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Master's Thesis
Academic Year 2022

MuMo:
Designing an Online-Offline Cooperative Activity for Distanced Children

Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

Yukiko Nishiwaki

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Abstract of Master's Thesis of Academic Year 2022

MuMo: Designing an Online-Offline Cooperative Activity for Distanced Children

Category: Design

Summary

We are living in an era of unprecedented changes as ICT is widely utilized in our lives and IoT/AI technologies develop. Moreover, it goes without saying that the COVID-19 pandemic is helping to push this forward. As more people become remotely and globally connected online, new skill sets, including collaboration, which will be essential for the next generation of children, are now in the spotlight.

This paper addresses the design of cooperative play for children at a distance, by the name of *MuMo*. Two kids will be roleplaying as creators to co-create a picture together, using their own monsters that they each create. They will asynchronously go through five activities using physical playing kits and online platforms. The three design concepts are; "co-creation", "embracing diversity" and "tangible artifacts".

The result of a user test showed that children played collaboratively and it implied that physical artifacts play an important role for their creativity. However, there were improvements to increase the sense of togetherness and to consider how to convey the cultural aspects to their friends that they reflected on their work. The technical challenges of the online platform were also identified.

Keywords:

design, long-distance communication, cooperative play, collaboration, early childhood

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Chapter 1
Introduction

1.1. Learning Paradigms in 21st Century

In today's 21st century, we are in the "age of great change" where social and economic structures are changing drastically on a daily basis due to the advance of ICT. Looking back at history, the first industrial revolution, which began in the late 18th century and was followed by the second industrial revolution from the end of the 19th century to the beginning of the 20th century, was a period of mass production. During this period, the key skills needed for most workers were *"knowing a trade, following directions, getting along with others, working hard, and being professional—efficient, prompt, honest, and fair (K-12 Thoughtful Learning 2015)."* However, the way people worked started to change as we entered the third industrial revolution that occurred in the mid to late 20th century. This was when the internet emerged. In the fourth industrial revolution, we will see even more use of automation with the development of IoT and AI technologies. It is also predicted that *"we will experience the biggest job transition in history (IBC Colorado 2020)."* We are required to have skills to respond flexibly to this rapidly changing age, and this has led to changes in education guidelines. The Partnership for 21st Century Skills lists a set of abilities that are required for students in the information age. They are learning skills, literacy skills, and life skills (Battelle for Kids 2019). Learning skills are also called 4Cs, which are: critical thinking, creativity, collaboration and communication. These skills help children to work together, come up with solutions and succeed in school and at their future workplace.

Education has come to a turning point not only because we are in the fourth industrial revolution but also due to the impact of COVID-19 pandemic. According to Dr. Bridget Terry Long, Dean of the Harvard Graduate School of

Education, the pandemic underscored what many educators already knew, which was “ one-size-fits-all ” does not work anymore, and what students need varies (Harvard Graduate School of Education 2021). When children learn from their home, it matters greatly about what is happening in their families and their environment they are situated in. This decentralization trend pushes forward for the growth of online education. A report conducted by Research and Markets in February of 2020 indicated that *“by 2025, the online education market would be valued at about $320 billion USD, representing a growth of 170% since 2019 (Interesting Engineering 2021).”* Although the digital divide, a gap between people who have access to ICT and those who don't, is a current concern, it is estimated that *“90% of the global population will have access to broadband internet services by 2050(Interesting Engineering 2021)”.* Hence, online education for each student will become mainstream in future education throughout the world.

As mentioned above, we will go through the age of drastic change accompanied by a new normal in education. Children will need new skill sets to prepare for these changes by utilizing the internet and emerging technologies. They will be more connected, collaborating and creating ideas with international networks and communities. In other words, they will need to become more responsible and active global citizens (Akkari and Maleq 2020). Educators, educational institutions and designers play an important role to empower children in such times and therefore need to adapt to new education systems to take a practical approach.

1.2. Contribution and Concept of This Research

This *MuMo* project proposes a design of an online-offline cooperative activity for physically distanced children. The aim is to prepare children to become global citizens by fostering their collaborative skill, which is one of the learning skills listed in 21st Century Skills. The research question is as follows;

“How might we design cooperative play for young children who are distanced from each other to help them prepare for the coming ages?”

The activity is played by two kids around age 5-7 who are at each home. They

will be using three platforms throughout the project: Playing Kit, Online Studio and VR (Virtual Reality) Museum. Playing Kit is a physical cardboard kit which comes with several paper-made activity items such as monster pieces. Playing Kit would be delivered to each household. Online Studio and VR Museum are both online platforms that they will access from their computers or tablets with the help from their guardians.

The whole activity consists of five activities. In Activity 1, they CREATE their own monsters using Playing Kit. In Activity 2, their guardians UPLOAD the photos of their monsters to Online Studio and they will SHARE their monsters to each other. Once they get to know each other's monsters, they INTERACT by giving comments and questions to each other in Activity 3. Activity 4 is CO-CREATING a drawing together, where they have their monsters as characters in the drawing. Finally, they will visit and ENJOY VR Museum where their drawing is exhibited.

There are three key ideas for the design concept: "co-creation", "tangible artifacts" and "embracing diversity". "Co-creating" one drawing together is categorized as cooperative play, where they work together with one goal in mind. The second key idea is "tangible artifacts". They play an important role in supporting cognitive processes. Physical objects also enhance their creativity. To "embrace diversity", it is designed with multicultural exchange in mind, with opportunities for exposure to different languages and the use of everyday objects in the activities.

1.3. Thesis Structure

This thesis is divided into five chapters. This introductory chapter will be followed by Chapter 2, where related literature and works will be discussed and the role of *MuMo* will be clarified. Topics include cooperative play, online collaboration and physical artifacts in play. Chapter 3 is about the design process. Firstly design processes of several activities and pilot tests that were implemented before *MuMo* will be discussed. Then the design process of *MuMo* itself will be described in detail. Chapter 4 addresses the validation of *MuMo* based on a user study in which target parents and children were asked to play *MuMo*. Results and

discussion follow in the same chapter. Finally, Chapter 5 concludes the paper with a summary of the project and future work for the proposed design.

Chapter 2
Literature Review

2.1. Cooperative Play

2.1.1 Significance of Play

Play has been long recognized by early childhood educators throughout the world as an essential experience for children. Nonetheless, regarding its definition, Hewes mentioned that *"it is difficult to define precisely for the purposes of multidisciplinary scholarly research (Hewes 2006)"* . Rubin, Fein, and Vandenburg (1983) have listed six factors that characterize play based on previous play theory and research. They are:

1. intrinsically motivated behavior
2. attention to means rather than ends
3. organism dominance
4. non-literal and simulative behavior
5. active engagement of the participants
6. freedom from externally imposed rules

However, for the last distinction "freedom from externally imposed rules", authors stated that there are problems because "games-with-rules have been shown to be developmentally related to earlier play behavior". Other researchers such as Verenikina et al. (2003) characterized play as *"spontaneous, self-initiated and self-regulated activity of young children, which is relatively risk free and not necessarily goal-oriented."* These features are almost equivalent to the list of factors

that Rubin, Fein, and Vandenburg stated, by excluding the last factor from the list. Therefore, this paper will characterize play as five characteristics listed above (1 to 5).

Although there is no viable definition of play among the world, contribution to children's developments are common understanding in much of theory and research. It helps children advance their cognitive, social and emotional development. Children acquire *"the foundations of self-reflection and abstract thinking, develop complex communication and meta-communication skills, learn to manage their emotions and explore the roles and rules of functioning in adult society(Verenikina et al. 2003)"*. Unfortunately, many educational systems used to teach us that playing and learning are separate activities. Today, "learning through play" is an approach that is promoted by many early childhood programs.

The way children play has also changed over the past decades. Firstly, children have less time to focus on play because of the trend that they have more activities that they learn and practice from early childhood professionals. *"Long uninterrupted blocks of time for children to play – by themselves and with peers, indoors and outdoors – are becoming increasingly rare (Hewes 2006)"*. Secondly, children are becoming digitally native, meaning that they use digital technology and it is a part of their lives. COVID-19 pandemic further pushed forward for children to use technology.

Furthermore, play can take many forms, stages and levels which has been proposed by play theorists. This will be discussed in detail in the latter section, especially focusing on "cooperative play".

2.1.2 What is Cooperative Play?

American sociologist Mildred Parten Newhall developed six levels of play regarding social engagement which is applicable to two to five year olds (Verenikina et al. 2003, Gudritz 2016). They are unoccupied (play), when an infant is performing random movements; independent/solitary play; onlooker play, when a child observes the play of other children; parallel play, when a child plays beside, rather than with, other children; associative play, when a child plays with other children without any common goal; and lastly cooperative play, when a child plays with

others for a common purpose.

Cooperative play is said to be the final developmental stage of the six forms requiring higher levels of interaction among children. Drew has listed five key features of cooperative play (Drew 2020):

1. Social interaction: This includes assigning roles to one another, negotiating, working together for the good of the group. It helps children to know others' perspectives, learn from them, and incorporate ideas to improve their own thinking.

2. Shared goals: Children will take turns when they work together and can work on different aspects of a task and link them together in the end to achieve the goal. They will need group work skills such as negotiation, collaboration and positive communication.

3. Language use: Children get to practice language skills, both expressing their thoughts and understanding when others speak.

4. Self-regulation: Rather than working on their own tasks and doing whatever they want, children try to compromise, such as absorbing disappointment or waiting their turn.

5. Agreed rules: Co-agreement of rules will let children get together and agree upon how a game or an activity should be played.

Examples of cooperative play include working on an art project together, finishing puzzles with a group, acting characters in a play, relay races, and many other teamwork activities. Although it is usually said that cooperative play begins around the age of four, it is not the case for all children. Support from adults is also essential in this type of play especially until around the age of six (Muto 2013). Teachers' role is to set the basic structure and guide (not deciding) children to shared goals.

2.1.3 Cooperation or Collaboration

When it comes to group activities in education, cooperative learning and collaborative learning are two terms that are often used interchangeably. However, there

are educators who emphasize a distinction between these two terms (Hord 1981, Oxford 1997). In general, those authors identify cooperative learning to be teacher centered and more structured, whereas collaborative learning to be student centered and less structured. Oxford had stated that the purpose is also different too. Cooperative learning enhances cognitive and social skills via a set of known techniques and working together to reach learning goals. Collaborative learning acculturates learners into knowledge communities.

Recent educators, on the other hand, argue that two terms should be treated as equivalent (Jacobs 2015, Jacobs and Ivone 2020). There are many similarities between them (Promethean Blog 2017), for example, they rely on active student participation rather than lecture-based learning, enhance participants' cognitive skills and team building skills, and embrace diversity among them. It is questionable to explain cooperative learning as a teacher centered activity because quite often, a student centric approach is seen during cooperative activities. Hence, the fact that they have a lot in common for their characteristics and much of the work uses them interchangeably, two terms would be used as synonyms in this paper.

2.2. Online Collaboration

2.2.1 Computers and Children

Many children today are digitally native, a generation in which living in an environment surrounded by digital devices is normal. According to UNICEF (United Nations Children's Fund), *"Children and adolescents under 18 account for an estimated one in three internet users around the world (UNICEF 2017)"*. and Pew Research Center survey of US parents with 5-8 year old children in 2020 showed that children's engagement with a television, tablet computer, smartphone were 93%, 81%, and 59% respectively (Pew Research Center 2020). Child-Computer Interaction (CCI) is a discipline that studies the relationship between computer technology and children. J.C. Read defines CCI as *"an area of scientific investigation that concerns the phenomena surrounding the interaction between children and computational and communication technologies (Read and Markopoulos 2013)"*. In recent years, there has been a change in perspectives about CCI, especially

during the pandemic. Antle et al. identify changes of parents' perception as one of them (Antle and Frauenberger 2020). They said that *"prior to the pandemic researchers recruiting for studies often experienced a feeling of reluctance from parents, caregivers and/or teachers to let children participate in interactive technology and/or digital media usage"*. However, since the pandemic, that thinking has changed, and parents and caretakers are moving in the direction that they believe it is desirable for children to participate in a variety of fields in order to develop digital literacy. Antle also stated that *"This shift may present an opportunity for the CCI community to contribute beyond academia to engage with ongoing societal debates with more nuanced views on the purpose and nature of different interactions with digital technology." "Ongoing societal debates"* here could refer to the impact of screen time on physical and mental health problems or the dangers of using social media (Viner et al. 2019). In response to this trend, we as designers and researchers, need to find ways to create a foundation for both parents and children to learn about digital technology, which is widely used in many aspects of life, and to develop the ability to respond to such technology.

2.2.2 Use Contexts of Online Collaboration

To this day, there are many online services and studies that connect geographically separated children or children and their families for collaborative activities. The uses are diverse, ranging from communication to entertainment to education.

One Space (Cohen et al. 2014) and *WaaZam!* (Hunter et al. 2014) are examples of communication between children or between parents and children. Both of these studies used a video conferencing tool that merged the video feeds of two remote places into the same virtual space. The purpose for *One Space* was to *"promote fundamentally active forms of engaged, co-operative play"*, and *WaaZam!* added the aspect of *"a creative studio and a rendering engine so users can build and interact together in worlds they construct"* so that they can *"support creative play and increase social engagement during video sessions of geographically separated families."* Note that both studies were conducted with children aged 6 years and older. For younger children, there was a study by name of *Pokaboo* (Raffle et al. 2011). This was research about a network toy where *"a child will press a button down to take their own photo, and their self-portrait will pop up on their*

partner's device." The result was that *"it was used by the children more as a toy and less as a communication tool."* In other words, the conclusion was that the focus was on the objects themselves, and that more investment was needed for remote collaborative play.

In the context of entertainment, video games such as *Nintendo Switch* and *Minecraft* are representative of online games for children. *Nintendo Switch* games such as *Mario Party* and *Overcooked!* are good examples that require multiple players to play cooperatively. *Minecraft* is a world composed of three-dimensional blocks, which players can assemble to build various objects and explore their structures. It is also possible to play with friends in multiplayer mode, another game in which cooperative play is key. Because of its flexibility, the game is increasingly being used not only for entertainment but also for educational purposes. One such example is a study by Walsh et al. (2016). They used the free and open source *Minecraft* clone, *Minetest* to develop a tool to support distributed co-design for children. As its potential, they mentioned that *"this flexibility and accessibility from home enabled children who could not attend in-person sessions to continue to participate with the group."*

Some online collaborations in education are based on community platforms. *Scratch*, a coding community for children, is a platform that allows children to modify other children's creations, and *DIY*, which is available in both app and website, has over 1,000 how-to videos, as well as a safe environment for children to interact with each other. In recent years, with the increase in online classes due to the pandemic, there have been many studies connecting school and home. Alonso-Campuzano et al. investigated collaborative behaviors through storytelling activities among 1st to 5th graders at home using existing online services (Alonso-Campuzano et al. 2021). Results suggest that online collaboration is possible, although some methodology adaptations were required for 1st and 2nd grade students.

However, most of the studies mentioned above target a minimum age of roughly 7 years old, and few of them have targeted preschoolers. While taking into account the impact on preschoolers as described in "2.2.1 Computers and Children", online activity development that allows preschoolers to engage in cooperative play is a possible and underdeveloped area.

Furthermore, when discussing online collaboration, it is necessary to understand the term Computer-supported Cooperative Work (CSCW). Schmidt and Bannon conceptualized it as *"an endeavor to understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work arrangements (Schmidt et al. 1992)"*. In terms of technologies, it takes place in two dimensions, which are forms of cooperation and geographical nature (Walsh et al. 2016). The forms of cooperation describe whether the work is done synchronous, asynchronous, or mixed, in other words, whether the work is done at the same time or not. The geographical nature dimension is whether the participants are in the same place or not. Walsh stated that workspace awareness, trust development, and engagement are the three most important concepts to have in mind for research on the effects of CSCW communication mediums, since it is likely that CSCW conditions suffer from having those as compared to face-to-face work.

2.2.3 Cross-cultural Learning

Cross-cultural experiences that not only provide an opportunity to learn about different values, but also to reflect on one's own experiences and culture, have been offered in a variety of ways. There are educational materials such as picture books and music, while some schools partner with other schools in different regions to offer programs that allow students to correspond with pen pals. As people become more connected with the spread of the Internet, opportunities for collaboration among people of different backgrounds will continue to increase. Regarding the importance of children's cross-cultural collaborative experiences, Yang et al. (2014) claimed that *"it has therefore become very important that current generation of students has acquired multi-cultural awareness and cross-cultural collaborative skills before it embarks on to the work environment."* They also mentioned that face-to-face would be the most effective way, but that only a limited number of people could have that experience, they sought ways to utilize online technologies for cross-cultural collaborative learning. Sharma et al. developed *CityCompass*, an *"online virtual navigational application for conversational language learning"* to find opportunities for inclusive collaboration between Indian and Finnish children (Sharma et al. 2019). Rötkönen et al. *"connected ten learn-*

ers from a Namibian and a Finnish school in virtual communications to co-design an interactive map game (Rötkönen et al. 2021)". For *CityCompass*, the average participant ages were 11-12 and the study was between children and researchers, not between children. The interactive map game was conducted with children in Grades 6 and 7, with ages ranging between 12 and 15 years. One existing service to experience other cultures is called *One Globe Kids* (Zuiderveld 2018), which offers educational content for kindergartens and schools, and their target age is 4-10 year olds. However, for safety reasons, there is no actual interaction between the children, and the educational material is based on photographs taken in advance. Therefore, globally collaborative one-on-one interactions with preschoolers are not well studied.

2.2.4 Collaboration in XR

Currently, when children play together online a video conference system is often used, but XR technology will be used more in the future. Vasilchenko et al. aims to connect XR, which they included Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR), and the learning/education community to explore *"the challenges, opportunities and long-term research plans of XR technologies for collaborative learning and co-creation (Vasilchenko et al. 2020)."* The previously mentioned study by Greg Walsh et al. is one such example (Walsh et al. 2016). The *ShareTable* developed by Yarosh et al. (2009, 2013) is a *"media space that supports synchronous interaction with children by augmenting video conferencing with a camera-projector system to allow for shared viewing of physical artifacts"* and has been user tested in divorce households. *Amazon Glow*, which Amazon began selling to the public in 2022, could be said that it is the commercialized version of *ShareTable*. With *Amazon Glow*, kids can *"enjoy hands-on activities on Glow's projection mat, while adults join in the fun through an interactive video call on their tablet or smartphone (Amazon 2022)"*. Currently this is only available in the United States.

There are several points to be aware of when young children are using XR. In VR, most guidelines for head-mounted displays prohibit use by preschool children. Hence, although research such as *TALK ME THROUGH THIS!* and *Jackin head* uses VR to allow two players to cooperate with each other (Robles de Medina

2016, Komiyama et al. 2017), unfortunately neither of these games are accessible to young children due to the use of head-mounted displays. Vasilchenko et al. also point out the risks of XR use that *"the frequent and prolonged exposure to XR environments could be harmful to our mental health, and lead to social isolation (Vasilchenko et al. 2020)"*.

However, the point here is that this is not to deny the use of XR. The advantage of using XR technology in a collaboration is that we can *"have the potential to portray 3D spatial information, to exploit learners' natural behaviors, and to immerse them in the virtual learning world (Vasilchenko et al. 2020)"*. It is necessary to understand the concerns and incorporate them appropriately into children's co-creation opportunities.

2.3. Physical Artifacts in Play

2.3.1 Touch Experiences and Children's Development

In multiple disciplines, such as evolutionary biology and neurology, *"the role of sensorimotor action in cognition is well established (Sylla et al. 2019)"*. Cornelia Elbrecht mentions how it plays an important role especially for children. According to her article, children can *"develop normally without a sense of sight, sound, or smell. Yet without touch they grow up to be emotionally and socially dysfunctional (Elbrecht 2020)"*. Neurologist Wilson stated that *"Our fingers and hands are highly active and important means of perception and exploration, representing an access to our life world which in some cases could not have been established by any other sense modality(R. Wilson 1998)"*. There is a strong connection between hand and brain function and without active touch experiences with our hands, children's cortex will not become active.

Sylla stated that *"the role of tools, artifacts or objects in supporting cognitive processes is well established in education (Sylla et al. 2019)"*. She also mentioned how creativity has much to do with what tools and materials we have, and what we make of or with them. There are well-designed toys that focus on hands-on experience and child development. *Rigamajig*, a building kit designed by a toy designer Cas Holman, inspires *"creativity, collaboration, problem-solving skills,*

and STEM/STEAM learning through hands-on play" (Rigamajig 2022). *KonneKt* is designed for isolated children in hospitals to play with their friends or families. They will stand on each side of the window and use *"a versatile set of shapes which can be attached to the window with suction cups and magnets (Jansweijer 2014)"*. This would not only allow them to enhance creativity but also helps *"developing social skills such as cooperation, teamwork and negotiation"*. A graduate student from Royal College of Art designed *Imaginary Language* (Alessandra 2019). It is a set of basic geometric objects that can be combined in a various ways to foster children's creativity.

2.3.2 TUI

Hiroshi Ishii, the Jerome B. Wiesner Professor of Media Arts and Sciences at the MIT Media Laboratory, is recognized as a founder of Tangible User Interfaces (TUI) when he presented a research *Tangible Bits* in 1997 (Ishii and Ullmer 1997). Sylla et al. defined TUIs as *"physical representations, materials or objects with embedded computational properties that allow interacting with and manipulating digital content. (Sylla et al. 2019)"* They often involve children by designing *"playful interactions focusing on learning, storytelling, dynamic systems, collaboration, or the learning of social skills among others (Catala et al. 2018)"*.TUI products for children which are already on the market include the *Amazon Glow*, which was mentioned in the previous section, and *Osmo*, which uses a tablet and a reflective mirror that attaches to the camera (Osmo 2014). Microsoft Research has also conducted a *ProjectZanzibar*, which was *"a flexible mat that locates, uniquely identifies, and communicates with tangible objects placed on its surface, as well as senses a user's touch and hover gestures (Villar et al. 2018)"*. It is similar to *Amazon Glow* or *Osmo* in that objects placed on the mat are displayed on the screen, but instead of a camera, the mat itself has a built-in sensor that detects the movement of objects and hands. As suggested in the study by Fails et al. that *"embedding technology in the physical world may be beneficial to young children (Fails et al. 2005)"*, applying TUI technology for children's education has a great potential. However, there is a lot of technical preparation as well as expense involved in terms of connecting each family with their children using TUI.

2.4. Summary

This chapter has discussed the importance of cooperative play for preschool children, the use of online collaboration in entertainment and learning, examples of the use of new technologies, and previous research on TUI combining online and physical activities. Among the various use contexts of online collaboration, this chapter focused on multi-cultural exchange, which is necessary for collaboration competence in 21st century skills, and described the significance of connecting and collaborating with people from other regions online. It revealed that globally collaborative one-on-one interactions for young children are not well studied. Furthermore, regarding XR, its potential can be expanded as a means of realizing global co-creation, while taking into consideration concerns about its use by young children. Past research has also suggested that TUIs contribute significantly to young children's play and learning, but their practical use is still difficult given their technical limitations and cost when implemented in each home. Many of the examples mentioned in the chapter are synchronous and there are few asynchronous efforts. This research then proposes to design cooperative play for young children, including those of preschool age, that can participate with their parents or caretakers from home. They will be physically distanced from each other, and play the activities asynchronously. From the perspective of simplicity of technical preparation and low expenses, instead of using TUIs, it incorporates both online and offline activities, and is designed to allow children to move seamlessly between those two environments. For the offline activities we make use of tangible artifacts which come with a kit. Online activities include the use of a shared platform, including a virtual space.

Chapter 3
Design

This research project was always motivated by the concept of "connecting young children at a distance" and several design processes were conducted prior to the start of the *MuMo* project. For each design process, it went through defining, ideating, prototyping, testing and redefining the design concept for the next step. Thus, all of the experiences and discoveries gained from these processes form the foundation of *MuMo*, and it is of great significance to record these initial approaches. This part describes the initial design approach that led to the *MuMo* project. It can be divided into two major phases, Phase 1 and Phase 2. Each phase would be discussed in the following sections.

3.1. Initial Design Approach

3.1.1 Phase 1: Distance Play in a Same Space

The COVID-19 pandemic had just begun across the world during this first phase. In Japan, attention was focused on measures that were proposed by the Ministry of Health, Labour and Welfare, to avoid the "Three Cs". "Three Cs" were "Closed spaces with poor ventilation," "Crowded spaces with many people nearby," and "Close-contact settings such as close-range conversations" (全国保育協議会 2020). It was a big challenge for many fields, including the field of childcare (Japanese Government 2020, ほいくる 2020). Many activities became individual tasks, which made it difficult to foster the cooperative skills that are fostered through relationships with friends. The aim for Phase 1 was to address this issue, and research on play for young children that fosters cooperativeness while maintaining distance. In Phase 1, an interview with teachers at a kindergarten, fieldwork and a test

using a prototype were carried out.

Interview and Fieldwork

On November 12, 2020, an online interview was held with Mr. Shinta Matsufuji, a Vice Principal of Ohno Kindergarten (Akebono Gakuen School Corporation) about the reality and needs at the kindergarten during the pandemic. He said that it was still difficult to avoid the "Three Cs", and that something that can be played with at a distance is very much in demand at the site. As fieldwork, a balloon-carrying relay was held in the Ohno Kindergarten on November 17, 2020 (Figure 3.1). It was a game in which children competed against each other in teams; they worked in pairs, and the team that carried a balloon on a cloth the fastest won. This game was chosen because it allowed the children to keep their distance while carrying the balloons. The participants, 99 children aged 5-6, were divided into three classes and further into three teams. As a result, several items related to cooperation were observed, such as cheering and picking up a teammate's balloon. Regarding the distance among the children, it was found that although there was little contact while carrying the balloons, contact was inevitable while waiting and when passing the balloons to the next pair.

Figure 3.1 Fieldwork at Ohno Kindergarten

Test using a prototype

A prototype of a toy was designed based on three concepts: it maintains a physical distance of at least one meter, it is collaborative play among two children, and it is something that enhances creativity and intellectual development. The toy consists of two boards with six holes respectively, six strings, and six play cards(Figure 3.2). Based on a play card which is presented by the facilitator, two players work together to create a shape with six strings and a board in front of them. The test was conducted on November 15, 2020, with a 5-year-old boy and his father (Figure 3.3). The results showed that they were able to play at a certain distance from each other during the 20-minute play time, but for most of the time, they played at a distance of less than one meter. The possibility of fostering cooperativeness was also observed in the test.

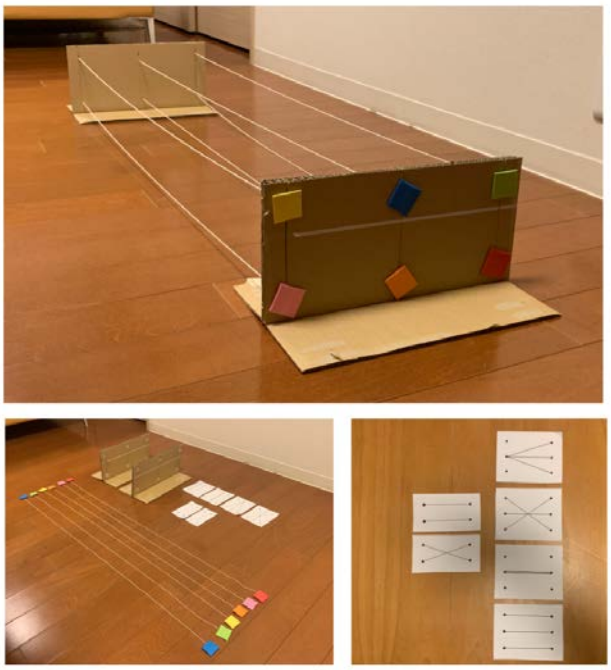

Figure 3.2 Prototype (Phase 1)

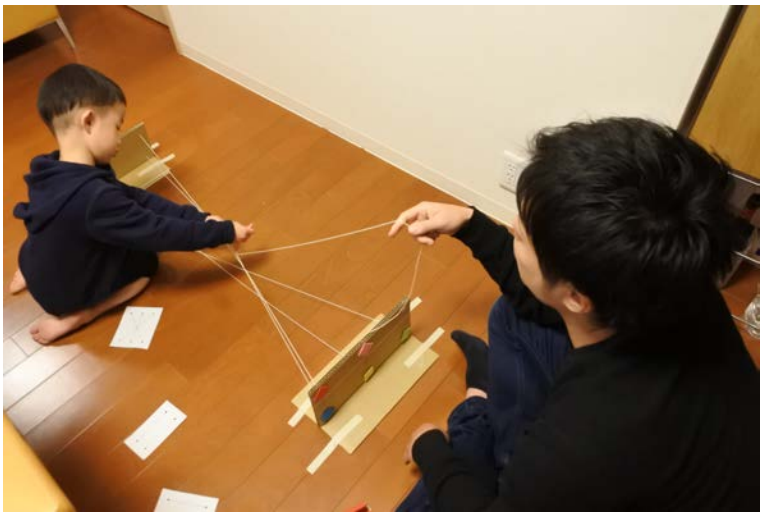

Figure 3.3 User Test Using the Prototype

As a takeaway from Phase 1, it was confirmed that it was possible to "keep as much distance as possible" in both fieldwork and the user test, however, it was difficult to completely separate the children from each other. It was also necessary to reconsider whether a complete separation was really necessary between those in the same space. Rather than targeting the children in the same space, the possibility of a system that would allow children who are physically separated from each other to connect online and play together, thereby enhancing their cooperative skills, was further investigated afterwards.

3.1.2 Phase 2: Co-creating a Story in a Real-time Online Setting

While Phase 1 explored how cooperative skills can be fostered in the same place while maintaining distance, Phase 2 focused on how cooperativeness can be fostered among children who are actually in distant places. Online classes, which spread rapidly during the pandemic, have the advantage that anyone with an online environment can take classes, but at the same time, several issues were brought to light. One of them is that physical movement is restricted. This limitation is a major issue, especially for preschoolers, who are at a stage in their

lives when they are gaining many skills through physical activity. Hence in Phase 2, the possibility was examined on designing activities that would allow children to stay at home, connect them online, and play with other children using their bodies. In the first prototype, a full-body activity using haptics was conducted, then redefined the research question based on the issues that emerged. Second prototype was then created and experimented.

First prototype using haptic feedback

For body movement activity among remote families, Hunter et al. designed *WaaZam!*, a video mediated communication system to *"support creative play and increase social engagement during video sessions of geographically separated families"* (Hunter et al. 2014). However, including this study, most were conducted with family members, and with children who were 6-12 years old, which was older than the target age for this project. Therefore, it was examined whether such activities could be implemented with the target age range and whether they would have the same effect. Assuming that the use of haptic devices as well as a synthesized video system would provide a greater sense of connectedness, the research question was: "How might we utilize haptic feedback in collaborative play for young children who are at a distance?"

In order to test this out, the author played remotely with a 5-year-old boy in two environments: one was using a conventional video conference system alone, and the other one was designed with haptic feedback and a video conference system that a kid and the author would be composed into the same screen (Figure 3.4). For the latter environment, it was a storytelling activity in which participants went on an adventure together, by author changing virtual backgrounds. For haptic feedback, *Buruburu cushion* was used, a haptic device which was used only on the child side (Shibasaki et al. 2020). The child would stand on the cushion, and it would vibrate when the author made a loud voice or created a noisy sound with stomping (Figure 3.5). The test was conducted at the author's home on June 5, 2021. As a result, it turned out that there was little difference in play involvement (amount of speech, concentration) between the two environments. Moreover, the child was not so much interested in haptic feedback. It could be estimated that children may need more complex feedback and need more room

to be able to customize their play by themselves. The child also had problems grasping space, such as misinterpreting something on the virtual background as being in front of him. Furthermore, it may have been obvious, but by actually testing in the house, it revealed that a large space is needed to capture the whole body.

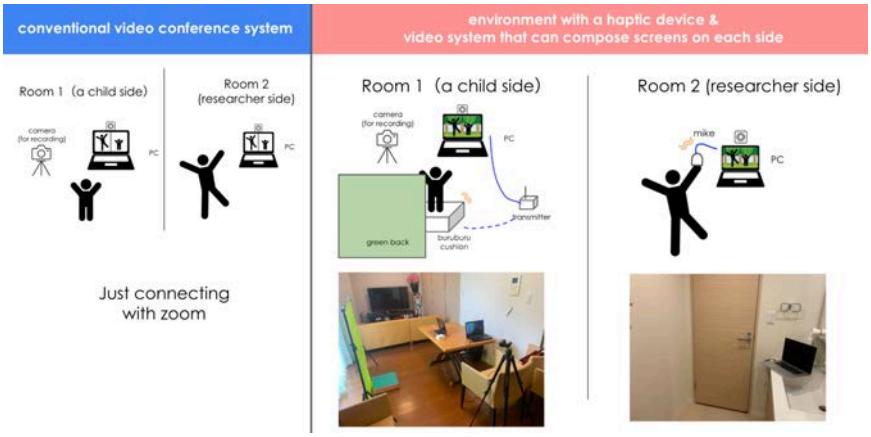

Figure 3.4 Testing Environments

Figure 3.5 A Child on a Haptic Device

Second Prototype using tangible pieces

As takeaways from the first prototype, it was necessary to consider a design that did not involve haptics using the entire body, in terms of the target age and the fact that it would be played at home. Although it was not a full-body haptic game, play with tangible objects using their hands was considered for the next prototype. "Cultural diversity" was also brought up as a concept, for that cooperative play helps children foster inclusivity and that the advantage of being online is that "any children, anywhere, can connect with any other children." I refined my research question as follows: "How might we design cooperative play for young children who are distanced from each other to develop their skills that can embrace their diversity through social interactions?"

Based on this research question, a second prototype was created that allowed two distanced children to co-create a story together with physical toy pieces. Technically, webcams on each side captured the pieces in real time, and the two children's work were combined on a single screen to complete a picture together. The screen can then be viewed in real time by two people on their respective computer screens. The background of the picture changed several times as the story went on. The content included things that gave a sense of cultural exchange, for example, making a feast on a plate. Two children, ages 4 and 5, participated in the user test (Figure 3.6). Since a remote environment was unable to arrange, the two children played together in the same space, avoiding contact as much as possible. They were cousins and the whole activity was facilitated by the author. As a result, there was little interaction among them because they concentrated on their own work most of the time. Furthermore, the 4-year-old child took time to choose the toy pieces by himself. Since it was the first time that the author met him, he might have been nervous or shy in front of someone he didn't know. From these findings, there was a necessity to reconsider the real-time interaction among two young children. It was also confirmed that there was cultural exchange, such as finding and sharing each other's favorite foods.

Figure 3.6 Co-creating a Story with Tangible Pieces

3.2. Design Process

The main findings and takeaways from several initial design approaches based on the concept of "cooperative play between young children at a distance" are as follows:

- It is targeted for two young children who are at home and are physically separated from each other.
- The design of the activity is not limited to the online environment, but also allows for hands-on play.
- The content should be designed so that children around the world can share and enjoy cultural diversity by taking advantage of the online environment.
- Choose asynchronous rather than synchronous implementation methods, taking into account time differences and target age groups.

The *MuMo* design process was developed with these considerations in mind. This section describes why monsters were chosen as the subject matter for the content, the process of creating the monster pieces, the design process of the activity itself, and the process of creating the Playing Kit box.

3.2.1 Monster Pieces

The two prototypes created in Phase 2 of the initial design approach were both about creating a story, but they already had a plot and lacked freedom. This limited children's creativity. Therefore, this time, the design was intended to allow the children to create their own characters and decide what two children would like to create together. At the same time, however, cooperative play has a purpose and is structured to some extent, thus too much freedom would not fit the purpose of this project. A balance between open-ended and structured play was very important. One idea that came up during the ideation process was using monsters as a subject. The word "monster" has different meanings and origins in different countries and cultures, but in a broad sense, it is a universal language in that it refers to "an imaginary creature". "Monster" does not have a fixed form, and each person can freely create his or her own monster. It was a suitable subject for a balance between structured and open-ended play.

Wanting to allow children to actually use tangible objects to create with their hands, monster pieces were designed so that they can freely combine these parts to create their own monsters. Several documents and apps were referred to in order to design the monster pieces. Especially the book written by Sandra Lawrence *The Atlas of Monsters: Mythical Creatures from Around the World (Lawrence 2019)* and a monster maker app *Sago Mini Monsters* (Figure 3.7) were very helpful during the design process. The author also visited the American Museum of Natural History and got some ideas seeing the cultural costumes and ornaments that were exhibited (Figure 3.8) . Figure 3.9 is an early sketch of monster pieces. When designing the pieces, it was kept in mind that each piece looks like various body parts depending on how you look at it, rather than one particular body part so that children can think more freely.

(Source: Sago Mini Monsters (Sago Sago Toys Inc 2014))

Figure 3.7 A Screenshot Photo of an App *Sago Mini Monsters*

Figure 3.8 Photos Taken at American Museum of Natural History

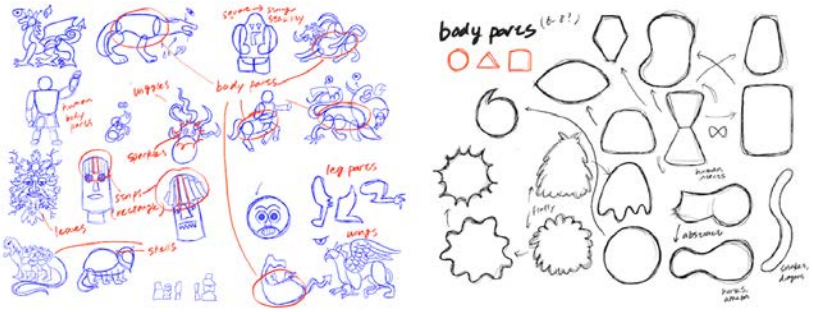

Figure 3.9 An Early Sketch of Monster Pieces

Initially, the idea was to create a monster using monster pieces only (Figure 3.10). However, it was discovered that by combining monster pieces with everyday objects, it could also incorporate an element of "cultural diversity". The work can naturally incorporate things that children use and see in their daily lives. The other child who sees the work can compare it with what he or she is actually using, discover differences and similarities, and hence perceive cultural elements. The colors were chosen to blend in with everyday objects rather than to be too bright (Figure 3.11). See "3.3.6 Playing Kit" for the final design of all the pieces.

Figure 3.10 An Early Stage of Monster Pieces

Figure 3.11 Testing Out Different Colors

3.2.2 Activities

Cooperative play is a kind of play in which children work toward a common goal, and thus the idea was to design an activity with the goal of "completing a picture together that involves monsters that each of the children had created." It was also necessary to create a scenario that explained why they were doing it, rather than just telling them to do it. A role-playing format was adopted, and at the ideation stage, scenarios such as each child becoming an astronaut to explore a monster planet or a researcher to conduct experiments on monsters were considered, but in the end, considering that the setting would not be too complicated, it was decided to adopt a scenario in which each child would work together as creators to create a drawing to be displayed in a museum.

The activity was designed to progress through several steps before reaching the goal; First, there is the "creation" step where the monsters are created, followed by the "sharing" step where the monsters are shared with a friend online, the "interacting" step where friends ask questions and comment on each other's monsters after sharing, the "understanding" step where they learn more about each other's monsters by customizing them, then there is the "co-creation" step, in which the drawing is completed, and finally, the "showing" step where the final work is exhibited. The author and a friend tested whether this step flow was appropriate and what kind of work could be created by combining the monster pieces with everyday objects. Since the test was conducted at the same time in the same place together, it was different from the "playing remotely and non-simultaneously" context, but communication took place only on the computer and there was little conversation. Figure 3.12 shows how the test went on and the outcomes of the activities are shown in Figure 3.13 .

Figure 3.12 MuMo Pilot Test

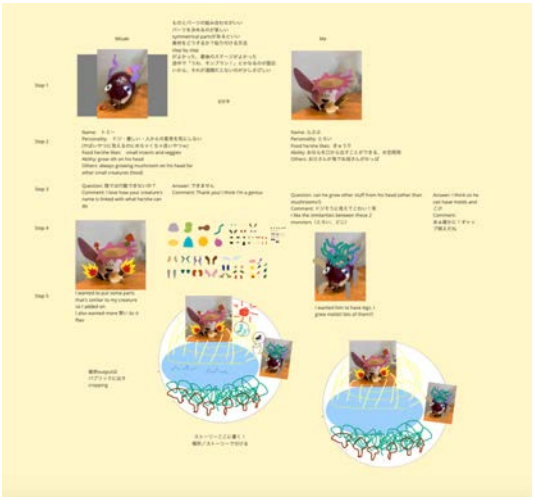

Figure 3.13 The Outcome of MuMo Pilot Test

As a result, feedback from the author's friend was that the flow of the steps was easy to understand with clear objectives, and that it was fun when she was thinking which monster pieces to attach with the groceries. One of the improvements was that since there was only one piece for each shape, there were not enough pieces when she wanted to make it symmetrical. She also mentioned that although there was not much talking, facial expressions played an important role during the test. Hence it could be assumed that it would be less fun if children couldn't see each other's faces. Also, as the author, the activity steps were too many considering that this would be a non-simultaneous activity. For these reasons, the design was revised to prepare most of the monster pieces in two pieces, to post each other's photos on the online platform, and to reduce the number of activity steps by combining the "understanding" and "co-creation" steps. The final activity design is described in "3.3.9 Activities".

As a method for communicating each step to children, *Sago Mini Box* was a good reference. It is a monthly make-and-play subscription that brings creative play for 3-5 year olds (Sago Mini 2013). Each month the theme is different and an activity is provided for each envelope. Inside the envelope is a letter, designed to allow children to pretend to be a character in the role-play setting. In this *MuMo* activity design, the Playing Kit also has envelopes that contain letters from the museum staff with the details of the request for each activity. The final envelope and letter designs are shown in "3.3.6 Playing Kit" .

3.2.3 Playing Kit Box

The Playing Kit, which contains the monster pieces and activity envelopes, is also based on the *Sago Mini Box*. The container of *Sago Mini box* is a playable kit in itself (e.g., when the theme is cooking, the box itself turns into a stove) and it is also made of recyclable materials. Getting an idea from this existing service, the Playing Kit for *MuMo* was designed using cardboards and was designed to resemble a desk that would be used by a creator, in other words, the child. Figure 3.14 shows the process of making the box.

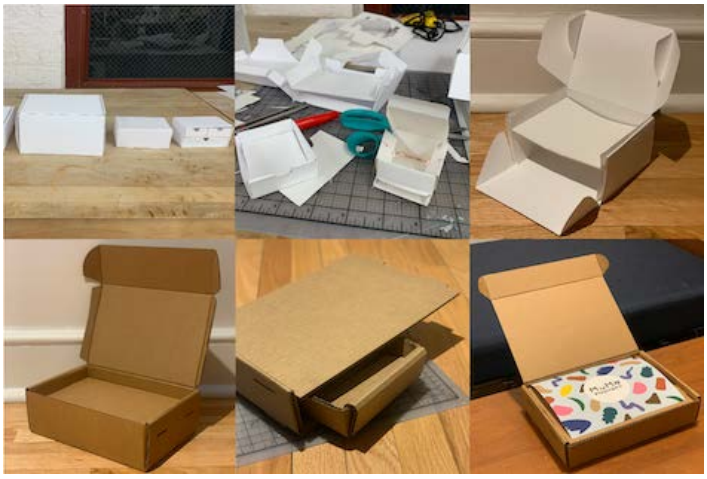

Figure 3.14 Process of Designing the Box

3.3. Design Artifact

3.3.1 Introduction

MuMo is an online-offline activity that allows two children to play together who are physically distanced from each other. Two kids will be roleplaying as creators who participate in *MuMo* (Museum of Monsters) project. They will go through five activities. They will first create their own monsters individually using a physical playing kit (Activity 1), share them and interact with each other online (Activity 2 & 3), and finally work together to create a drawing with their monsters as characters that appear in the drawing (Activity 4). Their drawing will eventually be exhibited in a virtual museum (Activity 5).

3.3.2 Plot

Welcome to *MuMo*! You are joining this *MuMo* project as a creator. You will have a partner, *MuMo* friend, who you are collaborating with. *MuMo* friend will be someone around your age, who lives in a different place. You two will each make your own monster and then create one drawing together online with those monsters appearing in the drawing. Your monster story artwork will then be exhibited in the virtual museum. Now, let's start your creative and collaborative

journey!

3.3.3 Concept

MuMo has three concepts: co-creation, embracing diversity, and tangible artifacts. *MuMo* is cooperative play, and the goal of the two children is to create a picture together, in other words "co-create" a picture, using their own monsters. It is also designed to give children a sense of playing together through the *MuMo* platforms, albeit remotely. The second concept, "embracing diversity," focuses especially on cultural diversity. It is designed with multicultural exchange in mind, with opportunities for exposure to each other's languages and the use of everyday objects in the activities. The third concept, "tangible artifacts" is also important for young children since the role of tools, artifacts or objects in supporting cognitive processes is well established in education. It is also known for enhancing their creativity.

3.3.4 Target Audience

This activity is designed for children with the age range of 5 to 7 year olds. There are mainly three reasons for the target age. Firstly, as stated in "2.2.2 Use Contexts of Online Collaboration", there are few research studies about online collaboration among this age group. Secondly, many studies have shown the importance of multicultural education in early childhood (Abdullah 2009). Lastly, as stated in section "2.1.2 What is cooperative play?", cooperative play begins around the age of four, which is possible and important for children around this age group to interact with others. It is also important to note that their guardians are required to have basic computer literacy skills since the activity uses online tools. Even if it was their first time to use some of those tools, it is designed so that they can participate in this activity if they have the basic skills to operate them with explanation beforehand.The tools include: communication softwares (zoom, LINE), interactive platforms (Miro, hubs mozilla) and a cloud platform (Google Drive). The role and use of each online tool will be explained in the latter section and chapter.

3.3.5 Playing Environment and Platforms

This activity is designed for a child and his or her guardian to play at their home. They will need access to the internet and a digital device, such as a computer or a tablet, to join the activity. Smartphones are not suitable in terms of an experience of a child and a guardian looking at the screen together, operability of digital drawing, and smoother VR experience. Another physical tool that they will need is a Playing Kit, one of the three platforms for this *MuMo* activity. Other two platforms are Online Studio and VR Museum. Each platform will be described in detail in the following sections.

3.3.6 Playing Kit

It is a 12.2 x 9.0 x 2.6 inches cardboard box with several paper-made activity items inside. Playing Kit will be sent to each home of the two children. As you can see from Figure 3.15, the cardboard packaging itself becomes a playing tool. Once the child opens the box, they will find out that it resembles a desk with two drawers. It was designed for them to immerse themselves as creators with their own desks. Monster pieces are equipped in the left drawer and four activity envelopes in the right.

The box itself is made out of 5/32 inch thickness of corrugated cardboard and consists of four parts: the outer box, a separating board and two drawers (Figure 3.16). With sustainability in mind, the three-dimensional structure is formed by folding instead of using glues or screws (Figure 3.17). This mono-material feature makes it easier to recycle the kit and it would also contribute to the quality of the recycled material. Another sustainable aspect is that it avoids excessive use of materials by having the function of packaging as well as the playing tool. Since the target age range is limited and it cannot be used for a long term, it is important to consider recyclability and reusability in the design.

Figure 3.15 Playing Kit (assembled)

Figure 3.16 Playing Kit (before assembling)

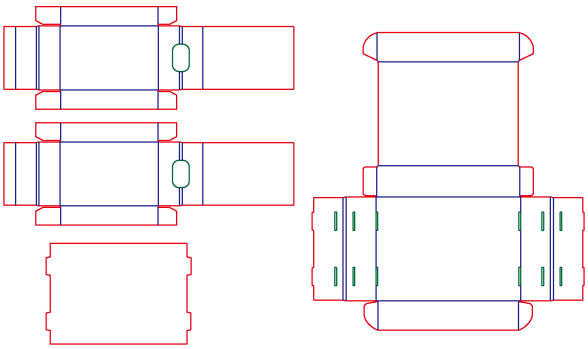

Figure 3.17 Nets of the Cardboard Box Design

For the items, an instruction booklet, monster pieces and four activity envelopes are included in the box.

- **Instruction booklet** is for children's guardians to read, understand and carry out the activities in order. It is a sheet of tabloid size paper (11 x 17 inch) which is folded to make a book-like structure. Again, no plastic or other materials are used for binding pages from the viewpoint of recyclability. Instructions are printed on one side of the paper as shown in Figure 3.18. It has eight pages: a front cover, a back cover, and six pages of instructions for each activity. It is written in both English and Japanese.

Figure 3.18 Instruction Booklet (before being folded)

- **Monster pieces** are used in Activity 1, where children attach these pieces to a daily object that they can find at their home to create their very own monsters. The pieces are made out of 2 ply bristol boards and they come in a variety of sizes, colors and shapes: 105 pieces in total, with 56 different designs and 14 colors (Figure 3.19). Although these shapes derive from body parts of mythical creatures or existing animals as explained in "3.2.1 Monster Pieces", they are designed to look like different shapes rather than a specific part of the body to encourage children's creativity. Abstraction was kept in mind during the design process.

Figure 3.19 Monster Pieces

- **Activity envelopes** are the four envelopes that each contains playing tools used in each activity. Since Activity 2 and 3 are combined together, there are four envelopes instead of five. Each envelope has a letter written in the scenario that the letter is from *MuMo* staff. It would be read by guardians to the children at the beginning of each activity, with the aim of immersing them more fully in the roleplay that they are *MuMo* creators.

3.3.7 Online Studio

Online Studio is where two children share their monsters, interact with each other, and collaborate together digitally. Miro is used as a platform, which is the online collaborative whiteboard platform used by over 35 million people worldwide. On Miro, there are various functions such as typing, drawing, uploading files and posting sticky notes on the vast online canvas. For this *MuMo* project, a section for each activity was created on Miro in advance and children and guardians are then asked to fill in the appropriate section using those functions. The Online Studio looks like what is shown in Figure 3.20. The left section is "Introduction", where instructions and necessary URLs are provided for guardians. Unlike the instruction booklet, which gives instructions for each activity itself, instructions written on Online Studio focus on how to conduct the overall *MuMo* project as a user test, such as when to take videos or how to use Miro. The right section

is the “Activity”, where children and their guardians actually engage for each activity. Speech bubbles on the very right are some examples of how they can finish their work to give them some ideas of their final output. Texts on Online Studio are written in both English and Japanese. How those sections are used in each activity would be described in detail in the latter section “3.3.9 Activities”.

Figure 3.20 Online Studio

3.3.8 VR Museum

In the last stage of this *MuMo* activity, children will visit the VR Museum which is a virtual room that they can enter via browsers (Figure 3.21). In the VR Museum, their drawing is exhibited with other drawings created by other pairs of children. By looking and walking around the space, they will find their drawing and explore around the virtual world. Hubs by Mozilla is used as a platform to create a virtual space for VR Museum. The 3D space is based on the existing one provided by the service, with photos of drawings and 3D models placed in it. Because it was intended to be a short activity for young children, 3D space which was not too spacious, but had a different scenery point (able to go in and out of the building) was chosen. All of the 3D models were downloaded from Hubs and are protected under copyright of CC Attribution [1]. For 3D models, it was mainly

1 Light Fixture - Ceiling Recessed by mozillareality on Sketchfab, `https://sketchfab.com/models/269fd427629548a8a0949a6493c5b223`

monsters or creatures placed in the space to make them look like they are visitors coming to the museum.

Figure 3.21 VR Museum

Fox Minecraft by kuzneciv on Sketchfab,
https://sketchfab.com/3d-models/fox-minecraft-3c7b1e0e9a5f4897805b7ec3c4eeb5a5
Om Nom by JuanG3D on Sketchfab,
https://sketchfab.com/3d-models/om-nom-bc5863dfedb74e3c96c64962a622fbbd
Mushroom Monster by Lizzy Koopa on Sketchfa,
https://sketchfab.com/3d-models/mushroom-monster-1088371bbd6e40699e8f8eff14b28954
Little Monster by Lizzy Koopa on Sketchfab,
https://sketchfab.com/3d-models/little-monster-2df096c92c95498ca69f1e205e370e3e
Sloth Stuffed Animal by Jesse Rose on Sketchfab,
https://sketchfab.com/3d-models/sloth-stuffed-animal-4fcb87e8e80c4e16b6c6a24804567372
Animal Ninja by little.bucket on Sketchfab,
https://sketchfab.com/3d-models/animal-ninja-60bf79c6ed5841bfa548ce7508c7ebd3
Celeste - Animal Crossing New Horizons by Ines on Sketchfab,
https://sketchfab.com/3d-models/celeste-animal-crossing-new-horizons-2f328b60753b4b88b246fe18963d98e5
Rhinoad by keianhzo on Sketchfab,
https://sketchfab.com/3d-models/rhinoad-7123b5daac1147b7864b783087fb4f10

3.3.9 Activities

The whole *MuMo* activity consists of five activities, from Activity 1 to Activity 5. It would proceed one by one in order. As shown in Figure 3.22, each activity has a theme: CREATE, UPLOAD & SHARE, INTERACT, CO-CREATE and ENJOY!. Each activity will be discussed in detail in the latter part of this section. Regarding the platforms, Playing Kit would be used throughout the activities, Online Studio from Activity 2 to Activity 4, and VR Museum at last, which is Activity 5. The entire process is designed to gradually move from a physical to an online environment. Furthermore, it is also designed to expand interactions with others step by step as they go through the activities, so that children can first focus on themselves and not be overwhelmed to interact with someone who they don't know. In Activity 5, it is open to anyone who has been involved in *MuMo* activity. This means that they get to know more about other children from different backgrounds through their artworks and it would also encourage them to have confidence by showing their drawing in an open space. What makes this online-offline activity notable is that each child is not connected at the same time, but can participate asynchronously. It is designed to complete 1-2 activities per week, 2-3 weeks for the whole process period.

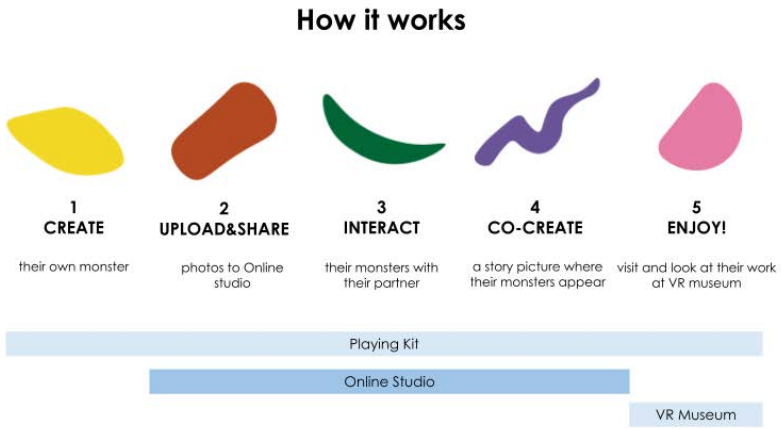

Figure 3.22 How It Works

Activity 1- CREATE

- Overview: Children create their own monster by using the Playing Kit and an object that they find in their house.
- Aim: Not only that hands-on creating activity encourages children's creativity, by incorporating daily objects in their work, it enables them to get the sense of cultural differences or similarities when they share their work in the latter activities.
- Platforms: Playing Kit
- Playing tools: Activity 1 letter, magnifying glass, monster pieces
- Steps:

  1-1. Their guardians take out the "Activity 1" envelope from the Playing Kit and read out the letter to them.

  1-2. Together with their guardians, they would search for an object such as food or daily items in their house that they want to turn into monsters. The magnifying glass is a prop that they can use when they explore around the house.

  1-3. Once they find the object, they will place it on a Playing Kit which has turned into a desk. Children will then use monster pieces and attach them on the object to create their monsters by using tapes.

Activity 2- UPLOAD & SHARE

- Overview: To share monsters to each other, their guardians will upload photos of their work to Online Studio and then type in monsters' details by communicating with their children.
- Aim: By giving his/her monster its name and characteristics, it helps the child to help the child to foster their creativity and feel more connected to a monster. It would also be easier for the child on the other side to relate himself or herself to what *MuMo* friend has created.
- Platforms: Playing Kit, Online Studio

- Playing tools: Activity 2 letter, ID card
- Steps:

  2-1. Their guardians take out the "Activity 2 & 3" envelope from the Playing Kit and read out the letter to them.

  2-2. The guardians will take photos of what their children made in Activity 1.

  2-3. The guardians will access Online Studio by reading the QR code or URL on the ID card and uploading the photos.

  2-4. The guardians will ask their children about the monsters and fill in the space marked "Activity 2" in Online Studio (Figure 3.23).

Figure 3.23 An Example Outcome of Activity 2

Activity 3- INTERACT

- Overview: After they saw each other's monsters, they would give comments and ask questions to each other by leaving texts in the Activity 3 section of Online Studio. Texts would be typed in by their guardians.
- Aim: The opportunity to think about questions and comments will encourage them to carefully observe the other one's monster and to try to learn

more about *MuMo* friend. Getting back answers would also make them feel that they are interacting with each other.

- Platforms: Playing Kit, Online Studio
- Playing tools: -
- Steps:

  3-1. Guardians will start a conversation with their children by looking at *MuMo* friend's monster. They would ask them if they have any questions or comments that they would like to hear from *MuMo* friend.

  3-2. The guardians will fill in the space marked "Activity 3" with at least one comment and one question that their children brought up during the conversation.

  3-3. They would reply to each other's comments and questions. Guardians would again type in those answers on Online Studio (Figure 3.24).

Figure 3.24 An Example Outcome of Activity 3

Activity 4- CO-CREATE

- Overview: Children would work together on the Online Studio to create one drawing with their monsters as characters that appear in the drawing(Figure 3.25). Teamwork is the key.

- Aim: By having the same goal (draw one picture together) with different roles assigned, they will enhance their cooperative skills.
- Platforms: Playing Kit, Online Studio
- Playing tools: Activity 4 letter
- Steps:

  4-1. Their guardians take out the "Activity 4" envelope from the Playing Kit and read out the letter to them.

  4-2. Guardians will access to Online Studio and reach to Activity 4 section.

  4-3. There is a white canvas, cropped photos of their monsters and digital version of monster pieces in the section. They would move around those elements, place them freely and also use a pen tool to draw on the canvas. However, there is one rule before they start drawing. If the canvas is still white, meaning that the child was the first to start the activity, that child would be in charge of drawing the background. He/She is responsible for deciding where the monsters are at. The next child, who saw the background being drawn, can decide what those monsters are doing at that place.

Figure 3.25 An Example Outcome of Activity 4

Activity 5- ENJOY!

- Overview: They will explore around the VR Museum where their collaborative drawing is exhibited.
- Aim: By experiencing the work not as something that stays among the two children, but as something that is open to anyone who accesses the virtual space, it can encourage them to get a sense of accomplishment from having completed something together. They would also have the opportunity to look at other children's work, which they can compare with their own experience to notice what are the similarities and differences.
- Platforms: Playing Kit, VR Museum
- Playing tools: Activity 5 letter, museum tickets
- Steps:

  5-1. Their guardians take out the "Activity 5" envelope from the Playing Kit and read out the letter to them.

  5-2. Guardians will access the VR Museum by reading the QR code or URL on the museum tickets.

  5-3. Once they enter the virtual room, they will find a panel in front of them which has an easy instruction on how to move around the space. Children will then freely explore the museum. There will be other drawings exhibited in the museum as well, which are drawn by other pairs of children (the VR space used for the experiment actually displayed drawings created by the author). They will experience a virtual museum tour, by exploring the space, finding their drawing, and also looking at those other drawings.

3.3.10 Logo

The logo of *MuMo* is designed based on the font Quicksand. It shows how *MuMo* can let children cooperate with each other, and connects children around the globe. Two letters of "M" represent the two children, with "u" connecting between the two pairs, and "o" representing that the connection goes beyond (Figure 3.26, Figure 3.27).

Figure 3.26 Logo Design Process

Figure 3.27 Logo

Chapter 4
Validation

4.1. Method of Inquiry

4.1.1 Purpose

An experiment was conducted with two children actually playing *MuMo* together participating from each home. There are mainly three purposes for the experiment. Firstly, to verify whether the elements of the three concepts, which are "co-creation", "embracing diversity" and "tangible artifacts", can be identified during the experiment. Secondly, to understand how the three *MuMo* platforms are used for each activity by children and their parents, and where improvements can be made. Thirdly, from those results, to verify whether the aims of each of the five activities were achieved or not.

4.1.2 Partcipants

Two 6-year-old children, T and S, and their parents participated in the experiment. They were not acquainted with each other, and this was their first meeting in this experiment. R was T's father and Y was S's mother. T's mother, K, participated in the experiment occasionally. Both families lived in Japan, and their native language was Japanese. In terms of learning other languages, S took an online class in English for about 20 minutes almost every day. Both children were exposed to devices on a daily basis, with T using a smartphone or an iPad for up to 30 minutes and S using Nintendo Switch to play games for up to an hour each day. Both parents had basic computer literacy skills as they used computers for work. When asked in a pre-test interview about how they relate to their friends, R responded that T is a gentle type who is shy at first but shows leadership and

values harmony once they get to know each other, and S is the type of person who is flexible and kind, not stubborn when it comes to changing what friends do together. Both children liked to play outside with their friends, and at the time of the pre-test interview, they were both into a pretend play of Minecraft, where they used rocks and other objects they picked up outside as if they were items in the video game. T had never played the actual Minecraft, and S only played it when he went to a friend's house.

4.1.3 Settings

The experiment was conducted in each family's home, T in the living room and S in his room. In both cases, the experiment was conducted on a table using a Playing Kit or a device. As devices, T used an iPad and S used a PC. The author was not present at most of the experiments except for T's Activity 5, because the author was not in Japan and also because to test how *MuMo* is actually used with only the parents and children. For T's Activity 5, the author actually went to T's house to conduct the experiment. It was conducted in the common space of T's apartment, and the device was the author's laptop.

4.1.4 Procedure

First, before starting the experiment, there was an explanation from the author to parents, and confirmed that they agree to participate in the experiment. Then a pre-test interview was conducted. These were all done online, using Zoom, respectively with each family. Pre-test interviews were for both parents and children. Then each family participated in five activities divided into four days, over a period of about three weeks. For each activity, parents were asked to take videos of their children participating in the activities and also to fill out a questionnaire after they have finished. Questionnaires were sent from the author via a messaging app, LINE. If parents had any questions during the period, they were able to ask the author via LINE. After all activities were completed, post-test interviews were conducted with each family. Again, the interviews were for both parents and children. S's family was interviewed online using Zoom but T's family was interviewed face-to-face, right after completing Activity 5. Prior to the start of

the experiment, the plan was to divide the activities into three days in a two-week period, assuming that children and parents will be busy on weekdays. However, due to the late arrival of the Playing Kit and the child being sick, it took about three weeks from the start of Activity 1 to the end of Activity 5.

4.1.5 Data Collection and Evaluation Method

Three types of data were collected: video recordings, questionnaires, and interviews. As described in "4.1.4 Procedure", the videos were taken by the parents during the activities (T's Activity 5 was taken by the author). They filmed how the children were playing from before the start of the activity to the end of it. All the videos were uploaded and stored in a Google Drive folder, which the link was shared from the author to their parents beforehand. The video recordings were closely observed by the author and the words and actions were recorded as writing.

The questionnaires were sent by the author after receiving a message from the parents after each activity. The questionnaires asked how their experience of the activity and platforms was, their child's reaction, and any other feedback. Google Form was used to create the questionnaires. The one for Activity 1 can be found in Appendix A.

Interviews were conducted twice, before and after the experiment. In the pre-test interview, in addition to basic demographic information about the children, it asked how they usually play, whether they are familiar with the online environment, and whether they have had any experience with multicultural exchange. We also asked directly from the children themselves what kind of games they like to play and what kind of games they usually play. We also asked the children what they thought about playing with children they did not know.The post-test interview was about what the author would like to ask the family further after the video observation of each activity and the results of the survey, and about their thoughts of the whole process. Interviews were video recorded then observed. It was also recorded in writing.

For the evaluation, a qualitative method was conducted using these data. The points to be validated and the platforms used for each activity were different; Table 4.1 summarizes the validation items. For the concept of "co-creation", it

was evaluated based on whether or not items of cooperative play were found in those data (Table 4.2). The checklist described here was created based on Scoring Sheets by Lee et al. In addition to Lee et al, Miyake also created a checklist for cooperative play (Lee et al. 2022, Miyake 2016), but since both of these checklists are based on play between children who are actually together in the same place, many items do not apply to this study. Therefore, the number of items is limited. Let it be noted that the CSCW evaluation method was not adopted due to the context of this experiment. Neale et al. noted the complexity of the CSCW evaluation and offered several suggestions for how to do it. Because those suggestions were intended for participants who were old enough to be aware of their goals, it was determined that, in this study, they were not applicable to children who were not yet able to work collaboratively on their own (Neale et al. 2004). For "tangible artifacts", since it helps children's creativity, it was evaluated based on whether or not items related to creativity were found (Table 4.3). The commonly used Guilford Measures was used (Iga 1993). The concept of "embracing diversity" is specifically about cultural diversity, so the evaluation will be based on whether there are any references to or expressions of lifestyles in the experiment.

Table 4.1 Validation Items for Each Activity

		Activity 1	Activity 2	Activity 3	Activity 4	Activity 5
Aims for Activities		Not only that hands-on creating activity encourages children's creativity, by incorporating daily objects in their work, it enables them to get the sense of cultural differences or similarities when they share their work in the latter activities.	By giving his/her monster its name and characteristics, it helps the child to foster their creativity and feel more connected to a monster. It would also be easier for the child on the other side to relate himself or herself to what MuMo friend has created.	The opportunity to think about questions and comments will encourage them to carefully observe the other one's monster and to try to learn more about MuMo friend. Getting back answers would also make them feel that they are interacting with each other.	By having the same goal (draw one picture together) with different roles assigned, they will enhance their cooperative skills.	By experiencing the work not as something that stays among the two children, but as something that is open to anyone who accesses the virtual space, it can encourage them to get a sense of accomplishment from having completed something together. They would also have the opportunity to look at other children's work, which they can compare with their own experience to notice what are the similarities and differences.
Design Concepts	co-creation			▲	•	•
	cultural diversity	•	•	•	•	•
	tangible artifact	•	▲			
Platforms	Playing Kit	•	•	▲	•	•
	Online Studio		•	•	•	
	VR Museum					•

•: items that should be observed

▲: items that might be observed

Table 4.2 Checklist for Cooperative Play

1	Associative Play	The child plays by interacting with another child, such as by asking questions
2		The child tells the parent or caregiver the story of the play with another child
3		The child pay attention to other children's play activities and engages in many conversations.
4	Cooperative Play	The child remembers previous play with other children and is able to continue it the next time they meet
5		The child engage in play activities with rules
6		The child can play given roles in the process of play with other children
7		The child play cooperatively with other children to complete objects or structures
8		The child can work with other children to create new ways of playing or rules

(Cited from Scoring Sheets by Lee et al. (Lee et al. 2022))

Table 4.3 Checklist for Creativity

1	fluency （流暢性）
2	flexibility （柔軟性）
3	originality（独創性）
4	elaboration（綿密性）

(Guilford Measures (Iga 1993))

4.2. Results

The results of the observation of video recordings, questionnaires, and interviews will be recorded in Appendix B, C, and D, respectively. Below is a summary of each activity, captured video images, and the children's final work.

Opening the Playing Kit

Parents were also asked in advance to take videos when they open the Playing Kit. Their reactions are shown in Figure 4.1 and Figure 4.2. T seemed to be excited to see what was inside and he cheered when he knew he could play Activity 1 right away. S stared at the Playing Kit for a while after he opened it and pulled out the two drawers to see what was inside.

Figure 4.1 T's Reaction when He Opened the Playing Kit

Figure 4.2 S's Reaction when He Opened the Playing Kit

Activity 1

T didn't use any daily object and only used monster pieces when he made his monster. This is due to his father not understanding what exactly he needed to do. This would be discussed in detail in the latter section. T also got several suggestions from R on how to place the pieces. Figure 4.3 shows him playing Activity 1 and his final outcome. S eventually made three monsters in total, using an empty tissue box, a plastic bottle and a magnifying glass, which was one of the props in the Playing Kit. S continuously came up with ideas on how to create them without any suggestions from Y. Figure 4.4 shows him playing Activity 1 and his final outcome.

Figure 4.3 T Playing Activity 1 (left) and His Final Outcome (right)

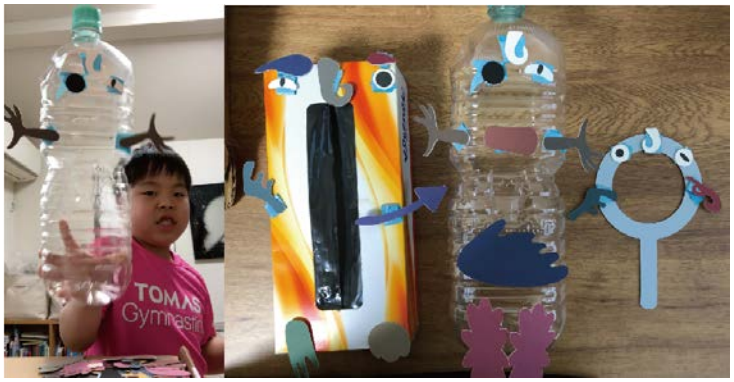

Figure 4.4 S Playing Activity 1 (left) and His Final Outcome (right)

Activity 2

Because it was an activity where parents type in what their children elaborate about their monsters, both families had an active parent-child conversation. There was a time that R had to wait for T when R couldn't use Miro the way he wanted to. For S's family, S always had his monster that he created in his hand while he was explaining to Y.

Figure 4.5 T Explaining His Monster's Personality (left) and His Final Outcome (right)

Figure 4.6 S Explaining His Monster's Ability (left) and His Final Outcome (right)

Activity 3

When it comes to asking questions and giving comments to each other's monster, S came up with several questions immediately, whereas T said he has none when he was asked by R, although he had several comments or questions when he was listening to R explaining about S's monsters. Although both T and S replied to each other's questions in detail, R and Y summarized their stories when it came to writing down inside the speech bubbles (Figure 4.7 and 4.8).

Figure 4.7 T Listening to R Explaining about S's Monsters (left) and His Final Outcome (right)

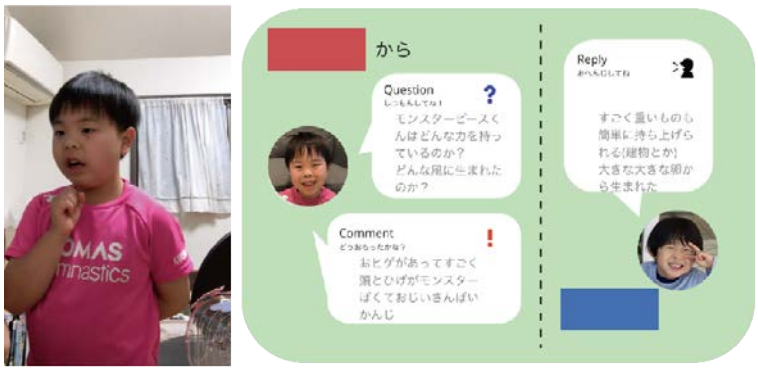

Figure 4.8 S Asking Questions to T About Monsters (left) and His Final Outcome (right)

Activity 4

In Activity 4, technical constraints of Miro were seen on both sides, although they were using different devices. For T's family, they struggled with moving the objects, using the pen tool, and choosing the right colors. For S's family, because they didn't have a mouse, S couldn't draw with his fingers on the touchpad as he liked. Hence, S would say verbally how he wants to draw on the canvas and Y drew it for him. Despite these technical limitations, there were several moments when the children smiled after they were able to draw as they wanted. There was also a conversation between T and R to leave out some space for S so that he can also draw on the same canvas later on. S who saw T's drawing on the canvas, made use of some drawings to create a new monster (eyes were added on top of the mountains and a mouth at the bottom).

Figure 4.9 T and S Playing Activity 4 (top) and Their Final Work (bottom)

Activity 5

In the VR Museum, both T and S seemed to be excited while they were looking for their work. When they found it, T mentioned what was drawn in the drawing whereas S did not. After they found their drawing, they seemed to enjoy the VR Museum in a little different way, depending on whether they had virtual experience or not. It was T's first experience to join VR rooms and he enjoyed moving around the space itself. S, on the other hand, who had virtual experiences before, also enjoyed moving in the room but also had time to mention about other drawings exhibited in the museum.

Figure 4.10 T and S Playing Activity 5

4.3. Discussion

4.3.1 Concepts

Regarding the elements of the three concepts, the first concept, "co-creation" was able to confirm behaviors and actions related to the items on the list of cooperative play in the video observation. In particular, we were able to identify many items in Activity 4. The picture was created in the order T and then S, and it was remarkable that T took care to leave space for S to draw. This can be considered as a sign of concern for the other one and a desire to cooperate to complete the work. S, who saw T's drawing, updated it by adding new parts to it. It could

be said that the two completed the picture together as a collaborative work. S had also incorporated T's monsters into his own story in the previous Activity 3. The characteristics of cooperative play, such as caring for the other person and creating something new by incorporating ideas of others, were observed. On the other hand, in the post-test interview, the parents gave feedback that most of the time their children did not feel that they were playing together with the other child. The asynchronous nature of this play and the fact that the interaction was text-based may have been the cause. Even though the players understood that there was a partner and could play according to the rules, the design made it difficult for them to intuitively understand that they were playing with a partner. As for Y, she did not mention T's name at all and called him "friend". This may have contributed to the difficulty for S to relate him to T. Improvements such as exchanging videos in advance, or to play with both synchronous and asynchronous situations are needed.

Regarding the second concept, "embracing diversity", there was little cultural exchange between T and S. However, cultural aspects were mentioned by both T and S. Y mentioned in the post-interview that "S said he was surprised when he saw the sample image of the shoes being used, as if he had never thought of that idea". Video observation of them talking with their parents in Activity 2 and Activity 3 also revealed that the characteristics of the monsters reflected their respective experiences. For S, the monsters were all elementary school kids, which may have been influenced by the fact that he himself entered elementary school in April of this year; for T, the monster's ability to be strong and could carry a box of beer reflected the fact that T was helping his parents carry their deliverables. These therefore suggest that both individuals were projecting their own daily lives onto the monster. While the design was able to pull out the cultural elements, it was not able to convey them to their friends. Design that can share their cultural experiences with others is an issue for the future.

The last concept, "tangible pieces", confirmed its usefulness, especially how it is used and how important its design is. In Activity 1, T used only monster pieces, while S used them in combination with the daily objects, in other words, created monsters in a way that was designed. As a result, many items related to creativity were found for S, such as "fluency", in which S came up with and pasted monster

body parts one after another using objects, “flexibility”, in which S created three pieces of work instead of just one, and “originality”, in which S expressed not only body parts but also the inner concept with monster parts. T, on the other hand, had monster pieces only, so he had to create a monster from nothing. There were several occasions when it took time for him to choose the next piece or to get suggestions from his parents. These indicate that there was a significant difference in creativity depending on whether or not monster pieces were used in combination with daily objects. Furthermore, in a post-test interview, Y provided a comment as follows: “I think S is not a crafty type, so it would’ve been difficult for him to create from scratch. However, when the well-made pieces like these were prepared properly, he was able to concentrate and stimulate his creativity.” A balance between open-ended and structured play, as described in “3.2.1 Monster Pieces”, worked well. It is also notable that S explained the monster’s characteristics while holding the work in his hand in Activity 2. This allowed for a concrete explanation of what parts of the monster’s body represent what. T was explaining while looking at a photo of his monster on an iPad. Although the “originality” of its name and the “flexibility” of him mentioning the favorite foods one after another were observed, “elaboration” was little compared to S. Therefore, it can be suggested that the daily objects, which were initially designed for cultural elements, actually contributed greatly to creativity by being designed to be used in combination with the monster pieces.

4.3.2 Platforms

The Playing Kit cardboard box was not used as it was intended. R, who did not have the explanation in advance, took off the separating board (see Figure 4.1). In addition, neither T nor S used it as a desk. In Activity 1, R did not use the magnifying glass and daily objects. He explained that he had read the instruction booklet but did not get the idea of what he needed to do. All of these problems regarding the Playing Kit can be solved by adding illustrations of how to use them to the instruction booklet.

As for Online Studio, it was difficult to use Miro if it was their first time, and this affected their satisfaction. The questionnaire result showed that R rated the usability of Online Studio as 1 for both Activity 3 and Activity 4, and his

satisfaction was also linked to this rating. The platform for Online Studio should be changed. Another area for improvement is its layout design. Y did not read the name of the monster created by T, and parents didn't write all of the children's stories due to the limited space.

As for the VR Museum, R could not connect due to technical issues, and the author ended up going to their house. Y mentioned the complexity of accessing the VR Museum, starting from the QR code on the ticket, sending that link to her email, and eventually opening the browser from her computer. Regarding the virtual experience, both T and S enjoyed looking at the 3D models. S, who had experience with virtual spaces, also had time to look at the exhibited pictures although he didn't mention many about what was drawn on each picture. For future work, it could be better to have a more seamless integration of their creation and the 3D space.

4.3.3 Activities

From these results and discussions, the following is a description of what conclusions were reached for Activity 1 to Activity 5.

- Activity 1: Creativity was encouraged, and the role of the daily objects was found to help the creativity even more when combined with the monster pieces.
- Activity 2: Through parent-child communication, children further expanded their creativity. Creativity was especially encouraged when the children actually had their work in their hands.
- Activity 3: Although they talk about each other's monsters or incorporate in their own stories, they rarely mentioned each other. They were also found to reflect their own experiences on monsters.
- Activity 4: Cooperative play features were observed, such as caring for others and taking their ideas and creating new ones. Role-sharing did not function well for the latter child.

- Activity 5: Although there were no words or actions that corresponded to a sense of accomplishment, the children were excited to discover their work, and even after finding it, they talked about the picture with their parents. A child with the VR experience was able to mention other works, but a child without VR experience tended to enjoy the space itself. Both showed interest in the 3D modeled characters.

Additionally, there were two findings regarding parent-child communication considerations throughout the activities. First, several children's behaviors were restricted by comments and actions of their parents. For example, in Activity 3, R failed to pick up on several questions that were raised by T during the conversation, and in Activity 4, R stopped T from creating another monster although T wanted to. The second finding is the reference to the other child: R had mentioned S's name and T sometimes mentioned his name as well, whereas Y called T "friend", so S never said T's name during the activities. This could be a factor that reduced the sense of togetherness. The design of parent-child communication needs to be further explored.

4.3.4 Limitations

There were some limitations concerning the experiment. First, only one case of the experiment had been completed by the time this paper was written. Other experiments were planned with two 6-year-olds of Chinese nationality living in Shanghai, one 6-year-old of Japanese nationality living in London, and one 6-year-old of Japanese nationality living in Japan. However, Shanghai was locked down during the experimental phase due to the COVID-19 pandemic, and subsequent experiments had to be canceled due to uncertainty about how long it would take for the Playing Kits to be delivered. Although some suggestions were presented, it is not possible to draw statistical conclusions from this experiment alone due to the small sample size. Second, the experiment was conducted between two native Japanese-speaking boys living in Japan. Compared to the interaction between children who live in different places or speak different languages, there may be less interaction in terms of cultural factors.

Chapter 5
Conclusion and Future Work

5.1. Conclusion

This research proposed to design cooperative play for children at a distance, by the name of *MuMo*. It is an online-offline activity that would allow two children (5-7 year olds) at home with their parents or caretakers to play together. They will be using three platforms: Playing Kit, Online Studio and VR Museum, and go through five activities in total, asynchronously. The goal of the two children is to co-create a picture together, using their own monsters that they created in the earlier activities. There are three design concepts for *MuMo* and they are "co-creation", "embracing diversity" and "tangible pieces".

Based on the results and discussions from the user test, the concept of "co-creation" was confirmed by having features of cooperative play such as caring for the other child and creating something new by incorporating ideas of others. However, asynchronous play did not make them feel that they were playing together. For "embracing diversity", although there was no cultural exchange between the children, it was possible to see that both children were projecting their own daily lives onto the monster. The next step would be to think of how to convey that cultural aspects to the other child. Regarding the "tangible pieces", the usefulness of the monster pieces was confirmed by combining them with everyday objects. The process of creating the monster and explaining about the monster both enhanced the children's creativity. It was also found that providing a step-by-step activity and a variety of pieces allows children to play freely in a structured play environment, and empowers their creativity. The Playing Kit did not convey some of the intended design to the participants. The Online Studio used Miro, the popular online collaborative whiteboard platform used around the world, but even if parents have basic digital literacy, the usability of the platform was not as good

as it was expected. While the VR platform was enjoyed by the children, more needs to be done to draw more attention to the content of the pictures exhibited. When looking at each activity, Activity 1, 2, and 4 accomplished most of the initial aims, although there were some improvements in the cultural exchange part and the design of the Online Studio. Activity 3 and 5 need major improvement in that they were not aware of their *MuMo* friends and others. The importance of parent-child communication was revealed throughout the activities, and it should be further explored to incorporate in design.

5.2. Future Work

5.2.1 Improvements

Playing Kit could be further improved by having a more visually understandable instruction booklet. It would be also better to have some advice in the instruction booklet for guardians for each activity so that they would not overlook or unknowingly restrict their children's speech and behavior. For the Online Studio, it should be transferred from Miro to another platform, which could also record their voices or videos during the activities. By exchanging their voices or photos or videos, it allows children to feel more connected to each other. For the same reason, the platform also needs a function for notifications when the other child has participated in the activity. In terms of connectedness, exchanging videos in advance, or to play with both synchronous and asynchronous situations should also be further explored. For the VR Museum, it could be better to have a more seamless integration of their creation and the 3D space, so that children can enjoy both the space and their outcomes at the same time. Since there was a limitation for the user test that it was done only once with two native Japanese-speaking boys living in Japan, more tests among children who live in different regions should be conducted. It should also be noted it is necessary to develop a checklist specifically for remote cooperative play among young children.

5.2.2 Extensibility

MuMo was an online-offline cooperative activity for young children who are located away from each other and can participate together with their parents from home. TUI was not used due to the difficulty of implementation of practical use considering the technological limitations and its cost. It was hence designed to play the activities in both online and offline environments individually, but seamlessly. If devices such as the Amazon Glow become more widely used in the future, practical research using TUI will be possible. Therefore, designing activities that use TUI in both synchronous and asynchronous situations at home would be the next step, and would be possible in the not so distant future.

References

Abdullah, Anna Christina (2009) "Multicultural Education in Early Childhood: Issues and Challenges," *Journal of International Cooperation in Education*, Vol. 12, No. 1, p. 159–175.

Akkari, Abdeljalil and Kathrine Maleq (2020) *Global Citizenship Education: Critical and International Perspectives*: Springer International Publishing.

Alessandra, Fumagalli Romario (2019) "Imaginary language," URL: `https://www.rca.ac.uk/students/alessandra-fumagalli-romario/`.

Alonso-Campuzano, Cristina, Giuseppe Iandolo, María Concetta Mazzeo, Noelia Sosa González, Michelle Jin Yee Neoh, Alessandro Carollo, Giulio Gabrieli, and Gianluca Esposito (2021) "Children's Online Collaborative Storytelling during 2020 COVID-19 Home Confinement," *European Journal of Investigation in Health, Psychology and Education*, Vol. 11, No. 4, pp. 1619–1634.

Amazon, . (2022) "Amazon Glow," URL: `https://www.amazon.com/Introducing-Amazon-Interactive-Projector-Togetherness/dp/B09DWNZQYM`.

Antle, Alissa N. and Christopher Frauenberger (2020) "Child–Computer Interaction in Times of a Pandemic," in *International Journal of Child-Computer Interaction*, Vol. 26, p. 100201.

Catala, Alejandro, Cristina Sylla, Manët Theune, Eva Brooks, and Janet C. Read (2018) "Rethinking Children's Co-Creation Processes beyond the Design of TUIs," in *Proceedings of the 17th ACM Conference on Interaction Design and Children*, pp. 733–740: ACM.

Cohen, Maayan, Kody R. Dillman, Haley MacLeod, Seth Hunter, and Anthony Tang (2014) "OneSpace: Shared Visual Scenes for Active Freeplay," in *Pro-*

ceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 2177–2180.

Drew, Chris (2020) "Cooperative Play – Benefits and Challenges for Children," January, URL: https://helpfulprofessor.com/cooperative-play/.

Harvard Graduate School of Education, . (2021) "COVID and Education: Challenges, Opportunities, and the Future of Learning," URL: https://www.youtube.com/watch?v=2KlzTEl8ATo.

Elbrecht, Cornelia (2020) "The Sensorimotor Hands-Brain Connection," July, URL: https://www.sensorimotorarttherapy.com/blog/2020/7/29/the-sensorimotor-hands-brain-connection.

Fails, Jerry Alan, Allison Druin, Mona Leigh Guha, Gene Chipman, Sante Simms, and Wayne Churaman (2005) "Child's Play: A Comparison of Desktop and Physical Interactive Environments," in *Proceeding of the 2005 Conference on Interaction Design and Children - IDC '05*, pp. 48–55: ACM Press.

Hewes, Jane (2006) "LET THE CHILDREN PLAY-Nature's Answer to Early Learning," p. 8.

Hunter, Seth E., Pattie Maes, Anthony Tang, Kori M. Inkpen, and Susan M. Hessey (2014) "WaaZam!: Supporting Creative Play at a Distance in Customized Video Environments," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 1197–1206.

IBC Colorado, . (2020) "Predicting the Future with Thomas Frey," November, URL: https://k12.thoughtfullearning.com/FAQ/what-are-21st-century-skills.

Iga, Noriko (1993) "創造的思考の評価基準," 日本心理学会第 *57*回大会発表論文集 .

Interesting Engineering, . (2021) "Life in 2050: A Glimpse at Education in the Future," June, URL: https://interestingengineering.com/life-in-2050-a-glimpse-at-education-in-the-future.

Ishii, Hiroshi and Brygg Ullmer (1997) "Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms," in *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems*, pp. 234–241: ACM.

Jansweijer, Job (2014) "KonneKt, a Game for Isolated Children in Hospitals," URL: `https://konnektplay.nl/`.

K-12 Thoughtful Learning, . (2015) "What Are 21st Century Skills?," August, URL: `https://k12.thoughtfullearning.com/FAQ/what-are-21st-century-skills`.

Battelle for Kids, . (2019) "P21 Frameworks & Resources," URL: `https://www.battelleforkids.org/networks/p21`.

Lawrence, Sandra (2019) *The Atlas of Monsters: Mythical Creatures from Around the World*: Running Press Kids.

Lee, Sun-Hee, Ickpyo Hong, and Hae Yean Park (2022) "Development of a Social Play Evaluation Tool for Preschool Children," Vol. 10, No. 1, p. 102.

Muto, Takashi (2013) 幼児教育のデザイン*:* 保育の生態学: 東京大学出版会, pp.173-202.

Neale, Dennis C, John M Carroll, and Mary Beth Rosson (2004) "Evaluating Computer-Supported Cooperative Work: Models and Frameworks," Vol. 6, No. 3, p. 10.

Osmo, . (2014) "Osmo," URL: `https://www.playosmo.com/en/`.

Pew Research Center, . (2020) "PARENTING CHILDREN IN THE AGE OF SCREENS," July, URL: `https://www.pewresearch.org/internet/2020/07/28/childrens-engagement-with-digital-devices-screen-time/`.

Promethean Blog, . (2017) "Collaborative Learning vs. Cooperative Learning: What's the Difference?," URL: `https://resourced.prometheanworld.com/collaborative-cooperative-learning/`.

R. Wilson, Frank (1998) *The Hand: How Its Use Shapes the Brain, Language, and Human Culture*: Pantheon.

Raffle, Hayes, Koichi Mori, Rafael Ballagas, and Mirjana Spasojevic (2011) "Pokaboo: A Networked Toy for Distance Communication and Play," IDC '11, p. 201–204, New York, NY, USA: Association for Computing Machinery.

Read, J.C. and P. Markopoulos (2013) "Child–Computer Interaction," in *International Journal of Child-Computer Interaction*, Vol. 1, pp. 2–6.

Rigamajig, . (2022) "Rigamajig Building Kits & Geemo – Children's STEM Learning through Play," URL: `https://www.rigamajig.com/`.

Rötkönen, Erkki, Heike Winschiers-Theophilus, Naska Goagoses, Helvi Itenge, Gabriel Shinedima, and Erkki Sutinen (2021) "Playing on the Globe: Facilitating Virtual Communications between Namibian and Finnish Learners to Co-Design an Interactive Map Game," in *Interaction Design and Children*, IDC '21, p. 160–170, New York, NY, USA: Association for Computing Machinery.

Sago Mini, . (2013) "Sago Mini Box: Award-Winning Subscription Box for Kids," URL: `https://sagominibox.com/`.

Sago Sago Toys Inc, . (2014) "Sago Mini Monsters," URL: `https://sagomini.com/apps/monsters/`.

Schmidt, Kjeld, P O Box, and Liam Bannon (1992) "Taking CSCW Seriously: Supporting Articulation Work," p. 34.

Sharma, Sumita, Pekka Kallioniemi, Jaakko Hakulinen, Tuuli Keskinen, and Markku Turunen (2019) "Exploring Globally Inclusive Online Collaboration for Indian and Finnish Schoolchildren," in *Proceedings of the 18th ACM International Conference on Interaction Design and Children*, IDC '19, p. 153–160, New York, NY, USA: Association for Computing Machinery.

Shibasaki, Mina, Youichi Kamiyama, Elaine Czech, Koichi Obata, Yusuke Wakamoto, Keisuke Kishi, Takayuki Hasegawa, Shinkuro Tsuchiya, Soichiro Matsuda, and Kouta Minamizawa (2020) "Interest Arousal by Haptic Feedback During a Storytelling for Kindergarten Children," in Ilana Nisky, Jess Hartcher-O ' Brien, Michaël Wiertlewski, and Jeroen Smeets eds. *Haptics:*

Science, Technology, Applications, Vol. 12272 of Lecture Notes in Computer Science: Springer International Publishing, pp. 518–526.

Sylla, Cristina, Íris Susana Pires Pereira, and Gabriela Sá (2019) "Designing Manipulative Tools for Creative Multi and Cross-Cultural Storytelling," in *Proceedings of the 2019 on Creativity and Cognition*, pp. 396–406: ACM.

UNICEF, . (2017) *THE STATE OF THE WORLD' S CHILDREN 2017- Children in a Digital World*, USA: UNICEF Division of Communication, pp.173-202.

Vasilchenko, Anna, Jie Li, Bektur Ryskeldiev, Sayan Sarcar, Yoichi Ochiai, Kai Kunze, and Iulian Radu (2020) "Collaborative Learning & Co-Creation in XR," CHI EA '20, p. 1–4, New York, NY, USA: Association for Computing Machinery.

Verenikina, Irina, Pauline Harris, and Pauline Lysaght (2003) "Child's Play: Computer Games, Theories of Play and Children's Development," CRPIT '03, p. 99–106, AUS: Australian Computer Society, Inc.

Villar, Nicolas, Daniel Cletheroe, Greg Saul, Christian Holz, Tim Regan, Oscar Salandin, Misha Sra, Hui-Shyong Yeo, William Field, and Haiyan Zhang (2018) "Project Zanzibar Demonstration: A Portable and Flexible Tangible Interaction Platform," in *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, pp. 1–4: ACM.

Viner, Russell, Max Davie, and Alison Firth (2019) *The health impacts of screen time: a guide for clinicians and parents*: Royal College of Paediatrics and Child Health, pp.11.

Walsh, Greg, Craig Donahue, and Zachary Pease (2016) "Inclusive Co-Design within a Three-Dimensional Game Environment," IDC '16, p. 1–10, New York, NY, USA: Association for Computing Machinery.

Zuiderveld, Sanny (2018) "One Globe Kids - Make Friends around the world," URL: `https://oneglobekids.org/`.

全国保育協議会, . (2020) “Information on health and medical consultation,” URL: https://www.mhlw.go.jp/stf/covid-19/kenkou-iryousoudan_00006.html.

Appendices

A. Post-Test Questionnaire (Activity 1)

MuMo Survey-Activity 1

MuMo アンケート- アクティビティ 1

*必須

Thank you for participating in the MuMo project. Please take a few minutes to complete the brief 3-5 minute survey below. MuMo プロジェクトにご参加いただき誠にありがとうございます。以下3-5分程度の簡単なアンケートにご協力ください。

*Information collected on this survey will be managed appropriately with Keio University Basic Policy Concerning Protection of Personal Information.
https://www.keio.ac.jp/en/privacy-policy/
**This form is provided by Google Workspace.
https://www.mita.itc.keio.ac.jp/en/keioic_qsuite.html

●本アンケートにて収集される情報は、慶應義塾個人情報保護基本方針に基づき適正に管理します。
https://www.keio.ac.jp/ja/privacy-policy/
●本フォームはGoogle Workspaceにて提供されています。
https://www.mita.itc.keio.ac.jp/ja/keioic_qsuite.html

基本情報

1. 基本情報1: 記入されている方のお名前とお子様との関係を教えて下さい。（記入例：西脇由希子、母） *

2. 基本情報2: アクティビティ1の実施日時を教えて下さい。（記入例：2022年5月1日（日）11:30~12:00） *

1. アクティビティについて

3. 1-1. 内容と目標はわかりやすかったですか？ *
1 つだけマークしてください。

	1	2	3	4	5	
とてもわかりづらい	○	○	○	○	○	とてもわかりやすい

4. 1-2. どれくらい時間がかかりましたか？ *
1 つだけマークしてください。

- ○ 10分未満
- ○ 10~20分程度
- ○ 20~30分程度
- ○ 30分以上

5. 1-3. 満足度について教えてください。 *
1 つだけマークしてください。

	1	2	3	4	5	
全く満足していない	○	○	○	○	○	とても満足している

2. プレイキットとMiroboardについて

6. 2-1. 今回のアクティビティ1において、プレイキットは色やデザイン、ツールや文字の大きさは使いやすいものになっていましたか？ *
1 つだけマークしてください。

	1	2	3	4	5	
とても使いづらい	○	○	○	○	○	とても使いやすい

Figure A.1 Post-Test Questionnaire- Page 1 of 2

3. お子様の反応について

7. 3-1. お子様が一番楽しそうにしていた時はどんな時ですか？ *

8. 3-2. お子様が一番つまらなそう、わからなそうにしていた時はどんな時ですか？ *

9. 3-3. お子様の行動で気になったこと、意外だったことを教えて下さい。 *

4. お子様のご意見
お子様に質問し、感想をご記入ください。

10. 4-1. 何が一番楽しかった？ *

11. 4-2. 何がつまらなかった？ *

5. その他

12. 5-1. 今回よかったことを教えてください。

13. 5-2. 気になることややりづらかったことがあれば教えて下さい。

14. 5-3. その他何かあれば自由にご記入ください。

Figure A.2 Post-Test Questionnaire- Page 2 of 2

B. Results of Video Recordings

00_Opening the Kit

child T/recorded by mother K

No	Video	Time	Actions	Conversation	Notes
1	T0_01	0:00-0:07	The video starts right after his father R has cut the tapes on the lid. T puts his hands on both sides of his face with smiles. He seemed to be excited to see what is inside.	Rだいじょう？ KT1、開けていいよ」	
2		0:07-0:12	T opens the lid of the box, saying "ooh!" as soon as he sees inside. Hands out the sheet of paper to his father R.	Tだおー！」	
3		0:12-0:23	T holds the instruction booklet and opens it. When he tries to look inside, his mother K persuades him to look what's inside the box. During T and K's conversation, father R opens the box, but instead of taking out the drawers, he took the separation board off the box. He covers it again on top of the drawers for T to open it.	Kだそれ説明書だね、中見てみていいよ」 Tだなんで？」 Kだ箱開けてごらん」	Haven't told him beforehand how to open the box. Without any instrutions, they would open the box in an unintended way.
4		0:23-0:31	T holds up the separation board up and sees inside. He first picks up the bag of monster pieces and shows in front of the camera.	Rだおお！」 Tだお」 Kだ何それ見てみて？」 Rだこの間き、こういうので遊んだじゃん、それと似てるんじゃない？」	Since T participated in one of the pilot tests, father R mentioned about how it is similar to what they have done before.
5		0:31-0:42	He puts the bag beside him, stares for a while, then moves on to pick one of the envelopes. He opens the "Activity 1" envelope. Then his mother tells him that these might be for parents to read. R takes out the other 3 envelopes and sees what is written on it.	Tだこれなんだ？」 Rだお手紙かな？」 Kだそのお手紙はお母さんたちが見ようかな」	
6		0:42-0:56	T takes out letters and a magnifying glass from the envelope. When K says to stop, he puts them back in the envelope. He asks K whether they are going to start the activity now. K replies yes and he cheers.	Kだいくつかやることがさ、待ってて！これさ、1とか書いてあるからこれからやるんだねきっとね…」 Tだこれから？ややるの？」 Kだやってみよ」 Tだいえーい！」	

child S/recorded by mother Y

No	Video	Time	Actions	Conversation	Notes
1	S0_01	0:00-0:12	S trys to open the box with scissors.	-	
2	S0_02	0:00-0:12	S opens the lid of the box, sees a sheet of paper that had a MuMo logo, then sees the camera. His face seemed to be a little bit confused.	-	He almost had no reaction towards the Playing Kit.
3	S0_03	0:00-0:10	S starts to introduce things (the MuMo logo paper and the instruction booklet) inside the box. He shows them to the camera that his mother Y was holding.	Sこんな感じでーす」	
4		0:10-0:14	S cannot figure out how to take out the drawers. He looks into the box from the front, where drawers were stored, then looks at the box from the top and tries to take the separating board off.	Sん？」	Need improvements for the Playing Kit to intuitively understand how to open it and that it can be used as a desk.
5		0:14-0:24	His mother Y tells him how to open it by pointing to the hole of the left drawer. S then pulls the drawer and took out a bag with monster pieces inside. He shows the bag to the camera.	Yここだよ」	
6		0:24-0:38	He pulls out the whole drawer, puts it on the separation board (on the desk), and then opens the right drawer. He takes out all the envelopes, again takes out the drawer and puts it on top of the left drawer. He shows the envelopes to the camera.	Sまあ手紙っていう感じ？」	

Figure B.1 Video Recording- Opening the Playing Kit

Figure B.2 Video Recording- Activity 1

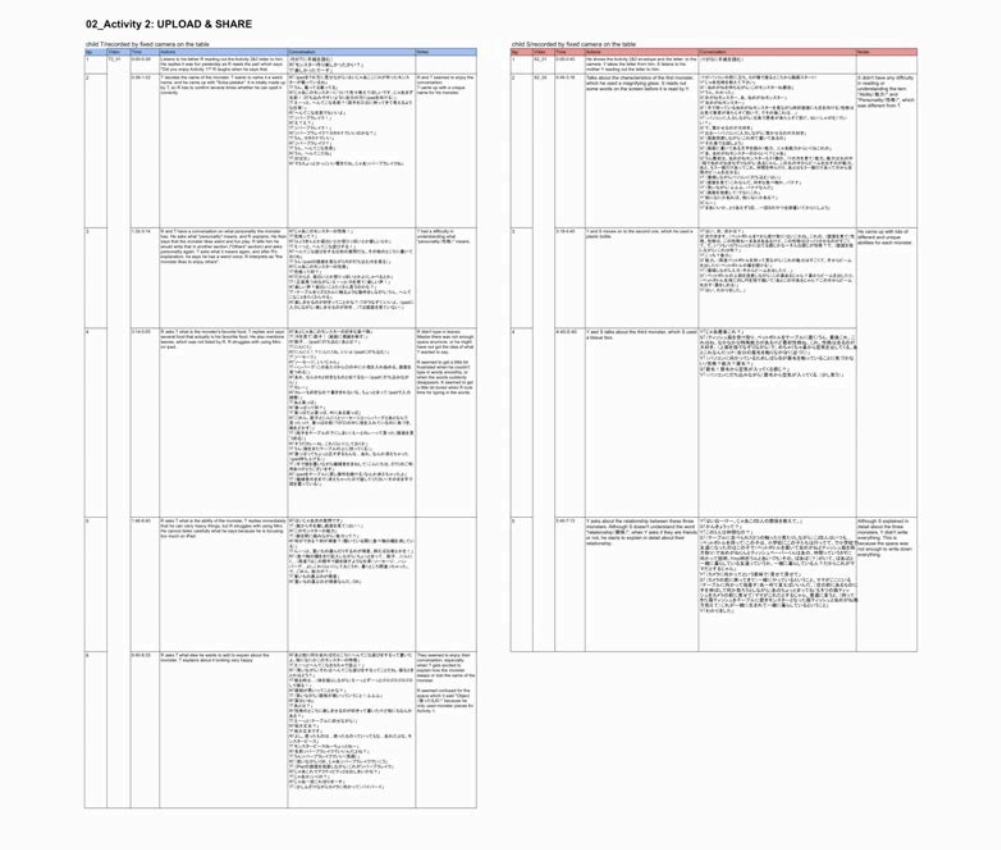

Figure B.3 Video Recording- Activity 2

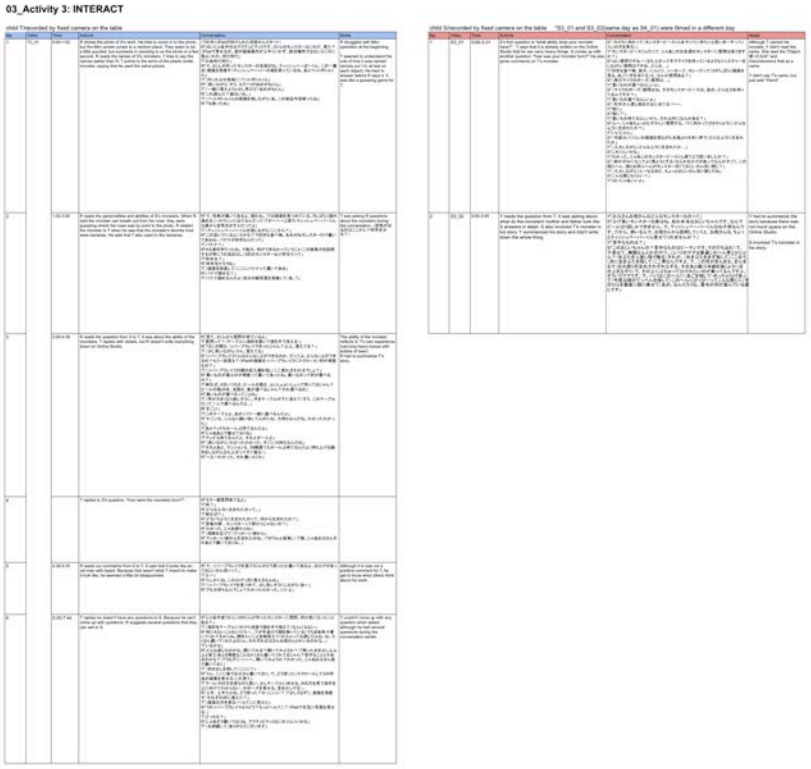

Figure B.4 Video Recording- Activity 3

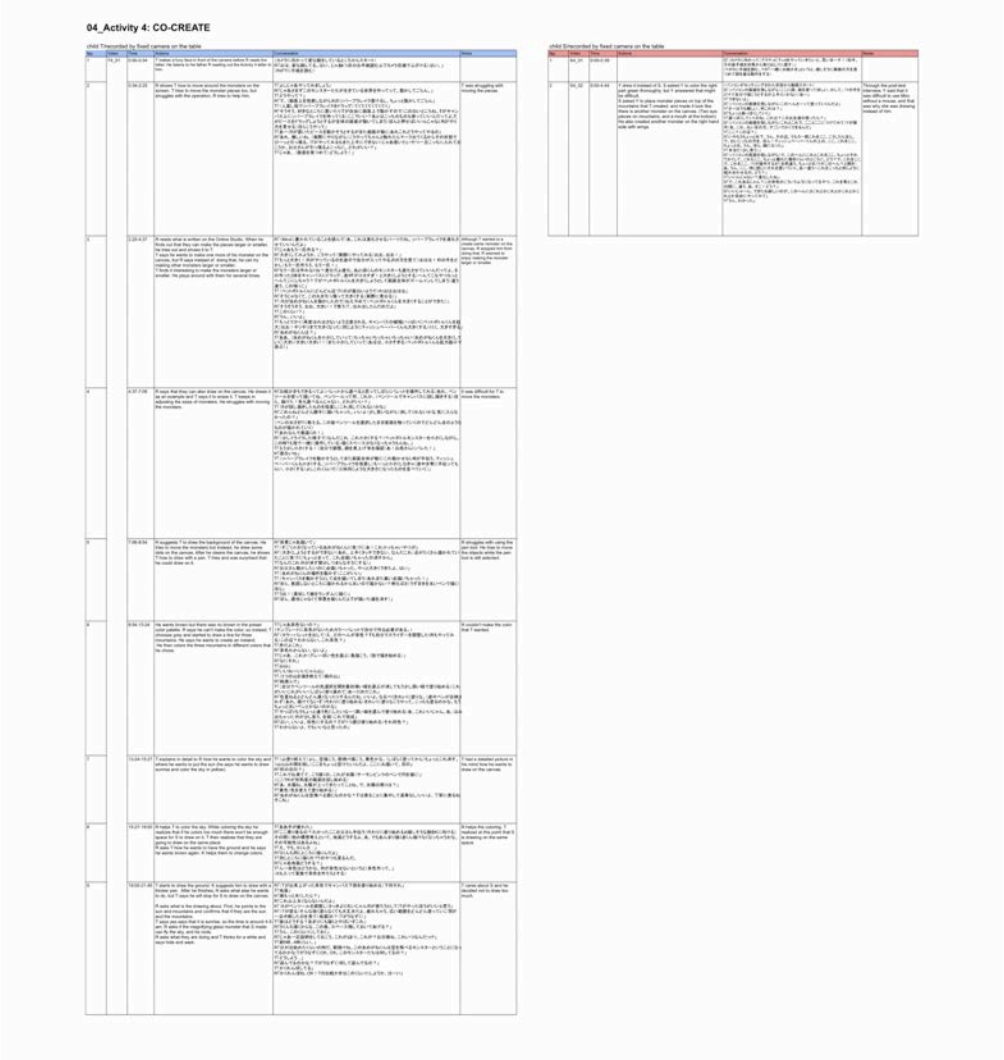

Figure B.5 Video Recording- Activity 4

Figure B.6 Video Recording- Activity 5

C. Results of Questionnaires

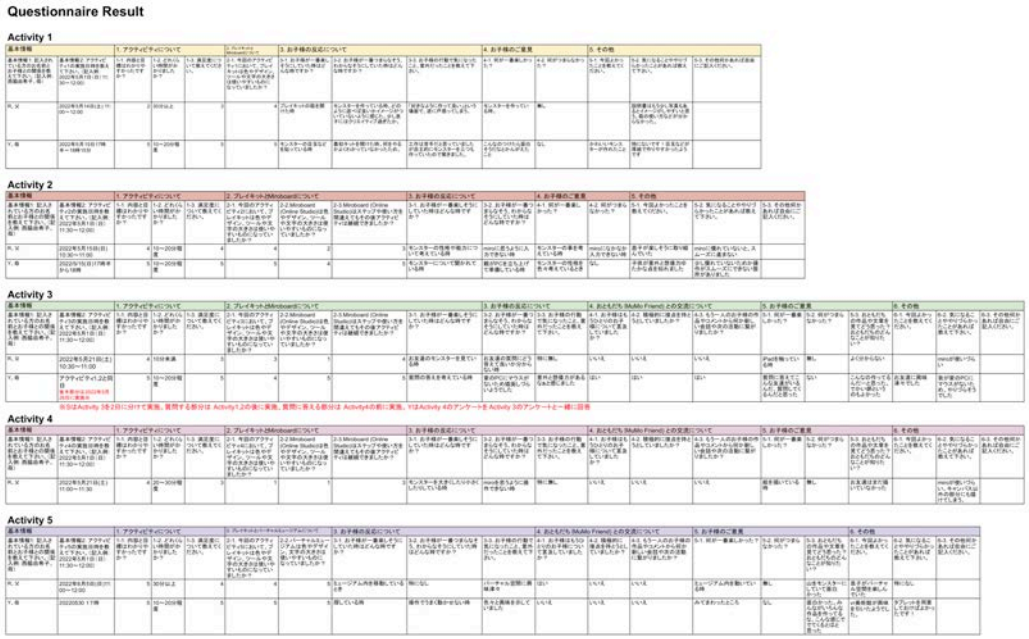

Figure C.1 Results of Questionnaires

D. Results of Interviews

Pre-test Interview

No.	Questions	T's family (2022/5/7 11:00 AM※オンラインミーティング)	S's family (2022/5/7 9:00 AM※オンラインミーティング)	MEMO
	Questions to the children			
1	知らない子と遊ぶのはどう思う？	※先にこのオンラインについて質問、その後この質問。 筆者:Sくんという、同い年の子と遊ぶよ。楽しみって言っていたよ。 ※黙ってじっと見つめる、その後、筆者からどんな遊びか説明、その間も一言もしゃべらない。 筆者:やはり少し緊張するかな。 K:誰と会っても最初は緊張するみたい。おばあちゃんやおじいちゃんと会ってもそう。 ※ここで少しにやにやする。	S:緊張しないです。知らない人と話すの俺はあまり緊張しないかな。	
2	オンラインは何かやっている？	※しばらく黙ってKの方を見る。 筆者:そういえば、前にオンラインで体操やってるって言ってたよね？ K:先生がメインでしゃべる、話まされながらやる感じ。 筆者:今もやってる？ ※お母さんの方を見つめる K:今はもうやってないね。 ※うなずく K:オンラインでやっていたのは去年の6月まで。 T:いや、7月まで！ K:7月は実際に行ったじゃん。	S:英語のオンラインとかやってる、ちょっと待ってね。(テキスト本を持ってきて2秒見せてから、1秒待ちとげて)こっちが一番最初にやった、こういうふうにしたり、(2秒目を見せながら)こっちは新しい感じにいろんなやつをやっていってる。 筆者:こちゃんの文字が見えたよ、これがオンラインでやってるやつ？ S:うん、で、ここまでやった(FAMILYのページを開いて見せてくれた)、これは最後まで終わった、大体毎日やってる。 筆者:オンラインも毎日？どれくらいやってるの？ S:オンラインは予約するとできる、毎日20分ぐらい。 筆者:だからsixとかsoccerはっているんだね、すごいね。 S:でも俺、15以外の数字は知ってるから。 ※このあと英語でカウントしてくれた。	Sは積極的に話す。 Tはお母さんであるKの方を見つめることが多くKが回答することが多かった。
3	ゲームとかしたりする？	K:知育ゲームはやるが、本格的なゲームはそんなに教えていない。 筆者:どれが一番好きなの？ T:銭湯を作るやつ！ K:お母さんじゃなくて(筆者のあだ名)と話してるんでしょ。 ※ここから回答するようになる 筆者:一人でやる？それともお母さんAとやる？ T:一人でやる 筆者:やとおうちどっちが好き？ T:どっちも 筆者:お友達とどんな遊びをするの？ T:かくれんぼ、マイクラごっこ ※秘密の遊びとして、マイクラごっこを最初教えてくれなかったので決してゲームに、本人はマイクラごっこのルールをあまり理解していないが一緒に遊んでいる、とKから説明あり。	※Sに直接質問しなかったがYが回答している。	
	Questions to the parents			
1	年齢	6歳 2016年4月25日生まれ	6歳 2016年3月20日生まれ	1ヶ月違いだが、学年が違う
2	国籍	日本	日本	
3	どこに住んでいるか？	日本／川崎、横浜	日本／都内	
4	母語	日本語	日本語 英語塾1回通っていたがほとんど意味がないと思い、現在は週5でオンライン英会話を毎日20分やっている。	
5	他の言語について	英会話は習っていない	語学は英語のみ 習い事は体操教室が週1、くもんは週2回国語・算数、和太鼓もやっている。前行っていた保育園の園長先生がやっていて、本人が興味が湧いて、引っ越しすることになったが近くに和太鼓教室がたまたまあってそこに通っている。	
6	お子様が外国語もしくは自分とは違う背景の子どもたちと触れたり知る機会などのようなもので、どれくらいあるか？(絵本、ビデオ教材など)	ない	他の文化のお子さんと交流する機会はない	
7	お子様の性格について(内向的、外交的など)	R:一旦仲良くなるとリーダーシップを発揮、仕切りたがり、引っ張っていく感じ。 筆者:仲良くなるまでは？初対面のお子さんに対しては？ K:最初もじもじ、積極的していけば楽しく遊ぶ、今日みたいな感じ。 筆者:けんかは？ K:けんかはあるけど周を引くことはない、優しいと言われることが多い、和を大切にする。 R:場の空気が悪くなるのを嫌がる。 お母さん:お調子者なところもある、ひょうきん。	Y:マイペース、やさしい、こだわらずにあれやって言われたらやることが多い。 筆者:喧嘩とかあまりしない？ Y:もちろんするが、一晩すれば絶対忘れちゃっているし、さっぱりしているタイプ 筆者:お子様同士でどんな遊びをしている？ Y:公園でボールで遊んだり、道具で遊んだり、一方でマイクラごっこもやったりする、石をマイクラのアイテムと見立ててやったりしている、マイクラは持っていないけどYouTubeで見たり友達が持っていたりして一緒に遊んだりすることもある。	
8	普段何をして遊んでいるか？	K:家の中で遊んでいるのは電気回路を組み立てるキット T:見せたい ※お母さん説明。 お母さん:迷路系のものがもともと好きでこれを選んだら見事にはまった、私はもう教えることができない。 R:レゴとか好き。 ※取扱説明書をもってきてそれを見せながら。 T:これ作ったことあるよ、一人で、1時間くらいかかったけどね。 筆者:どれが一番楽しかった？ ※本人中身を見せる R:ラジオの仕組みを知ろう、とか。	Y:レゴはそんなに好きじゃない、ゲームが好き、補助があれば工作やおえかきも、遊んだりすると折りなどの作るアクティビティ、遊れ出したら遊れ出したで特にゲームをしたいなどとは言わずに楽しんでやっている。	
9	How often does your child use a computer, tablet or smartphones? お子様の普段のパソコンの使用頻度(オンライン教室の経験など)	K:スマホやipad使うのがすき、google earthを見たり、雨雲レーダーを見たり。 筆者:時間は決めているか？ K:大体30分くらいで私から声かける。	Y:ゲームの頻度は毎日1時間まで、30分で区切ってやっている、デバイスはSwitch。	
10	How often do you (guardians) use a computer, tablet or smartphones?	R:平日はパソコンずっと、土日はスマホ、気がつくと触っている。 K:歩きながら漫画をスマホを読んでいてびっくりした、私もスマホはよく使う、パソコンは今使っていない、今はipad2とiphoneを使ってる、スマホは4時間くらいだと思う。	Y:PCは仕事でよく使う、VRチャットを最近よく使う、いろんなワールドに行ける、各国の人たちが集まっているので特に話したりはしないがこうちゃんと一緒にうろうろしている、今後VR や仮想空間が当たり前になったらと思い、遊ばせたりしている。	

Figure D.1 Pre-Test Interview

Post-test Interview-R

No	Questions			T's family (2022/6/5 12:00PM@ご自宅共有スペース)	MEMO
	Questions to T				
1	(Tに向けた質問)何が一番楽しかった？			モンスター作るのが楽しかった。 筆者)Sくんとあそんでみてどうだった？ T)楽しかった。 筆者)どのモンスターが一番好きだった？なんでかな？ T)ペットボトルくん。大きいし、強そうだったから。	
	Questions to R for each ativity (Activity 1-5)				
1	Activity 1	T0_01	なぜ周りのものを探さなかったか？説明書が分かりづらかったか？(Tから虫めがねの使い方を聞かれてる)	どうすればいいのか読んだけど分からなかった、イメージが湧かなかった、サンプル画像が1つでもあると分かりやすかった、虫めがねについても同様、そもそものイメージができなかった。 机もキットのことを言っていたのであれば、それもイラスト一発あれば分かるからあった方がいい。	
2		T1_01	どのパーツのことだった？足？ 14:30_このパーツもう一個ない	T)目もそう、なかった 筆者)一応全部2つずつ入れていた R)見つけられなかったのかもしれない	
3		T1_01	1時間かかった？	大体動画の時間と一緒	動画が20分弱なので実際1時間はかかっていない？
4	Activity 2	T1_01	ソバープラレイク、どこから？	T)(ヒント)ないよ、急に思いついた	
6		T2_01	あまりこういう言葉は親しみがない？ 2:18_性格って？ 5:10_能力って？	そういう場面があまりなかった、性格は聞いたことが人に伝える経験がなかったからどうしたらいいのか分からなかったのだと思う。	
7		T2_01	ほっぽを書かなかった理由	(他が具体的すぎて？と聞いたところ)そうかも、大半がTが好きなものだった。	
9	Activity 3	アンケート	Activity3の満足度はなぜ3？	アクティビティの内容自体というよりはmiroがいろいろの操作にストレスがかかっていた、字を動かそうとしたらイラストが動く、みたいな。だから内容自体の満足度ではなくmiroの使い勝手の話。	
10		T3_01	カタカナもひらがなも全部読める？ 2:50_ここにバナナって書いてある	ひらがなは全部、カタカナはちょっと T)トだけ？	
11		T3_01	3:52_選べるもの具体的に出てくる、想像力豊か(重いビールを選べる、など)	あれも自分に重ね合わせただけ。	SくんもモンスターのSの設定が全員小学生だった。(今年小学1年生になったばかり) →モンスターを通して相手のことも知れる
15	Activity 4	アンケート	他のお子さんに言及していたか？のアンケートで全部いい、になっているが、なぜいいえにしたのか？言及していた(SくんもR見るんだ、とか、16分すぎに言及、最後の方も気遣いを見せていた、残してあげる、とか)	まだキャンバスがまっしろだったからSくんについては触れなかった。 (言及していた場面について聞くと)それはあったね。	
16		アンケート	なぜ満足度が3？	質問No9のActivity3と同様、miroの使い勝手の話。	
	Activity 5			※Activity5実施直後にオンタビュー実施したため事前に用意した質問なし。	
	Questions to T for the entire MuMo activity				
1	英語もキットやmiroboardに書かれていたが、言及したり読もうとしたりしていたか？			特になかった	
2	全体の満足度について教えてください。			miroの作り込みの改善余地はたくさんあったのかな、と。今後作り込むのだろうけど細かいところでやりたいことができない、それが徐々に満足度を下げていた。内容以前のところで気持ちが落ちちゃう。	
3	今回知らないお子様と遊んだことに対する保護者の皆様のご意見をお聞かせください。			miroとの質問が文字で来ていたけど、一緒にやっている感を出すんだったら相手の動画、みたいなのもアップロードする形式の方がいいかなと思った。 (今回実験用にアップロードされている動画、先方のも見たかという質問に対し)1個くらい見たかな	
4	全体を通し色やデザイン、ツールや文字の大きさは使いやすいものになっていましたか？ 家で使うのに適したデザインになっていますか？ ・キット ・miroboard ・VRミュージアム			もちろんお金をかければもっとしっかり作れるんだろうけどダンボールそのままだったから、もう少しデザインできたんじゃないかな、と。VRミュージアムは良かった。 (モンスターピースについて質問すると)発想がどんどん出てくる子供だといいのかもしれないけど使いづらいピースもあったと思う。(ピースを出しながら)	
5	お子様は… お友達と一緒に遊んでいることがわかっている様子でしたか？ お友達と同じ目標を達成したことに対して、楽しんでいる様子でしたか？ お友達についてもっと知りたい、もっと遊びたいと思っている様子でしたか？			SくんとあそんでいるSの感覚は薄かったと思う、リアルタイム感が薄くなっちゃったからというのもあると思う、Sくんに対する興味はそこまで出なかったかも。	
6	全体を通してよかったことを教えて下さい。			VRがよかったと思う、こういう空間は子どもたちが好き、創作活動もこういう空間でできたらいいんじゃないか。	
7	全体を通して気になることややりづらかったこと、こうしたらいい、などがあれば教えて下さい。			(各項目で色々言ってくださったので直接の質問は省略。)	

Figure D.2 Post-Test Interview with R

Post-test Interview-Y

No	Questions			S's family (2022/6/2 7:00PM@オンラインミーティング)
	Questions to S			
1	(Sに向けた質問) 何が一番楽しかった？			S) モンスター作り！そういえば、博物館に階段にずっと走っているマイクラのきつねがいたけどあれ何なんだろう？ 筆者) あれマイクラから来たきつねさんです。 S) やっぱりマイクラぽいと思った。 筆者) S(くん)マイクラやるんだっけ？ S) やってない、(なんでわかったか聞く(と) よく動画見てるから。 筆者) (絵をオンラインで見せながら) 上手だったね！ S) まあ普通に作りましたけど。 筆者) 普段からこういうことする？ S) やっていません。 筆者) すごいね、このお話を教えてくれる？ S) 話ここにあるやつなら教えられます。何か飛んでるやつを作った。水色の羽はなんか普通にやったらいいかな、みたいな。 筆者) 何をしてるのかな？ S) そういうのは考えていない 筆者) この山の目は？ S) これは山が2つあったからそこに目を置いたらもう1つのモンスターができるかんじかなと。ちょっと見えないけど下に白いの(口)もあるよ。 筆者) ペンツールで描いてくれた感じかな？ Y) iPadがなかったので操作が難しく、ほとんど描けなかった。 S) 右の黄緑だけ描いた。 筆者) じゃあS(くん)にとってモンスター作りが一番楽しかったんだね、3つも作ってくれたもんね。 S) 3匹より4匹にしようかなと思ったけど多すぎると思ってやめた。 筆者) お友達のモンスターはどう思った？ S) こんなふうに作るんだと思った。
	Questions to Y for each ativity (Activity 1-5)			
1	Activity 1	S1_01	手紙は理解している様子だったか？設定が少し難しかったか？	結構すんなり、そんなに難しいとは思っていなかった。すぐに動いてどれにしようか探し回っていた。
2		S1_02	箱ティッシュはどう探した？	結構すぐ箱ティッシュだった、見本にある靴というよりは工作のイメージ。
3		S1_02	パーツの数や大きさは適切だったか？	
4		S1_03	なぜ虫がねにはまった？虫めがねを使って捜索はしなかったか？	子供ってああいうものが好き、持って遊べるものが好き、モノ自体が魅力的だったと思う、持ちながらうろうろ発見！とやっていた、気に入っていたと思う。
5		S1_03	やはりテープは援助がないとまだ難しい？	丸めて貼る、という作業が多分ちょっと苦手。
7		全体	カメラに向かってしゃべっていた、Youtuberなどの影響？	Youtuberの影響、ヒカキンの影響だと思う、では今からやっていきたいと思いまーすみたいなのも。
8	Activity 2	-	miroboard は今回初めて？ アップロードする際など、何か手こずったこと(アンケートで「スムーズにできなかった」とあるが、具体的にどのあたりか？)	初めてここら辺の問題で最初からタブレットでやればよかった、スマホ、タブレット、パソコンを行ったり来たりして、タブレットは今パパ(が)持っていて使えなかった、子供を待たせてしまった、あそうろうろうしてしまう、一連の流れをスムーズにやる必要があったと思う、フォルダにとがっていた動画を向こうのおすえさんの動画を見てああ、タブレットでできるのかと思った。
9		S2_01	「のうりょく」という文字は自分で読んだ？(1:46あたり)	そうですね、ひらがなは読める。
10		S2_01	想像力豊か(まゆげから空気が入ってくるなど)、お話づくりは普段から学校とかでやっている？	全然しないから意外だった。するすると出てきたんで。
11	Activity 3	S3_01	手にマイクを当てるのはどこからの影響？	インタビューのイメージ？テレビかな？
12	Activity 4	-	-	※まだこの時点で動画が格納されていなかったため、Sに向けてのインタビューの際に詳しく話を聞いた
13	Activity 5	S5_01	チケットのQRからではなく、LINEで送ったURLから飛んだ？	QRコードで読んで、safariで出てきたURLをコピペして、メールで送って、パソコンから入る、という流れ、そういう意味ではタブレットがやはりよかった、仮VRチャットやってるからできるけど、タブレットの方がよかったかも。
14		S5全体	VRミュージアムに入るのに操作的に何か大変だったこと	VRチャットと同じなので基本的に同じ。
15		S5_07	お母さんに「見て！」と言っている動画、発見したのを共有したかった？VRミュージアムで一番興味を持っていたところは？	外に出たいんだけど、と言われた、あとマイクラのきつねはマイクラじゃーんとか言ってた。
	Questions to Y for the entire MuMo ativity			
1	英語もキットやmiroboardに書かれていたが、言及したり読もうとしたりしていたか？			触れなかった、もうちょっと遊んでれば、これ何て書いてあるのとこちらから聞けたかもしれない。
2	VRチャットについてもう少し詳しく。			VRチャットという世界 まだ日本語になっていないやつで英語でたくさん話しかけられる。
3	全体の満足度について教えてください。			工作キット、ちゃんと作ってあって、厚紙で、だから作るのが楽しそうだった、ここに貼ろうとか、弟も遊んでいた、あそこまできっちり作っていただいているとあとは貼ったりとか作ることに集中できるのでよかったなと。
4	今回知らないお子様と遊んだことに対する保護者の皆様のご意見をお聞かせください。			あまり本人にその認識がなかった、もっと前に言っておけばよかった。 質問コーナーはちゃんと相手を認識していた、例にあった靴に反応していた、この発想はない、みたいな。
5	お子様は… お友達と一緒に遊んでいることがわかっている様子でしたか？ お友達と同じ目標を達成したことに対して、楽しんでいる様子でしたか？ お友達についてもっと知りたい、もっと遊びたいと思っている様子でしたか？			最初にお名前と動画でシェアしていれば、事前に言っといてもらえるともっと認識できたんだろうなと思う。
6	全体を通し色やデザイン、ツールや文字の大きさは使いやすいものになっていましたか？ 家で使うのに適したデザインになっていますか？ ・キット ・miroboard ・VRミュージアム			制作キットは先程言ったみたいによかった、ちゃんと作られていて売り物みたいだった。 miroboardは子供だけだとしんどかったのでタブレットはちゃんと用意しなきゃいけなかったのかなと、拡大縮小が難しかった、VRチャットやっていたからナチュラルに受け入れられていた、あれやっていなかったらもっとすごいとなっていたかも、でも探しているのは楽しそうだった、新しい経験みたいな感じで。
7	全体を通してよかったことを教えて下さい。			工作を進んでするタイプでもない、ああいうふうに色々セットしてもらえると意外と色々考えられるんだなとわかってすごいよかった、ゼロベースだとなかなかそこまで生み出していくタイプでもないので目があったり、虫めがねがあったりとかすると作ろうと思うみたい、創作意欲が刺激されたんだと思う。
8	全体を通して気になることやりづらかったこと、こうしたらいい、などがあれば教えて下さい。			事前に名前と動画とか写真をいただけると、もう少し相手のことを認識できたのかなと。

Figure D.3 Post-Test Interview with Y