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Interactive Music Systems

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INTERACTIVE MUSIC SYSTEMS

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Submitted to:
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Abstract

Children with special needs often find difficulty learning due to their disabilities. Music therapy is an alternate method of learning music composition that benefits those with special needs. This project developed a music technology application that addressed needs related to facilitating musicianship with special needs populations. The application was implemented in a public school classroom where professional educators surveyed its viability as an instructional tool. The data received from the survey suggest that this survey suggest that the application would be a viable instructional resource.

Acknowledgements

We would like to thank our advisor, V. J. Manzo, for all of his help and guidance throughout the project. We would have been completely lost without him and would not have the same product we have today. We will miss our weekly meetings and will always remember Manzo's secrets to success in life. Rock on!

We would also like to thank Zach Poff and Bob Godbout for the inspiration and help needed to achieve all of our goals. You all made this project possible!

Thank you!

Authorship

This report was written by Zachary Chupka, Kyle Burns, and Danielle LaRose. All chapters were done in collaboration and are the responsibility of the group.

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Executive Summary

Children with special needs have a limited range of opportunities. Whether their disabilities are physical or mental, they may be unable to participate in the same activities as other children. Because of this, they are often provided with alternate methods of learning. This project proposes a solution to this issue as it applies to music education and special needs children. Music therapy is a method of improving cognitive skills through music-based activities. This form of learning music is less intensive than traditional learning because it is intuitive and it applies musical concepts at a more basic level. For these reasons, children with special needs may take music therapy as a means of relieving stress and uncovering musical potential.

An educational application was developed that informally teaches students music composition. It incorporates the art of composition into a unique motion tracking game that is simple to use and enjoyable for the user. The initial target audience was special needs elementary school students, especially those with Autism Spectrum Disorder, or ASD. Research has shown that children diagnosed with ASD tend to excel in the field of music. The project was also designed to improve their dexterity and coordination skills.

A programming language called Max offered the best opportunity for implementing a motion tracking system. Existing applications in Max that successfully implemented motion tracking were researched and analyzed. An application called Video Trigger, by Zach Poff, is an open source program with a functioning motion tracking system that allows the user to trigger six different zones that play sound clips when activated. It requires a webcam, which is integrated into many modern computers. The Video Trigger was modified such that the user is introduced to an interface that features augmented reality. When the program is launched, a drum loop starts to play. They see themself overlaid on a scene with five interactive objects surrounding them. The

user may interact with these objects by waving a body part over them, which activates an audio loop. Together, all five of the loops and the drums make up a well composed song. The loops may be activated in any combination to form a unique composition. The purpose of having each object control different instruments was to teach the students how a song is composed and how each instrument works together to make up a song.

Five scenes were included in the application, each one based on a different theme. These included outer space, a jungle, the Wild West, an ocean, and a cave. Each of these scenes was to incorporate three separate musical tracks that would loop; however, only one scene was implemented, which included one musical track. Physical constraints had to be considered when determining how the application would be used. The user would be interacting with their full body, so they would require several feet of space around them. Projection screens would allow the user to clearly see themself while standing a fair distance away from the screen. Since the application is intended for use in a classroom environment, this seemed to be a reasonable requirement.

Upon completion of the prototype of the application, it was brought to an elementary school for experimentation. The staff and students at the school used the application for approximately three weeks. Two staff members completed a survey regarding many aspects of the project such as visual and audio appeal, usability, and whether the application was enjoyable. Afterwards, an interview was conducted with one of the staff members. This interview discussed how the students interacted with the program and whether they found it educational.

During the testing phase, the application was given to the school's music teacher to use in his music classes as he saw fit. His classes consisted of fourth and fifth grade students including some with special needs. The overall reaction to the product was positive. The school's staff members enjoyed the game and watching the students interact with it. They thought that the

application would be great for elementary students. Since there has been more effort to incorporate technology into special needs programs, they also believed that the program would work especially well with special needs students.

Our data suggested that the students that did use the application thoroughly enjoyed it and did not want to stop playing with it. They simply loved getting up and playing the game. However, they did have a few suggestions for further improvement. The children suggested that the different musical parts be reflected in the size of each object. For example, the smaller objects should be associated with the higher, soprano parts of the music, while the larger objects should be associated with the lower, bass parts of the music.

Overall, students enjoyed the application and found it easy to use, and teachers found it to be a viable educational resource. Although we have created a final version of the application, there is still much more than can done for it to be considered a finished product. The remaining scenes and main menu screen have to be integrated into the prototype. The opacity for each of the scenes also needs to be adjusted so that the individual using the application can be seen clearer. In addition, the tutorial video for using the application has to be made. The remaining sounds for each of the scenes also need to be created and incorporated into the final product. Furthermore, the application could be tested for its use as a therapeutic tool. The prototype is very open-ended and has potential to expand and be developed for different fields.

Chapter 1: Introduction

The greatest composers intuitively produce complex musical masterpieces. People often listen to music and ignore the structure of what they are listening to. When broken down into separate parts, there is the simple beat of the drum, the rhythm and the lead guitar, and perhaps the synthesizer or main melody. An artist has the ability to piece all the musical fragments together to create complex, yet aesthetically pleasing, arrangements. For the average person, music composition tends to be arduous, time consuming, and generally stressful. Music therapy addresses this challenging task in a way that aids patients in fine-tuning cognitive skills. Music therapy is very useful at an early age, especially for children with conditions such as Autism Spectrum Disorder, or ASD. Children with ASD have impaired cognitive skills and physical coordination that can be enhanced by participating in music therapy activities. This project creates software that provides a fun and interactive way for children with ASD to piece together musical looping patterns to create euphonious compositions. It features augmented reality where the user will be standing in a particular environmental scene containing objects with which they can interact. Objects may be "touched" to trigger different looping patterns which can be overlaid to create different beats and melodies. While the software is designed to teach children with ASD how to compose music, it is also meant to aid in self-expression, sensory and motor skills, and even in relaxation and stress alleviation. The interface will be tested by children with ASD to further conclude that it functions as intended.

Chapter 2: Background

2.1 The Problem

Children with special needs are limited in the musical world and may not be provided the same opportunities as other children. Due to their limited range of opportunities, these students with disabilities may have musical interests that they are unable to discover or expand upon. It may be difficult for them to learn music theory and to play musical instruments. Research has shown that students with disabilities have trouble with logical processing and dexterity which can prevent them from delving into the musical field (What Is Autism?, 2013).

2.2 Autism Spectrum Disorder

Autism Spectrum Disorder, or ASD, is a condition that inhibits brain development of those affected. Specifically, it may cause impairment in communication skills and motor coordination as well as attention and physical health issues. ASD is caused by abnormalities in the structures of the corpus callosum, the amygdala, and the cerebellum (What Is Autism?, 2013). The corpus callosum expedites communication between the two hemispheres of the brain, the amygdala is responsible for emotion and social behavior, and the cerebellum affects coordination and motor skills.

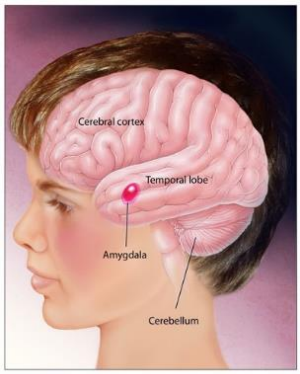

Figure 2.1 Areas of the brain affected by ASD.

For years, scientists have been researching the causes of autism in infants. Although there is no single cause of the condition, gene mutations and environmental factors may influence brain development, potentially leading to a case of autism. Certain factors such as illness during pregnancy and periods of oxygen deprivation to a baby's brain may increase the risk of autism at birth (What Is Autism?, 2013). Research suggests that women who maintain a diet consisting of folic acid can decrease the likelihood of having a child with autism.

Genetics also play a role in determining the probability of a child being born with autism. Researchers have noticed that if a couple has multiple children with autism, they are likely to have a combination of many genes that increase the chance of the condition (Autism and genetics, 2013). They have also found that ten percent of autistic children had additional or missing DNA when compared to their parents. Scientists have discovered twenty different chromosomes that may affect autism, so finding individual genes that are responsible has proven to be very difficult (Autism and genetics, 2013).

Autism is usually diagnosed in children at a very early age based on symptoms such as lack of speech and failure to display signs of communication. More obvious symptoms may emerge between two and three years of age when most children begin to communicate more coherently. In the case of severe autism, a child may not learn to communicate verbally at all (Learn the Signs of Autism, 2013). One in 88 children born in the United States is diagnosed with some form of autism, including one in 54 males (What Is Autism?, 2013). It is important for autism to be diagnosed as early as possible so that the parent of the child can take appropriate action, such as offering different styles of learning and seeking proper treatment methods.

2.3 Music Therapy

Children with autism often excel in music, art, or other visual fields (What Is Autism?, 2013). They show equal and in some cases more advanced processing in techniques such as pitch interpretation, show greater emotion in different genres of music, and have a broader musical preference than children without disabilities (What is Music Therapy, 2013). Many schools offer programs to students that open them up to the world of music, but unfortunately, music programs around the country are being cut from the curriculum. Therefore, people may turn to music therapy as a way to benefit those with autism. Music therapy is a method of facilitating cognitive functionality through musical intervention (What is Music Therapy, 2013). It is often introduced to children as young as six years old. Music therapy can aid children in enhancing speech and language skills since music is processed in both hemispheres of the brain. Music is a great tool for development because it promotes self-expression, learning, and relaxation. Depending on a child's behavior, music therapists identify objectives for the child and devise a music-oriented plan to achieve these objectives.

Music therapy can be performed through various methods, including listening to music, composing songs, and discussing lyrics (Music Therapy, 2013). Sessions may include an individual with a therapist or a group of patients with common objectives. Music therapy also relieves physical symptoms, such as high blood pressure, rapid heartbeat, and fast breathing rate, mainly due to the effects on stress hormones in patients (Music Therapy, 2013). When a patient listens to music, the brain releases dopamine, a chemical associated with pleasure (Landau, 2013). Since music therapy is usually performed in a non-verbal manner, it is especially useful for patients with autism as it can help them focus on their strengths.

One form of therapy involves composition of music by the patient. While listening to music is often effective in relieving stress in patients with autism, composing may invoke a greater sense of accomplishment. Having the ability to create music provides children with the opportunity to experiment with different types of music and enhance their creativity in the process. Composition often contributes the most entertainment because it allows them to discover different styles of music and to focus on the styles that they enjoy most.

One goal was to incorporate a therapeutic feel to the project. It should allow the user to express their musical talents and give them a sense of accomplishment. It was important that the project alleviate stress and help children with autism remain calm. In order to get a better idea of how to integrate functionalities that achieve these goals, research was done about applications that exist today.

2.4 Existing Software

Several resources were inquired that addressed the problem at hand. These resources and projects were further modified and incorporated into this project. Existing projects were previously designed to help solve this problem, including EAMIR and Groovy Jungle that gave children with special needs a chance to succeed in learning musical techniques and theory. These applications are intended to educate the user in an informal manner while keeping them entertained and interested in the subject.

2.4.1 EAMIR

Electro-Acoustic Musically Interactive Room, or EAMIR, is a music technology project by Vincent J. Manzo that specializes in facilitating music composition and performance through

the use of sensors, controllers, and instruments (EAMIR, n.d.). This project is designed to expand the creation of music to populations such as people with physical disabilities, children with special needs, and people who are less inclined to experience music for themselves. Components of the project appeal to musicians of any skill level, as well as those who enjoy listening to and experimenting with music.

EAMIR was created in a programming language called Max/MSP using existing and custom objects created by V. J. Manzo. Manzo wanted to give students with different musical backgrounds an opportunity to advance in the field of music without leaving students who lack a background behind or keeping the more trained students from progressing in their studies. It had to apply to different types of students which included children with physical or mental disabilities. EAMIR is a library of applications that functions in many different ways. A popular concept that EAMIR demonstrates is motion and color tracking. The user stands in front of a camera, and the application will track specific colors or even the user themselves to manipulate sound. This allows the user to learn chord progressions and scales while having fun at the same time. The student may not realize it, but while they think they are just changing pitches and chords, EAMIR is training their ear how to create and interpret the different musical combinations that created musical compositions that exist in the world today.

EAMIR condenses technology that is used in expensive and space consuming hardware, like mixing boards and controls, into a small application that requires little to no equipment. The user may use external hardware if they please, such as an application where the user connects a Guitar Hero guitar into the computer. Sounds are mapped to four of the buttons on the guitar, and depending on which direction the user strums (up or down on the strum bar) a different chord will play. Manzo wrote a new notation called EAMIR-O, seen in figure 2.2 that helps the user play

specific chords at precise times. This may seem like a game to the user, but it teaches them the building blocks that compose famous songs like “Ode to Joy,” by Beethoven.

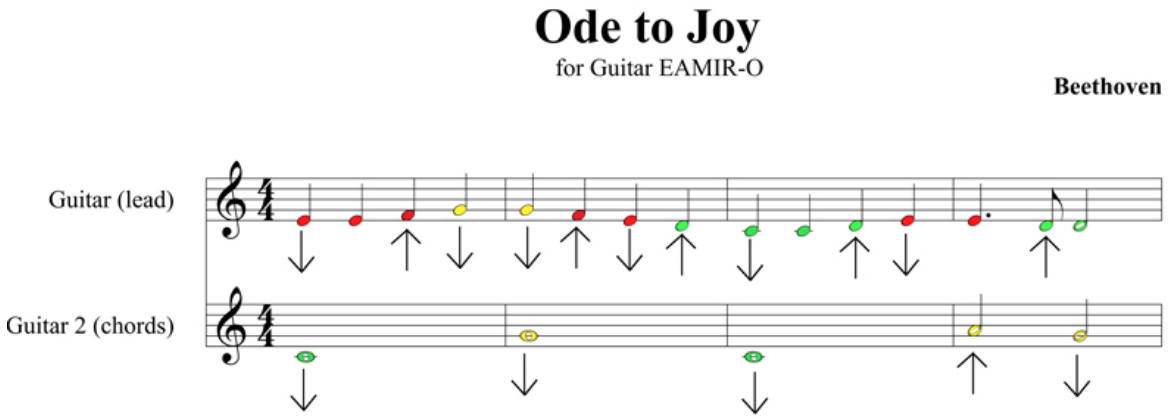

Figure 2.2 Guitar EAMIR-O notation with colored note heads and flipper position markings.

2.4.2 Max/MSP/Jitter

Max is an expansive media-based piece of software developed by Cycling-74 that allows users to design sounds, visuals, and interactive programs. Each object represents a small program, some of which modify audio inputs, while others act as switches to determine the activity of a certain component. In Max, the user takes control of objects which are used to create sounds, visuals, and interactive media. Objects are connected on a canvas, creating interactive programs that span a wide range of possibilities. Many developers for Max have designed software that assists in composing and editing music and sound effects. Some programs use a webcam to integrate a video feed that allows users to physically interact with on-screen visuals to create and adjust audio components (Max, n.d.).

Max programs, or patches, can be created without intensive code. Objects can be dragged onto the canvas from existing libraries to create unique patches that achieve the programmer’s

goal. The patches do not have to be musical and can vary in functionality. Max is an open source software that can be manipulated by any programmer. Object libraries may be created by individual programmers and redistributed to the rest of the Max community (Max, n.d.).

MSP is a feature in Max that adds real time audio synthesis on digital signal processing. It is used for modeling wave forms and can convert digital to analog and vice versa. Jitter is an extension in Max that provides the video support previously mentioned and allows for the creation and manipulation of matrix data (Grover, n.d.). Max became an integral part for completing this project. The user interface and application functionalities were all developed using Max.

2.4.3 Groovy Jungle

Groovy Jungle is a game developed by Sibelius that teaches children music theory and composition. This game involves a character dressed in a safari costume who explores various jungle environments. The user drags animals on the screen and places them anywhere in the scene, whether it is on the ground or in the sky. After the animals are placed, the user can use arrow keys to direct the safari explorer to the right or left along a single path. As they pass each animal, a short sound clip is played. A subtle drum beat is constantly playing in the background, and each sound can be lined up in the scene so they synchronize with the beat (Sibelius Groovy Jungle, 2013). Each animal plays a clip that is in the same key so they blend well together. It is a very simple concept, but it provides the user with a fun way to practice basic composition and grouping of instruments. This game is designed to integrate music composition in an enjoyable and effective manner.

2.5 Possible Approaches

A goal for this project was to create an application that was unique to existing ones. It was unanimously agreed that any sound implemented into the application was to be originally composed by the members in the group. This gave the application a unique personality that had not been used anywhere else. The application had to be extremely interactive, and motion tracking had the most potential for offering a hands-on experience. In order to create a functional motion tracking program, the users would have to be able to see themselves on the screen using some form of computer webcam. A creative scene needed to be displayed behind the user to prevent them from losing interest in the application.

2.5.1 Ableton Live

Ableton Live is an audio program that is used for recording, editing, and composing music and sound effects (What is Live?, n.d.). Ableton Live can simulate instrumental sounds through kits that are defined by the user. It includes tools such as samplers, triggers, and sequencers that modify the pitch, timing, and other attributes of each rhythm and beat. Many music projects utilize Ableton Live to customize audio samples to suit their requirements. Projects may also make use of the recording devices to create original sounds and modify them as necessary. In this project, Ableton Live was used to create the unique soundtracks for each scene. It played an essential part in giving the application a unique personality which helped achieve the overall goal of teaching music composition.

2.5.2 Kinect

Kinect is a peripheral developed by Microsoft that is designed to allow hands-free control of software, particularly in video games. The Kinect is a base mounted camera that is used for the Xbox 360 and Xbox One for tracking players' movements for various video games. It connects to the Xbox via a Universal Serial Bus, or USB, which could also be plugged into the computer. It uses an infrared camera to track a person's movement in three dimensions, enabling gesture and facial recognition. It also includes a multi-array microphone that provides voice recognition and acoustic source localization. Kinect's motion capture features enable users to interact with software through physical movement rather than through the operation of a standard controller (Kinect for Xbox 360, 2013). This often creates a more immersive experience for the user as it allows full control over the software. Kinect could be integrated into Max for motion tracking and detection purposes. Free software is available on the Cycling 74 website to pair with the Kinect sensor which can be used to track human gestures and actions.

2.5.3 Augmented Reality

Augmented reality is the concept of manipulating a person's perception by introducing computer-generated objects. This virtual effect allows users to interact with a simulated environment and view information that is generated through particular actions. Augmented reality has been implemented in games and for informational purposes. Products such as Google Glass utilize augmented reality to inform users of their surroundings, while many games will use it to create virtual objects that players can interact with (Google Glass, n.d.). Augmented reality has been introduced to develop a more immersive sensation when using these products.

2.5.4 Zach Poff's Video Trigger Program

A programmer named Zach Poff developed a motion tracking program in Max that plays sound files when a user activates a detection zone. It is a free program available on his website, www.zachpoff.com, and emphasizes the experimentation of musical interactivity without having to construct custom hardware or software (Poff, 2013). When the program opens, it will take a snapshot of the environment that the user is standing in. This image is used for detecting when the user comes in contact with a motion tracking zone. The video trigger allows them to draw up to 6 rectangular zones in a window that shows live video feed using a video capturing device. The user can see the zones in the video feed and may activate them by waving a body part over it. If the video trigger detects a difference in a zone between the snapshot taken and the live feed, then it will activate. When it is triggered, a sound clip of the user's choosing will begin to play.

Contact was made with Zach through email asking if modifications were allowed to be made to the source code. The Video Trigger came with licensing information describing what could be done to the program. Any modifications can be made to the program, as long as it is released under the same license and the source code must be made available to end-users for free. This program became the basis for the new application. Extreme modifications were made to suit the needs for the project.

Chapter 3: Methodology

3.1 Introduction

The objective for this project was to create an interactive music system that allowed children with special needs to informally learn about music composition in a relaxing and enjoyable way. The viability of the methodological approach was tested by survey and interview with individuals who had the musical and teaching knowledge required.

There were a number of possible resources that could have been used to achieve this goal. Some that were experimented worked better than others, but further research for the scope of the project had to be done before deciding which to use. For this project, most of the research was done using online resources. Simple online searches were made to obtain websites with appropriate information. While processing the documents, many had repetitive information. Once all the documents were reviewed, the list of sources was decreased but suitable.

3.2 Target Audience and Goals

At this point, a possible goal was to give students means to learn music theory on their own without the help from a school music program. Deciding the target audience was important for narrowing down the objectives and purpose of the project. Originally, the intended audience for this project was teenagers. There are fewer music teaching programs available that target teenagers than there are directed toward younger children. However, children generally have an easier time understanding the concepts of music during their developmental years (PIAGET'S MODEL, n.d.). This led to the decision to include children, ages five to ten, as the target audience for the project.

A child's brain is in the concrete operations stage from ages six to twelve. At this time in their development, they begin to grasp abstract concepts such as music (Guberti, 2012).

Elementary school is a good time to introduce music to students. However, some children with disabilities may not be able to understand these concepts as easily. To give them an equal opportunity for learning music theory, it was decided that the application would be designed for children with disabilities.

Once research was done on the different types of developmental disorders, it became a unanimous decision that the target audience would include children with ASD, since they tend to excel in the field of music (What is Music Therapy, 2013). It is believed that children with ASD have difficulties with the concepts of music theory, but research has shown that their abilities often exceed those whose mental development is not impaired. Additional research was done to identify projects that have been developed and released for public use that focus on teaching children the form of music composition and theory.

3.3 Existing Applications

In order to advance the project to the developmental stage, it was necessary to research existing applications to identify both beneficial and impractical concepts which would help achieve the goal of the project. While researching, there were several sample projects found that each contained parts of the prospective application envisioned. However, it was difficult to find projects that encompassed a majority of the application. When an application was found, much of the source code was difficult to decipher correctly.

A project named EAMIR, by V. J. Manzo, began to attract attention. This project contained several different applications designed to help teach music theory to children with and without developmental disorders using a variety of different approaches. An interesting concept used in many of the applications in EAMIR is motion tracking through a webcam. It is common to see

webcams integrated into computers, so users do not have to purchase external hardware to use the programs found in the EAMIR library. One of Manzo's biggest achievements is that his product is available to a large audience. Anyone with a computer and a webcam can use a variety of the applications offered in EAMIR. Manzo was able to incorporate concepts into EAMIR that keep the user interested and always wanting more. Motion tracking showed the most potential for interactivity between the user and the application.

Manzo was able to use Max to implement the motion tracking system. The code was very straightforward and concepts found in the EAMIR library were to be redesigned to suit the needs for this Interactive Qualifying Project. The examination of the functionality and success of the EAMIR project led to the conclusion that this project would be developed in Max.

Many concepts from Groovy Jungle were implemented into the final application. It offers the user a child friendly user interface that keeps them drawn to the game. The interface is very simple and is easy to navigate. The use of vibrant colors and creative objects make the game interesting and fun to interact with. These aspects are extremely important because it is the first part of the game the user sees. If they are introduced to a complex interface or a dull environment, it is likely that a bad first impression would be instilled in their mind. Groovy Jungle showed that the first impression is essential for getting the user interested and engaged in the application.

Groovy Jungle offers unique gameplay that allows the user to be individualistic. They can customize their own song by being able to put any object anywhere on the screen. The user has a variety of options for creating their own song. However, it may be difficult for them to time when the sound is activated because the safari character moves slowly across the path. Concepts adopted from Groovy Jungle included the simple user interface, using vibrant environmental scenes to attract attention, and using dynamic objects to play sound clips.

3.4 Platforms

The application could be designed for a few different platforms. Options included creating an application for mobile devices such as iPads and Tablets, or developing an application or game for a desktop computer or laptop. The scope of the project and its limitations had to be considered before deciding which device would run the application. Previous research and decisions made in existing applications emphasized that mobile devices were not ideal. The user must be able to see themselves on the screen. Mobile devices would not project a large enough image for the user to see themselves causing interaction with the interface and the various objects in each scene to be difficult. Another issue with using a mobile device is that they are less common in a school environment. Desktop computers are found more often in the classroom and are more accessible for students to use. Therefore, desktop and laptop computers were chosen to run the final product. Although laptops and desktop computers also have small displays, they can easily be connected to projection screens or smartboards. This provided the user with a large visual display in which the virtual environment and objects would be clearly visible.

3.5 Motion Tracking

The concept of motion tracking was a favorable feature that was included in the project. Motion tracking requires the user to stand in front of a recording device and allows the user to use their body as a controller for applications. The children with ASD would not need to become acclimated with a physical controller, which could cause stress and would defeat the purpose of the application. They would be able to freely interact with the music system and not have to worry about the coordination skills to press and memorize where buttons are on a controller. Motion tracking does propose one concerning restriction. The user will need to have a significant amount

of room to use the application. After thinking about the environment for which it is designed, space limitations should not be an issue. As stated previously, this program is designed to give students a way to learn musical concepts without an established school music program. Generally, classrooms contain a large amount of space where this application can be used.

3.5.1 Kinect

The first device that was considered for detecting motion was the Microsoft Kinect. The Kinect showed potential for being able to track accurate and precise movement as it offered a useful way to incorporate a camera system while being able to track the user's motions. It also has the ability to use voice recognition, which became a possible feature to add in the project. The main downfall to using the Kinect was that it could limit the amount of people who could use the application. The Kinect is expensive and some computers may not be compatible with the device. It would have also been difficult to translate the data captured by the Kinect into information that a programming language could use and interpret. It became apparent that alternative methods of tracking motion needed to be researched. It was agreed that a simple laptop webcam or external recording device would work better than Kinect. Most laptops come integrated with a camera and, in the case where they do not have one, cheap external webcams can be purchased. This means that users would usually not have to purchase any external and essential hardware to operate the software.

3.5.2 Motion Tracking in Max

Max offers many options for designing a motion tracking system. EAMIR uses a color tracking model where a specific color is detected as it moves around the screen. The color can be

chosen prior to the operation of the application by holding the object up to the camera and clicking on it in the video feed window. The color is tracked within a slider and the pitch and volume changes based on the vertical and horizontal location of the color. Color tracking may be more accurate in the sense that only a certain shade will be detected. It allows other people to move in the background without interrupting the detection system. However, this does require users to have an object with a distinct and noticeable color such as a laser pointer.

Zach Poff's video trigger program allows the user to operate the system with their body without requiring any external hardware. This method lets the user become more interactive with the application because it allows for direct manipulation with the objects on the screen. However, this method is flawed because any other moving objects detected in the video feed could interfere with the actions made by the primary user.

The next step was to decide what the application would actually do and how the user would interact with it. The project could be a game, a tutorial, or a mixture of the two. It had to be entertaining and educational at the same time so that the user would want to use the software frequently.

A checklist was created for the desired features of the application. The list became guidelines for the implementation of the final product. It had to involve a simple user interface that required little time to become accustomed with. The interface had to be vibrant to keep users drawn to the screen. Augmented reality would let the users see themselves in a creative environmental scene designed by the group members. The sounds had to be original and pleasing to the ear. A subtle drum beat would constantly play in the background and the user could activate objects that were synchronized to the beat. The user had to be able to activate the objects using motion tracking

to allow for maximum interactivity with the program. All of these requirements had to mesh together to make a simple application that allowed for a low learning curve.

3.6 Scenes

Originally, a level-based game was considered for the application. However, it was ultimately decided upon to make separate scenes that the user could play freely. There had to be enough scenes where the user would stay interested but not be overwhelmed by the number of scene choices. It was decided that five scenes would suffice. Further testing through a survey, which will be explained later in this paper, would be administered to determine if the interface was favored by the user, if the sounds blended well together, if the concept was successful and popular with the target audience, etc.

The next step was to design a simple storyboard, or prototype, of what each scene should look like. It was mentioned above that the user would be able to stand in five different scenes. It was decided that the scenes would expand off of the jungle idea in Groovy Jungle, so the application will include scenes from space, the jungle, a cave, the ocean, and the wild west. These were simple sketches on paper to be used as guidelines for digitization. A main menu scene was also designed so that the user could choose which scene they wished to enter. On the main menu screen, there were options to enter any of the five scenes as well as an option to watch a tutorial video. However, the main menu and tutorial video were not implemented for this product prototype.

When digitization began, there were multiple options regarding which programs would be used to make the scenes. Microsoft Paint was the initial contender. However, after beginning to digitize some of the scenes, Paint was too simplistic for this project. Through further research,

Adobe Illustrator was chosen. It had significantly more options and allowed for a more aesthetically pleasing scene. Although there was a steep learning curve, the overall products brought immediate satisfaction.

3.7 Music Composition

Creating music to play during each scene was a key component of the project because its intent was to develop a sense of enjoyment in the user. Keeping this in mind, the music must sound appealing and could not be created without putting much thought into the synergy of the instruments involved. Since the user is able to choose from five different scenes, making each song unique was important for avoiding redundancy. This encouraged the use of different instrument combinations in each song, which allowed several tracks to be created with no two songs sounding alike. If each song were to use the same instruments with different melodies, the user may find them to be repetitive, which would have a negative impact on their opinion of the application. Ensuring uniqueness in each song gave the user a reason to experience each scene rather than only trying one of them.

When composing the songs for each scene, the drum beat was created first to set the metronome for the five remaining instruments. Since the drum beat was enabled by default, it was important for it to be fairly simple such that it would not overwhelm the other instruments, but it must also play a significant part of the overall song. Once the drum beat was completed, the other instruments were chosen based on the scene for which the song was being developed. For example, an outer space-themed scene would include futuristic sounds and high-pitched music.

The main challenge when creating music was ensuring that several instruments could play simultaneously without the songs sounding cluttered. If too many different rhythms were playing,

it may become difficult to distinguish between the various instruments. It was important to remember that the player had the option of activating any combination of instruments. This meant that each individual instrument needed to sound as appealing as every possible combination of instruments in each song. Balancing the volume and velocity of each instrument was the main step in allowing each instrument to remain audible even while several other instruments were playing.

Some instruments, such as guitar and bells, stand out because they are louder and therefore easier to hear among other instruments. On the contrary, instruments such as bass may be overtaken rather easily when played simultaneously with other instruments. This issue was usually able to be solved by adjusting the volume of each instrument, but this could sometimes cause the music to sound unnatural. Alternating rhythms were used which allowed all components of the music to be audible while maintaining appealing sounds. Ableton Live was used to compose the different instrumental tracks for each scene, with each instrument corresponding to an object that the player "touches."

3.8 Creating the Product

The video trigger program became the main structure for the application. In its current state, the user can draw zones in the video feed window and import a sound clip of their choosing. There are different options for when a zone is triggered. For example, the user can change a setting so the sound clip will start playing when a zone is entered. As soon as they exit the zone, the sound will stop and rewind to the beginning. There are also settings for saving the position in the sound clip when a zone is exited and an option to loop the sound when it reaches the end. The interface is complex and a child may have trouble figuring out what every option does.

Modifications had to be made so the video trigger program was child friendly. To start, the video feed window had to be much larger and the resolution increased to project a clear image of the user's environment. An important functionality that had to be implemented into the application was that the users could easily see themselves manipulating objects on the screen. Various objects were overlaid on top of the detection areas. The zone triggering was changed such that when the user comes in contact with an object, the zone would activate and start playing the sound clip. It would stay on even if the user exited the zone. To turn it off, they must touch the object again. When the objects are turned off, they are grayed out to let the user know they are deactivated. An original drum beat turns on when the program is opened. By default, the application was designed so that all of the objects are off when the program is loaded. The object sounds are always playing so they are synchronized with the drums, but the volume is adjusted to zero. Essentially, the user turns the volume to a set number when they activate an object. The user may also trigger objects by using keys one through five on the keyboard. The motion tracking technique that the original video trigger program had was left in the final product. The memorize button and snapshot image were moved to a different location where the user could change multiple settings.

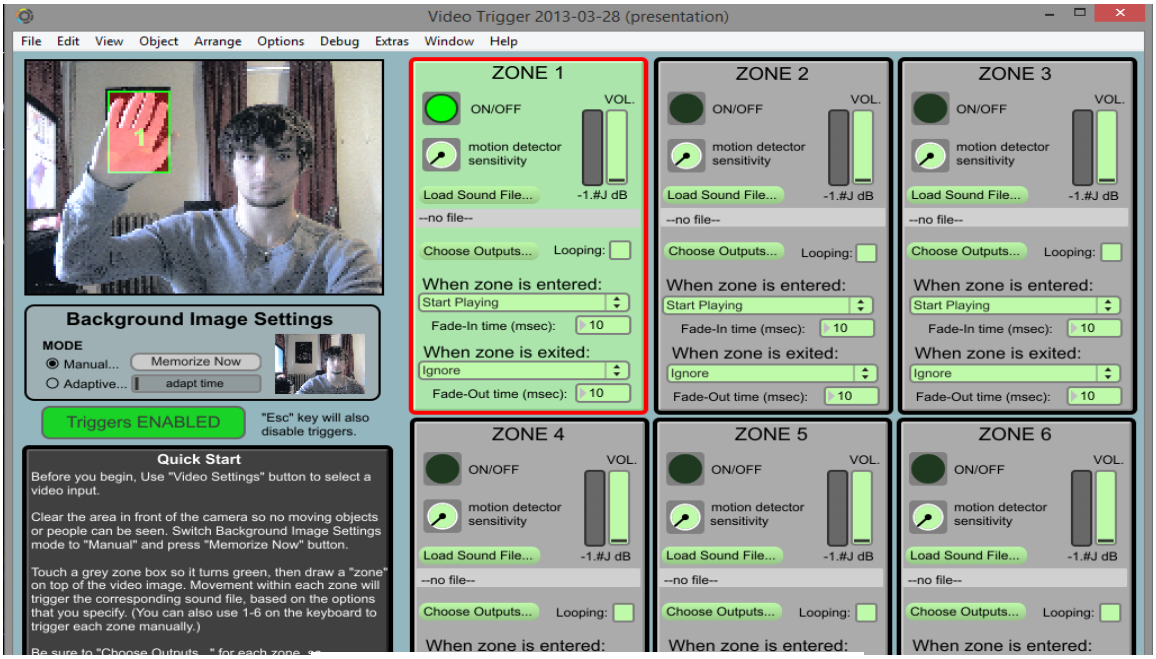

Figure 3.1 Zach Poff's Video Trigger.

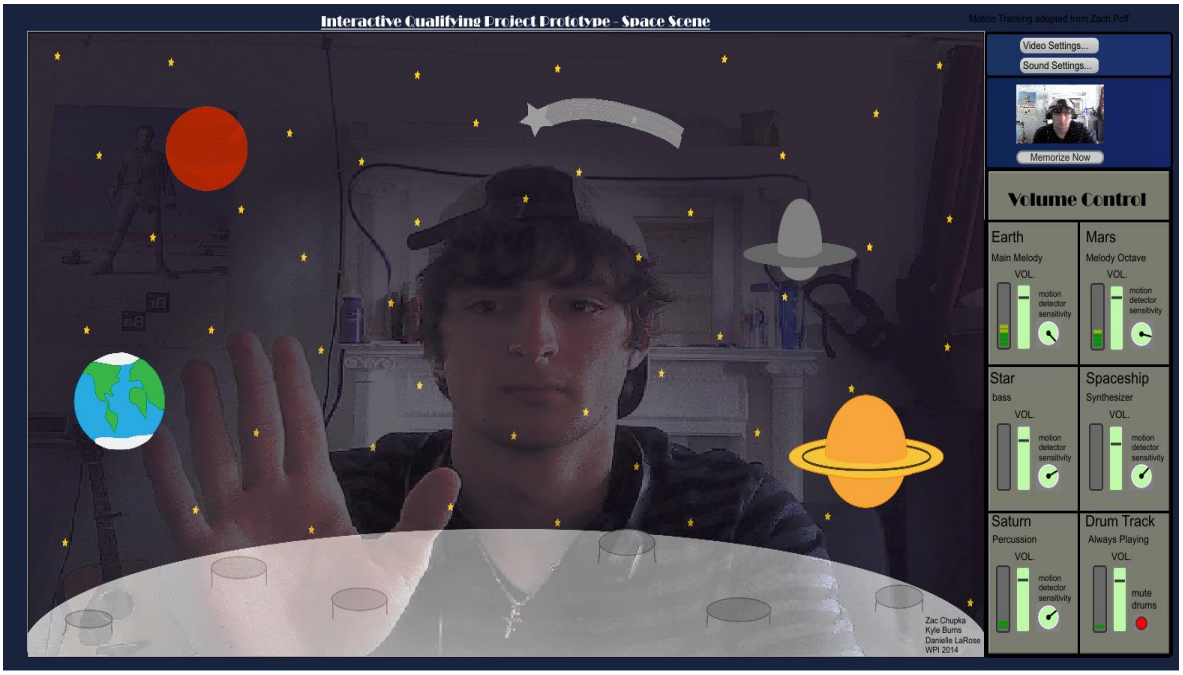

Figure 3.2 The Prototype

Many of the user interface objects and settings in the video trigger program seen in Figure 3.1 were removed from the final product. By the end of the implementation phase, many were no longer functional, or available for end users to change. The user could no longer load in their own sound file to each object, draw detection zones in the video window, and decide how a zone reacts when they interact with it. These settings were taken out to maintain consistency in functionality for the final product. The settings menu was reduced to a single column that was placed on the right side of the interface. The settings include video and audio options, scene memorization, and object sensitivity controls. The video settings detect different device drivers which are used to record the user. The sound settings also detect sound drivers which are used to project audio. Occasionally, the motion tracking becomes impaired and some of the objects do not react when a user comes in contact with them. This can be caused by a drastic change in lighting in the room the user is in, if the camera is moved, or if additional real world objects, such as people, move behind the user. The memorization button can be clicked to reset the

comparison image used for detecting changes in the zones. A volume control section allows the user to adjust the volume for each object. They may also use a virtual dial to change the sensitivity of the detection zone for each object. The zones react differently based on the room lighting and objects in the background of the video feed. Users also have the option to turn off the drum beat that constantly plays. This allows them to hear the object sound clips alone to analyze how each clip works together without a percussive beat.

The five scenes were made opaque to overlay the video feed so the user could still be seen behind them. It was difficult to find a balance between being able to see what scene the user is in and being able to see the user behind the scene. The interface and functionality of the application was at a presentable state and was validated during the testing phase of the project. Refer to the Data and Analysis section for more details.

3.9 Application Setup

The project was designed to be used a certain distance away from the camera. Some variables to take into account included physical space required to use the application, equipment available, and other movable objects that the camera could detect. Grade schools generally have access to projection screens and smartboards. This was the incentive to give the application the ability to enlarge the video screen so the user had a clear image to look at. They would be able to stand a fair distance away from the screen and still be able to recognize the scenes and objects. To let the user know where to stand, there was a virtual "hat" that they would line up with their head. When it looked like they were wearing the hat, then they would know that they were standing the correct distance away from the camera. A facial recognition functionality was implemented in the

beginning phases of the production stage in order to attach the hat object to the user's head. The facial recognition objects used made the video feed window grayscale and altered the resolution.

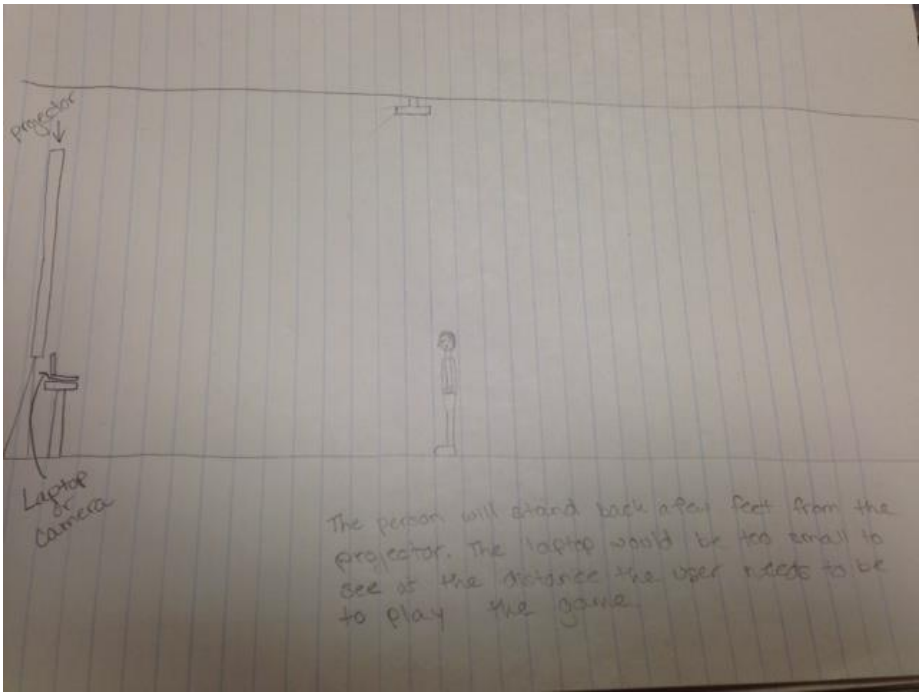

Figure 3.3 Proposed Setup.

This made the detection zones too sensitive, so the virtual hat idea was removed from the project. The prototype is supported by both Windows and Mac computers as two separate programs. For each operating system, there are also two separate programs for smaller or larger screen sizes. This was included in order to allow better use on personal computers versus on a projector screen. Going forward, a simple drawing was created to show what the final physical environment could look like.

3.10 Deliverable and Feedback

During the first week of March 2014, the initial prototype and idea were brought to the principal of an intermediate elementary school. This visit was to gauge his interest in allowing the application to be tested in his school. Since he had a musical background, he was quite

interested in the application and what it had to offer. After the prototype was presented to him, he was eager to begin testing of the application. It was agreed that the application would be presented to him at the end of March 2014. This testing was to be held during March 31, 2014 through April 18, 2014, which was also the beginning of Autism Awareness Month.

After much time and energy, the space scene was complete and operable. It had functional motion tracking, a completed musical track, and a finished digital scene. However, it only played one looping musical track rather than the initial target of three looping tracks. There was still much work to be done to finish the remainder of the scenes and sounds. However, the application needed testing. Therefore, the application was brought to the intermediate elementary school on March 31, 2014. The principal was taught how to use the program and how each setting functioned. It was important that he knew every aspect of the program in case of malfunctions. An important part of this testing phase was to see if the target audience could operate the application without needing help from the developers. Instructions were included with the application to use as a reference. The principal was told to use the application within his school as he saw fit. The testing concluded on April 17, 2014.

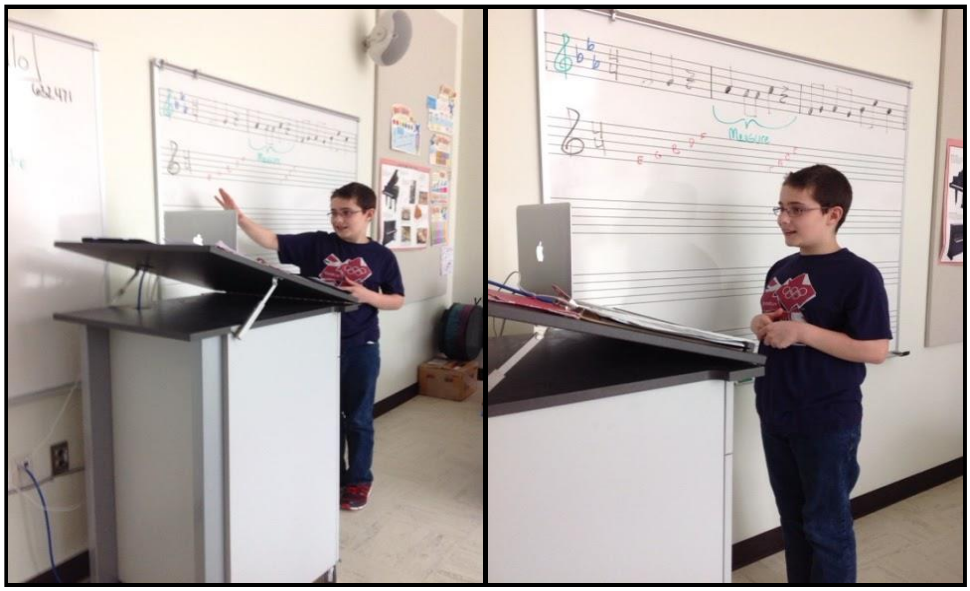

Figure 3.4 The application being used by a student during the testing phase

In order to obtain feedback on the project, a survey was created to be completed by the test subjects. The survey consisted of fifteen questions to cover all aspects of the project. Nine of the questions were on a ten-point Likert scale, while the remaining six questions asked for a brief response. The main focus of this survey was to obtain the observations and reactions of the respondents. The questions revolved around the aesthetics of the prototype and its functionality as an educational device. It asked for feedback on the appeal of the graphics and audio, usability and mechanics, and the entertainment value of the program. This survey was given to the intermediate elementary school music teacher as well as the principal of the school. This particular teacher was chosen for the application testing because the project demanded a specific set of children and teachers: young special needs students and a music teacher for all levels of learner. In his classes, he presented the prototype to his students as he saw fit and responded to the survey based on his observations of the children. The teacher and principal, rather than the students, were chosen to respond to the survey because their answers were likely to be more constructive.

In addition to the survey, an interview was scheduled with the principal to obtain feedback on the relevance of the application to music learning within the school system. This interview consisted of fourteen questions revolving around the aesthetics and functionality of the application to the students, its appropriate demographics, and the educational value it brought to the students. This interview was conducted upon conclusion of the testing period. The audio for the interview was recorded so that it could be referred to for analysis.

Although the completed project exceeded expectations, there were some monetary, time, and human resource constraints while implementing the application. Monetary constraints included art software such as Photoshop that could have been used to design backgrounds for the project. In addition, there was only one product key for Max, rather than three separate keys, which

was shared throughout the group. Time and human resource constraints included underestimating the amount of time it would take to make the application and implement the desired features. Also, the application lacked preliminary testing by outside sources prior to its shipment to the middle school. In addition, the application was only tested by one set of test subjects.

Chapter 4: Data and Analysis

A qualitative study was performed at an intermediate elementary school through a survey completed by the school principal and a music teacher. An additional interview was conducted after the testing phase with the same principal. To test the prototype, he incorporated it into the music program at the school. Their music program consists of a general music class for students as well as an adaptive physical education class, or adaptive music. This program aids children with special needs by improving their dexterity through fine arts. Since the prototype involves the use of physical movement, the principal believed that it would incorporate well into this program. He also used it in the normal music classroom environment, and it was tested by fourth- and fifth-grade students, ages eight to ten. This allowed the inclusion of children with and without special needs, which provided more general feedback than with a single group of students. The principal and the music teacher observed the students, basing the feedback on the student's reactions as well as their own reactions.

In testing, one student controlled the application at a time. The other students in the class watched a projector from outside the camera's field of view, so as not to interfere with the application. It was intuitive to the students as they were able to learn how to use the application quickly. Whether they were controlling or observing, "the children were 100% engaged" in the application. Students were suggesting which objects to activate on the screen, transforming the experience into a collaborative one. They found the application educational because it involved kinetic and auditory skills, creating a multidimensional experience.

The participants note that they enjoyed the application, especially because the individual controlling it could be seen on the screen within the scene. In addition, they could use their bodies to control the music in the game. The children loved to simply play the game, and their favorite

part was “getting up and doing it.” Each of the students wanted to play the game and were disappointed when another classmate was called upon. Many of the students wanted to continue playing even though the class had already ended.

Although the students’ overall reception was positive, they did encounter various issues with the application. One of these issues was that the user was difficult to see on the screen amongst the objects. This issue may have been due to the lighting in the room, or because the opacity of the background image was too low. Another reported problem was that the various instruments being played in the song were difficult to distinguish. The song was “too well-composed,” such that the students did not always notice a difference in the music when an object was activated or deactivated. The children should be able to hear the different layers of the music in order to learn the basics of music composition. Also, some of the objects in the scene were difficult to trigger. This was most likely due to smaller zones representing the parts of the screen that would activate these objects. The students asked for more variety in the music, though this criticism was expected because the demo included only one song.

The participants were also asked about their opinion on the demographics for the application. The application was originally designed for children ages five to ten with ASD. Both subjects suggested that the game should target primary to elementary school students of both genders. One test subject responded that the application was “very elementary friendly, K-5, especially with special needs children.” In addition, there has been a “big push” for the incorporation of technology into special education. “For a child who has sensory issues, the fact that you can move and still hear the [musical] components” is quite beneficial. They stated that the application was well suited for students with or without special needs. They believed that the application could integrate well into their music program to be used on an occasional basis.

The students offered many suggestions regarding future improvements that could be made for the application. Each object in a scene could play a track belonging to a different family of instruments, such as brass and strings, allowing the students to identify particular families by activating each instrument. Another recommendation was that the appearance of each object could influence the track that plays when it is activated. For example, the larger objects would control bass sounds while the celestial objects would correspond to higher-pitched instruments. A major suggestion, which could potentially be implemented as a future project, was to create a game out of this application. This could involve points being awarded to the player for activating the correct objects, which would be prompted to the user. The students also suggested a version of the application for the iPad and other mobile devices. However, this would likely require significant modifications to allow use on a smaller screen. The final recommendation was to add diversity to the remaining songs such that they are recognizably different. These ideas would add new functionality to the application and create appeal for a broader audience.

Chapter 5: Conclusion

Based on the data received through the interview and surveys, the application is practical for teaching music composition in the classroom at an elementary school level. The students thoroughly enjoyed the experience of interacting with the application, and they felt that it improved their musical knowledge. The technological aspect of the project was very appealing to the students, such that they discovered an appreciation for watching others interact with it. Children without special needs also became immersed in the application, representing a broader audience.

An objective for this project was to ensure that the application was intuitive to the user. According to the feedback provided, the students did not require any additional instructions for operating the application. This was positive feedback because the students would not have enjoyed the application as much if the instructions were confusing. The students remained interested in the program mainly because of the incorporation of motion tracking. This made the application much more interactive than a typical game and removed the need for the students to use peripherals.

This application is intended to be used in a classroom environment for elementary students. It will have a lasting impression on the students as the school administrators would like to see it being used on an occasional basis. Since the application is repetitive in its current state with only one song, students would probably grow tired if it were used more frequently. The application will also be used in the school's adaptive music program. This program helps patients with coordination and dexterity through physical activities, many of which are music-oriented.

This project achieved the various goals that were intended for it. The responses provided by the students and staff who experimented with the project confirm that it benefits children, both with and without special needs. The application is simple to use, which permits use by elementary students without instruction. It is enjoyable for the user as well as the audience due to the appeal

of its motion-tracking technology. The project educates students about musical composition in an enjoyable manner that also improves physical abilities. Future development for this project may uncover more uses for it and expand the audience that it will benefit.

Chapter 6: Recommendations

There has been much progress made on the implementation of this educational game. However, there are many features that still need to be included in order for it to be considered a completed product. The original plan for the application was to have five scenes with three distinct looping tracks for each of the objects in the different scenes. In addition, there was to be a main menu screen for the user to select which scene to enter and a tutorial video for the user to view if necessary. The designs for the five scenes and main menu screen have already been created, but were not implemented in the current version of the product. In addition, the remainder of the soundtracks must be created and implemented for the product. All of the scenes require three tracks to be made, but the space scene only requires two additional tracks.

Students had trouble seeing themselves behind the space scene in the prototype. Alterations should be made to make the scene more opaque to allow for a clear image of the user. They also suggested implementing a game feature to the application. The project could be modified in a variety of different ways to add an objective style game. A popular request was to add a timing based game where the user has to trigger zones at the right time and be awarded points or multipliers for successful triggering.

The students enjoyed the prototype and wanted more by the end of the testing phase. However, it was difficult to conclude if it alleviated stress. The application could be given to a therapeutic practice to determine if it could be used as a relaxant or even as a tool for occupational therapy. How could this project be used to improve patient health and recovery?

The prototype is still in a stage where many changes or additions can be made while maintaining or expanding on the original goal of the project. This project is very open ended for modifications which can be directed toward other fields such as occupational therapy and other

medical practices. The source code is available with the prototype download on www.eamir.org and can be opened with Max. Any changes made must be released under the same licensing that came with the Video Trigger program.

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Appendices

A. Application Testing Cover Letter

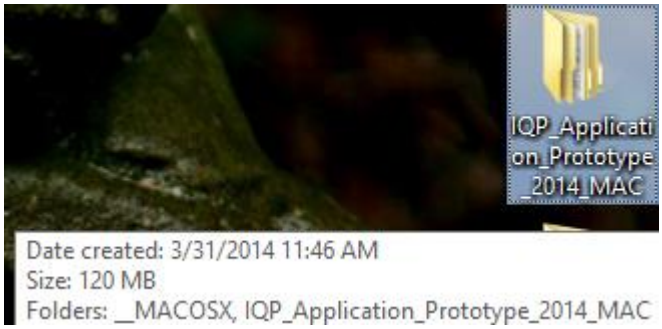
Dear *Principal* and staff,
We are a group of undergraduates from Worcester Polytechnic Institute working on a music technology project with Professor Manzo of WPI. Our prototype is an educational video game that teaches fundamental music concepts to young students who are not musically inclined.
We would like to propose an opportunity to you that would allow us to conduct a small study on how video games are capable of teaching music. We would be conducting a survey about the player's response to the video game based on visual aesthetics, sound, gameplay, usability, and music concepts. The playtest would begin on March 31st, 2014 and end on April 18th, 2014.
We would like for you to let your students test the game we're developing in any capacity that you see fit. We will be sending you a survey regarding aspects of the game that the children liked, and general comments that might improve the game. We would then like for you to kindly return the survey back to us by April 20th, 2014.
In conclusion, the feedback would allow us to make the game a more enjoyable experience. We hope that you will be able to participate in this study. Thank you for taking the time to read this and, if you choose to do so, we appreciate your partaking in this activity.

Sincerely,

Kyle Burns
Zachary Chupka
Danielle LaRose

B. IQP Prototype Instructions

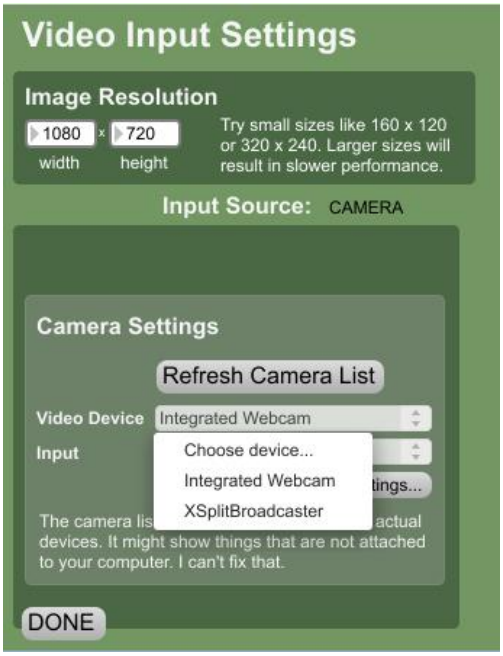
We have sent the **Mac** version of our application to you, so they will work on any Macintosh computer. Two versions were included to accommodate for different **screen sizes**. The ability to dynamically adjust to the screen will be added in a later version. The application file for a **15+ inch screen** is located in a folder called **"IQP_Application_Prototype_2014_MAC."**

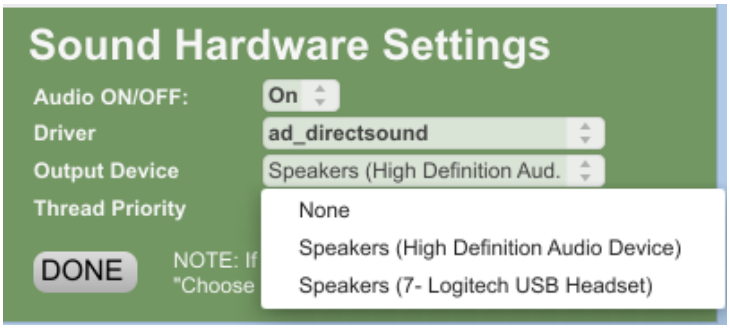


The application file for screens about the size of a **MacBook** is located in the folder called "**IQP_Application_Prototype_Smaller_Screen_2014_MAC."**

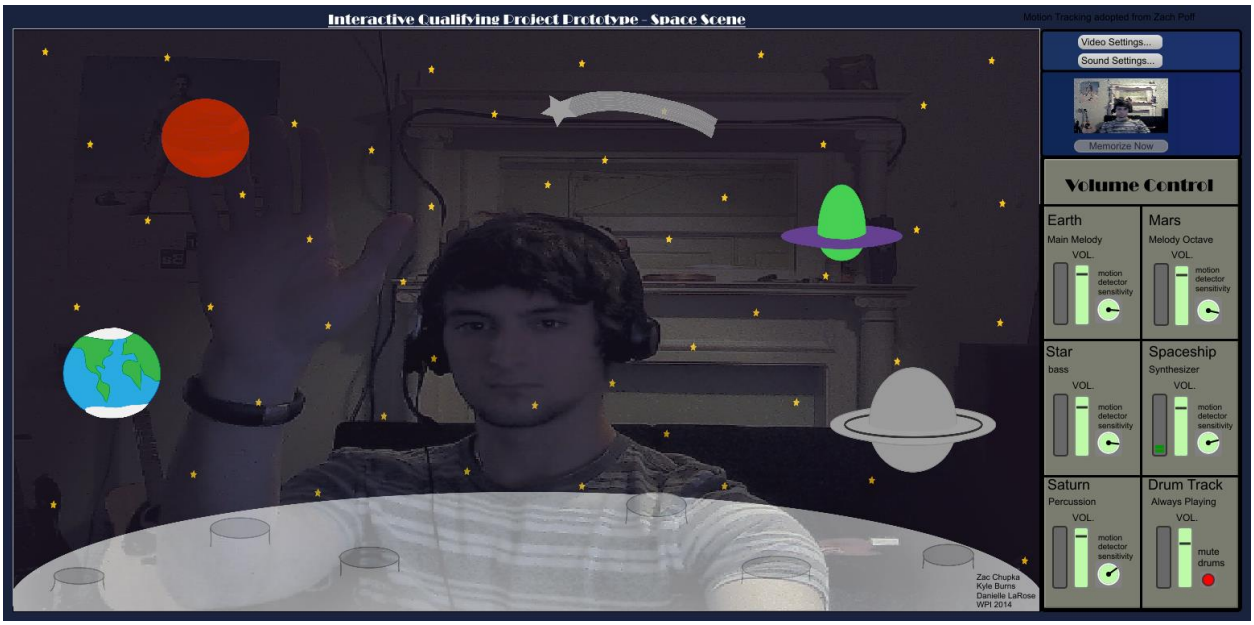
Go ahead and open the folder. You will see a bunch of WAV files (don't worry about these, the application needs these sound files to be in the folder to read in the music that you will hear later on) and a few other files that are necessary for the application to run. The file that you need to open to run the app will look like this:

Open the file **and wait for the settings to restore and the webcam to start**. About 20 seconds after the program opens, a drum track will start to play.
The program should analyze your computer's drivers and automatically set the webcam and sound settings so everything will be ready to use when the program opens, but if the webcam and or sound does not turn on, there is a way to change the app settings by clicking on the **Video Settings button or Sound Settings button** located on the right side of the application. Each Settings button will open a new Interface where you may click on a dropdown menu to choose the appropriate video and or sound device. Click **DONE** when the desired settings are chosen.





The application is now ready to use! You will see yourself in **a space scene** "standing" on the moon with various planets and other things you find in space floating around. They should be black and white at this time. Each object triggers a different audio track which is described in the **Volume Control** box located on the right side of the screen. You may need to scroll to the Controls depending on the size of your screen. To **trigger** an object, "**touch**" it by **waving your limbs, head, throwing objects, etc. over the object.** Once an object is **turned on**, it will **light up** and a music track will start to play. You may turn on **any combination of objects** to give the scene a different overall sound.



It is important that the webcam remains still. You will notice a small picture and button labeled **Memorize Now** on the right hand side of the screen above the volume controls. When the program opens, it takes a snapshot to use for motion detection. The image is stored within the program and is constantly being compared to the video feed. When the image detects a change in the comparison in a trigger zone, the zone will turn on and music will start to play. If the camera moves or the background in the video feed is constantly changing, the motion tracking may not work as it is supposed to. If a new person comes into the scene to play the application, or if the computer is moved to a new location, click the **Memorize Now button** to take a new snapshot of the area the user will play in.
You may **change the sensitivity of the motion detecting zones** by **clicking and moving** the **dials** in the **Volume Control box**. Moving the dial to the **right** will make the zones more sensitive. The application reacts best when the room is **dimly lit** and there **is high contrast** between the background and the user/object that is triggering each zone. A higher contrast allows the comparison between the video feed and snapshot to easily detect changes.
Sometimes the video feed will freeze. This is a bug that we are looking into and will fix for later productions of the application. If this bug occurs, close the program by hitting **Command + Q**. It should return back to normal when you reopen the application.

If you have any questions about the operation of our application, please email me at zdchupka@wpi.edu and I will reply as soon as I can.

Thank you and enjoy our application!!!

C. Participant Survey

Below are statements about our application. On a scale from 1-10 (1 meaning you completely disagree, 10 meaning that you completely agree), please rate the statements on how much you agree or disagree with them.

The graphics and backgrounds were appealing and you could tell what type of scene you were in.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

The objects that played sound were fun to interact with.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

The touch sensitive objects reacted when you came in contact with them.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

The sounds were appealing and fun to listen to.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

The sound combinations for each scene went well together and sounded great when they were all on at the same time.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

The instructions on how to use the application were easy to follow.

Disagree									Agree
1	2	3	4	5	6	7	8	9	10

Please give a brief description on your opinion of the questions listed below.

What was your favorite part about the application?

What was your least favorite part about the application?

Do you see yourself using this application frequently?

In one or two words, tell us the experience you had with the application.

Did the kids enjoy the application?

Do you see this application being used for educational purposes?

Is there a certain demographic group that you feel this application should be directed towards (a range of grades, different programs offered in the school system, etc.)?

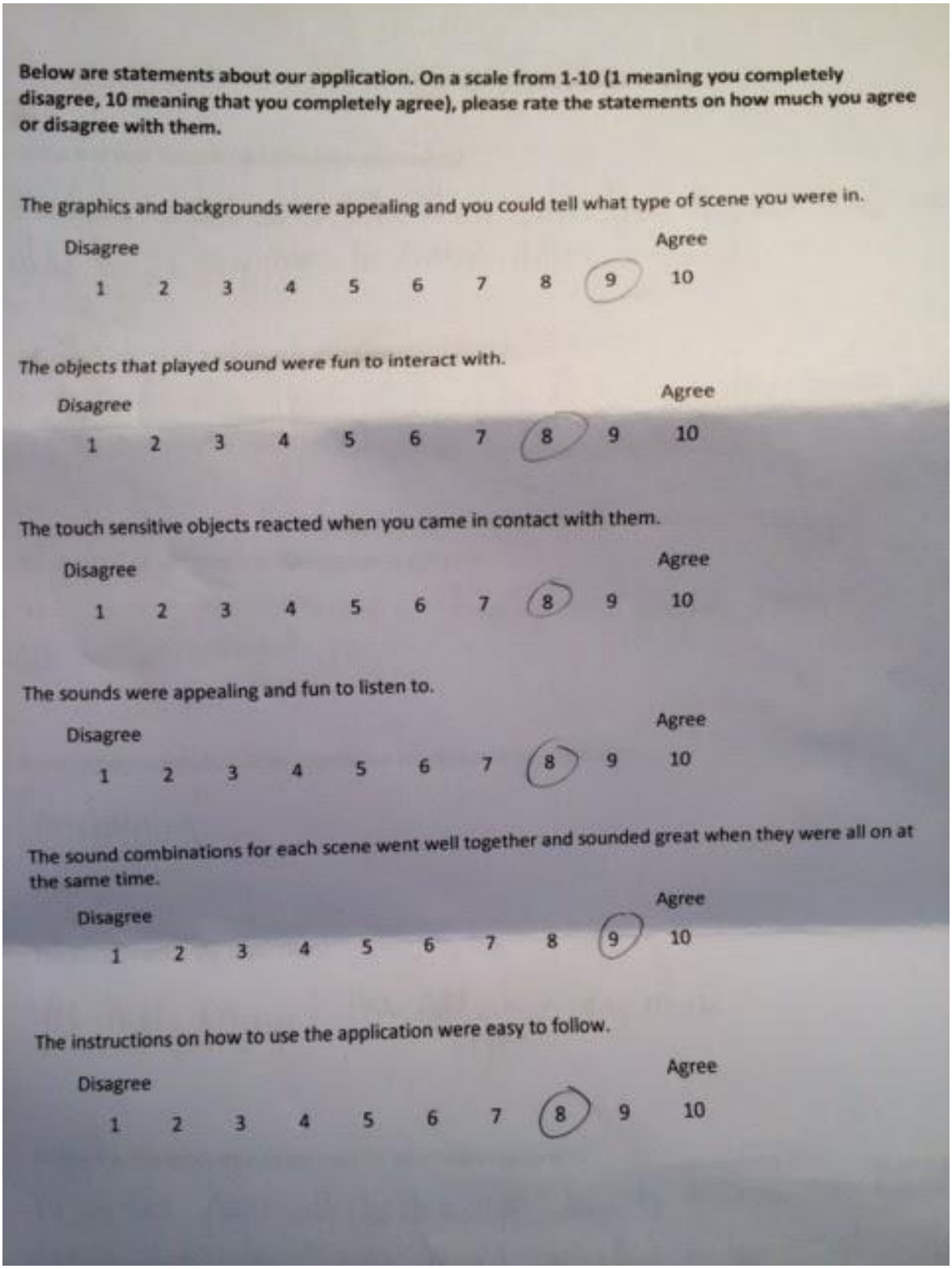
Were there noticeable glitches or bugs that you observed while testing the prototype?

Did the students stay interested in the application? If they did not, why?

Did the students come to you with any comments on the application, if so, provide a description of the comments?

D. Survey Results

Subject A:



Below are statements about our application. On a scale from 1-10 (1 meaning you completely disagree, 10 meaning that you completely agree), please rate the statements on how much you agree or disagree with them.

The graphics and backgrounds were appealing and you could tell what type of scene you were in.

Disagree 1 2 3 4 5 6 7 8 (9) 10 Agree

The objects that played sound were fun to interact with.

Disagree 1 2 3 4 5 6 7 (8) 9 10 Agree

The touch sensitive objects reacted when you came in contact with them.

Disagree 1 2 3 4 5 6 7 (8) 9 10 Agree

The sounds were appealing and fun to listen to.

Disagree 1 2 3 4 5 6 7 (8) 9 10 Agree

The sound combinations for each scene went well together and sounded great when they were all on at the same time.

Disagree 1 2 3 4 5 6 7 8 (9) 10 Agree

The instructions on how to use the application were easy to follow.

Disagree 1 2 3 4 5 6 7 (8) 9 10 Agree

Please give a brief description on your opinion of the questions listed below.

What was your favorite part about the application?

My favorite part was interacting with the program and being able to use my arms to control different sounds.

What was your least favorite part about the application?

My least favorite part of the application was the sound samples and the limited instrumentation of the soundtracks

Do you see yourself using this application frequently?

With the right demographic, I could see myself using this application on an occasional basis.

In one or two words, tell us the experience you had with the application.

Entertaining!

Did the kids enjoy the application?

Yes they enjoyed the application very much

Do you see this application being used for educational purposes?

I can see potential for the application to become an educational application. Maybe if each planet controlled a family of instruments (brass family, strings family, etc), then students could learn + identify instrument families based on sound

Is there a certain demographic group that you feel this application should be directed towards (a range of grades, different programs offered in the school system, etc.)?

I would suggest using this application in grades k-5. Especially special needs children.

Were there noticeable glitches or bugs that you observed while testing the prototype?

Occasionally one or two of the planets would not turn on a track, or turn off a track.

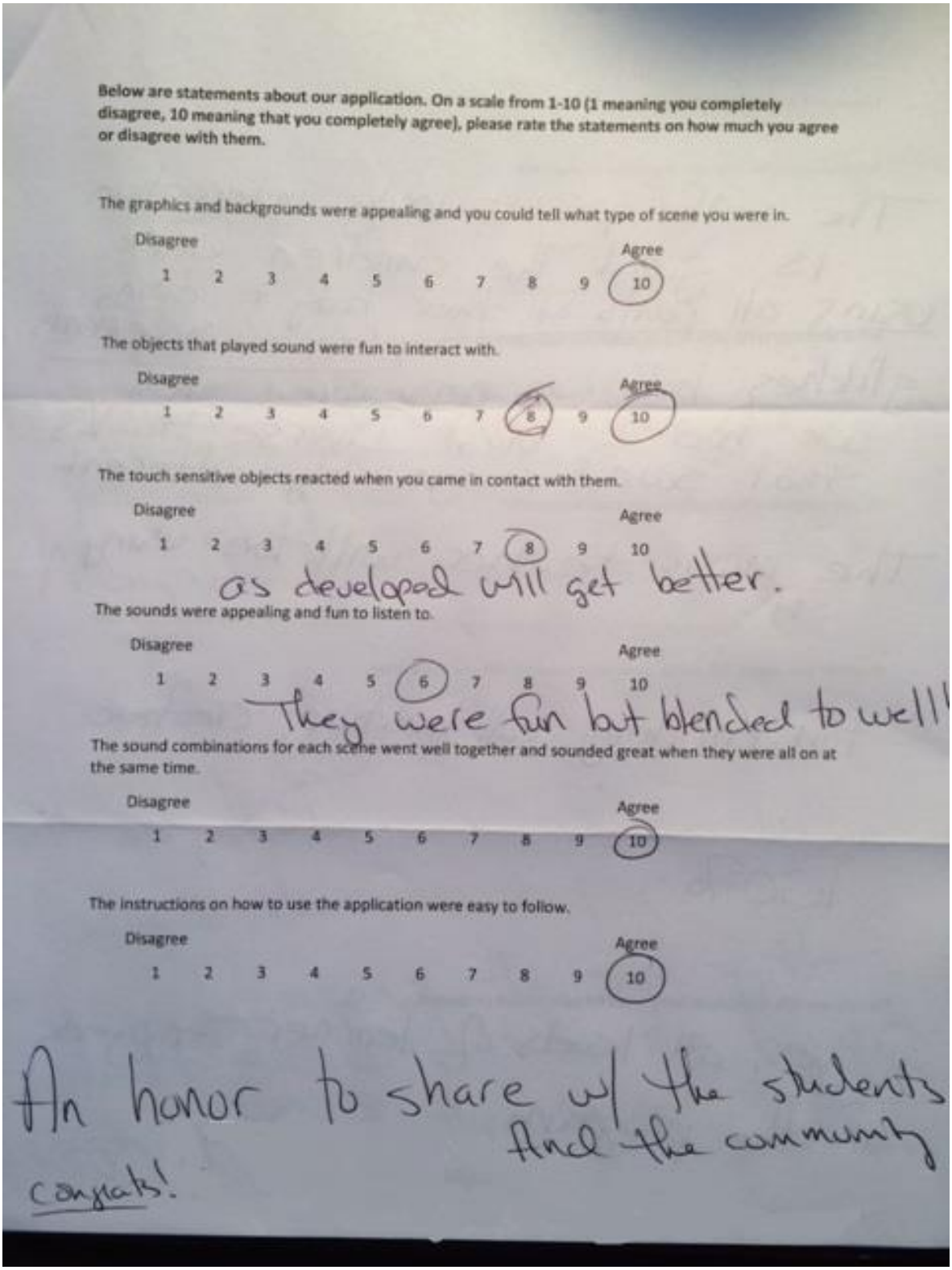
Did the students stay interested in the application? If they did not, why?

Yes, students were very engaged - whether they were playing watching another student use the application.

Did the students come to you with any comments on the application, if so, provide a description of the comments?

Students suggested making a game component - almost like garage band or a just dance game. Different planets would control th music during the game + points could be attained for each correct planet/track that was switched on.

Subject B:



Below are statements about our application. On a scale from 1-10 (1 meaning you completely disagree, 10 meaning that you completely agree), please rate the statements on how much you agree or disagree with them.

The graphics and backgrounds were appealing and you could tell what type of scene you were in.

Disagree 1 2 3 4 5 6 7 8 9 (10) Agree

The objects that played sound were fun to interact with.

Disagree 1 2 3 4 5 6 7 (8) 9 (10) Agree

The touch sensitive objects reacted when you came in contact with them.

Disagree 1 2 3 4 5 6 7 (8) 9 10 Agree

as developed will get better.

The sounds were appealing and fun to listen to.

Disagree 1 2 3 4 5 (6) 7 8 9 10 Agree

They were fun but blended to well!

The sound combinations for each scene went well together and sounded great when they were all on at the same time.

Disagree 1 2 3 4 5 6 7 8 9 (10) Agree

The instructions on how to use the application were easy to follow.

Disagree 1 2 3 4 5 6 7 8 9 (10) Agree

An honor to share w/ the students And the community

congrats!

Please give a brief description on your opinion of the questions listed below.

What was your favorite part about the application?

The selfie pic + body interaction is great. The children were using all parts of their body + doing creative movements

What was your least favorite part about the application?

glitches but we persevered and we had a blast. Diverse tracks that sound recognizably different

Do you see yourself using this application frequently?

the music teacher will be using it.

In one or two words, tell us the experience you had with the application.

fun, enriching, collaborative, creative

Did the kids enjoy the application?

100%

Do you see this application being used for educational purposes?

yes, all levels of learner enjoyed the program.

Is there a certain demographic group that you feel this application should be directed towards (a range of grades, different programs offered in the school system, etc.)?

We used for grades 4+5 plus inclusion Elementary friendly.

Were there noticeable glitches or bugs that you observed while testing the prototype?

Earth was a little challenging. But we got it to work Could not get sound over sound system. will trouble shoot.

Did the students stay interested in the application? If they did not, why?

Yes, 100% from all children Many children wanted to try.

Did the students come to you with any comments on the application, if so, provide a description of the comments?

Background hard to see person. Children said to lighten it up if possible.

Loved the stars + planets

They recommend the size of the planet should dictate the low or high pitch of the sound. stars = soprano Saturn - bass

E. Interview Questions

1. Explain the program that is done at the end of the day with the kids.
2. Was the application used in any other class/program besides the end of day program?
3. Do you feel that the application was educational for the students? If not, what can be done to make it more educational?
4. How well were the kids able to interact with the software? Was it easy for them to learn how to use it?
5. Did the students seem to enjoy the application? Why or why not?
6. What age groups did you use the application with?
7. What age group do you feel it worked best with and why?
8. Was the application appropriate for the special needs students? Why or why not?
9. Is there anything else you would like to see added to the application?
10. When we finish the final version, would you be willing to continue using it in the classroom environment?
11. Were there any parts of the application that did not work well?
12. What do you think the kids' favorite part of the application was?
13. Did there appear to be different reactions between the male and female students? If so, what were the differences?
14. Did you personally enjoy the program?

F. Interview Consent Form

Consent to participate in this interview

Project Title**: Interactive Music Systems**
Researchers: **Zac Chupka, Kyle Burns, Danielle LaRose**
Faculty Adviser: **Vincent J Manzo**
I would like to thank you for administering our Interactive Qualifying Project prototype to your students of your intermediate elementary school. During this study, we would like to ask you a few questions as to how the prototype testing went. The information gathered will help us improve the application's functionality to achieve our objective and better suit the needs of the students who use it. This interview is designed to be approximately twenty minutes in length. However, please feel free to expand on the topic or talk about any ideas that you may have for the application. If there are any questions you would rather not answer or that you do not feel comfortable answering, please let us know and we will stop the interview or move on to the next question based on your preference.
The data collected may be used in our project report for data and analysis. We will record the audio of the interview to obtain detailed feedback and to capture everything said during the interview. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.
Participant's Agreement:

I am aware that my participation in this interview is voluntary. I understand the intent and purpose of this research. If, for any reason, at any time, I wish to stop the interview, I may do so without having to give an explanation.

The researcher has reviewed the individual and social benefits and risks of this project with me. I am aware the data will be used in an Interactive Qualifying Project that will be publicly available on the Worcester Polytechnic Institute website. I have the right to review, comment on, and/or withdraw information prior to the Interactive Qualifying Project's submission. The data gathered in this study may be used in a report to reflect on collected data and analysis unless I specify otherwise. I understand if I say anything that I believe may incriminate myself, the interviewer will immediately rewind the tape and record over the potentially incriminating information. The interviewer will then ask me if I would like to continue the interview. I do not give up any of my legal rights by signing this statement.

If I have any questions about this study, I am free to contact the student researcher (zdchupka@wpi.edu, 774-280-0927) or the faculty adviser (vjmanzo@wpi.edu). If I have any questions about my rights as a research assistant, I am free to contact the chair of the IRB: (Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu) and the University Compliance Officer (Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu).

I have been offered a copy of this consent form that I may keep for my own reference. I have read the above form and, with the understanding that I can withdraw at any time and for whatever reason, I consent to participate in today's interview.

_____ _____
Participant's signature Date

_____
Interviewer's signature

G. Interview Transcription

Z: So, I'm just gonna start reading… we have about fifteen questions.

P: Okay.

Z: So question one… So explain the program. You were talking about a program that you did at the end of the day with the special needs kids.

P: Yes.

Z: Did you use it during that?

P: We used it, well, we just decided to use it for… we called it adaptive PE, or adaptive music, where it's basically children that are maybe substantially separate. There's a curriculum that you use in music and physical education and all that other stuff that helps them with the dexterities and those kinds of issues through the fine arts. But we decided, the music teacher just wanted to use it in the regular classroom also.

Z: Okay, so other students got to use it?

P: Yeah, absolutely.

Z: Alright. Question two was if there was any classroom use of it. Do you feel it was educational?

P: Absolutely times ten.

Z: How so?

P: How so… How is it educational? Well, number one, it's kinetic, so it's movement. It's auditory, which is huge for listening. And as expected, it's multi-dimensional, or modal I guess you could say, where you're putting together the modality of the music into the movement of the hands and movement of the body, and you know, the function that you're making the decision on how to interact with the device. It was kind of cool.

Z: Okay, how about the compositional part of it? Does it teach them the building blocks of how a song is built or…?

P: Well, that would have been the concern. I think because the music is so well done, I don't think the children can hear the different layering parts of it? You know what I'm saying? When it comes to a compositional standpoint, because when you layer music, you want to be able to… and again, this is a child who doesn't know anything about composition, so if they're gonna be able to pull things away from it, I think it has to be a little bit more… distinctive.

Z: Like separate?

P: Yeah, just distinctive. And again, that could be the highs and the lows, you know what I'm saying? Like with Saturn being the bass to the soprano. On an elementary school level, that's much more approachable to music. But again, the kids loved it. And it tuned to their ears, which is kind of neat. But you know, if you're gonna take it into the whole theory part of it, you might want to diversify a little bit more.

Z: To make it more of an educational music compositional…

P: Right, if you want to give it the 360-degree musical experience, you know what I'm saying, where you're talking about you know, theory, music, you know, application to performance, and all those other things, then yeah, you might want to.

Z: Okay. How well were the kids able to interact with it?

P: They loved it. From the fact that I just captured their picture, you know what I'm saying? We put on the Eno Board, which was an easel where everyone could see the child interacting with it. You know, it was like watching a performance. The kids were like eyes open and mouths open, and there were nice friendly suggestions like you know, hit this Saturn, hit this, you know, touch it with your elbow, jump up and down. The interaction was awesome. A-plus. A-PLUS.

Z: Alright, that's… we're trying to create a unique activity.

P: It was collaborative, you know what I'm saying? As long as being individualistic, it was collaborative, it was, you know, a full ensemble kind of thing experience.

Z: Did you have more than one person at the same time?

P: No, it was always one person. Yeah, we had audience members and then the performer. You're gonna see in the picture, you know how it was the child on the side? So, the kids, the children, were actually like facing the Eno Board, and the child was on the side doing like an orchestra kind of thing.

Z: Okay, that works.

P: That was kind of neat.

Z: I was gonna build off of that but I forgot… Oh, was it easy for them to like pick up? So, was it difficult for them to learn how to use it?

P: No. Oh, no, no, no. No, they knew. Again, guys touch the planet, and you know, there's like that enlightenment was kind of really neat, you know.

Z: Making something work.

P: Exactly. One of the biggest complaints they did have, when we projected it onto the Eno Board, because the background was dark gray, they said maybe if they could lighten that up a little bit so they could see their image on the Eno Board. The room was really bright, we shut off the lights and everything else, but it was still a little hard to see.

Z: Like the space background?

P: Right, the actual background because when it was transposed onto the Eno Board, you could see it, but it wasn't like uber… I don't know if you could sharpen that up. I mean, food for thought.

D: Yeah, that also just happened to be one of the darker scenes. A lot of the other ones will be brighter.

P: Yeah, exactly. With the plethora of the other scenes, when you put them together, I'm sure, you know,

Z: Yeah, we're gonna try to get it done by the end of the school year. Got a few weeks to do that, so… Well here's a good one. Did the students seem to enjoy the application and why or why not?

P: Yes, the children were 100 percent engaged.

Z: Good.

P: (laughing). It was very nice.

Z: What were the varying age groups?

P: We were fourth and fifth graders.

Z: Fourth and fifth?

P: Yeah, so I'd say between ages eight, nine, and ten.

Z: Perfect. And that seemed to work with all of them?

P: Oh, absolutely.

Z: A specific age group in general?

P: Well, we kept it elementary, and again you know, fourth and fifth, I mean actually, the fifth graders loved it and again, it was highly effective. Again, it's technology. Children love technology.

Z: Well, you loved it too so… (laughing)

P: Oh, it was awesome. A-plus.

Z: So, you said what age group did you feel it worked best with. Elementary you said is…

P: Yup, it would be primary to elementary. I think, I mean we didn't go into middle school, but I'm sure, you know, that with even more complexities, you know, into the program itself, I think it would be awesome.

Z: And you can keep the program, so you can use it whenever.

P: Yup, and he [the music teacher] downloaded it on his MacBook too, so we're good to go, and then we'll put it on some Airs. Kids actually asked me if it was iPad-compatible.

Z: We can probably make it into an app.

P: Food for thought, maybe. Because every child has an iPad so…
(phone rang, interview interrupted)

Z: Okay, where were we… Did you use it on any special needs students?

P: Yup, actually that picture you have of that child, he's special needs.

Z: And it worked well?

P: Oh my, absolutely. Absolutely, I mean, that's the nice thing about those kinds of programs, I mean, especially for special-ed, I mean the big push is technology, so anything that's interactive with that kind of stuff.

Z: Do you think it should be geared towards one or the other or both?

P: No, it's both, no, no, no. Absolutely keep that the way it is.

Z: Perfect, it's probably better to have bigger range.

P: I think it lends itself to, I mean again for a child who has either sensory issues or whatever, I mean the fact that you can move, you know what I'm saying, and still hear the components. I mean again, usually with those kinds of children anyways, their intelligence in that aspect is phenomenal, you know what I'm saying? That's where you get the savants and that kind of stuff.

Z: That's where we put the research, that they sometimes, a lot of times, surpass.

P: Oh, absolutely. I mean, like you said, the research proves itself, that you know, creativity in savants and whatever, children with autism, and things like that.

Z: Have you ever seen those documentaries like on savants?

P: Oh yeah, absolutely. I mean I still teach piano and I have one child, he's been diagnosed with Asperger's, and you should hear him play the piano. And he's only been playing for maybe six months.

Z: Really?

P: Oh yeah, it's really cool to watch.

Z: Just their level of focus is…

P: Oh, it's that whole cognitive thing. You know, it just triggers and off you go.

Z: Is there anything that should be added to the application? Maybe some setting or functionality.

P: No, I think you're going on the right track. I think more variety, you know what I'm saying, that it, man.

Z: Yeah, I mean we have four more scenes coming, each of them with a different feel.

P: That would be cool, to like explore the different genres of music, you know what I'm saying? Absolutely, a lot of variety.

Z: We've got like a Wild West one. I want to get like some Spanish guitar.

D: I started the drum beat for that one.

P: Oh, good. Now do you guys all have experience in music?

D: I do.

K: I don't, really.

Z: You gave me piano lessons when I was like eight.

P: Exactly, many years ago. (laughing)

Z: I wish I stuck with piano.

D: I do too, sometimes.

P: Hey, you're still doing a lot with it, that's great.

(Off-topic conversation)

Z: When we're done with the final version, do you want a copy of it?

P: Yup, absolutely.

Z: Okay. Were there any parts of the app that didn't work well?

P: No, I mean, I immersed myself and made sure that I was able to do it, you know what I'm saying? I mean when [assistant] said she saw me and I couldn't let go of the stuff. I practiced a lot before I entered the classroom. I just think that, and again, I think with it being a new program, and it's even becoming intuitive with the Mac and whatever it's, you know, the more I think I did it, and we went to the classroom, and again, minor, minor glitches. You know what I'm saying, it was just the fact of you know, getting used to how to actually get the planet or the star to ignite or whatever.

Z: Our advisor was using it and he was like perfectly timing, it was crazy. He just picked it up instantly.

P: That's cool, very good.

Z: Did you show any teachers, any other teachers?

P: Nothing per se, just [music teacher].

Z: I know my mom had seen it and she was like "Oh my god!"

P: Absolutely, and I'm sure word will get out, we'll share it more. You know what I'm saying, we put it in the Vlog, you know what I'm saying, so it's going out to the world.

Z: We're gonna publish this, like the study, in our school paper. We'll send you a copy of that.

P: We would love to see it, absolutely.

Z: And he's gonna put it in his big project that he's been working on, our advisor. And that's posted online and there's a lot. We'll send you the project he made, it's unreal. Yeah, with all the interactive stuff, there's like laser tracking, like you have a laser pointer and you just point it at the camera and it's pretty cool.

P: Oh, that's cool. And it actually interacts with the screen?

Z: Yeah. What was the kids' favorite part about the application?

P: Getting up and doing it. Absolutely, I mean every child raised like "Can I be next?" and we'd pick somebody and they'd be like "Awwwwww" (laughing). And then I'd be back and then [music teacher] said he's just gonna incorporate it into his classroom.

Z: Did they ever get sick of the song?

P: Well, I think that's any bell curve for enjoying music. I mean, you're gonna get to a point where you're like "Pshh" so that's why you need that variety, you know what I'm saying? Because that's where you're gonna lose that interest, so that updatability kind of thing.

Z: I can't wait until we get variety. Hearing that song makes me want to pull my hair out now.

P: Yeah, that's just the bell curve of appreciation.

D: Yeah, what we originally wanted to do was have each scene have three different tracks, so you would have the three different tracks for each scene, and then there's five scenes, so there would be a lot of variety. We haven't gotten there yet.

P: Right, very cool and good luck. (laughing)

Z: We're gonna post the project so if any other group behind us wants to start working on it, they can actually pick this up and improve on it. So we'll leave them with the information that we have here so they can bring it back.

P: Absolutely.

Z: So did the male students react differently from the female students at all?

P: (laughing) No, it was both. No, it's a good question, I'm just giggling a little bit, just got my funny bone. No, it is a heterogeneous setting for the class for the boys and girls, it was perfect.

Z: We were just making sure like the scene didn't target one gender

P: Oh no, hello, STEMM? I mean, you guys know STEMM, I mean, the whole astronomy thing and all that other stuff. I mean, that's perfect. We're a big STEMM school, so it kind of has a pull for us, boy and girl.

Z: Our last question, can't wait to hear your answer. Did you personally enjoy the program?

P: Ah, yes, I'm playing with it in my office. I'm gonna have to say yes. (laughing)

Z: Bring it home and play it.

P: Yeah, absolutely. It was a joy, an absolute joy. So thank you.

D: And you mentioned earlier about the low notes and everything. Can you just repeat that for the recording?

P: Oh, repeat that? The children made the suggestion of the fact that the larger planets should be your bass notes or your bass sequences and you know, the more celestial stars and that kind of stuff should be more soprano into your tenors, which would be, I don't know…

Z: I think right now we just grouped it with the way…

P: Absolutely, you know if you're doing like a farm scene or whatever, the cow would be the bass or tuba.

Z: Yeah, we could just change the filepath and put in the sounds. Were there any other suggestions they had?

P: No, just that it was hard to see on the Eno Board with the background. But I mean, once you became adjusted to it, you know what I'm saying, and again it's initial.

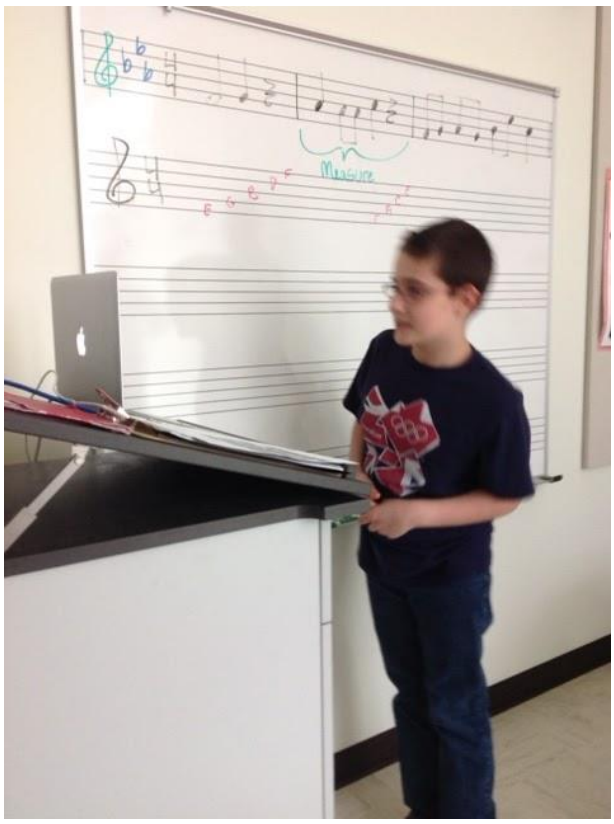
Z: Could you easily see the person behind the scene?

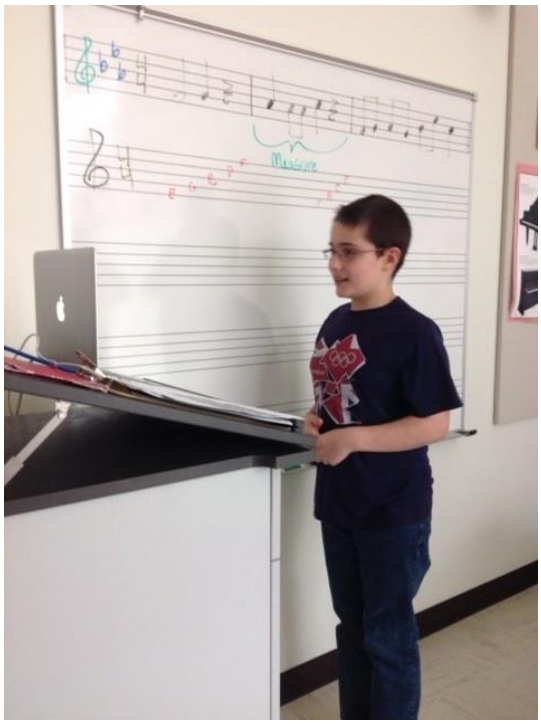
P: That was the hard part, they wanted to see more of the child. They wanted to see the friend interacting with it. You know, that was the biggest issue. It was awesome, the kids loved it. They wanted me to stay forever and I was like "I gotta go, guys. We'll come back again." (laughing) Then again, you want them to want more, so… we definitely left there with them wanting more. I think that definitely was the goal of what you guys wanted to do.

Z: So a good, big success?

P: Yeah, huge success. Ton of fun. I put it on my little thing [laptop] there too, so...

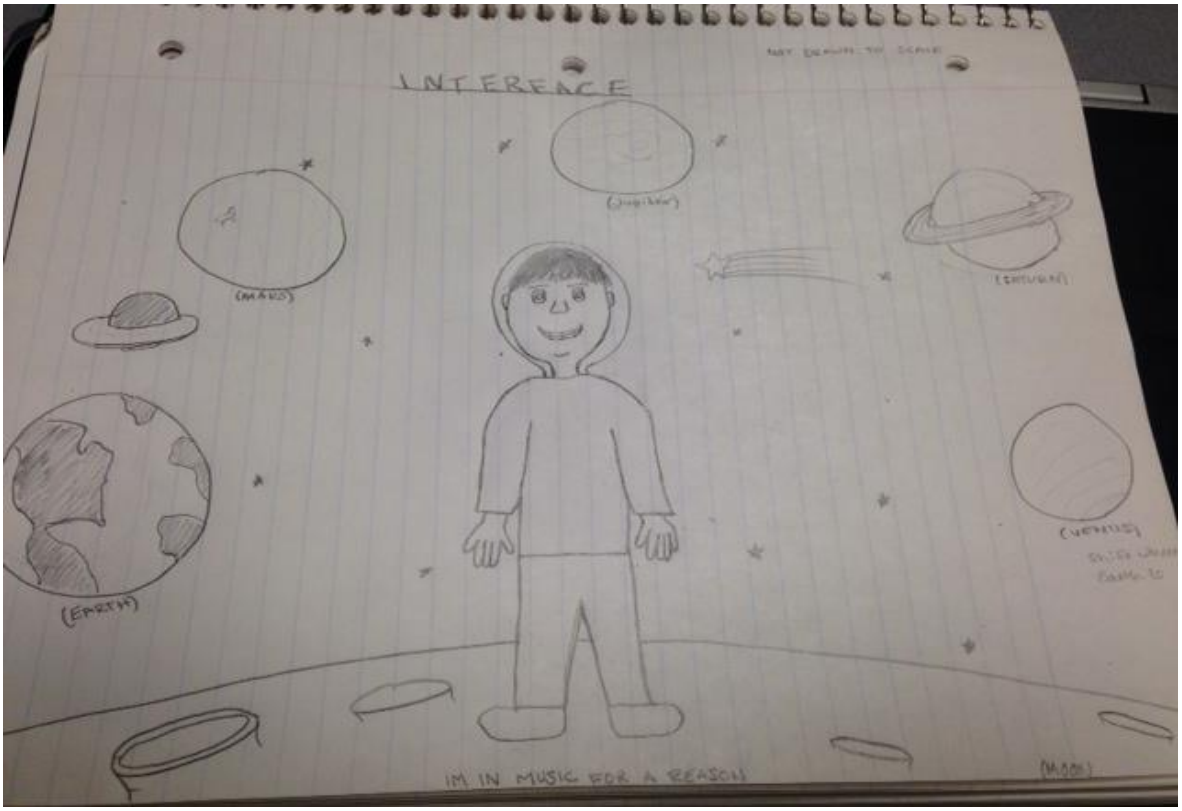
H. Application in Use

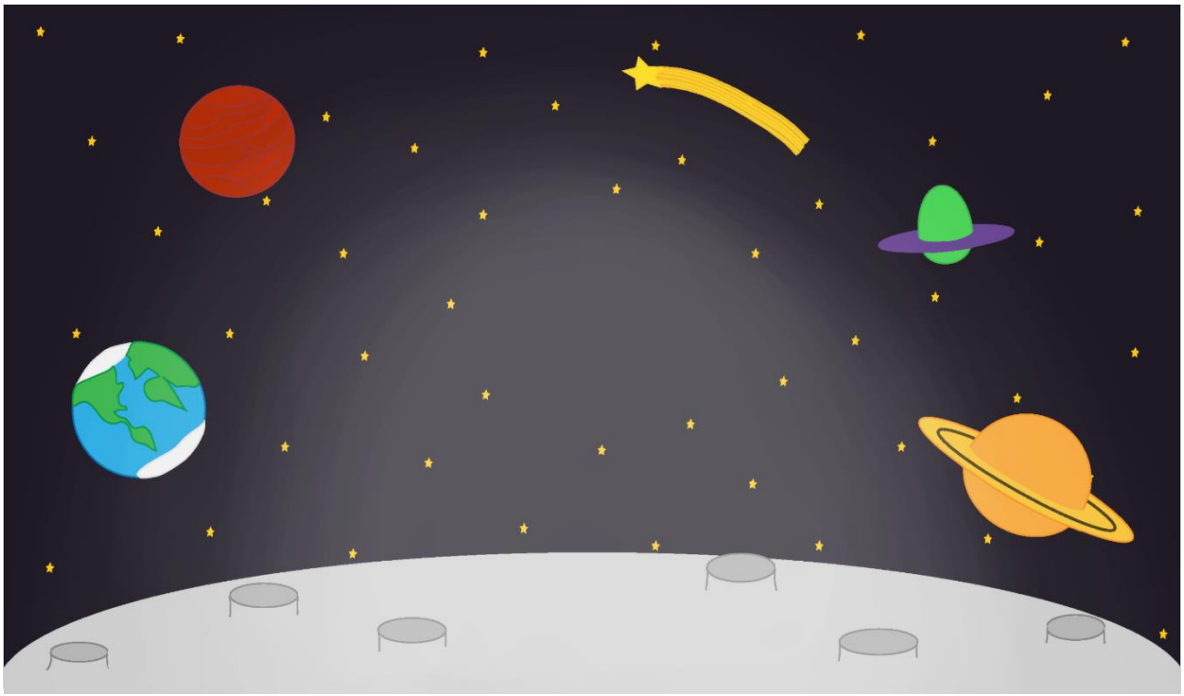




I. Original and Digital Scene Designs

Space:





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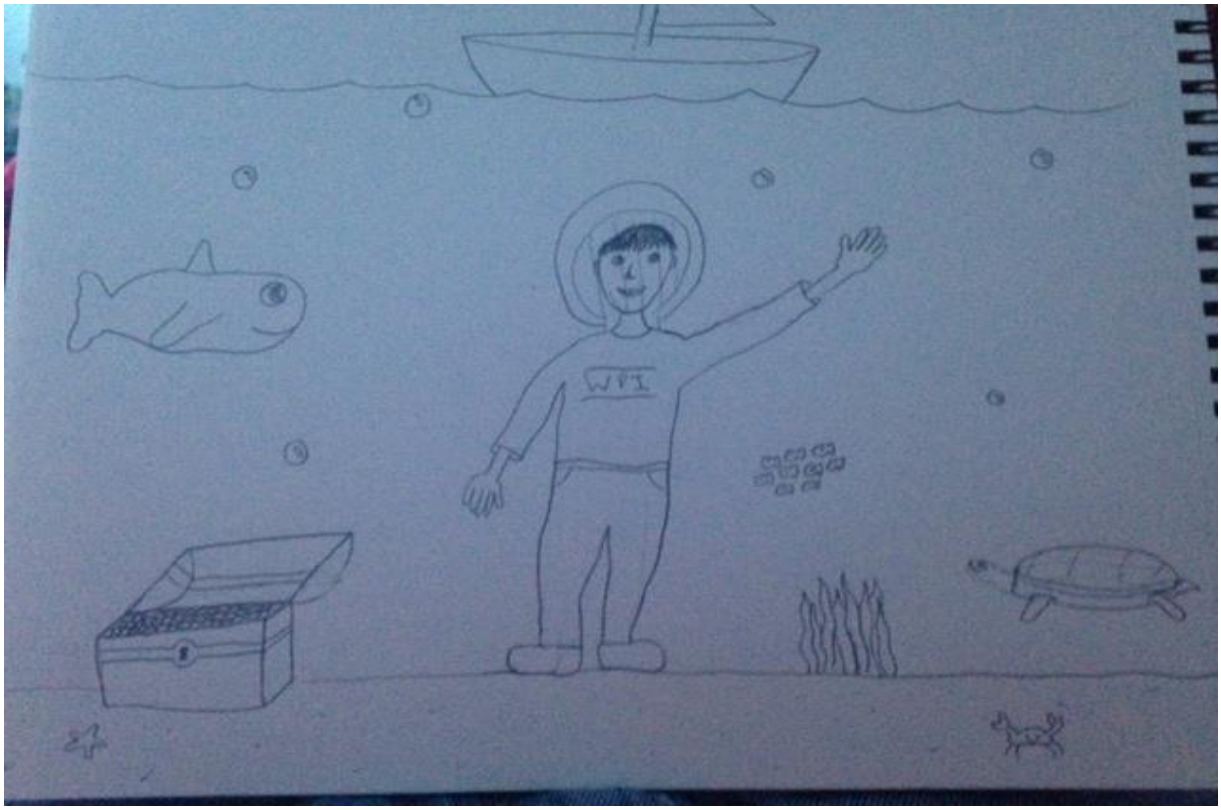
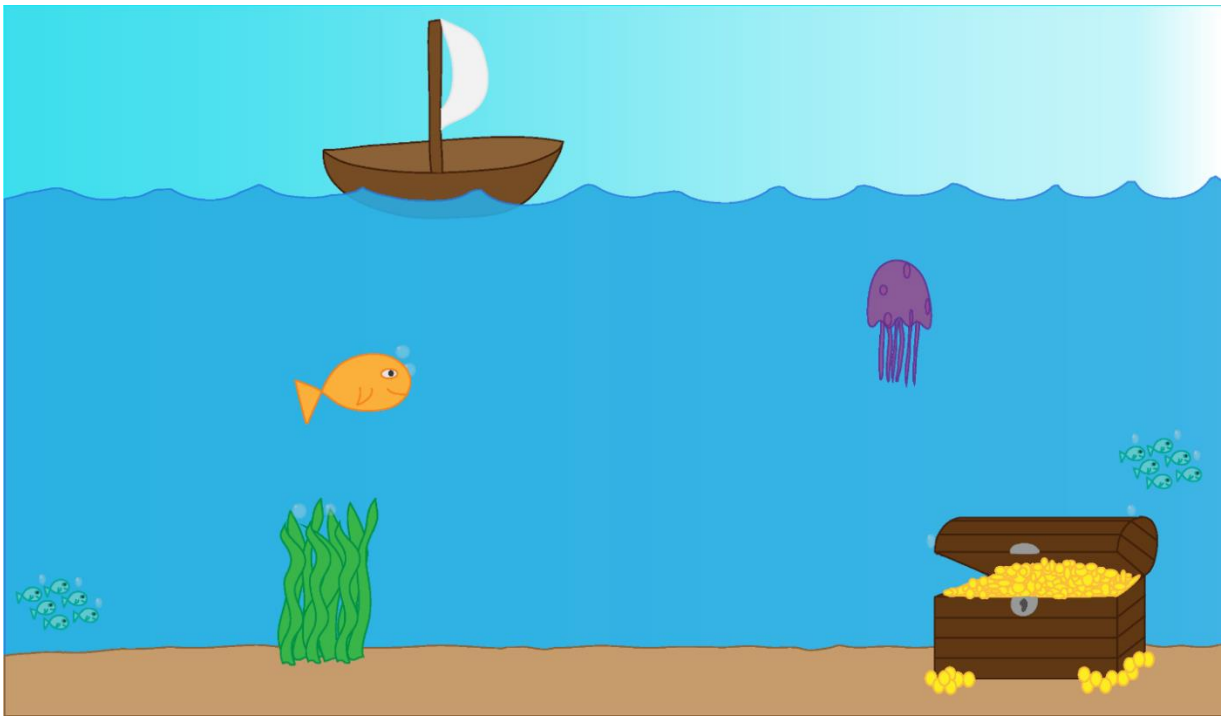
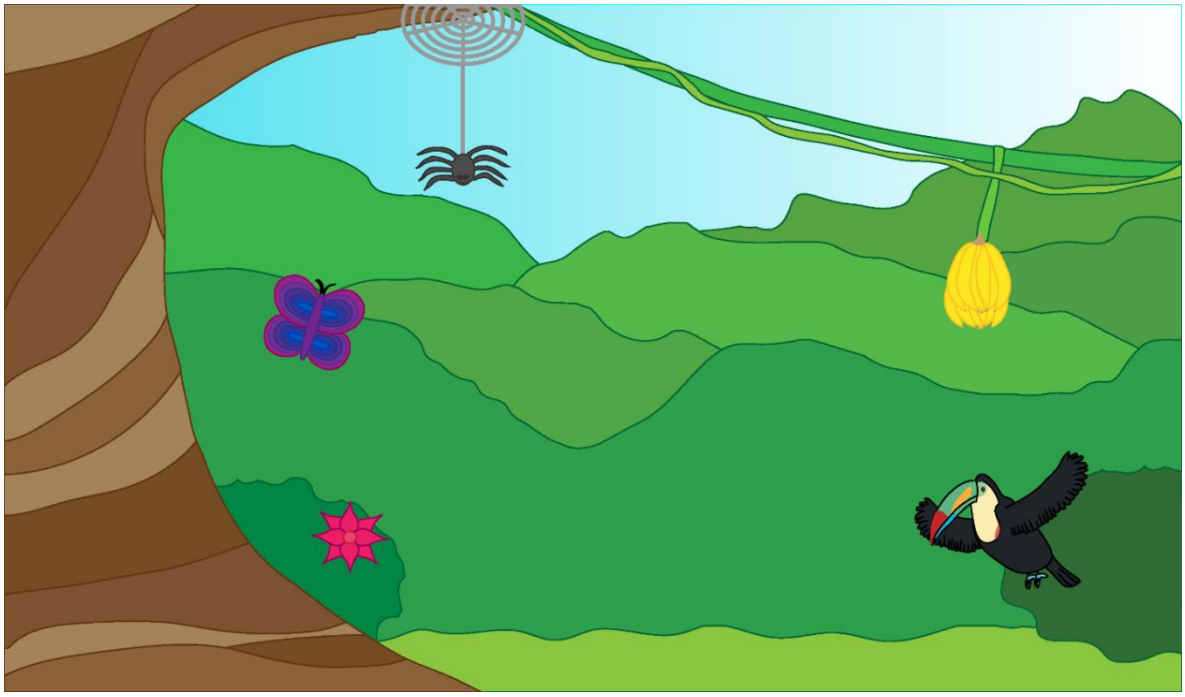
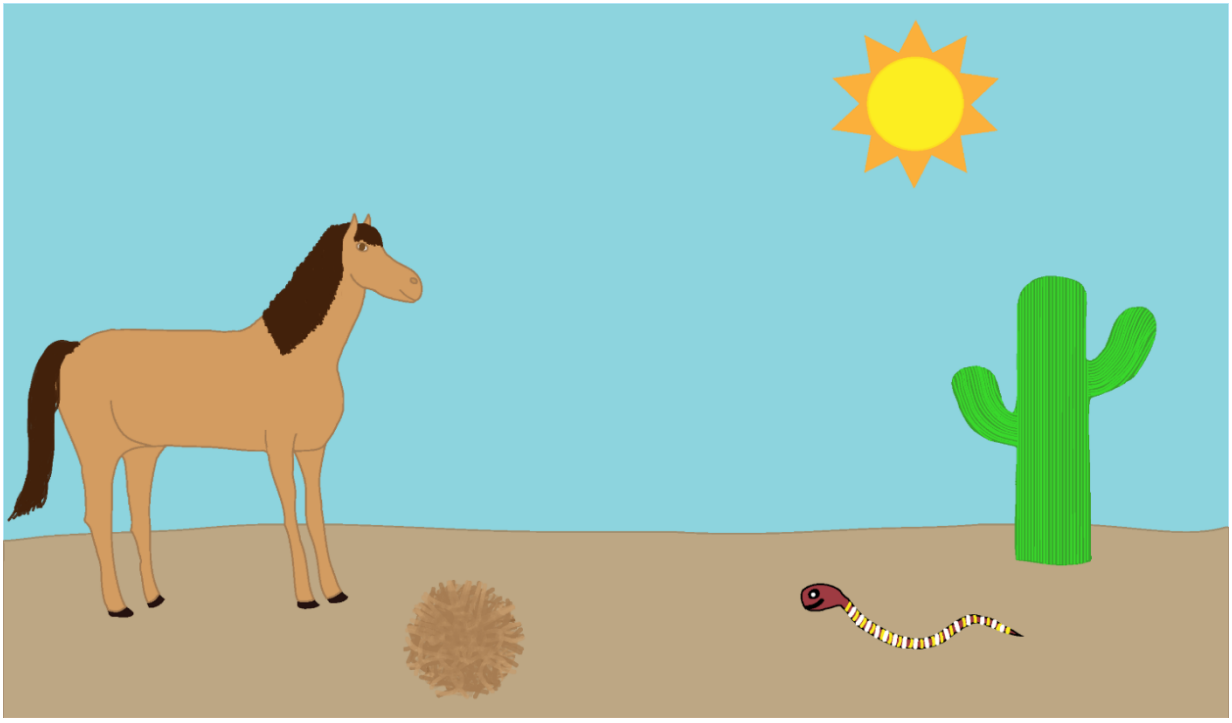




Jungle:

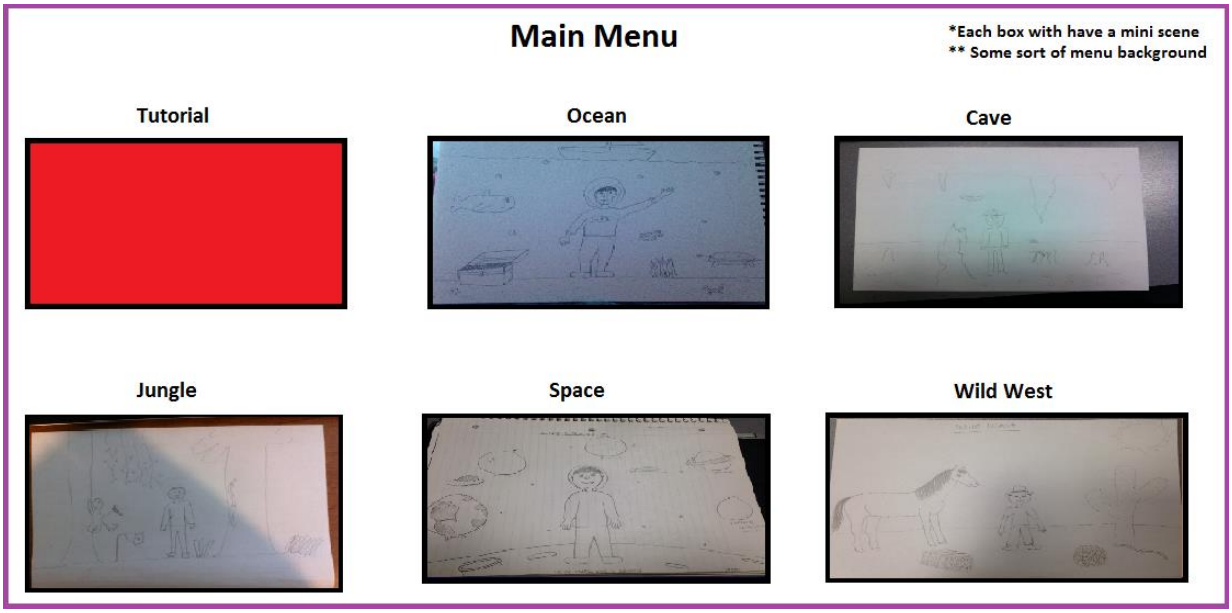


Wild West:



Cave:

Main Menu:


Main Menu
*Each box with have a mini scene
** Some sort of menu background
Tutorial
Ocean
Cave
Jungle
Space
Wild West


Main Menu
Tutorial
Caves
The Jungle
Space
Wild West
The Ocean