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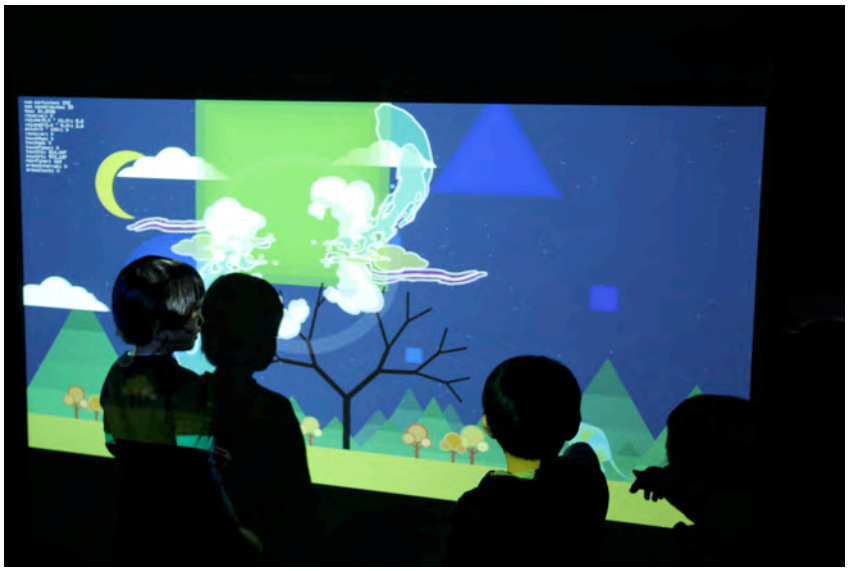
Study on Enhancement of the Creative Field in Music Education

Create an Opportunity by Interactive Art



Abstract
Japanese music education is composed of "Appreciation", "Common knowledge" and "Representation". In this last one, the fields of singing, instruments, and creation are included. However, current education programs are built around singing and instrumental activities, and there has been a lack of improving the creative field. In this study, an interactive art installation was developed in order to offer an opportunity for children to enjoy playing with sounds. In addition, considerations about how to connect this kind of activities to the school curriculum are made. The ultimate goal of this study is to engage children in sound and music, and to make an approximation on how to enhance the creative field in the current education program.

Keywords: Music education, Creative field, Interactive art

1 Background

1.1. The Creative field and music education in Japan

Japanese music education is composed of "Representation", "Appreciation" and "Common matters". The fields of singing, instruments and creation are included in "Representation" [1]. (See Figure 1)

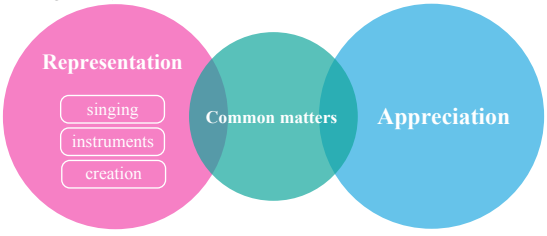


Fig. 1 Configuration of music education in Japan

It is mentioned that in the creative field, children should "find interest in the sounds from the voice and things around themselves, and play with them". It is also important that "by having fun using sounds to make music, musical structures should be shown, and create easy compositions".

Nevertheless, the current education program is focused in singing and instruments, and there has not been sufficient emphasis regarding the creative field.

In a related research [2], a questionnaire took place in order to investigate the children's interest in music. The results were positive on the singing, instruments and appreciation fields for most of the respondents. However in the creative field, the number of positive answers was cut in about half. (See Figure 2)

Causes of this problem include the lack of specialized

knowledge and anxiety towards the contents of the creative field.

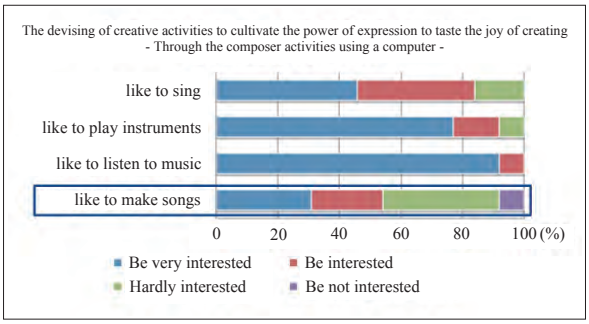


Fig. 2 Results of the questionnaire of the related research

Several studies have been made around this problem; however there has not been any around the idea of making the act of composing a musical piece fun. Some of these studies part from encouraging the children's interest in the sounds from the voice and the things that surround one, as mentioned in the creative field. Also, many focus on interesting the children in sound through acts of play. Although many of these only stay in the teaching method and those with verified practical content are scarce.

This research parts from the concept that by increasing opportunities for the children to get in contact with sounds and enjoy playing with them they will be interested in the act of making music, leading to an enhancement on the creative field of music education. Making music requires making choices about sounds, however these choices are limited in the public spaces of our modern society. This is because the environment is surrounded by multiple noise sources that decrease the possible sounds that can be heard outdoors. As a result, a decline in recognition of sounds has been occurring among children. In other words, opportunities for the children to stimulate their curiosity by interacting with things that surround them have decreased.

From the above, it was concluded that conveying the fun and pleasure of sounds to children had to be a requisite in the present study. Furthermore, since contents with verification were scarcely found in related researches, it was decided to develop contents and test them.

1.2. Interactive art

Technology advancements have brought certain kinds of works that do not fit within traditional art frameworks; from here a new field in art was born. Interactive art is characterized in reflecting the actions of the viewer on itself. Rather than only viewing the art piece, it responds to the viewer in some way. In recent years, Japan has seen a growth in the interest regarding interactive art; in fact the media arts field's budget has seen an increase [3].

Mochizuki, who is an associate professor of Ritsumeikan University in Japan, provides problem-solving opportunities by taking advantage of the characteristics of interactive art [4]. For example, one of his works is a red mailbox equipped with a sensor that reacts when putting inside a letter, and plays nostalgic music related to the postal service, such as "Mr. Goat's mail"[1].

At first glance, these compositions seem useless, however by putting this work in an elderly care facility, it actually becomes a playful way to change the mood of the elderly by hearing old songs every time they put in a letter. This work becomes a trigger, and it leads to new opportunities of exchange between the elderly and their families, and the facilities staff.

In another work, a sensor was placed on the back of a 10 months old baby in order to trace its trajectory while playing and crawling in a room. This trajectory was then presented in visual form as colorful lines. (See Figure 3) By combining movement trails with colorful graphics, an artistic work was made that captured the random behavior of the baby. This transmits a fun picture to the viewer and specially has the possibility of providing a new perspective of the child to his mother.

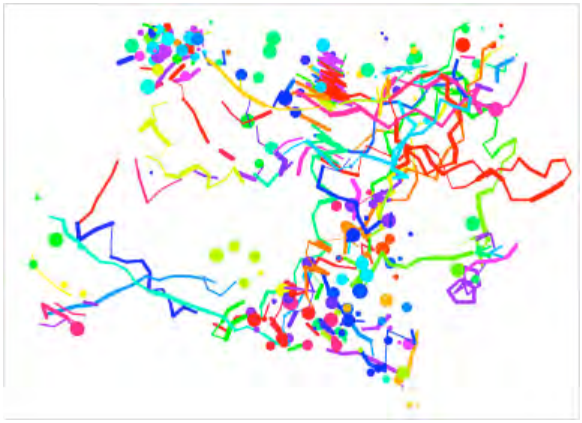


Fig. 3 "Crawling art" captured from a baby's movement

From the examples above, it can be said that although interactive art works do not directly present a method of problem solving, there is an opportunity offered to the viewer in order to get influenced by it. Therefore, the present study aims to create an opportunity for children to enjoy playing with sounds by creating an artwork that uses the characteristics of interactive art.

2 Purpose of study

This study aims to create an interactive art piece that offers an opportunity for children to enjoy playing with sounds. In its development, the following points were taken in consideration.

・An environment that takes advantage of wide space in order

[1] An old popular Japanese song (やぎさんゆうびん).

to offer a joyful experience with sounds for the children.

・An intuitively operable user interface

・A mechanism that can be exposed to volume, pitch, and sound length with a voice interface

In addition, we consider the possibility of connecting fun and play components with learning about sound education, specifically on the creative field. The ultimate goal of this study is to interest the children in sound and music, and to improve the education in the creative field.

3 Artwork Design

3.1. Overview

The artwork developed is an interactive art piece that implements a pseudo-touch screen and microphone as input interfaces. It was designed for children to play without necessarily having knowledge about sound, and it aims to become an opportunity to know the fun and joy of sound. It was called OTONOMI. (See Figure 4)

Fig. 4 Photo of OTONOMI

The ultimate goal is that through experiencing the contents on OTONOMI, children recognize and play with sounds in order to improve the learning on the creative field of music education.

In the first part of the experience, the children are provided with tree fruits on the screen. When the children emit voice into the microphone, the fruits take various forms and change their appearance depending on the sound. The colors and shapes change according to the voice's size, height and length. Once the fruits appear, the children can play the sounds by touching them. (See Figure 5)

Fig. 5 Children using OTONOMI

The title "OTONOMI" means, "Sound fruit". It was created from the concept of sounds hanging from a tree. It expresses the idea of originating sounds from one's voice and then using them in order to make a musical performance.

In addition, visual elements that could grasp the children interest such as changing scenes and interactive animals were incorporated. It was also added the possibility of participating more than a single person: up to three users can interact at the same time and the installation react accordingly.

OTONOMI was designed in a way that let children play without requiring any specialized knowledge, so it aimed at presenting an opportunity to know the fun and enjoyment of sound. What differentiates this artwork from others is that in OTONOMI a microphone is used as an interface input, and lets the users select the size, length and height of the sounds. Then, it was possible to play with these user-generated sounds in any desired way through touching them in the screen.

3.2. Layout of the Art installation

The layout of the art installation is as shown below (See Figure 6). The touch interaction is made through a projector along with a Kinect™ sensor. The microphone for voice input is put in a way that lets the viewer contemplate the projection and avoid capturing the sounds emitted from the speakers.

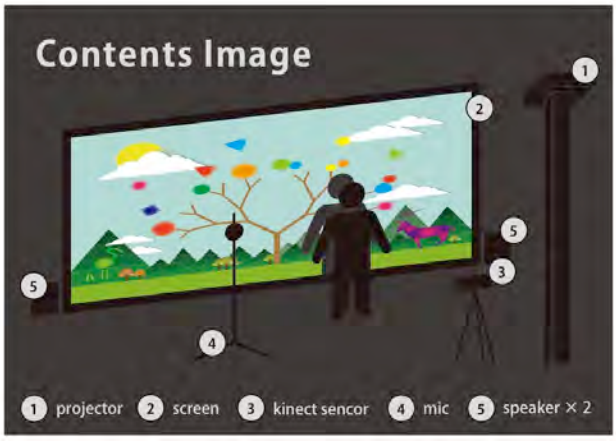


Fig. 6 Layout of the art installation

3.3. System Design

A flow chart presenting the overview of the system design is shown below (Figure 7).

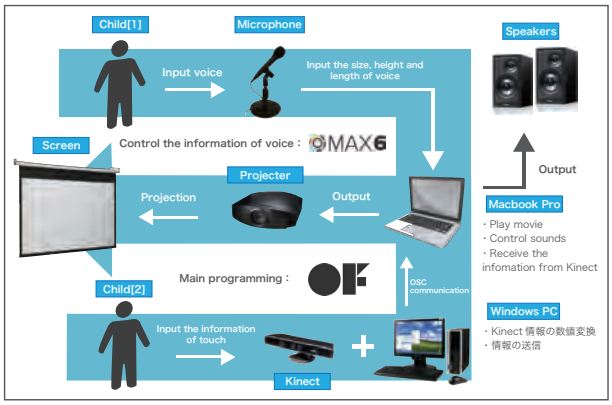


Fig. 7 System design image

The 2D graphics, sounds and information coming from the Kinect™ sensor are controlled using openFrameworks.
The data from the microphone interface and pseudo-touch screen interface coming from the Kinect™ sensor are managed with a PC and a Macbook Pro as shown in the picture.
Voice analysis is made using Max on the Macbook Pro, and the Kinect™ data is analyzed using Kinect™ for Windows®.
Data management between Mac and PC is achieved by using the OSC communication protocol.

4 Development Process

4.1. Tree design and implementation of physics engine

The creation of OTONOMI started its visual design around the concept of a tree. The work "KYOTO"[5] produced by FunkTronicLabs[2] was studied as reference. In this work, Leap Motion™ is used for manipulating sounds in an interactive space. A custom engine based on C++/OpenGL is used for this project. The concept of the tree, its aesthetic value and use of physics engine were taken in consideration for this research production.

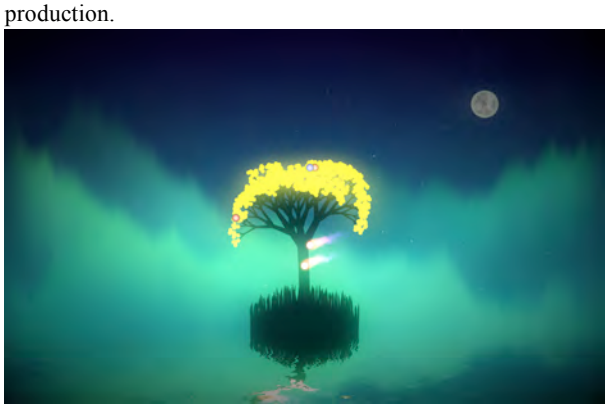


Fig. 8 Picture of "KYOTO"

The physics engine that affects the movement in the tree of "KYOTO" uses the Verlet algorithm. (see Figure 9) This formula is used to calculate trajectories of particles in molecular dynamics.
In simple terms, while most physics engines determine the speed from the acceleration and define the position, the Verlet integration calculates the speed difference between the current and previous positions, and then determines the next position.

$$\vec{R}_I(t+\Delta t) = 2\vec{R}_I(t) - \vec{R}_I(t-\Delta t) + \frac{\vec{F}_I}{M_I}(\Delta t)^2$$

Fig. 9 Formula of the Verlet integration[3]

The benefits of using the Verlet integration are that it can move objects with less programming code and that expressions such as elasticity are easy to handle. Also, the reaction to collisions in the tree of "KYOTO" is very smooth; it is capable of producing a natural atmosphere.
We wanted to achieve this kind of natural reactions in this project, so it was decided to implement the Verlet Integration for the physics engine.
Also, this program drew fractals using recursive functions in order to produce a model of the tree in the program. (See Figure 10) The fractal is a shape that reproduces itself while being reduced in size but maintains the original form. The recursive function is a function that calls itself from within itself in order to achieve the fractal's appearance.

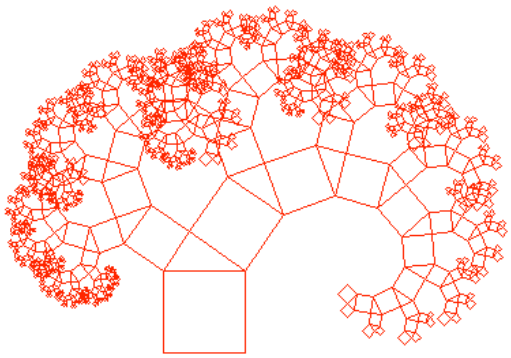


Fig. 10 Sample of a fractal

4.2. Fruit's sounds, music and instruments sounds

The tree fruits are drawn as basic geometric figures. The color of the figure represents the height of the sound. If it is a high sound it becomes red and if it is low, it becomes blue. (See Figure 11)

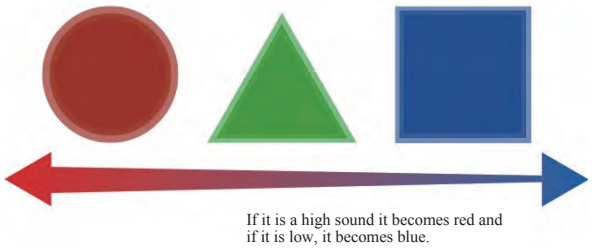


Fig. 11 The tree nuts of sound

Children were given the freedom to perform with the sounds stored in the fruits along three scenes.
The generated fruits could be dragged into the main part of the tree in order to connect them through branches. Some improvement regarding the animations in this point was still needed in order to be more appealing for the children. (See Figure 12)

[2] A studio that "focuses on delivering creative experiences through games, VR and other interactive media", as presented in their website.
[3] In the formula, position is R, mass is MI, force is F, and t is time.

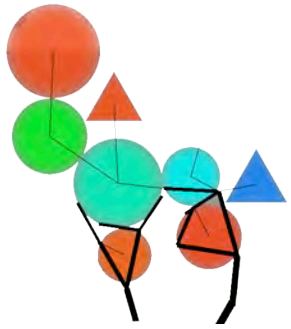


Fig. 12 Appearance of the tree nuts of sounds connected

The sounds that come from interacting with the tree nuts, along with the background music, were produced using the Logic Pro X software. The production of music and musical instruments was very important since it was necessary to make the sounds created by the children pleasing. For this purpose, an ambient sound was selected, that maintained a pleasing atmosphere even with the cacophony of sounds produced by the users. The sounds assigned to the fruits were based on three different instruments that could be appropriated easily by the children. Also, these sounds were considered as capable of repeating rhythmic patters that wouldn't become unpleasant sounds.

4.3. Microphone input system

A program that calculates the voice input that affects the sound of the tree fruits was made using the Max software. With microphone input, the children can choose the sound size, height and lenght easily. The voice's information is decomposed in size, lenght and height through openframeworks in order to be reflected on the tree fruit's sounds.

The size affects the speed of the fruit being generated, the voice height affects the color and the height of the sound when the fruit is touched, and the lenght affects the fruit's size.

Also, other elements were incorporated in order to motivate children to try different voices. For example, the color of the fruit varies by continuously performing in the microphone input and changing the height of the voice.

4.4. Pseudo-touch screen

A pseudo-touch screen was used in order to provide an intuitive interface. The pseudo-touch screen is a technique that uses a projection on a wall or screen and combines it with a movement sensor such as Kinect. The pseudo-touch screen does not present great difficulty to make, however depending on the site where it is placed, the interaction response can change in various ways, and so it was necessary to make adjustments at the moment of presentation.

An example of the pseudo-touch screen is shown below. (See figure 13)

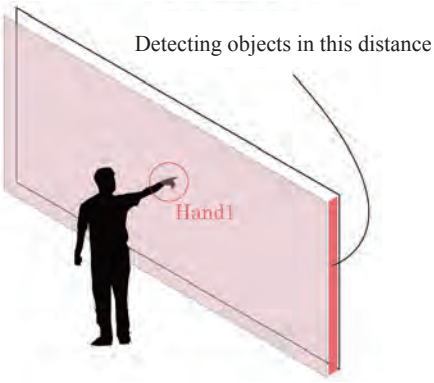


Fig. 13 The pseudo-touch screen technology

Only a small range of distance is used for the movement detection. The computing process is as follows.

1. Detect with Kinect™ if the distance of the object in front is constant.
2. The system assigns a number to the detected object in its appearing order (Hand1, Hand2, etc.)
3. The touched objects are detected and this information is sent through OSC from the Windows PC to the Mac.
4. The Macbook Pro receives the OSC message and draws the graphics.

Based on this process flow, we produced a program for the touch detection. (See Figure 14)

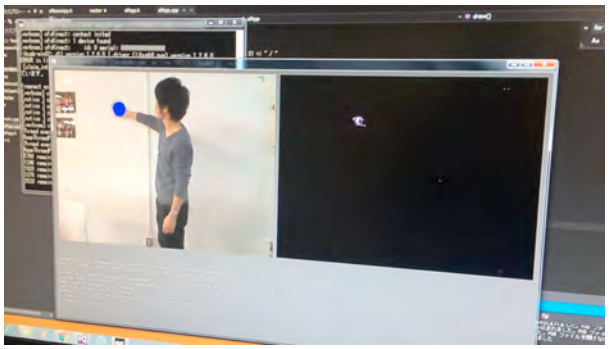


Fig. 14 Complete touch screen program (Windows side)

4.5. Communication through OSC

For the creation of OTONOMI, a Windows PC was necessary in order to use Kinect™ for Windows®, however openframeworks needed to be coded using Mac. For this reason, we created an environment in which the data could be exchanged between Mac and Windows PC using OSC communication. The Windows side transmits the coordinates of the object detected by Kinect™, and in the receiving Mac side, the data is converted into the coordinates of the screen. Although, the problem in this phase was the resolution of Kinect™ v1, since it was lower than the projector's which caused a less precise recognition. This problem was resolved by doing a numerical conversion that permitted matching both resolutions.

4.6. 2D graphic resources

After building the system, graphic resources were planned in order to determine an overall atmosphere of the installation. At first, 3D graphics were considered, but in order to make a friendlier design for children of early ages, a 2D design was preferred.

With the objective of making a design that would not tire out the children, a background scene was designed that alternated between a clear day, rain and night. (See figure 15) The scenery doesn't include any interactions, only animations of the clouds moving.

Fig. 15 Background movie: clear day, rain, and night

Additionally, animals were put in each scene in order to include more variation. When the animals were touched, a small animation was played along with the animal's sounds. With this component, it was aimed to increase the interactivity component by also offering children the possibility to interact with the environmental sounds. The animals created are shown below. (See figure 16)

The visual design of OTONOMI was planned to have a cheerful tone in order to be friendly for the children. All of the 2D visuals, including the sceneries, animals and the fruit's symbols were designed in this way, with bright color palettes and smooth animations. This was in order to transmit a richer and more entertaining experience in the moments of interaction when touching the fruits and the animals.

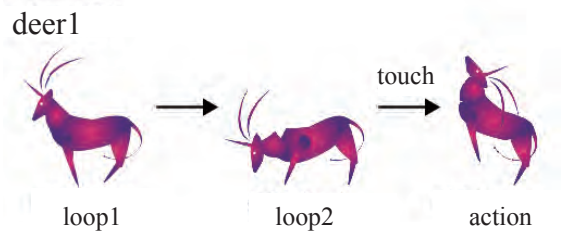


Fig. 16 Animals from the "clear day" scene, a deer

4.7. Additional implementations and final adjustments

With the points explained above, the interactive elements of the installation were ready, and it was possible to experience it. Therefore, it was decided to include additional elements in order to capture the children's interest and improve the quality of the installation. These are:

・A visual effect when something is touched.

・This effect changes when more than one person uses the microphone.

The effect for the touch detection looks like an explosion of shapes with its center located in the coordinates of the detected touch. (See Figure 17)

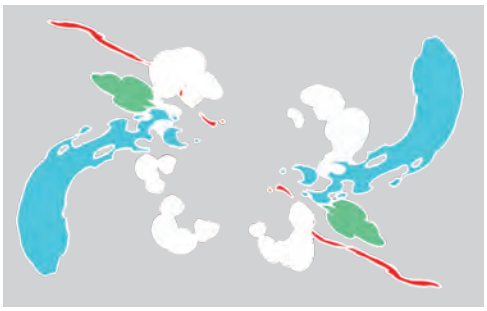


Fig. 17 Effect when children touch the tree fruits

On the other hand, when multiple persons made voice input via the microphone, a big effect that covered the entire screen appeared. (See Figure 18)

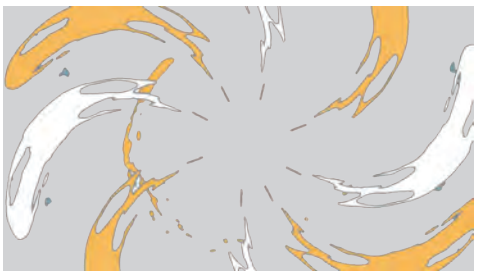


Fig. 18 Effect on the entire screen

After the contents production was completed, an experiment took place with the finished version of the program that included all of the elements explained above. Final adjustments were made, such as the microphone input controls, the screen size, and the speed of the touch response. (See Figure 19)

For this final phase, the children's experience conditions were contemplated, and considerations about the size of the tree fruits and the screen size were especially critical.

It was also necessary to adjust the location of the Kinect in order to correctly detect the hands corresponding to the position of a child's height. Furthermore, when the fruits were touched, the hand's shadow would cover them, so it was necessary to find an appropriate minimum size of the fruit in order to be visible when manipulated.

Adjustments on the same day of the verification experiment were also made, since the variation of the children's movement, height, and voices affected the experiment's site.

Fig. 19 Final version of the program

5 Verification

A group of children was selected to experience "OTONOMI" in order to verify whether the installation led them to enjoy playing with sounds. The main objectives of the verification experiment are as follows.

1. Whether the children were able to enjoy playing with sounds in "OTONOMI".

2. Whether the input interface was easy to handle by their voice and touch.

3. Whether children would enjoy making music in the future.

4. Examine the effectiveness of the content for providing an opportunity to enjoy being creative, and find points for improvement.

The tested children were asked to evaluate the installation by filling surveys after they experienced "OTONOMI". This survey presented questions about their impressions towards the installation and what they felt about the creation interface.

The survey (see Figure 20) had six items; five were quantitative answers and the last one was an open answer.

The verification experiment took various groups, each of two or three children that played with "OTONOMI" at the same time. The details of the experiment are as follows.

・Date: January 23, 2016

・Location: Fukuoka Municipal Miyatake Elementary School, in the after-school care take program.

・Method: Fill out surveys after experiencing the installation.

・Subjects: 15 Elementary school children between grades 1 and 4.

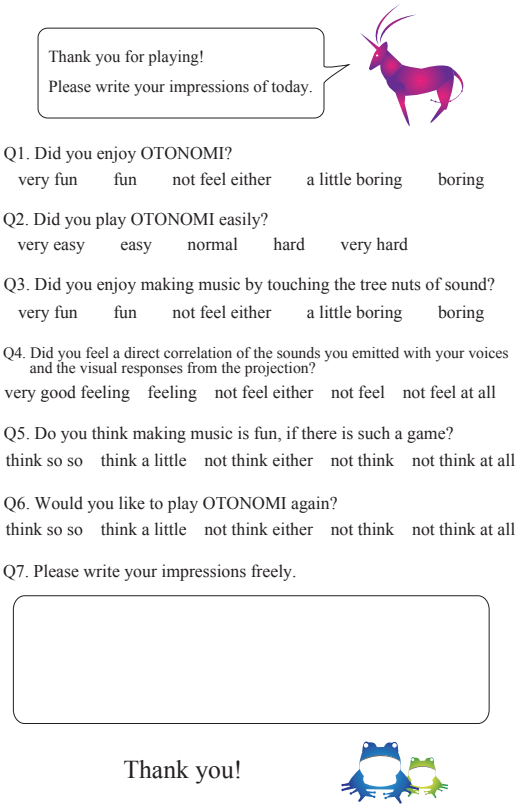


Fig. 20 Survey

The survey results show positive responses so the purpose of this verification was satisfied. (See Table 1) From this, it can be said that it was possible to give the opportunity to children to know the fun and pleasure of sound through the interactive artwork created for this study.

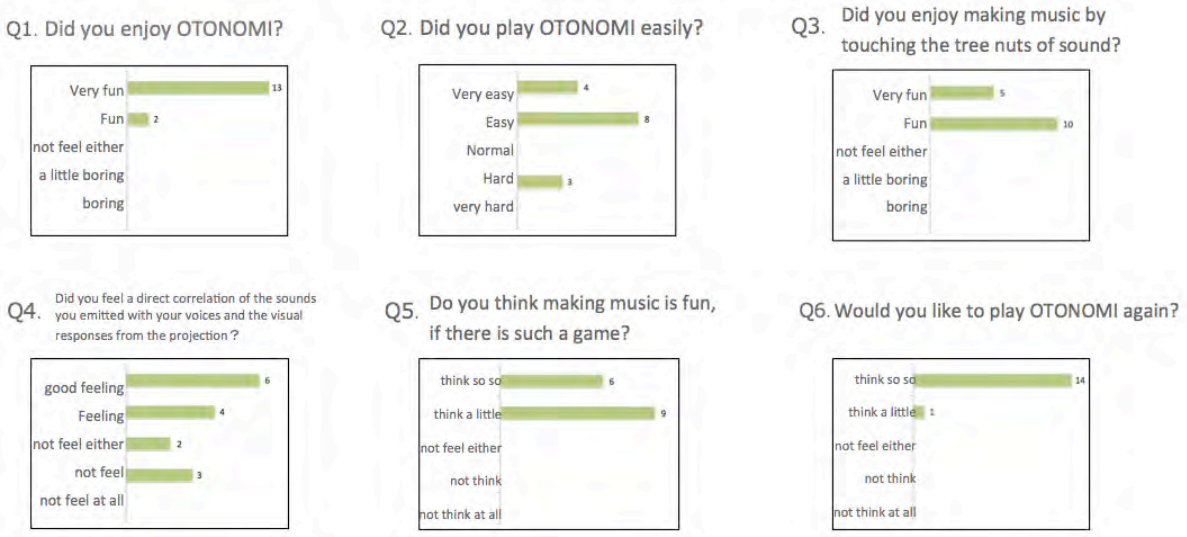
Furthermore, the evaluation pointed to improvements that could be made in various points in order to make the interactive art experience better.

First, the most serious problem was the reaction of the touch operation. In this work, the reaction speed was reduced in order to prevent many sounds to play at the same time and causing a sound discord. However, this seemed to be frustrating for the children. From this, we can conclude that adjustments are necessary in order to proportionate freedom to use the installation with any desired speed. It would be also important to find a way that the multiple sounds don't cause an unpleasant cacophony.

From the question Q4, we concluded that the children did not feel a direct correlation of the sounds they emitted with their voices and the visual responses from the projection. It would be necessary to make clearer graphic responses towards the voice input.

Regarding the opportunity intended to be offered by the installation for having fun interacting with sounds, according to the surveys responses alone, it could be concluded that the children felt interested in creating music in the future. Also, after the surveys, some interviews were made and we learned that the children had interest in matching the sounds they

Table 1 Results of Survey



made with the background music in order to make an appropriate musical response. From this we could say that after experiencing the installation, the children's interest towards sounds and music was increased.

In the future, it is desired to investigate how the experience with this installation affects the interest and attention of the children towards the school's music classes. For example, take two groups of students, one that have experienced the installation and the other that doesn't. Then, make them take a music class related to the creative field, and compare their results in order to determine the impact of the installation.

6 Conclusions

In this study, we focused on the problems of the creative field in music education and found that it was necessary to research about a practical way to transmit the fun of playing with voice and surrounding sounds to children. Furthermore, we found that the contact that children have with surrounding sounds has been decreasing. For this purpose, an interactive art installation was created in order to offer children an opportunity to get to know the joy of creating sounds.

The purpose of this study is to connect the opportunity offered by the interactive installation with the creative field of music education in order to enhance it. With the verification experiment, the effectiveness of capturing the children's interest and responding actively in the creative field was tested.

The results showed a positive response towards the experience and showed that they had fun with the installation. Children got immersed in the activity, and they could be seen interacting with the microphone and touch screen repeatedly.

Furthermore, the children were aware of the change of sounds related to the color of the tree fruits and tried various sounds with their voices by themselves, without any previous explanation. Based on the above, we proved the possibility of creating this kind of opportunities through an interactive art installation.

It can be said that it was possible to attract the children's interests because the scores of the items on the survey that inquired about their enjoyment had high evaluations.

However, the response of the questions related to the operation of the installation showed that some problems of the user interface and technical issues remain. The following improvement points were identified.

・Improve the design of responses to the interaction of the children, specially regarding the microphone input.

・Improvement and election of an optimal interface.

・Clearer reactions towards the children's voices and movements.

Our current society is overflowing with information, and this has an impact on the current generation. Young people are tending to lack ambition and desire, this have been called the "Satori" generation in Japan. We have though the work described in this paper to be directed towards this phenomenon, in order to engage the students and motivate their imagination for better ways of transmitting education. In the future, it would be desired to spread the use of this kind of interactive art installations, with works that can convey joy to the children and improve from the one presented in this paper.

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