week before the official data collection for the study began. There were two aims for the familiarization sessions. The first aim was to informally introduce the students to the technology they would be using. Students in the glove class had KAiKU Gloves which they were free to explore without instructions or interventions from the teacher. The students were allowed to play with and test out the gloves, and get a handle on how they worked. While the iPad class was already familiar with their technology as there is a music class set of iPads at Jyväskylän normaalikoulu, the students were still given a familiarization session in which they played with the iPads using Garageband. At the end of both technologies' familiarization sessions, the students were instructed to use their technologies to play simple four-bar rhythms on one note, F.

The second aim of the familiarization sessions was to introduce the students to the two new researchers present and observing the class. In an effort to minimize the Hawthorne effect, a video camera was also recording during the familiarization sessions (McCarney, Warner, Iliffe, Van Haselen, Griffin, & Fisher, 2007). The goal was to make the camera feel as "normal" as possible in hopes the students would not change their behavior because of their awareness of being recorded. Since the Jyväskylän normaalikoulu works closely with the University of Jyväskylä, many university students and student teachers practice and observe

at the school. Due to the partnership between university and the comprehensive school, the students are familiar with having strangers observing and recording their classes.

3.6.2 Weekly Lessons

For this study, each class participated in six instructional lessons. The lessons were 45 minutes long, once a week, for six consecutive weeks. Both classes followed the same lesson structure for their respective technology and both technologies covered the same content during every lesson. Each lesson was divided into two sections: solo student practice using headphones for the first half, followed by full class instruction and playing without headphones during the second half. The general structure of each lesson is displayed in Figure 2.

The content taught in week one began with the students incorporating three notes, C-D-E, into four-bar simple melodies (whole note/whole rest, half note/half rest, quarter note/quarter rest, eighth note/eighth rest). Week two saw the students learning about and identifying note names on the staff. During week three, the students rehearsed the melody and harmony of ‘Twinkle Twinkle Little Star.’ The teacher assisted the classes by playing on the electric keyboard. In week four, the students began working on a Finnish Christmas tune (Joulu on Taas). This was the first attempt for the students to sing and perform on their technology at the same time. During week five, the students learned about the ¾ time signature, and incorporated two new notes including low H (B). The students also sang and played their technology in unison. Week six was the final week of instruction, and the students continued rehearsing the Christmas tune while singing and playing.

Lesson Format
Students enter class
Complete pre-lesson self-report Likert scale
Collect technology/headphones
Teacher gives instructions
Individual practice time with headphones
Group instruction and practice without headphones
Return technology/headphones
Complete post-lesson self-report Likert scale

FIGURE 2. Typical structure of the lessons during the study.

3.7 Ethics

While planning and executing this study, ethical research was at the forefront of every decision made (Alderson, 2005; Allmark, 2002; Morrow & Richards, 1996). Jyväskylän normaalikoulu was chosen as a location for this study specifically because of its close working partnership with the University of Jyväskylä, as it is a training school for the university's Faculty of Education. To attend the Jyväskylän normaalikoulu, parents give permission for their children to participate in studies and work with student teachers. All parental consent was obtained by the school prior to the start of this study. The consent granted permission for researchers to video record, photograph, and use data pertaining to the students in the study. Precautions were taken to ensure an ethical study was fulfilled and no ethical issues arose throughout any stages of the study.

All students participating in the study were assigned a number to protect their identity. Students wore the numbers around their necks, and the numbers were used by the students to identify themselves when completing the baseline test of musical knowledge and the pre- and post- lesson self-reports. Wearing numbers provided the students anonymity and also allowed the researchers to identify students in the video recordings. At the conclusion of the study, the video records were properly destroyed.

Only two third grade classes participated in the study, dedicating one of their two weekly music classes for eight consecutive weeks. The other third grade classes at the Jyväskylän

normaalikoulu continued with two music lessons weekly. In order to ensure that the students who participated in the study did not fall behind in the amount of music education they received, the teacher incorporated the technology into the already established curriculum and lesson plans of the grade level. By integrating the technology into the lessons, the students were able to participate in the study without sacrificing the amount of material covered.

It was determined that the devices used in the study posed no likely physical risks to the students. The iPad is an established piece of technology used often in the classroom at the Jyväskylän normaalikoulu, with no incidents of physical harm. Furthermore, the KAiKU Glove has been previously used with human participants of a variety of ages with no incidents of physical harm. All electronical components of the KAiKU Glove are properly concealed within the device and the glove is designed to comfortably fit on the students' hand.

4 RESULTS

Results from the pre- and post- lesson self-report Likert scales and the pre- and post- study baseline tests of musical knowledge are explained below. First, the pre- and post- study self-report responses are presented for the iPad group, followed by the pre- and post- study results for the KAiKU Glove group. The information is presented through analyzing data from weeks one, three, and six. Second, the pre- and post- study baseline test of musical knowledge scores are presented for the iPad class, followed by the KAiKU Glove class. Finally, student growth is analyzed between the iPad class and the KAiKU Glove class using the scores from the baseline test.

4.1 Self-Report Likert Scale

The three-question pre-lesson self-report Likert scale addressed three topics: excitement, ease of use, and technological instrument association. Descriptive statistics for all responses on the pre-lesson self-report Likert scales for the iPad class can be found in Table 3. Descriptive statistics for all responses on the pre-lesson self-report Likert scales for the KAiKU Glove class can be found in Table 4.

The six-question post-lesson self-report Likert scale addressed two topics: ease of use and technological instrument association. Descriptive statistics for all of the responses on the post-lesson self-report Likert scales for the iPad class can be found in Table 5. Descriptive statistics for all of the responses on the post-lesson self-report Likert scales for the KAiKU Glove class can be found in Table 6. Responses to question 1, “Today, I found the iPad/glove easy to use” and question 3, “Today I viewed the iPad/glove as a musical instrument just like the recorder and piano” were analyzed further, as they correlate with two of the hypotheses this study aims to prove. Mann-Whitney U tests were run on the post-lesson self-report questionnaire data for the technologies on the two questions most relevant to the study’s hypotheses.

TABLE 3. Descriptive statistics for answers to pre-lesson self-report Likert scales: iPad.

	Week 1			Week 3			Week 6		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
"I am very excited to use the iPad today."	3.84	4	1.12	3.50	4	1.43	3.76	4	1.25
"I think the iPad will be easy to use today."	3.89	4	0.74	3.70	3.5	1.17	3.65	4	1.22
"I view the iPad as a musical instrument just like the recorder and piano."	2.84	3	1.07	2.80	3	1.28	2.52	2	1.55

TABLE 4. Descriptive statistics for answers to post-lesson self-report Likert scales: iPad.

	Week 1			Week 3			Week 6		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
"Today, I found the iPad easy to use."	4.47	5	0.61	4.25	4	0.72	4.06	4	1.03
"Making music on the iPad today was easy."	4.16	4	0.83	4.05	4	1.00	3.65	4	1.37
"Today I viewed the iPad as a musical instrument just like the recorder and piano."	3.05	3	1.18	3.20	3	1.36	2.53	2	1.42
"I think I could teach my friends to play the iPad."	3.37	3	1.34	3.75	4	1.33	3.06	4	1.52
"Today it was easy for me to follow directions while playing the iPad."	3.89	4	0.74	4.15	4	0.67	3.41	4	1.50
"Today Henna helped me play the iPad."	3.26	4	1.19	3.45	4	1.32	2.76	3	1.52

TABLE 5. Descriptive statistics for answers to pre-lesson self-report Likert scales: KAiKU Glove.

	Week 1			Week 3			Week 6		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
"I am very excited to use the glove today."	4.30	4.5	0.98	3.95	4	0.94	3.70	4	1.17
"I think the glove will be easy to use today."	3.65	4	1.09	3.65	3.5	0.88	3.60	3	1.23
"I view the glove as a musical instrument just like the recorder and piano."	2.80	3	1.06	2.35	2	1.18	2.10	1.5	1.21

TABLE 6. Descriptive Statistics for answers to post-lesson self-report Likert scales: KAiKU Glove.

	Week 1			Week 3			Week 6		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
"Today, I found the glove easy to use."	4.35	5	0.99	4.05	4	1.10	3.75	4	0.97
"Making music on the glove today was easy."	4.30	4.5	0.98	3.80	4	1.01	3.70	4	1.17
"Today I viewed the glove as a musical instrument just like the recorder and piano."	2.90	3	1.21	2.40	2	1.35	2.35	3	1.35
"I think I could teach my friends to play the glove."	2.75	3	1.16	2.80	3	1.32	2.85	3	1.50
"Today it was easy for me to follow directions while playing the glove."	4.30	4	0.92	4.05	4	0.89	4.00	4	1.03
"Today Henna helped me play the glove."	2.95	3	1.50	2.70	3	1.42	3.05	3	1.32

Through the post-lesson self-report Likert scale, students in both classes were asked to report their perception of their assigned technology's ease of use. As the self-report questionnaire yielded ordinal data, non-parametric statistics were used (Fields, 2009). A Mann-Whitney U test found no statistical difference between overall Likert scale scores for the question, "Today, I found the iPad/glove easy to use" for the two classes. Ease of use in the KAiKU Glove class (*Mdn* = 4) did not differ significantly from the iPad class (*Mdn* = 4) in the post-lesson Likert scale, $U = 1527.5$, $z = -0.905$, $p = .365$, $r = -0.08$.

Through the post-lesson self-report Likert scale, students in both classes were asked to report on their perception of their assigned technology's association with a traditional classroom instrument, such as the recorder and piano. As previously mentioned, since the self-report questionnaire yielded ordinal data, non-parametric statistics were used. A Mann-Whitney U test found significant statistical difference between overall Likert scores for the question, "Today, I viewed the iPad/glove as a musical instrument just like the recorder and piano" for the two classes. Musical instrument association in the iPad class (*Mdn* = 3) was significantly more than the KAiKU Glove class (*Mdn* = 3), $U = 1247$, $z = -2.451$, $p = .014$, $r = -0.023$.

The value of the mean ranks indicates that the iPad class had significantly higher levels of instrument association than the KAiKU Glove class. This conclusion is drawn by observing the musical instrument association scores and noting that the average rank is higher in the iPad class (66.23) than in the KAiKU Glove class (51.28) (Fields, 2009).

4.2 Baseline Test of Musical Knowledge

The baseline test of musical knowledge was taken by both the iPad class and the KAiKU Glove class. The test was identical for both classes and it was taken twice by the students: once before the study began and again after the study was complete. It was graded on a numerical scale, with the maximum score being 31. The test was administered and scored by the classroom teacher/experiment facilitator. As the baseline test of musical knowledge yielded ratio data, parametric statistics were used to analyze the data. The following present pre- and post- study results for the iPad, followed by pre- and post- study results for the KAiKU Glove. After the individual results as presented by each technology, there is a section outlining overall student growth as compared between the two technologies.

4.2.1 Results

Descriptive statistics were run to compare the pre- and post- baseline test of musical knowledge scores for the two pieces of music technology and to provide an overview of the students' performances. The mean pre-study score for the iPad class was 9.58 and the mean post-study score for the iPad class was 16.17. As previously mentioned, the maximum score on the baseline test of musical knowledge was 31. Descriptive statistics for the iPad class pre- and post- study can be found in Table 7.

The mean pre-study score for the KAiKU Glove class was 12.52 and the mean post-study score for the KAiKU Glove class was 15.60. Descriptive statistics for the KAiKU Glove class pre- and post- study can be found in Table 8.

TABLE 7. Descriptive statistics for pre- and post- baseline test of musical knowledge scores: iPad.

	Mean	Median	SD
Pre-study	9.58	7.5	5.80
Post-study	16.17	16	7.80

TABLE 8. Descriptive statistics for pre- and post- baseline test of musical knowledge scores: KAiKU Glove.

	Mean	Median	SD
Pre-study	12.52	10	9.30
Post-study	15.60	10.5	9.90

4.2.2 Independent Samples *t*-tests

Since the baseline test of musical knowledge yielded ratio data, parametric statistics were used for analysis. Two independent samples *t*-tests were performed to examine the post study scores and the growth for both the iPad class and the KAiKU Glove class. Independent samples *t*-tests were performed as there were two conditions (iPad class and KAiKU Glove class) and both conditions consisted of different participants (Fields, 2009).

The first independent samples *t*-test was run to compare the students' overall post-study score on the baseline test of musical knowledge. Levene's Test for Equality of Variances showed equal variances not assumed. Since a hypothesis was made about which class would have the highest overall test scores, one-tailed test significance was calculated. On average, students scored higher on the post-study baseline test of musical knowledge in the iPad class (M = 16.17, SE = 1.83) than the KAiKU Glove class (M = 15.60, SE = 2.21). This difference was not significant t (35.391) = 0.197, p = 0.423, and represented a small-size effect r = 0.033. No significant difference was found between the means of the two classes post-study baseline of musical knowledge test score as the $p > .05$.

The second independent samples *t*-test was run to compare the students' growth between the pre- and post-study baseline tests of musical knowledge. Levene's Test for Equality of Variances showed equal variances assumed. Since a hypothesis was made about which class would have the highest overall growth, one-tailed significance was calculated. On average, students' growth was greater in the iPad class (M = 6.29, SE = 0.856) than the KAiKU Glove class (M = 3.00, SE = 1.35). This difference was significant t (35) = 1.983, p = 0.028, and represented a small-size effect r = 0.199. A significant difference was found between iPad student growth and KAiKU Glove class student growth as the $p < .05$.

Two outliers were detected in the KAiKU Glove classes growth. An independent samples *t*-test was run with and without the outliers. It was found that the outliers made too big of a difference in the results, so it was decided to keep the outliers in the dataset. The outliers influenced the significance and they transformed the data from insignificant (p = .055) to significant (p = .00).

5 DISCUSSION

This study aimed to explore two pieces of music technology, the iPad and the KAiKU Glove through educational action research. While many studies have been conducted using the iPad in the classroom (Culén & Gasparini, 2011; Manuguerra & Petocz, 2011), the KAiKU Glove is a new piece of music technology that has not been previously researched in the elementary music classroom. Two classes of third grade students at a local Finnish elementary school were selected to participate in the study. One class was assigned the iPad (N = 21) and one class was assigned the KAiKU Glove (N = 21). The study lasted eight weeks and each class was taught the same curriculum using their assigned technology.

Before the study began, students in both classes completed a baseline test of musical knowledge to determine their current understanding of basic music theory. Questions on the baseline test of musical knowledge were the same for both classes. During the study, the students filled out a five-point self-report Likert scale before and after each of the eight lessons. The self-report Likert scales explored the students' perception of the technologies ease of use and the students' view on the technologies association with a traditional classroom instrument. At the conclusion of the study, students completed the same baseline test of musical knowledge to investigate the knowledge retained as well as knowledge gained.

A discussion of the implementation of action research follows. The results of two questions from the post-lesson self-report questionnaire were analyzed using non-parametric statistics. Two independent samples *t*-tests were run on the students' post-study baseline test of musical knowledge scores. The first *t*-test investigated the students score on the test. Students' overall growth was compared by examining pre- and post- study scores on the baseline test of musical knowledge using another independent sample *t*-test. The results of the statistical analysis will be discussed in more detail in the following sections. An overview of the limitations of the study is also discussed.

5.1 Action Research

Educational action research was the framework used to inspire the development of this study. As previously mentioned, action research is a research method that allows educators and researchers to assess educational practices and student learning. Action research follows a basic pattern of planning, acting, observing, reflecting and repeating (Frost, 2002; Nolen & Vander Putten, 2007). In this study, there was not a problem that needed to be fixed, but rather information that was sought after for the support of incorporating novel music technology in the elementary music classroom.

Bassey's (1998) eight stage model was used in the development and execution of this study. Stage 1, defining the enquiry, was the basis of the study and what helped to form the three hypotheses: that (1) the KAiKU Glove would be easier to use than the iPad, that (2) the iPad would have a greater association with a traditional classroom instrument than the KAiKU Glove, and that (3) the KAiKU Glove would be associated with greater knowledge retention and knowledge growth than the iPad. This study aimed to find support for the incorporation of novel music technology in the elementary music classroom. Stage 2, describing the educational situation, was taken into account when planning the study. Since the study was completed in an elementary music classroom with Finnish as the language of instruction, the classroom training was delivered by a Finnish music teacher. Stage 3, collecting and analyzing evaluative data, and Stage 4, reviewing the data and looking for contradictions, included the students' baseline test of musical knowledge that was taken prior to the start of the study. This test provided data that allowed researchers to compare the two classes' general musical knowledge. Results from this pre-intervention test showed that the iPad class (M = 9.58) had an overall lower mean score than the KAiKU Glove class (M = 12.52), suggesting that the KAiKU Glove class entered the experiment with a slightly better understanding of basic music theory. Stages 1-4 helped to provide information as to what was going on in the classroom, as well as the students' level of basic knowledge about music (Bassey, 1998; Costello, 2003).

In this study, Stage 5, introducing an aspect of change, was the implementation of the KAiKU Gloves in the music classroom. All students were familiar with the iPad as a piece of music technology, but the KAiKU Glove was new to participants. Stage 6 of this educational action

research plan, monitoring the change, was done throughout the entirety of the six-week study by observing, discussions with the classroom teacher, and the pre- and post- lesson self-report questionnaires filled out by the students. Stage 7 was the most time-consuming aspect of the study, as it included analyzing evaluative data concerning the change. This is where the pre- and post- lesson self-report questionnaires, as well as all scores from the pre- and post- study baseline test of musical knowledge were evaluated and analyzed. More information about each is presented below. The final stage of the action research plan involved reviewing the change and deciding what to do next. In this case, the addition of the KAiKU Glove to the music classroom showed support for the inclusion of novel music technology in such an environment (Bassey, 1998; Costello, 2003).

5.2 Self-Report Likert Scale

Within the six-question post-lesson questionnaire, two questions were designed with the aim of investigating Hypothesis 1 and Hypothesis 2. The student responses to the question "Today, I found the iPad/glove easy to use" were analyzed to find supporting evidence for Hypothesis 1, which is as follows: Students in the KAiKU Glove class will find their technology easier to use than students in the iPad class as operationally defined by overall higher ratings in the post-lesson self-report Likert scale statement, "Today, I found the glove easy to use." Although the students filled out the pre- and post-lesson self-report Likert scales for all eight lessons, only data from weeks one, three, and six were analyzed. There was an overall downward trend in mean responses from the students. This could be attributed to the students losing interest and lacking engagement as the experiment progressed.

A Mann-Whitney U test found that there was not a significant difference in perception on the technologies' ease of use between the iPad class and the KAiKU Glove class. Ease of use in the KAiKU Glove class ($Mdn = 4$) did not differ significantly from the iPad class ($Mdn = 4$). Since there was no significant difference between the classes' perception of ease of use, Hypothesis 1 was not proven to be true.

There are many possible explanations as to why the KAiKU Glove was not perceived as easier to use than the iPad. The iPad is a piece of technology that the students are more familiar with. At the Jyväskylän normaalikoulu, there is a music class set of iPads, and each

student in the school is issued their own iPad. While the students are not constantly using Garageband on the iPads, there are many opportunities for the students to work with iPads and become familiar with their operating system. The iPad operating system is also commonly found on other devices the students may be familiar with, such as iPhones, iPods, and Apple computers. The students' familiarity with the iPads and their operating systems may have afforded the students more freedom in troubleshooting their own problems. A study conducted by Culén and Gasparini (2011) using elementary aged students found the students thought the iPad was easy to use, playful, and intuitive. The students who participated in Culén and Gasparini's 2011 study were the same age (8-9 years old) as the students who participated in the current study. The results from the current study are consistent with Culén and Gasparini's (2011) study in arguing that elementary aged students find the iPad easy to use (*Mdn* = 4).

Connectivity issues arose with the KAiKU Glove that the students were unable to fix without adult assistance. Not being able to troubleshoot their own issues could have impacted the students' perception of the ease of use of the technology. Had the students been as familiar with the KAiKU Glove as they were with the iPad, there may have been differences in the students' perception of ease of use.

Student responses to the question "Today, I viewed the iPad/glove as a musical instrument, just like the recorder and piano" were analyzed to find supporting evidence for Hypothesis 2, which is as follows: Students in the iPad class will have a greater association between their technology and musical instruments (e.g. recorder, piano) than students in the KAiKU Glove class, as operationally defined by overall higher ratings in the post-lesson self-report Likert scale statement, "Today, I viewed the iPad as a musical instrument just like the recorder and piano." As previously mentioned, the students filled out the self-report questionnaire before and after each of the eight lessons, but only data from weeks one, three, and six were used for the analysis.

A Mann-Whitney U test found that there was a significant statistical difference (p = .014) between the iPad class and the KAiKU Glove class' in terms of the association of their technology with traditional classroom instruments such as the recorder and piano. The iPad class associated their technology with a traditional classroom instrument more than the

KAiKU Glove class did. This conclusion was drawn by comparing the means of the two classes, with the iPad class (M = 66.23) mean being greater than the KAiKU Glove (M = 51.28) mean. Since there was a significant statistical difference between the two classes in associating their technology with traditional classroom instruments, the results of this study support Hypothesis 2.

The higher association in the iPad class could, again, be due to the students' familiarity with iPads and its operating system. It is highly likely that the students had used an iPad before the study to perform or listen to music. This already existing association with music could have an effect on their perception of the technology as a traditional classroom instrument. The KAiKU Glove was a foreign piece of technology for the students, and even with familiarization sessions, it was novel to them. Had the students entered this study with the same degree of background knowledge on their piece of music technology, the results of the KAiKU Glove's association with a traditional classroom instrument like the recorder or piano may have turned out differently. Similarly, as with ease of use, had the KAiKU Glove not been subject to technical issues as it was, the students may have associated it more with traditional instruments.

5.3 Baseline Test of Musical Knowledge

The baseline test of musical knowledge was taken by both classes. As previously mentioned, the test was the same for all students and was taken pre- and post- study. The scores from the first test served as a baseline of the students' basic music theory knowledge. After the eight lessons, the students took the same test again, where the scores from the second time were used to explore the students' knowledge retention and knowledge growth. Student scores on the pre- and post- baseline test of musical knowledge support one of the hypotheses of the study.

Descriptive statistics were run on the pre- and post- study baseline test of musical knowledge for the two technologies and found that the mean pre-study score for the iPad class (M = 9.58) was lower than the mean pre-study score for the KAiKU Glove class (M = 12.52). Before the study began, Henna Mikkonen, the music teacher at Jyväskylän normaalikoulu, made note that the KAiKU Glove class was chosen based on their musical aptitude. While the two technologies may have been more evenly compared had both classes been randomly selected, this was impossible due to the nature of the experiment. This selection could explain why the KAiKU Glove class scored higher on the pre-study baseline test than the iPad class. Post-study scores on the test were analyzed to find supporting evidence for Hypothesis 3, which is as follows: Students in the KAiKU Glove class will develop a better knowledge of music theory than students in the iPad class, as operationally defined by overall test scores on the pre- and post- baseline test of musical knowledge. An independent samples t-test found that the iPad class (M = 16.17, SE = 1.83) scored higher than the KAiKU Glove class (M = 15.60, SE = 2.21) and that there was no significant difference between the scores of both classes (t (35) = 0.197, p = .43).

While scores might suggest that the KAiKU Glove class performed lower than the iPad class, the baseline test contained one question that was potentially better suited for the iPad class as compared to the KAiKU Glove class. Question 3 on the test included an image of a keyboard, and instructed the students to label the keys with their corresponding note name. The image of the keyboard looked very similar to the keyboard displayed on the iPad. This image could have given the iPad group an advantage when labeling note names, and thus, that question

may have been better suited for the iPad. The image and question may be viewed in the baseline test of knowledge in Appendix C.

A second independent samples *t*-test was run to compare student growth between the pre- and post- study scores. The test found that student growth was greater in the iPad class (M = 6.00, SE = 0.856) than in the KAiKU Glove class (M = 3, SE = 1.35). There was a significant difference between the student growth in the iPad class as compared to the student growth in the KAiKU Glove class (t (35) = 1.983, p = 0.028). As previously mentioned, two outliers were detected in the KAiKU Glove class' growth. One outlier had a pre-study score of 5 and a post-study score of 23. The second outlier had a pre-study score of 12 and a post-study score of 29. It was determined through independent samples *t*-tests that the outliers transformed the data from insignificant to significant, and therefore had too much effect, if removed.

Data from the two independent samples *t*-tests show that the iPad class outperformed the KAiKU Glove class in both post-study scores and overall growth, thus nullifying Hypothesis 3, which is as follows: Students in the KAiKU Glove class will develop a better knowledge of music theory than students in the iPad class, as operationally defined by overall test scores on the pre- and post- baseline test of musical knowledge. The tests run show the iPad class developed a greater knowledge of music theory than KAiKU Glove class as defined by the pre- and post- study baseline test of musical knowledge scores.

Although the data analysis indicated nonsignificant evidence that the iPad was easier to use and significant evidence that it was more associated with traditional musical instruments, knowledge growth, and knowledge retention, the data for the KAiKU Glove also indicated that it was a comparable piece of music technology. The scores on the Likert scales and baseline tests of musical knowledge were not extremely different. Anttila (2010) makes note of the Finnish National Core Curriculum's recommendations that students need to experiment with their own musical ideas by composing, arranging and improvising using instruments, singing, dancing and music technology. The KAiKU Glove and iPad both met those standards by allowing the students to compose music, play different musical instruments, sing and perform in unison while engaging with music technology.

5.4 Limitations

As with all studies, limitations arose. This study was conducted in an elementary school, which resulted in interruptions and challenges outside the researchers' control. Furthermore, the sample size was fairly small, with 42 participants total. The sample size was constricted by the availability of the KAiKU Glove technology; there were only enough gloves accessible at the time of the study to supply one full class. The following is an overview of the limitations that surfaced while researching with the elementary music classes.

Every lesson for both technologies was video recorded with the initial purpose of conducting behavioral analysis of the students at the completion of the study. Behavioral analysis, however, proved to be difficult when observing lessons that were taught in Finnish. Analyzing the dialogue between students and teacher was impossible without a translator. An attempt was made to observe solely behaviors (not vocal interactions), but there are many cultural differences between Finnish classrooms and American classrooms. Actions that were initially viewed as misbehavior, for example, could be of the norm or even welcome within the context of a Finnish class.

Another issue with conducting behavioral analysis was the camera angle of the recordings. Since there was only one video camera available during the study, the placement of the camera was very important. The camera was placed in a position to capture as comprehensive a view of the class as possible, but even with the intentional placement of the camera, only part of the classroom was captured on the video. It was difficult to successfully analyze the students' behaviors, as the students moved around the classroom freely during the lessons. Not all students were in the frame at the same time and very few students were in the frame the entire time or for every lesson. This limitation could have been eradicated by having multiple cameras recording during the lessons. The language barrier also limited understanding of the students' interactions with each other, the technology, and the teacher. Given the cultural, behavioral, and technical issues with conducting behavioral analysis under such circumstances, the information gathered was not strong enough to analyze within this study.

As previously mentioned, the pre- and post- study baseline tests of musical knowledge were taken by both classes. The test was created by the school's music teacher, and the same test was used for both participating classes. There was a question on the test that instructed the students to label the keys on a keyboard with their associated note names. The image used on the test looked very similar to what was displayed on the iPad during the students' interaction with the technology. While the students in both classes used iPads to facilitate the sounds they produced, the students in the KAiKU Glove class only interacted with the glove, meaning that the students in the KAiKU Glove class did not view the screen of the iPad regularly. The students learned to associate note names to sensors while the iPad class learned to associate note names to the on-screen keyboard. Instead of asking both classes to label note names on a keyboard, it would have been more comparable for the KAiKU Glove class to have labeled the note names on a diagram of the glove, labeling each sensor with its corresponding note name. If each class had labelled the notes in accordance with their respective technology, the scores for the KAiKU Glove class may have reflected more growth in this area. The students who used the KAiKU Glove observed piano keyboards during their lessons, however, so the question was not completely irrelevant and is still an indicator of knowledge retained and gained.

The KAiKU Gloves used in the study also produced limitations. The gloves were not all ready to use at the beginning of the study, and there were not enough gloves for every student to use the same one. There were different versions of the gloves used in the study: wireless (Bluetooth connection), wired, fingerless, and full finger. It was impossible to keep track of the type of glove each student used from week to week, so there was a lack of consistency in glove usage among the students. While the placement of the sensors was similar between the different types of gloves, some design differences did exist. Mikkonen, the music teacher/experiment facilitator, and a student in the KAiKU Glove class both noted that the glove was limited by the order in which the notes were assigned to the sensors. The limitation was brought up because the order of the notes on the sensors was not in logical order, like the piano (H. Mikkonen, personal communication, February 13, 2018).

Because the KAiKU Glove is a prototype, some technical issues arose during the study. Connectivity issues occurred when the iPad lost its Bluetooth connection with the glove, resulting in the students needing technical assistance to continue. During the first weeks of the

study, it became apparent that the iPad would lose its connection with the glove any time the iPad went to sleep. At times, there were issues with the batteries not being fully charged before the lessons began, resulting in KAiKU Gloves that ran out of battery before the lesson was complete. Technical limitations and issues proved time consuming during the study, and this lessened the amount of class time spent on actual instruction for the KAiKU Glove group.

Like the KAiKU Glove class, there were also limitations when researching the iPad class. The students were already familiar with the iPad before the study began. The music class has its own set and all students are assigned a personal iPad at the Normaalikoulu. Using the iPad in different situations is very familiar for them. The KAiKU Glove was brand new to the students, so there were questions and uncertainties regarding how to play it that did not exist in the iPad class. Students in the KAiKU Glove class were observed being very gentle with the gloves during the first few weeks, as if the students were afraid they were going to break it. The iPad class was familiar and comfortable with their technology. Thus, their experience with the technology were markedly different.

Another potential limitation with the iPad was the lack of haptic tactile feedback received by the student when performing. Since the student was touching a flat, smooth screen and every part of the screen felt similar, the student needed to look at the screen to be successful. There are no tactile markers on the iPad, so there was nothing on the device for the students to learn or reference. The KAiKU Glove provided the students haptic tactile feedback when performing on the glove. By touching the different sensors on the KAiKU Glove with the opposite hand, the students gained an understanding of where different pitches were located, and began to locate the different pitches based on muscle memory. The tactile markers being present on the glove but not the iPad is a key difference between the two piece of music technology compared in this study.

When compared to the KAiKU Glove, performing on the iPad requires very little body movement to produce a sound. This can produce difficulties in keeping time (steady beat) as an ensemble (class) because body gestures are a crucial part of rhythmic cohesion during a group performance (Williams, 2014). This limitation should serve as a creative teaching moment, as the teacher should always be in search of new ways to share knowledge. A lack of body movement due to the iPad's way of producing sounds could be used as a teaching

moment to educate students on the need for over exaggerated gestures to allow synchronicity in a performance.

As is to be expected, events occurred during the study that were beyond the control of the researchers. For example, students were not always in attendance. When a student was absent, crucial information was lost, as the lessons were built upon compounding knowledge (Bandura, 1986) from one week to the next. Student attendance was uncontrollable. Other issues outside of the researchers' control included class start times and student tardiness. The classes did not arrive to music as a whole, which meant that the students to trickled in as they arrived. The teacher/experiment facilitator was unable to begin instruction promptly on time. This resulted in lost instructional time and repeated instructions as students who arrived late.

The amount of time needed for setup for each lesson was also a limitation in the study. In an attempt to reduce the amount of instructional time lost, the KAiKU Gloves were assembled before the class began. Regardless, the gloves constantly took more time to pass out as compared to the iPads, which resulted in more instructional time lost for the KAiKU Glove class. Since the KAiKU Glove was a new piece of music technology, the students were not able to troubleshoot their own issues. Every question required assistance from the teacher. The iPad class did not have that issue as it was a familiar piece of technology and the students were generally able to troubleshoot their own issues.

6 CONCLUSION

Technology encompasses the world we live in and has embedded itself in all aspects of our lives, including the world of education. Educational technology can supplement student learning and encourage student motivation (Konstantinou, 2016; Williams, 2014). Research has been conducted on the effects of the iPad in the classroom (Dhir et al., 2013; Manuguerra & Petocz, 2011), but this study differed as it investigated the effects of iPads and a comparable piece of new music technology, the KAiKU Glove, in an elementary music classroom. Since the KAiKU Glove is new music technology, this was the first study that introduced the glove in an elementary school setting and compared the glove with a common piece of music technology. The study investigated knowledge retention and knowledge growth, as well as the students' perception of ease of use and the students' association with the glove as a traditional classroom instrument.

By analyzing the data collected, the three hypotheses of the study were investigated. The data revealed that students in the iPad class found their technology easier to use than students in the KAiKU Glove class. While upon initial reaction this may sound discouraging for the KAiKU Glove, the students in the iPad class were already familiar with their technology and its operating system, which may have had an effect on the students' perception. Furthermore, the difference was found to be nonsignificant, suggesting that the technologies are comparable.

It was found that students in the iPad class also associated their technology more with a traditional classroom instrument, like the recorder or piano, than students in the KAiKU Glove class. This result may also be related to the students' familiarity with the iPad as compared to the KAiKU Glove. The students in the iPad class had previously used the iPads to create music, which was not true for the KAiKU Glove class. Finally, while students in the KAiKU Glove class scored higher on the pre-study baseline test of musical knowledge, students in the iPad class had both higher overall scores and greater knowledge growth when scoring the post-study baseline test of musical knowledge. However, it is impossible to separate this result from possible confounds, such as the reality that the iPad class spent less time on technological issues and were able to begin instruction quicker than the KAiKU

Glove class. Furthermore, while data suggests slight difference between classes, they are not astronomical. Had there been dramatic differences between the classes in terms of learning, it might be appropriate to suggest that the KAiKU Glove is incompatible with musical growth in an educational setting. Instead, students were introduced to a prototype technology and experienced growth comparable to that of an established technology.

While the results of this study's hypotheses indicate slightly greater student success with the iPad, further research into the effects of the KAiKU Glove on music education is needed. It is important to note that while the scores were higher in the iPad class, the KAiKU Glove class began the study with no prior knowledge of their technology. The KAiKU Glove students learned how to operate the glove and perform on their technology in the same amount of time it took the iPad class as both classes followed the same curriculum and covered the same amount of material.

As previously mentioned, this experiment was the first time the KAiKU Glove was studied in an elementary school environment. This study was the starting point into investigating the KAiKU Glove in an educational setting. Future studies are needed to assess the KAiKU Glove in different levels and facets of music education. Qualitative data, including video observations, behavioral analysis, and student interviews, could provide valuable information regarding the students' perception of the technology. It is important to remember that student success is not always defined by numbers on a test, and students in both classes were successful at creating and learning music using music technology. Student success in both classes supports utilizing and incorporating novel and existing music technology into the music education classroom.

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List of tables

(BEFORE THE LESSON)

Student Name: _____ Date: _____

Assigned Student Number: _____

1. I am very excited to use the iPad today.

2. I think the iPad will be easy to use today.

3. I view the iPad as a musical instrument just like the recorder and piano.

Appendix A

(AFTER THE LESSON)

Student Name: _____ Date: _____

Assigned Student Number: _____

1. Today, I found the iPad easy to use.	 not at all	 no	 maybe	 yes	 very much
2. Making music on the iPad today was easy.	 not at all	 no	 maybe	 yes	 very much
3. Today I viewed the iPad as a musical instrument just like the recorder and piano.	 not at all	 no	 maybe	 yes	 very much
4. I think I could teach my friends to play the iPad.	 not at all	 no	 maybe	 yes	 very much

Appendix B

(AFTER THE LESSON)

Student Name: _____ Date: _____

Assigned Student Number: _____

5. Today it was easy for me to follow directions while playing the iPad.

6. Today Henna helped me play the iPad.

Appendix C

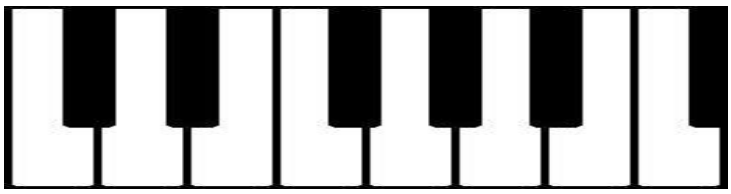
Nimi: _____ Luokka: _____

Numero: _____

1. **Minkä rytmin ope lukee?** (ympyröi) A B C D ___/1

2. **Missä järjestyksessä ope soittaa melodiat?** A B C D ___/4
   (laita numero kirjaimen alle) ___ ___ ___ ___

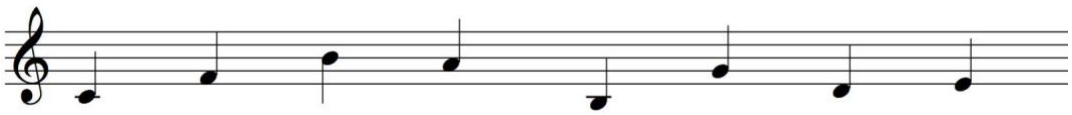
3. **Nimeä pianokoskettimet** (jos tiedät myös mustien koskettimien nimet, voit kirjoittaa ne niiden yläpuolelle).



___/8

(+)

4. **Tunnista nuotit.**



— — — — — — — —

___/8

5. **Tunnista musiikilliset symbolit nuottiesimerkistä** (laita numero selityksen eteen).

___ kertausmerkki

___ kokonuotti (taa-aa-aa-aa)

___ puolinuotti (taa-aa)

___ neljäsosanuotti (taa)

___ kaksi kahdeksasosanuottia (ti-ti)

___ kokotauko

___ puolitauko

___ neljäsosatauko

___ nuottiavain (g-avain)

___ tahtiosoitus

___/10

Testi oli minusta (ympyröi)