Interactive Music Composition App for Children

An Interactive Qualifying Project Report

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By:

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Onder Goksaran

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Kemal Yorulmaz

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Dervis Goksun

Submitted to:

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Vincent J. Manzo

Abstract

The objective of this project was to eliminate hindering factors of creative musical expression in children by developing a computer application that aided in performance and composition. Our application, DragNcompose, targeted children attending primary school, under the age of 12, and used a basic camera attached to a computer to control various musical loops. Our application tracks the movement of the user's hands to position and move virtual sliders to control instrumental loops. The motivation for this project was to help children cultivate interest in music. The viability of DragNcompose as a facilitator for classroom musicianship was assessed by a professor of music at a public university who reviewed the application and filled out an open-ended response survey.

Acknowledgements

The interactive music composition group would like to thank, Professor Vincent J. Manzo, our project advisor from Worcester Polytechnic Institute, for his invaluable guidance and terms-long feedback. We also would like to thank Dr. Rick Dammers for his exceptional and noteworthy feedback, which lead us to finalize our project and consider future works that can be done.

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Chapter 1: Introduction

Music composition is a creative task, which demands a set of skills and technical knowledge from potential composers. Some of the technical knowledge needed includes music theory, instrumentation, and the ability to work with musical notation, which take long periods of education to learn and digest in order to be effectively used to compose music. An aspiring composer may be unable to express his or her creativity in musical form as a result of his or her lack of theoretical knowledge and musical skills.

Children who attend primary school are prime examples of individuals who enjoy composing, but lack theoretical knowledge of music composition. Since there is no prerequisite to enjoy listening to music, we wanted to provide our target audiences with an application, which has fewer prerequisites to making music than are offered by traditional acoustic instruments.

This project aimed to eliminate factors that could potentially hinder creative musical expression in children by developing a computer application that uses camera input to facilitate performance and composition. Considering a number of existing control mechanisms, we found that camera input would give children the most freedom of control while maintaining the aspect of fun.

Our application uses a basic camera attached to a computer to control various musical loops consisting of a number of different musical instruments. It uses the movement of the children's hands to position and move virtual sliders vertically across the screen. The sliders control the gradual build-up of instrumental loops, in order to give children a sense of progression.

Chapter 2: Background

When building the application, the group aimed to create something that was as fun and engaging as possible. In light of this idea, it was obvious that the way our app would be controlled was the most crucial component of the design for immersing the children in the activity they are participating in. We took a look at existing applications of interactive music systems developed for children in order to understand what kinds of specific activities we could likely use for our project. During the literature review process, we considered different programs and controller options to decide which of them would be a better fit for our goal.

2.1 Mouse Controllers

A standard computer mouse is an accessible control mechanism used for a variety of computer operations and game applications. The mouse has an advantage of easy control and can be used to manipulate various elements on the screen. Software has been written to take advantage of the mouse control's accessibility and repurpose it for musical outcomes. One such application is the "Compose Your Own Music" game (Total Media Source, 2002). As seen in Figure 1 below, basic game play in "Compose Your Own Music" involves dragging notes of different duration onto a staff to form music that is played back. Musical rest signs also exist and can be incorporated among the notes. The measures are limited to four beats, the placement of the notes is restricted to chord progressions and a single instrument timbre is used. The mouse is only used to move notes around and play the music. The most prominent advantage of this application is its ease of use without requiring any additional hardware.
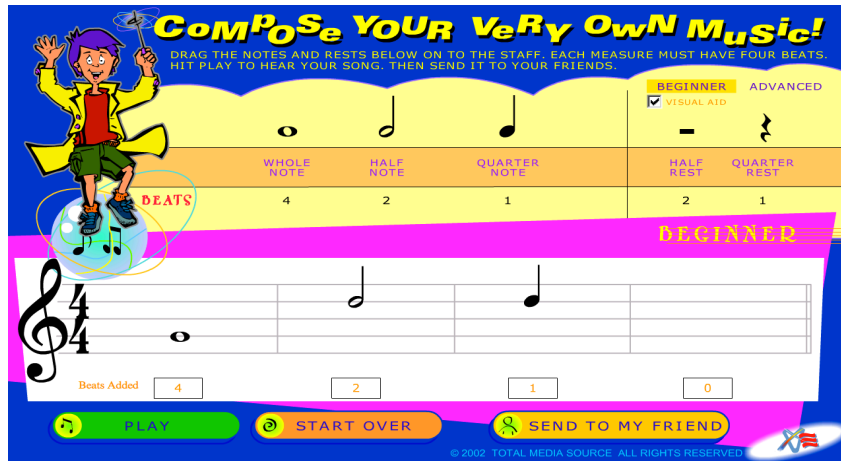
Figure 1: Compose Your Own Music

Another example, shown in figure 2, was the "Play Boomwhackers" game Plank Road Publishing, 1997-2014). The mouse is used to click on the color-coordinated tubes arranged in an ascending order of pitches to get sound. The user can play freely with no limitation on the order of notes she has to play. A whole scale of thirteen notes can be played, while the option to only play the diatonic scale is present.
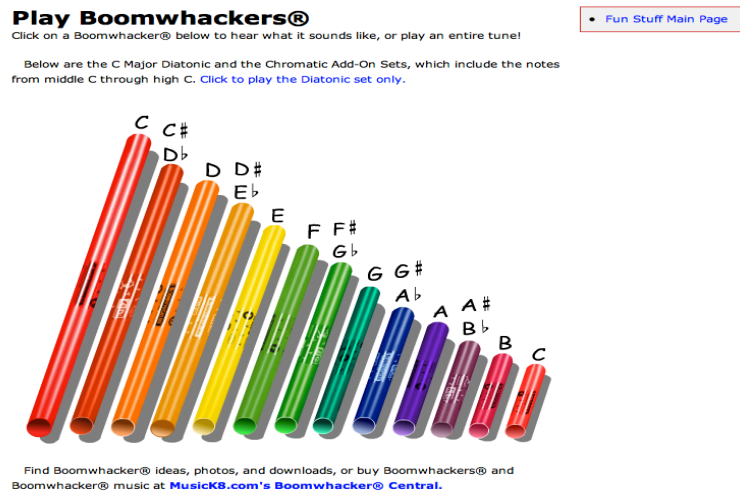
Figure 2: Play Boomwhackers

2.2 Keyboard Controllers

"Playing with Beethoven", shown in figure 3 below, is an application that uses the computer keyboard as the interactive music-making tool. Using this software, Beethoven's Sonate Op.31 No.3 utilizes the keyboard keys that correspond to different chords. Each keystroke plays one step of the piece, while the timing of the keystrokes is left up to the user. In addition there are options to go back to the beginning of the piece, and to play the entire piece with correct timing.
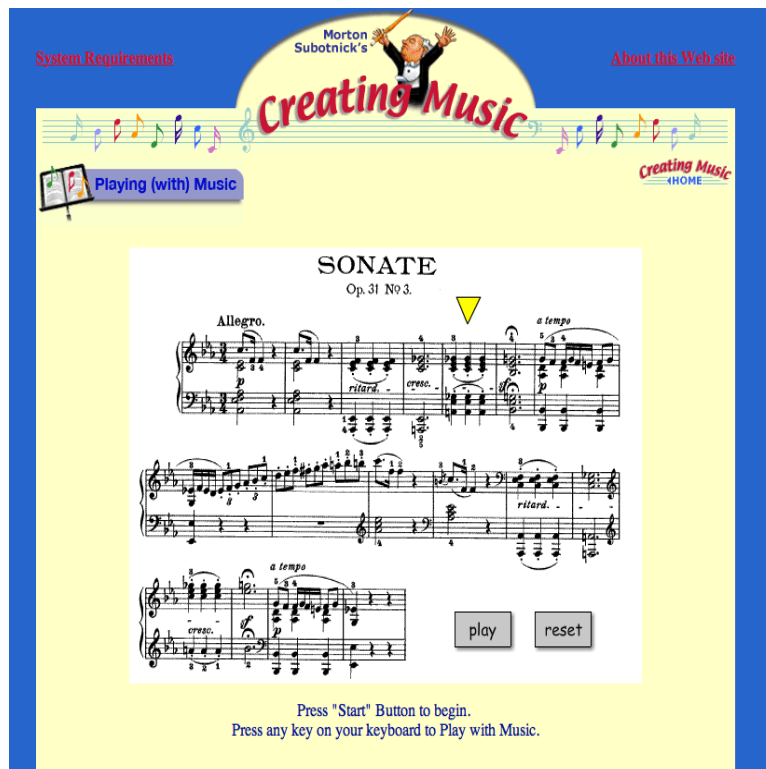
Figure 3: Playing Beethoven

The "Performalator" is another noteworthy application directed at kids, which uses the keyboard as the controller[4]. The user can choose among 6 music pieces to play. After choosing one, notes, which are colored and numbered, appear on a staff. A scale of 11 colored notes is presented to the user, which can be played using the number keys and the "-" key.

The user can choose to play the musical piece she chose with the help of the color code by matching the colors of the notes on the staff and the scale, or play freely using the notes she is given. The user is also given the option to go back and choose another song from the list initially given.

2.3 Camera Controllers

A noteworthy application using cameras as a controller was Yuvi Gerstein's "Drawing Music" (2011), which is represented in figure 4 below. This program used a camera pointed at a blank sheet of paper. When the user paints or draws on the paper using red, blue, and green colored pens, the application takes in the color information to form music. This application enables the user to convert drawings into music.

Figure 4: Drawing Music

Another particularly interesting application was called "Children's color-based note sequencer" (2013), which is shown in figure 5. This is another software, which uses the camera as the means of control. The camera input is analyzed and the color information is transferred to a note sequencer, which produces notes according to the data it receives. The application responds differently to different colors by changing pitch, duration and timbre. Unfortunately, this application was not published, so we could only examine it through video. However, the concept is interesting enough to mention.

Figure 5: Children's color-based note sequencer

2.4 Other Controllers

"Pitch Painter" (Subotnick, 2012), is an iPad application, which uses touch screen controls as shown in figure 6 below. Although directed at a younger group than our target, Pitch Painter uses interactivity to make composing available to children. The user can use colors to paint on the screen. Each color represents an instrument and the user can choose between them by tapping buttons on the screen. Sounds are put out simultaneously as the user paints. The

painting then can be scanned from left to right or right to left, to produce sounds corresponding

to the colors used on the painting. The canvas can also be edited anytime and work can be saved

and loaded.

Figure 6: Pitch Painter

These applications all share this commonality of engaging user interaction, user

friendliness and appeal to the aimed age group. In light of this, our efforts to develop an

application need to prominently fulfill these features. While the mouse or the keyboard would be

extremely easy to use, we though they were not interesting or engaging enough for children.

Pressing keys provides a mundane experience for children in the sense that channeling their

creativity is limited to a number of keys. Touch screens and cameras would be slightly tougher to

base the application on, however, they can immerse the user for a better experience. Taking the

accessibility of these hardware into consideration, we believe that the camera is a perfect match

for our project.

Chapter 3: Methodology

The objective of this project was to eliminate hindering factors of creative musical expression in children by developing a computer application that uses camera input to aid in performance and composition. The application was developed to focus on assisting children attending primary school, under the age of 12. The group completed a single person case study. A professor of music at a public university tested the application and filled out the provided open-ended response survey in order to give feedback on the performance of the application.

3.1 Previous Steps

The team went through many ideas before deciding on our current design concept. Over time, we built upon some ideas and rejected others. We strived to come up with a design that would allow children to receive musical output regardless of their performance in controlling the application. Using games that would allow the user to win in some way would mean that the user could also "lose", which would stop music composition without the user voluntarily turning it off. Therefore, we eliminated ideas that involved a specific goal to be accomplished to produce music.

Another guideline we set as a team was to lift as many barriers as possible between a child's creativity and music composition. Making music was the primary goal we hoped to accomplish with our application, and in order to do that, we decided against using techniques that would require children to learn how to operate the application correctly before enjoying it. The consensus was that we wanted children to jump into the activity and not worry about long tutorials or lessons.

3.2 Previous Project Considerations

Among many more basic ideas and concepts, these were the major designs we contemplated about the most before moving on to others. We discarded these ideas because we either thought they did not fit our guidelines or we improved it in a way that would be more fitting for our goal.

We experimented with the idea of a sound pattern matching game. This would resemble a memory match game, where instead of visual cues, the player would try to match pitches, melodies and timbres of various kinds to succeed. We planned on using the mouse as a controller to pick individual items on the screen. We eventually chose not to go for this kind of design because the music making aspect of it was very limited and the fun factor would diminish severely after even one game.

Another idea was using a graphics tablet, connected to the computer that would bridge two creative activities and would be very engaging for the user. We planned to take the graphical input of a painting drawn by the user, and simultaneously generate music according to color, shape, and position information from the painting. The reason we let go of this idea was the limited availability of graphics tablets. We did not want to limit our target audience by requiring a specific piece of hardware that is not widely available.

The mouse and the keyboard became prominent considerations for our application implementation given their accessibility and familiarity with most computer users. We thought about many styles we could use them, which included using the entire keyboard as a synthesizer to control all aspects of music produced by the application, or using the mouse positioning to generate pitches in real time. However, we quickly grew away from these ideas seeing the

innumerable examples of keyboard and mouse controlled music systems that already exist and how boring and limiting they can get in a short period of time.

3.3 Our Design

We ultimately considered the advantages of using a camera over a hardware controller and decided on using the camera as the physical controlling component of our application design. One of the reasons of our choice is the idea of operating the application without coming into contact with anything was interesting and attention grabbing for the users. We also wanted the control mechanism to be intuitive and not rely on heavy instructions. Accessibility was also another concern we had with controllers like graphics tablets, so cameras were a good solution since they are very widely used and inexpensive.

Our design consists of the camera input of the user with four controllable sliders overlaid onto the camera feed. At first, we built our application with 7 sliders, however we removed some of them in order to get better results. The sliders are modeled instruments being piano, guitar, bass and drums from the right to the left. The user drags and moves the instruments virtually up and down across the screen in order to control music loops of the four different instruments (drums, bass, guitar, piano). Each slider has an icon representing its purpose and has three levels of placement they can be set to. Moving the instrument up on the screen gradually builds up the corresponding instrumental loop in musical activity. The interface only has the camera feed and four instruments. Another feature of our application is adjusting the sensitivity of the sliders. The sensitivity scale goes from 1 to 10. Our group found the best sensitivity option to be 5, however

the users can set their own sensitivity scale. The group chose to name the application as

DragNcompose, since the aim of this application is compose by dragging.

3.4 Building the App

We built this application using Max/MSP visual programming language. The reason for

this is that we found Max/MSP to be versatile and competent enough for our design concept.

Max/MSP is also very user-friendly and has a big community of users that support the

development of new projects. We built the application using both the objects existing in the Max

language and external objects, premade instrumental loops, and artwork for the sliders, which we

created using the Autodesk Maya program. The pre-made loops we used were obtained from the

Apple Garage Band library. The application estimates the optical flow of object using the camera

and the movements of the user to manipulate the place of virtual objects in 3D space. The

positions of the objects determine which loops are played, therefore making up the music.

3.5 Assessment

The group completed the first assessment part of the application and then the

application was distributed to a professor of music at a public university. The group provided the

professor an open-ended response survey consisting of seven questions. The questions were on

the performance and viability of the built application (see Appendix A). The aim of the questions

was to provide the group with useful feedback on the outcome of the project.

3.6 Our Experience

When you launch our application, DragNcompose, two windows, will pop up as in figure below.
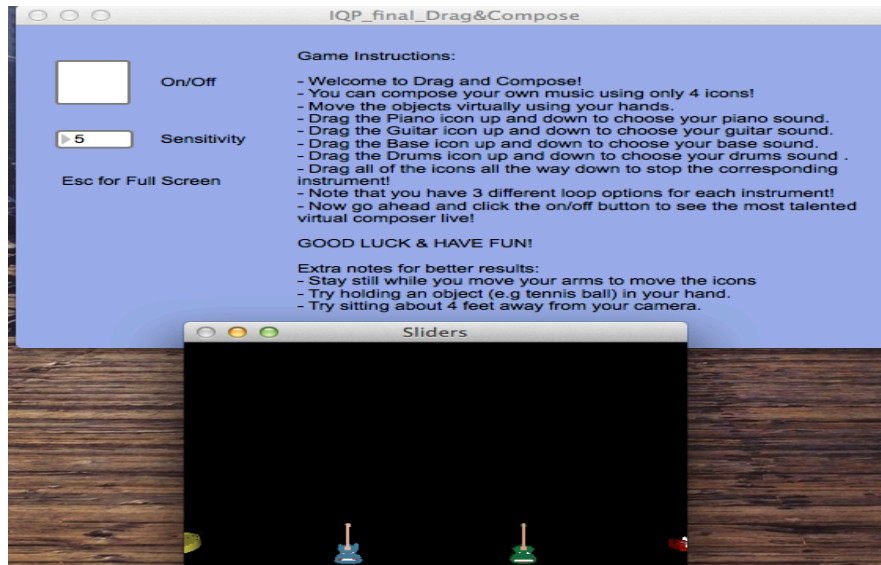

Figure 7: DragNcompose Starting Window

Before getting started we highly recommend the users to read the instructions carefully for better results. Once the instructions were followed one can simply press the on/off button to activate the camera and the sliders.
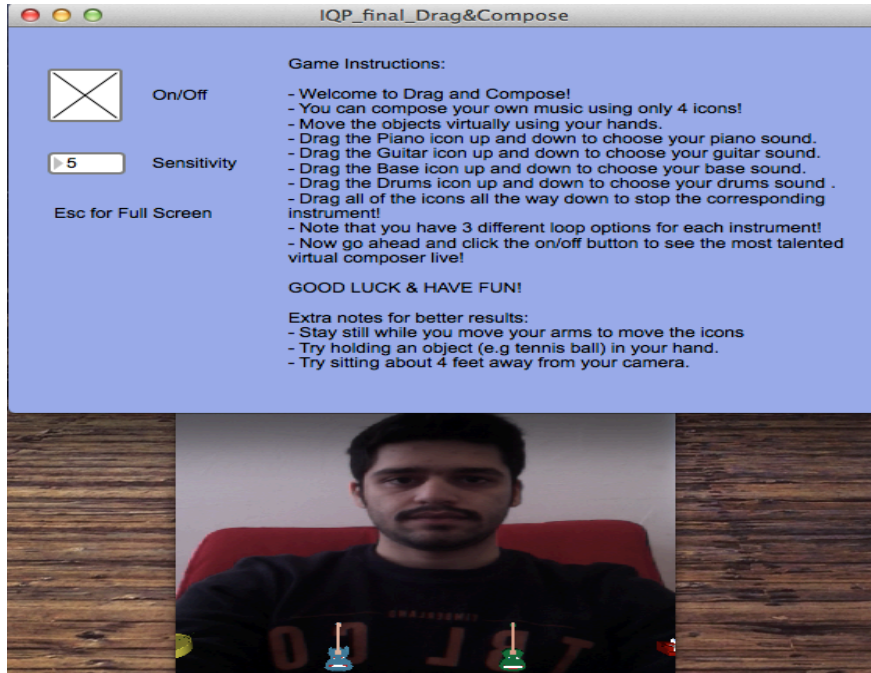
Figure 8: DragNcompose Starting Window On

As described above, each slider represents an instrument and has three different levels of placement they can be set to. Below are some screenshots from our application while our group was experimenting with the application. As seen below, bare hands or small objects can be used to move the sliders, while holding an object increases the responsiveness of the application.
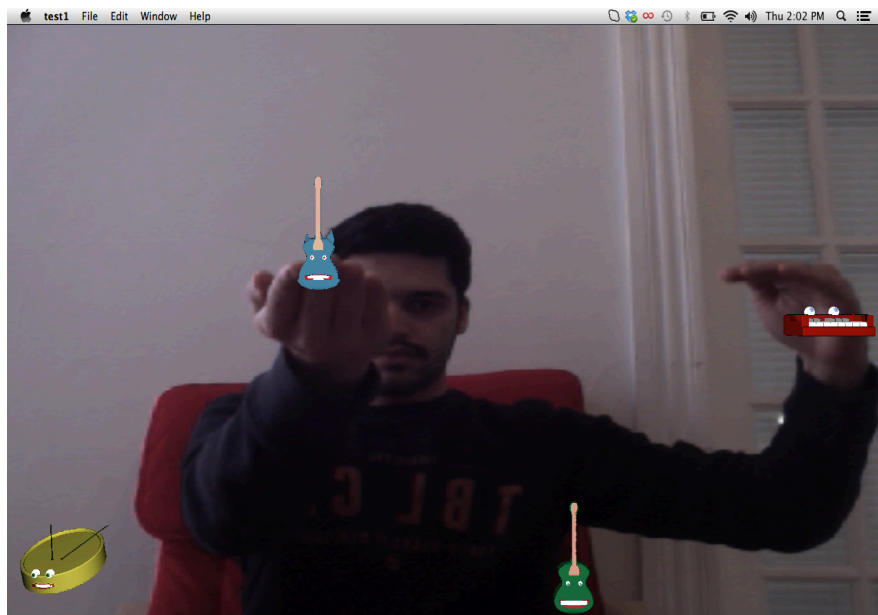
Figure 9: DragNcompose with Objects

Figure 10: DragNcompose with Hands

Chapter 4: Results

After building the application we ran our own tests in order to determine the parts of the application that could be improved for better results. The group decided to break down the evaluation into categories. The application was evaluated based on its ease of use, interaction environment, user interface, musical material, and educational use. After the first tests, the application was sent to Dr. Dammers, a music professor, and he was asked to test the application and fill out an open-ended response survey (see Appendix A). The survey questions were based on his experience testing the application and the evaluation categories, which would enable us to get more information on how the users approach our application.

The group aimed to make this application as fun and easy as possible to use for primary school students. Therefore we added some instructions onto the opening window of the application. Furthermore, a quick video demonstration was recorded and will be provided to the users to help their performance. Dr. Dammers found the instructions to be very helpful and emphasized that the video format was a very good idea to help the students to perform their best.

Another evaluation topic was the interaction environment. During our tests, some important details about the application's performance caught our attention. The group realized that the application performs better under certain conditions, which includes, wearing a dark colored shirt and holding a small object (e.g a tennis ball), sitting in front of a wall and positioning yourself in such a way that the background is static. Since the application uses camera input and detects movements, the background is very important to eliminate the unintentional movement of the sliders. This was one of the biggest concerns of the group and we pointed this out by asking Dr. Dammers' experience on this. One of the survey questions asked Dr. Dammers to explain us how

he used our application and his opinion on what conditions the app performs best under. Dr. Dammers words on this were as follows: "I tested the app for 30 minutes at home. The app worked best when I was wearing a dark colored shirt and when my face did not appear in the picture. This allowed my hand to show up better against the background field." Dr. Dammers' experience and opinion authorized the preconditions that we took into consideration for better results.

Another important aspect of the application is the visual interface. First we tested the application with 7 sliders overlaid onto the camera feed. After making some analysis the group realized that controlling 7 sliders would be a complex task for our target audience and we finalized the application with four controllable sliders corresponding to piano, base, guitar, and drums. His first impression about the instruments was the novelty of the visual interface. He also pointed out that the instruments and the application in general was entertaining to play with. For the instruments, Dr. Dammers added: "The only difficulty that I noticed was that I found it hard to control the inner instruments without accidentally moving the outside instruments." Dr. Dammer's comments on the instruments prove that we made a successful decision by reducing the amount of sliders overlaid onto the camera feed.

We, as a team, concentrated on making the application fun, and delivering a tactile experience for the users. Therefore, we could not spend as much time on creating the music to be used in the application in the limited amount of time we had. Dr. Dammers pointed out that the musical material should be expanded. In this state, our application is limited in its functionality overall. "It would also be cool if the sliders controlled a different parameter- like volume- i.e. a traditional mixing board." Dr. Dammers added.

DragNcompose, initially, was not designed for educational purposes. It was aimed to provide a fun experience for children using music. However, according to Dr. Dammers' response, our application has a lot of interesting possibilities for music education. Meaning, if modified, the application could be a viable tool for use in the classroom.

Chapter 5: Conclusion and Future Considerations

Based on our findings from the survey that Dr. Dammers completed, we have developed recommendations and conclusions that aim to improve our app. Areas for additional improvement for the user interface could include providing screen marks for each possible position of the controlling sliders within the frame to make the application more definite and easy to use for children. In addition, holding a small object to alter the slider position could provide a tactile experience along with a visual frame and could be more engaging and satisfying for young users. For a greater variance in user experience, adding a bank of musical loops from which the user can pick which loops to use would benefit the application. As our application provides limited combinations of loops for children to compose their own music with, enabling users to insert loops from a larger bank would be more entertaining. By this way, the application would have greater re-usability. Also, if further developers want to increase the target audience of this application, it would be functional to add extra sliders to control different parameters like volume or tempo.

We hope that our application can make way for better versions and iterations in the future. The application and the source code can be obtained form the EAMIR website (Manzo, 2007). We believe that a follow-up study using this app should be on its potential use in music education. Since Max/MSP proved to us to be a very versatile and capable platform, the application can be taken much further with sufficient effort. The project could focus on introducing musical elements such as, pitch, timbre, rhythm, melody, dynamics, and texture. For development, based on our program, some obstacles would include increasing responsiveness to movement captured by the camera, formatting the application to fit educational standards, and increasing its reusability through additional customizability. We are firm believers that education

should be a fun experience. Therefore, any upgraded version of DragNcompose should focus on building on the fun factor for children. Developers should ask themselves whether or not the app grabs attention, how useful it is for an alternative to traditional teaching methods, and how customizable it should be to fit the needs of specific classes.

To conclude, we believe that, with our application, a camera attached to a computer is sufficient for anyone to compose music without musical knowledge. When building this application, our aim was to help children enjoy musical composition and spark interest in the field of music. In the light of our main objective, DragNcompose was successful. With the recommendations provided, the application could be developed into a tool for education in music for children.

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Appendix A

Open-ended Response Survey

1. Were the instructions clear and helpful?

2. Did you have any trouble operating the app?

3. How did you test the app? (How long, where etc.)

4. What were your general impressions after using this program?

5. What did you particularly like/dislike about the application?

6. Under what conditions did you think the app performed the best?

7. How could the application be made better? If you made this application, what else would you

   put in it? How could it become a more viable application for classroom use?

Appendix B

Survey Response

1. Can you tell us your opinion about the instructions? Were they clear,

 helpful and easy to follow?

   The instructions were helpful- the video format is a good idea.

2. How did you test the app? (How long, where etc.)

   I tested the app for 30 minutes at home.

3. What did you particularly like/dislike about the application?

   I liked the novelty of the visual interface- it is just fun to play with.

4. Under what conditions did you think the app performed the best?

   The app worked best when I was wearing a dark colored shirt and when my face did not appear in the picture. This allowed my hand to show up better against the background field.

5. What were the difficulties you experienced while testing/using the app?

   The only difficult that I noticed was that I found it hard to control the inner instruments without accidentally moving the outside instruments.

6. What are your general impressions about the application? How do you think it could be more suitable for educational use?

I think this app has a lot of interesting possibilities for music education. I have two suggestions for future developments. The first is to make the experience more concrete with on screen marks for each position. This will frame the tool for the user and help younger students 'work the app'. I had my three year old daughters play with it, and they first tried to touch the screen (like an iPad) and then started to move my hand to move the instruments. I think that there may need to be a tactile experience along with a visual frame to guide their experience.

My second suggestion is to expand the musical material and/or change the parameters controlled. The interchangeable loops worked, but still limited overall functionality of the app. It would be great if students could insert loops form a larger bank. It would also be cool if the sliders controlled a different parameter- like volume- i.e. a traditional mixing board. (This could have uses outside education too.)

7. How could the application be made better? If you made this application, what else would you put in it?

I think covered this above. Overall- I enjoyed playing with the app- nice work! I think the possibilities are exciting!