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KMD-80836602

Master's Thesis

**Design of Physical and Interactive
Communication for Children**

Nancy Lan-Lan Ma

August 16, Academic Year 2010

Graduate School of Media Design
Keio University

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

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Design of Physical and Interactive Communication for Children*

Nancy Lan-Lan Ma

Abstract

Nowadays, the world is crowded with all kinds of media and new technology. Social websites and online communication are becoming an integral trend especially among young children for connecting friends and developing social networks. However, psychologists have theorized about the influence of online communication toward children's development and have warned about the dangers of exploitative relationships through Internet. To protect children from the potential risks in social networks and the virtual world, "Petimo" had been developed as an interactive robotic toy which empathizes that physical interaction applied in online social networking platform. Petimo can help children learn how to connect to their friends safely on Internet and increase the enjoyment of online communication. Based on the theory of children development and previous researches about the relationship of between children and new media, this research aims to evaluate the design of Petimo system can provide a more enjoyable platform for the young generation to engage in online social activities, and release parents' anxiety with a more secure environment. The results are concluded to verify that physical interaction is an essential part of children development for socialization in the online environment. In the same time, this research also aims to understand parents' concerns toward online SNS and how the Petimo system can be redesigned for a more secured platform.

Keywords:

Children Development, Physical Interaction, Communication, SNS

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Chapter 1

Introduction

1.1. Background and Motivation

Nowadays, the world of new technology is crowded with all kinds of media, cell phones, iPods, video games, instant messaging, interactive digital products, virtual reality websites, online social networks and email. Along with the development of media technology, Internet and online environment have become an integral part of life for our next generation. Compared to their parents from Generation X [1], children in the twenty-first century have faced very different society when they are growing up. Some researchers called them the “digital natives” [2], which describes the generation who had been born in the digital age and grow up with new technology. These children are all “native speakers” of the digital language of computers, video games and the Internet. On the other hands, for their parents, those generations who had been born before the boom of new technology, they have to adapt to the new environment and to learn the unfamiliar skills like immigrants in the new land. With the “culture shock” and the retained “accent” from the old world [2], the parents were socialized differently from their digital native children.

In digital age, children develop their social skills in a very different way with the multiple new media. Playground and school activities are still the fields which allow children to make friends and build their social networks. It is the similar experience shared with digital native and their parents. However, in today’s

digital world, Internet and online social network system (SNS) become integral and more popular as media for children to connect with their friends and family. This situation reveals serious problems when children develop their social network with new media. First, parents of digital natives did not have the same experience growing up with new media, and many of them are not familiar with the current online social media. Second, parents and teachers were not well educated to instruct digital natives when they develop their networks by using online SNS. Some of the adults themselves are not using new media to connect with friends, so it is an unknown field of communication for them too. Third, another serious problem is most of the current social networking websites are designed for adults, who had well developed their social skill and already have the established and mature networks in their life. These online websites which mainly targeted toward grownups may not be very safe and protected environment for children to develop their networks.

It is apparently an inevitable trend for children using new social media to connect with their friends. Internet and online SNS become a complex virtual world behind the computer screen. In this environment, children developmental issues play out in old and new ways, and offer new views into the thoughts, feelings, and behaviors of children. However, the fundamental properties of online social networks - persistence, searchability, replicability, and invisible audiences - are unfamiliar to the adults who are guiding children through social life [3]. The current education system did not provide a more suitable and comprehensive strategy that instructs children to safely interact with the peers in the online environment and to freely develop their social network with new media. It has become a critical topic for researchers to discuss safety and secured issues which exist among the social websites and online environment [4]. Based on online relationships, the researches emphasized the dangers of bullying and the negative influence to children [5]. Markopoulos summarized the influences brought from Internet and affect children development on the stage of socialization [6]:

- Children are exposed to more dangers in today's world.
- Children are more likely to isolate themselves from their parents.

- Children feel the lack of tangible interactions and physical contact.
- Children find it more difficult to express intimate feelings today.
- Parents feel insecure about their children's social relationships.

Nevertheless, recent researches also indicated that it is unavoidable trend of online communication, and there is no way to prohibit children from using social websites [7]. It is true that digital natives face more complicated environment in both real and virtual world. Therefore, it is important to provide a new social norm which let children can freely develop their social network with a more secure platform.

Based on the issues discussed above, the author joined in a research project in Keio-NUS CUTE center, which aim to designed a robot and platform for younger generation. The author and the team proposed to provide a safe path for children to make friends in online social environment. This social networking platform for children called "Petimo" - a small partner which helps children to make more friends. Petimo is an interactive robotic toy which empathized that physical interaction applied in online social networking platform can help children learn how to connect to their friends safely on Internet and increases the enjoyment of online communication. Petimo is both fun to use, face-to-face interaction with friends and at the same time protects children from the dangers of online social networks. By adding a physical proximity requirement for adding friends, Petimo increases security and adds a new physical dimension to social computing. The physical touch requirement will help prevent dangerous adult strangers being added as friends, and allowing children to fully exploit the new digital social world. In addition, children experience enhanced relationships with their friends through interactions in the real and virtual world by sending gifts and emoticons mediated by their robots with haptic, visual, and audible events.

1.2. Objectives and Aims

Based on the theory of children development and related researches, this research aims to evaluate the design of Petimo system can provide a more enjoyable platform for young generation to engage in online social activities, and release parents' anxiety with a more secure environment. By using mixed research method in the field of social science, this research verified the hypotheses with collected quantitative and qualitative data. The main objectives of the research are shown as below:

- To evaluate that Petimo system can enhance the communicative satisfaction for children and release parents' anxiety about online SNS.
- To verify that physical interaction is an essential part of children development for socialization in online environment.
- To understand parents' concerns toward online SNS and how the system can be redesigned for a more secured platform.

1.3. Research Hypotheses

According to the research background and objectives, the following are the problem statements of this research:

Approach 1: Communicative satisfaction with Petimo

H1: Children are more satisfied in communication, when using physical interaction with Petimo Robot in Petimo World than only playing in Petimo World.

Approach 2: Safety issues with online social networking system

H2: Parents feel safer when their children use physical interaction with Petimo than when they normally interact with SNS.

H3: With Petimo, it will increase parents' intention to allow their children engaging in SNS.

1.4. Overview of Thesis

Figure 1.1 shows the basic structure of this research. The research background, motivation and objectives were presented in Chapter 1. In the following Chapter 2, there were some related works of Petimo and literatures about children development and new media technology reviewed in this section. Main design and concepts of Petimo system, which include Peitmo Robot and Petimo World, were introduced in Chapter 3. In Chapter 4, the research method were presented including the description of experiment design. The results of evaluation were shown in tables and discussed in Chpater 5. In the end, the whole research were concluded and the future work were discussed in Chapter 6.

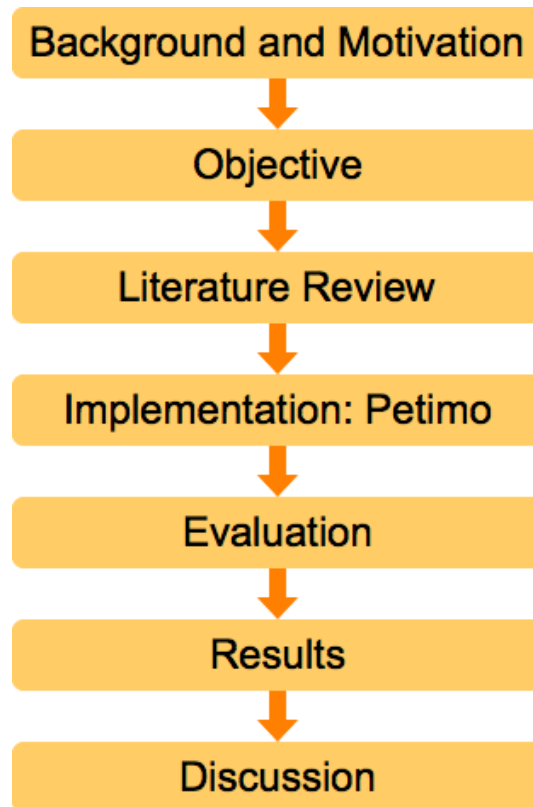


Figure 1.1: Overview of Research

Chapter 2

Background Review

Children learn how to make friends and develop their social skills through play. When children are playing with peers, they learn how to express their feelings and how to maintain relationships with others [8]. In this research, based on key principles in play theories, Petimo is designed to assist children when they are developing their social network.

Meanwhile, another main focus of this research is to evaluate Petimo system as a social media for children. To understand children's development is necessary for researchers who want to design an evaluation studies with and for children. The understanding would help researchers to prevent errors in design of evaluation studies, reduce biases in judgment, and provide more believable results [9]. This research focused on the social development of children, especially on the stages of preschoolers (4-6 years old) and school-aged child (6-13 years old) [10].

In the first section of this chapter, it reviewed some important theories of children's development, especially some essential theories of play, and the researches about children's development with new media in the digital age. In the next section, it introduced some related works and how Petimo will provide solution to the insufficient parts.

2.1. Literature Review

2.1.1 Children development theory

In modern and classical theories of children development, psychologists and sociologists indicated that play is very important because it contributes to the cognitive, physical, emotional and social development of children and youth . This section will introduce four main theories of play in the field of children development.

Groos (1901) argued that play prepares children for adulthood [11]. Based on the assumption that play is unique to childhood, Groos stated that play develops children's physical, mental, and social capacities that will serve them as adults. On the social side, he especially pointed out that companionship in play for children has a determinative influence on the intensity of the social impulse. Groos considered children's enactment of adult roles and activities in what we now call pretend play, make-believe play or imaginative play.

For the psychoanalytic theorists such as Anna and Sigmund Freud (1959) and Erikson (1963), they looked at play in terms of an essentiality to children's cognitive and social development. Freud regarded play as the means by which the child accomplishes his/her first great cultural and psychological achievements; through play child expresses himself/herself [12]. For Erikson, children gain mastery over the world as they control toys and materials, and, to the macro level, children develop a shared view of the world as they engage in sociodramatic play and games [13]. Psychoanalytic perspectives explain the value of play is to provide children a safe context for expressing emotions and gaining a sense of control [13][14]. In play, children's mastery over many situations is nurtured. Repetitive play is important as children act out the same situation time and again.

Piaget (1962) placed play within his stage-based theory of cognitive development and assigned it a significant role in the growing of children's mind and skills [8]. In Piaget's theory, play allows children to sublimate reality through a pro-

cess involving accommodation and assimilation. Piaget believed that some plays are almost pure assimilation without any attempt to adapt to outer reality [15]. However, the opposite of this almost pure assimilation is imitation, or the child's serious attempt to accommodate to outer reality. As they played this situation through, they were making a serious attempt to accommodate the reality about which they had seen or heard [16]. Assimilation and accommodation are both included in the interaction uniting the individual child to the environment and the child's reality. The give and take in play and imitation is one way that the child learns about the child's world. In both play and imitation, children are learning about symbols, or they are learning that one thing can stand for something else. Play itself is a symbolic representation of the child's own inner world [17].

Piaget's idea was further developed in sociocultural approach of theories of play. Vygotsky (1977) viewed play as highly significant to children's development. He stated that play allows child to engage in wish fulfillment and it leads to further development.

The child always behaves beyond his average age, above his daily behavior; in play it is as though he were a head taller than himself. . . . Play contains in a concentrated form, as in the focus of a magnifying glass, all developmental tendencies [18].

Vygotsky described that play creates the Zone of Proximal Development (ZPD), which defined as the difference between a child's actual and potential level of development. According to Vygotsky's theory, play creates a broad zone of proximal development, both in cognitive and socio-emotional development. Vygotsky believed that play is a mean for children to fulfill their needs. Children can learn to live within self imposed rules during play and play allows children to practice self regulation. Play, for Vygotsky, is vehicle for children behaving more maturely than at other times.

2.1.2 New technology and children

In twenty-first century, children have much more chance to be exposed to media and technology than the previous generations. The vast of children have access to multiple media, for example, cell phones, video games, instant messaging, interactive product, and social networking websites. Marc Prensky (2001) used the term, Digital Natives, to describe today children are all “native speakers” of the digital language of computers, video games, and the Internet [2]. Nowadays, children have almost constant access to media in places where, most of the time, adult supervision is absent. As a result, young people spend more time using media than they engage in any single activity.

According to the research from the Corporation for Public Broadcasting, the results were based on a nationwide study of American family households. The report examined the positive growth trends in children’s Internet use since the turn of the most recent century [19]. As shown in Figure 2.1, preschool children are one of the fastest growing groups to be online. Only 6 percent of children ages 2-5 used the Internet from any location in 2000. However, in 2002, 35 percent of the same age group went online from some location. It is the largest increase of any age or demographic group [19].

Recently, researchers continually pay a lot of attention on the influence of new media and technology to the young generation. Most of the researches have discussed on the same subject especially in the field of Internet use: Is media technology a boon, one that leaves children today better educated, more socially connected, and better informed than any previous generation of children? Or is it, as many voices warn, a hazard for vulnerable children – an endless source of advertising, portrayals of violence, and opportunities for dangerous encounters with strangers and possible exposure to pornography or violence contents [20]?

Some researchers, like Marc Prensky, had positive perspectives toward the children use of new technology and Internet. He stated that young people generally have a much better idea of what the future is bringing than we do. The responsibility for parents or educators is to help all our students take advantage of these new tools and systems to educate themselves [21].

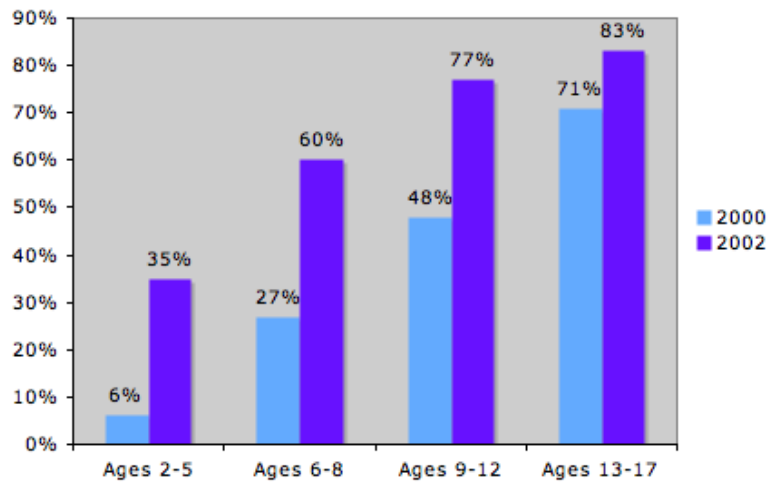


Figure 2.1: Children and Internet Use between 2000 and 2002. (Source: Corporation for Public Broadcasting, U.S., Connected to the future: A report on children’s Internet use. June, 2003.)

However, most of the researches argued and empathized that cyber-space increasingly becomes an unsafe and more victimized environment, especially for children [22]. This results in conflicting messages between parent and child, social isolation, cyber connectivity with strangers with unknown identities. Psychologists and sociologists have warned about the potential dangers from Internet use and Internet exposure [23].

According to the research by Rochester Institute of Technology in 2008 [24], 48 percent of children interacted with people on Web sites, while 50 percent indicated that their parents watch them when they use a computer, leaving the other half of those youngsters more prone to being exposed to predation behaviors or other threats posed by online strangers or even persons they know or regard as friends. Also, 48 percent of children reported they viewed online content that sometimes made them feel uncomfortable. From another research by the office of Juvenile Justice and Delinquency Prevention [25], the risks to children in cyberspace include exposure to unwanted exposure to sexual material (1 in 3 youth) and harassment - threatening or other offensive behavior directed at them

(1 in 11 youth).

2.1.3 Social networking system and children

Social networks are becoming the latest trend for online communication especially among young children and helps for making new friends while keeping old friends in close contact. With the expansion of digital media, the attraction of teenagers and younger children to social networks and other activities in the online environment is growing.

According to the research by Wolak et al. [23], 14 percent of youth reported they have close online friendships. Girls were slightly more likely than boys to have close online relationship with 16 and 12 percent, respectively. Researchers found that children and youth increasingly become heavy users of online communication and most of them have online relationship with peers. According to the study from Rochester Institute of Technology in 2008 [24], children in 4th-6th grade levels engage in social networking activities. In the process, they post personal and potentially exploitable information about themselves online. Specifically, and within the last school year: 16 percent posted personal interests online, 15 percent posted information about their physical activities and 20 percent gave out their real name. In addition, 5 percent posted information about their school, 6 percent posted their home address, 6 percent posted their phone number and 9 percent posted pictures of themselves.

The challenge for parents and schools is to eliminate the negative uses of the Internet while preserving their significant contributions to education and social connection. Children's development issue - identity and socialization - have all been transferred to and transformed by the digital age. The big topics among this issue are greater youth autonomy, the decline of face-to-face communication, enhancement of peer group relations at the possible expense of family relations, and greater teen choice. Given the connectedness between the physical and virtual worlds, the challenge is to keep adolescents safe (both physically and psychologically) while at the same time allowing for the explorations and interactions that

are crucial for healthy social development [26].

2.2. Related Works

To support the novelty and concept behind Petimo, this research also reviewed some similar works related to both online social networks and physical interactions. According to the reviews carried out, Hello Kitty Online and Club Penguin could be categorized as similar social networks to Petimo World. Bricks and Topobo can be considered as similar work carried out in the physical interaction arena considering Petimo.

Modern online social networks have been enhanced with lots of attention grabbing features as the worldwide user attractions are expected to rise unlimitedly. MySpace and Facebook can be considered as some of the common online social networks for adults. Safe social networking cannot be expected through these networks, especially for children as they may provide unsafe methods in socializing. Conversely social networks, which are specially designed for children like Hello Kitty Online [27] and Club Penguin [28], could be categorized as similar social networks to Petimo World. They provides messaging and social networking services like email, emotes (emotion icons), actions such as waving or dancing, bloggings, discussion boards, online video sharing etc. This may create certain security lapse for child-safety, especially by exposing children to abuse by unknown strangers. More importantly these are purely virtual worlds which do not have the advantage of having physical interaction and safe friend making features like Petimo.

Poken [29] allows users to “hi-4” with one other using a small tangible device in the shape of a palm with four fingers. In this way, users make friends and exchange social information based on the time and place that they meet. While this may be effective for adults to interact and socialize with one another, there are potential problems for young children in using Poken. The physical device itself is relatively small, enclosed in a hard casing. Currently as the Poken user interface has a quite simple contact adding mechanism, emotional and expression

based communication is difficult to express among users [29]. Unlike Poken and other similar systems, Petimo is designed for children, with a soft, cute design and color display integrated to allow children to perform emotional communication such as sending emoticons and gifts. Children do not need to plug-in their devices to the computer to upload their new contacts information to the Internet as this is done automatically through wireless communication with the computer. In the online PetimoWorld, instead of exchanging messages and writing notes to organize contacts, children exchange gifts and emoticons and visit one another via their 3D virtual characters.

Accordingly, Petimo is a safe-social networking robot which stands uniquely from existing social networks. It has its own cute virtual world that is influenced by the Japanese Kawaii culture. Moreover, Petimo interaction has been extended to virtual worlds. Hence children, who met in the physical world can buildup friendship through Petimo robot and meet easily without any issue of present location. As physical interaction via robot is available, parents can keep track of their childs' presence and their robot interactions. Consequently childrens security can be maintained compared to the above two social networks. Additionally there is a Parent Control Module which filters chat messages tightening the security of the social networking environment.

Tangible and physical objects have rich affordances which users can learn simply by grasping and manipulating them [30]. Previous generation of children before the explosive growth of computers and the Internet had learnt by exploring and manipulating physical objects. However, there is a huge change for children to learn in this digital generation. The power of information and the Internet mean that computers have taken over any other toys or natural physical environment as the tool for learning. Computer holds immense power for children to learn from it. However, there still exist a gap between the digital computer and the physical world. Learning using the computer as a tool neglects, in some degrees, the lessons children can learn from interacting with real physical objects. Therefore, Petimo would like to support traditional play with physical objects, extend and enhance by the interactive power of digital technology.

For young children, traditional computer interfaces might even be an obstacle to interactive learning. The traditional GUI, coupled with mouse and keyboard interaction method limits what children can learn, explore and manipulate to 2-dimensional abstract representation, not real physical objects. The lack of fine motor control skills in young children needed to use existing point and click devices becomes a further obstacle. Researchers in education, developmental psychological and cognitive sciences have found that movement occupies a central position in human activity [31] and it is a central feature of early learning [32].

According to the literature reviews in section 2.1 in this chapter, the research works have determined that interacting with physical objects is the best learning environment for young children. Piaget and developmental psychologists ever since have emphasized the critical importance of manipulation of physical objects for young children's cognitive development [33]. In addition, Vygotsky[18] emphasized the importance of play in facilitating child development.

In addition, other researchers have proposed that haptic and tangible interaction is an important part of learning and a natural form of interaction for humans [30]. Tangible user interfaces exploit embodied interaction which ideally empowers users with simple and natural physical interaction metaphors [34]. Tangible User Interfaces (TUI) make effective use of the affordances of physical objects which can directly represent their functionality.

Another important point about physical object is that we could see the result of our actions immediately on the object itself. This allows users to learn about the spatial orientation and the position of a physical object in relation to its surrounding, and provide interaction insight and task awareness to the user.

Fitzmaurice and Buxton [35] have conducted an experiment which allowed users to use Bricks as physical handles to directly manipulate virtual objects. Their study has shown that a space-multiplex input scheme with specialized devices can outperform a time-multiplex (e.g., mouse-based) input design for certain

situations. This is followed by the TUI work by Ishii and Ulmer [30]. In essence this work focuses on TUI as seamless coupling of everyday graspable objects with the digital information that pertains to them. A good TUI for children should afford them the ability to easily map physical and spatial characteristics to the physical state or actions of the device.

Another quality of TUI, which is important for young children, is the natural coupling of action and perception space [36]. TUIs can allow the user to perceive and act at the same place and at the same time. Traditionally, action space (e.g. mouse) is often separated from perception space (e.g. display). Preserving the natural characteristics of physical objects allow users to be more attentive and focused on their tasks.

In another example, Resnick et al. embedded a programmability into a building toy, synthesizing a scalable physical language (LEGO bricks) and a scalable computational language (LOGO). This work led to the development of the LEGO Mindstorms line that is successful in many schools today [37].

A variety of projects have combined building toys with programmable behaviors to support children's education. Recently, Wyeth and Purchase have embedded programmable behaviors in LEGO Duplo Primo blocks to allow children to use physical manipulation to develop conceptual abstraction skills [38].

The cute and soft Petimo design promotes multi-sensational interaction and communication among children. The small size fits just nice into the hands of children, and allow them to carry the Petimos around. One of the main safety feature is the adding of friends on the social network through physical touch. Just as children in the playground shake hands and give 'hi-five's, Petimo robot allow children to make friends through touch, which is a natural gesture. This increases the safety quotient as parents are aware of their childrens new friend, and children see each other physically to make friends.

Chapter 3

Implementation

“Petimo Robot” and the “Petimo World”, as shown in Figure 3.1, are two main components developed with the intention of helping children develop their social skills and overcoming some of the dangers exhibited by the cyber world. Based on current contexts, the prototype of Petimo was designed to introduce several novel interaction scenarios between the virtual social networks and the real life. Both the Petimo Robot and Petimo World are influenced by the popular Japanese “Kawaii” (cute) culture. The Petimo World is a 3D virtual world with added social networking capabilities along with the soft robotic toy named Petimo. Petimo extends the virtual social network into the real world and provides physical interactions and direct communication with the characters in Petimo World.

Petimo adds a novel physical dimension to the traditional interface media to social networking world. Without limiting to a regular web interface through a desktop machine, children can extend their interactions into the real world through Petimo Robot. They can carry out usual social networking activities such as sending gifts, emoticons, etc. through this robotic interface. Petimo introduces a novel physical friend-adding feature through the SNS environment, Petimo world. Petimo requires two new friends to physically touch their Petimo Robots together in order to add themselves in Petimo world as friends. This is presented as a novel tangible experience to interact with the SNS. Besides the novel experience, this increases the security against dangers in SNS services. This requirement warrants physical presence of two friends, which reduces the

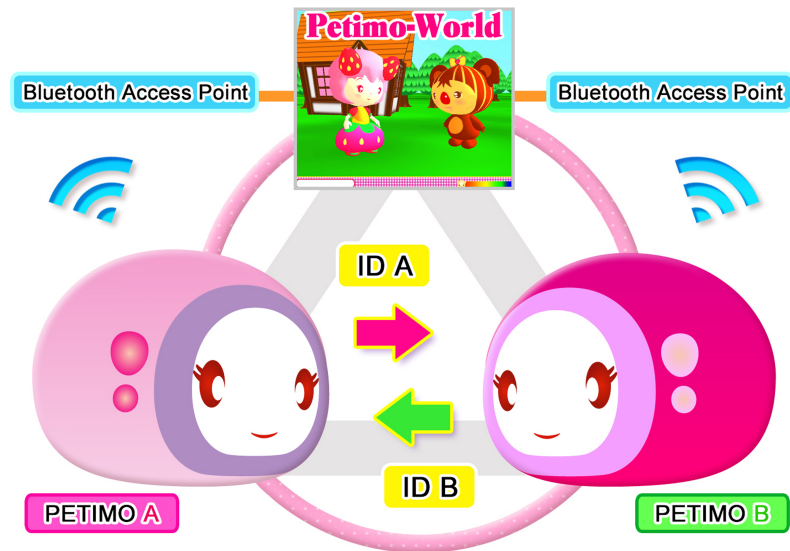


Figure 3.1: Petimo Robot and Petimo World

risk factors of adult strangers being added as friends and provides the freedom for children to fully experience the digital social world.

3.1. Influence from cute culture

Since the 1970s, “Kawaii” has become a prominent aspect of Japanese popular culture, entertainment, clothing, toys, personal appearance, and behavior [39]. Especially, Hello Kitty has led a huge boom of “Kawaii” culture as a representative of cute characters, and, most importantly, brought the power of cuteness into our world. In this characterized cute culture, not only are children fascinated by those adorable characters from Japan, but also adults are enjoyed and attracted by this Kawaii culture. The design of Petimo is motivated by Japanese cute values and aiming for designing a communication implement with this insight of cuteness. From this perspective, it was decided to focus on creating a robot with a warm feeling and a tender image of personality. By using feminine colors and a smooth surface, the prototype was designed to reduce mechanical feeling and increase human kind sensation into Petimo robot. With this kind of spherical

outer, the appearance of the display was changed from square to curve so that it will be more like a pet which could watch out the children with its lovely cute eyes.

Cute “Kawaii” culture is not only adopted by popular culture, entertainment, toys, personal appearance, making not only tasty but adorable food is quite prominent as well. Especially in Japanese department stores customers can find specially decorated strawberry cakes, chocolates, lollypops and traditional candies. The character design in Petimo World was influenced by these “Kawaii” food decorations and thus it was decided to design the characters based on the concept of sweets and desert. For example, there are strawberry, chocolate, and peanut characters in Petimo World. These cute characters represent the cuteness of Petimo and it could be a common language crossing location and generation to improve peoples’ communication. Moreover, based on Japanese manga (comic) culture [40], the characters are designed with big eyes and egg-shaped face. Big and round eyes give a friendly image and it is easier to recognize by users [41]. Egg-shaped surface of the character face brings a soft feeling to children and the chubby cheeks are similar to a baby face, which gives cute and warm emotions [42].

3.2. Interface Design

3.2.1 Petimo World

Most children like to follow their own heros, or favorite cute characters in many day-to-day activities and belongings. For example, Japanese children would like to carry their favorite kawaii character based cute bunny with their backpack. Also some children have pencil cases with their favorite character printed on, some has favorite logo pencils, pens etc [43]. Therefore, the system is designed to let the users select their favorite character as their avatar in Petimo World. According to users’ personality and preference, children can choose characters such as Berina, Rolla, and Pepe, as shown in Figure 3.2. Berina was designed with an image of a strawberry princess, and we use different kinds of pink colors, such

as dark pink, baby pink, and pink from cherry blossom. For Rolla, it was created an elegant style and enhanced her attractiveness from the image of a chocolate cake. Pepe is a unique character we designed for our cute world. He represents a role, which is not conventionally cute but friendly and amiable with a little humorous personality. The most essential point for designing the Petimo World was to express the cute feeling between 3D real-time rendering and 2D graphics design. In general, shadow processing in 3D design does not fit in the preference for plane graphics in Japanese Kawaii culture. The shading and space design, the distinguished parts in the world of second life, does not blend harmonious with the Japanese POP color of Kawaii expression to represent the flourished cute world. From this main aspect, the design of Petimo 3D world is designed to avoid the unnecessary shadows and complicated forms and shades, and focused more on choosing delicate colors of the sky and other features to build an environment with a warm and cute feeling.



Figure 3.2: Characters in Petimo World

Present web based social networks represent rather 2D list based friend lists and the friends are displayed in an alphabetical order. Petimo World presents a new way of visualizing the friend network in a 3D virtual world based on the friendship strength of the user and his/her friends. Such an arrangement of

friends' data in graphs can influence different perceptions of the user of the social network [44]. In fact the beginning of the era of the social networks had started with use of the sociogram to communicate the abilities of network ideas [44]. For the arranging of friends in the Macro world we have chosen the concept of spherical orbits since spherical orbits provides more space for friends to be arranged. The Spherical Orbits concept is shown in Figure 3.3.

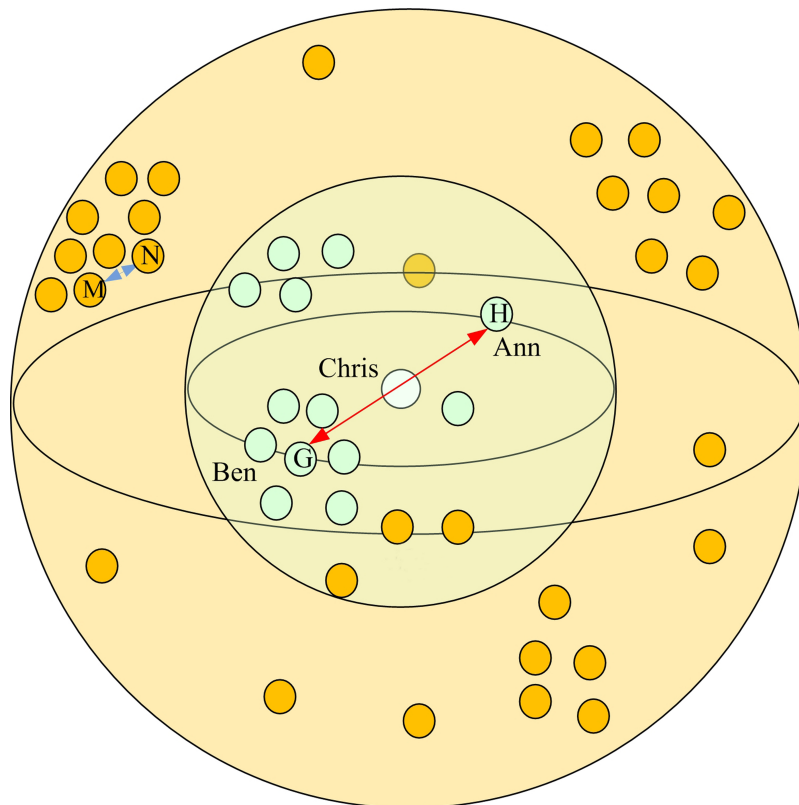


Figure 3.3: Spherical Orbits

3.2.2 Petimo Robot

Petimo Robot is designed specially for the use of children of the age group of 7-9 and its physical properties have been given special consideration of this factor.

Its simple and easy to use interface is specially designed keeping in mind the shapes and sizes that will well suit the children of this age group. The furry surface like an animal skin, the small round physical shape, provides a warm and tender feeling of a baby animal bringing a friendly and touchable feeling as well as making it more adorable for children to use.

When designing for children, it is necessary to pay careful attention on the interpretation of objects and interactions. When a child sees something, first they try to touch it and control it by hand. This is a very important consideration when designing Petimo Robot. The selection of input, especially the touch screen allows the user to visually relate to the consequences of actions. For an example, the user can really touch the menu he or she wants to scroll through and simply move the menu with fingers. This is a very critical point compared to other sensors. For an example, if we take a jog dial, or a push button, the places the child (target user of Petimo) touches or pushes is not the place he or she actually wanted to be changed by the action. It is hard to children to relate between the moving of the jog dial and the moving menu in the screen and does not support the intuition of small children. But, in the case of the touch screen, the child can actually place his or her finger on the menu and move the menu to the direction wanted. And he can see the changes he made in real time as the menu moves. Therefore, the touch sensor based controlling of the robot will allow children to easily relate their action with its consequences.

Emoticons and gifts with its aesthetic design have been design specially to enhance the cute feeling of Petimo. Children could send or view gifts and emoticons just by simply touching on the buttons on the screen. When the robot receives a gift it will turn on a very happy face making a trilled sound enhancing the enjoyability of using the toy robot creating a unique experience for children.

3.3. System Description

3.3.1 Petimo World

The software architecture of the system is presented in Figure 3.4. The Petimo World client side comprises of two software components, Petimo World Client and Petimo Interface Client. Petimo World Client is an extension to Multiverse Client. Petimo Interface is the software component that implements the communication between the Petimos. Petimo interface connects directly with the Petimo World server while the communication between two PetimoWorld browsers is done through Multiverse online gaming platform. Petimo World server is a centralized server that stores the data related to Petimo World users and coordinates the communication in Petimo World. This section presents a detailed technical description of the two levels in the Petimo world, known as the Macro and Micro worlds.

When the user logs in to the Petimo world, he or she is directed to the Macro level. The user's seedar appears on the screen with friends arranged in spherical orbits in the galaxy. The user can navigate through the galaxy and reach the friend seeders. Macro level provides interactions such as visiting a friends micro level, removing a friend through right clicking on the seedar character. Further user can perform tasks such as searching for and adding friends.

As the arrangement of the friends in the Macro world is based on the concept of spherical orbits (as shown in Figure 3.3), the Perline noise [45] based approach was chosen for the algorithmic base because it renders a more natural arrangement of friends in a spherical orbit. The friends are scattered in to spheres based on the grouping created by a grouping algorithm as shown in Figure 3.5. The spatial algorithm renders friends in to different spheres based on this grouping. After the friends have been distributed in to different spheres, the Perlin noise is applied to make the seedar characters disperse within the spherical orbit. The resulting 3D friend network is depicted in the below figure.

By clicking on friends' Petimo characters, users can visit their friends micro

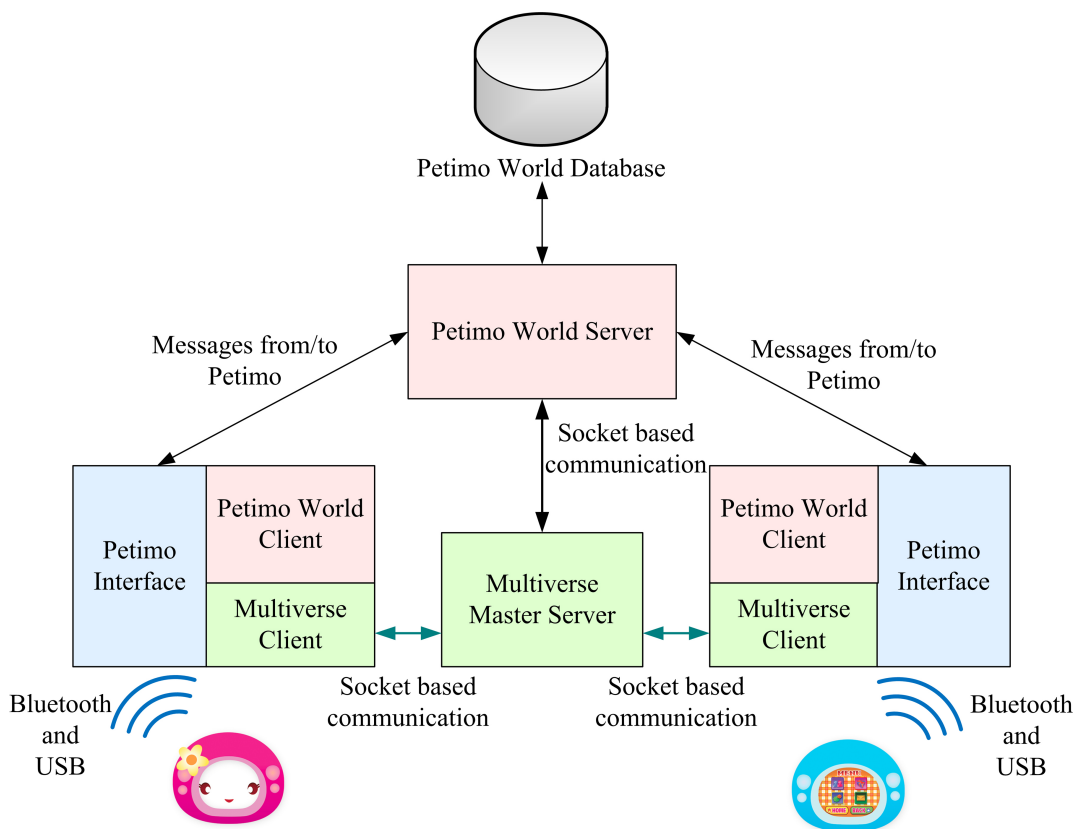


Figure 3.4: Software Architecture of Petimo



Figure 3.5: Macro World of Petimo

world, which lies below the macro world. Micro world is a garden like environment, representing the world inside the Petimo planet. It presents the user's mind and personal character. While visiting a friend's micro world, the user is represented as a cute character which he/she chooses at the registration stage. Users can chat with each other in the micro world. While chatting, users can send cute emoticons to friends, and receive emoticon from friends, as shown in Figure 3.6 (b). If the user's robot is connected to the Petimo World, the emoticons will be received and shown in the robot's screen. Users can also send virtual gifts to each other in the micro world. By sending gifts to friends, user can gain social capital which depicts their online friendly behavior. When a virtual gift is received, the gift character will appear beside the virtual character, as shown in Figure 3.6 (a). By chatting, sending and receiving virtual emoticons and gifts in micro world, children can maintain their physical friendship wherever they are and what cultural background they have.

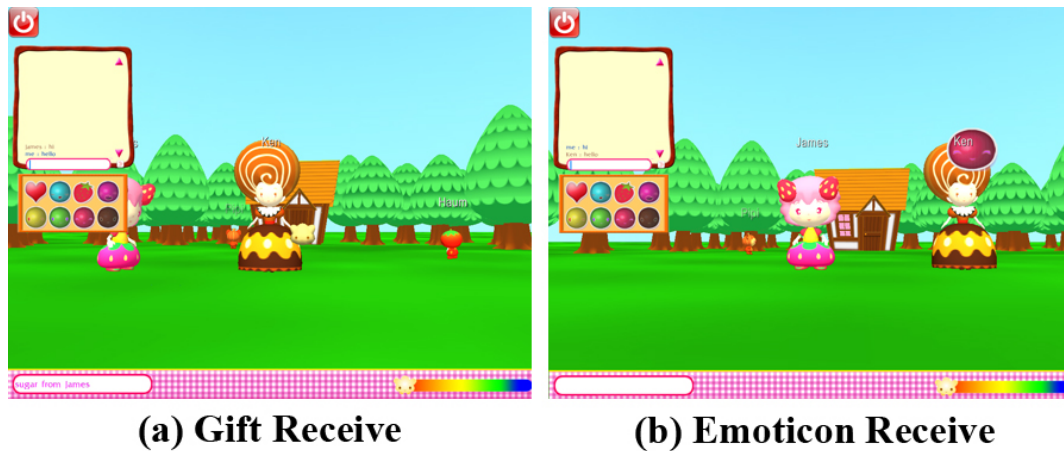


Figure 3.6: Micro World of Petimo

3.3.2 Petimo Robot

Petimo Robot includes a close proximity contact-less friend adding function using close proximity radio frequency identification (RFID) technology. As shown in Figure 3.7, children can add friends by activating the “Add Friend” option on the menu and physically touching their friends’ Petimo. This internally results in exchanging of unique 64-bit identification keys between two Petimo Robots and sending this event to the online user verification system for authentication, after which the relationship is created. The user input sensing includes a smooth scrolling enabled resistive touch sensing pad primarily for child-friendly menu navigation. Pressure activated squeeze areas of the robot surface facilitates exchange of special gifts and emoticons online. User also can experience a multimodal engagement visually via a miniature OLED graphics display, audibly by an embedded sound module for producing cute sounds, and through haptics using a vibrotactile effects generator.

Unlike existing software extensions to social networks, Petimo Robot provides a physical extension which expands the multimodal engagement not only audibly and visually but also tactually. Considering humans’ strong positive bias towards physical touch [46], a squeeze and touch sensing mechanism has been added as



Figure 3.7: Physical Friends-Adding Feature

the primary input method. To ensure the rich content and feeling delivery, for actuation, sound output module, and a display module have also been used.

The display module is the primary media for interactive feedback. It transforms digital and analog interactive information into visual spectrum. Visualized information and the related user-interaction techniques have the advantage of being simple, fast and straight forward in conveying high bandwidth data for human perception. A small size, low cost, energy saving color Organic Light Emitting Diode (OLED) [47] display has been used in Petimo Robot and it is the face of Petimo Robot. Figure 3.8 shows the different display animations for different menus of Petimo Robot. Like this it is possible to show number of emotions adding fidelity to the degree of emotions giving rise to the resolution of feeling it can handle.

Considering touch sensing, in Petimo Robot, there is a menu based navigation system and a selecting mechanism to scroll through friends, sending gifts and sending emoticons etc. Thus a user friendly input system for navigation was a main requirement. Petimo Robot uses a four-wire resistive touch screen along with a touch screen controller. Touch screen system operates in ultra low power mode to save battery power. A touch can be detected using a simple interrupt mechanism and system starts tracking the input. If there is no input for a preset time, it will automatically go back to the low power mode.



Figure 3.8: Menus of Petimo Robot

Children who want to be friend with each other have to physically touch other’s Petimo Robots. This results in exchanging the unique RFID keys. This simple physical attribute extends the communication bandwidth comprehensively without additional complexity associated with tangible interfaces. Low frequency RFID (125Khz) was preferred for its robustness and detection distance controllability. The detection range has been set to almost physically touchable distance so that there wont be false detections in everyday use. In Idle mode of Petimo Robot, any Petimo Robot which is in the “Friend add” menu can detect the ID. When it is in the friend add menu, its ID is disabled automatically providing extra security. Once a successful ID is received, a standard checksum calculation is performed for added reliability. Then the ID is sent to the Petimo world server for authentication. In the case of a checksum failure it keeps the RFID active until it reads a proper ID value or it timeouts. At the manufacturing stage of Petimo Robot, a unique ID database of RFID keys are maintained for remove any ambuiguity. The ID’s will be activated upon first online user registration of Petimo Robot with the Petimo world. This ensures any possible abuse of the Petimo Robots and enables hardware level deactivation of Petimo in an unlikely scenario.

The audio to be outputted by the sound module has a few characteristics

which determine the design of the module. First of all, the sounds have to be cute. This means they have a lot of high frequency components in them. Second, they are a bit abstract. So in case the module does not manage to reproduce the sounds perfectly this is not too big of an issue. Therefore a microcontroller based approach has been chosen. This is a very simple, cheap and low power solution. The microcontroller outputs the audio samples through its built-in PWM port. This signal is then sent through a low-pass filter and an audio amplifier IC. The sampling rate has empirically been chosen at 16kHz. This is a trade-off between audio quality, memory requirements and simplicity of the low-pass filter. In order to avoid large number of calculations in the microcontroller no compression has been applied to the audio samples. One sample consists of 8 bits. Also the audio is recorded mono, since the device only has one speaker. This yields a data rate of 128kbits per second. 512kbyte of EEPROM has been added to the device. Therefore a total of 32 seconds of audio can be played back in this configuration.

Chapter 4

Evaluation

As Petimo can create more intended communication among children, as well as between children and parents, the first and most important research approach is to explore “Communicative satisfaction with physical interaction”. The physical interaction can enhance the enjoyment of online communication for children. For this purpose, the intended participants were children and we collected quantitative and qualitative data to prove our hypothesis about communicative satisfaction gaining from physical interaction while engaging with online SNS.

With the parents of those participated children, a qualitative user study is designed to explore safety issue which is addressed by Petimo through physical interaction. The safety factor is important both in the physical and virtual world, and this research hypothesized that Petimo system can be a more secured platform for young generation to engage in social activities online. Moreover, parents can feel released and safe when their children communicate through Petimo social networking system.

4.1. Framework

There are two trials in this experiment, and participants (children and parents) were all asked to experience both trials in the study. In trial A, participants would only play with Petimo World; in trial B, they would be asked to interact with

both Petimo robot and Petimo World. Children were mainly asked to interact with Petimo system. Their parents had chances to use Petimo system and play with their children, but they were mainly asked to observe their children during the two trials. The collected results would be used in two approaches of this research. The framework of evaluation presented in Figure 4.1.

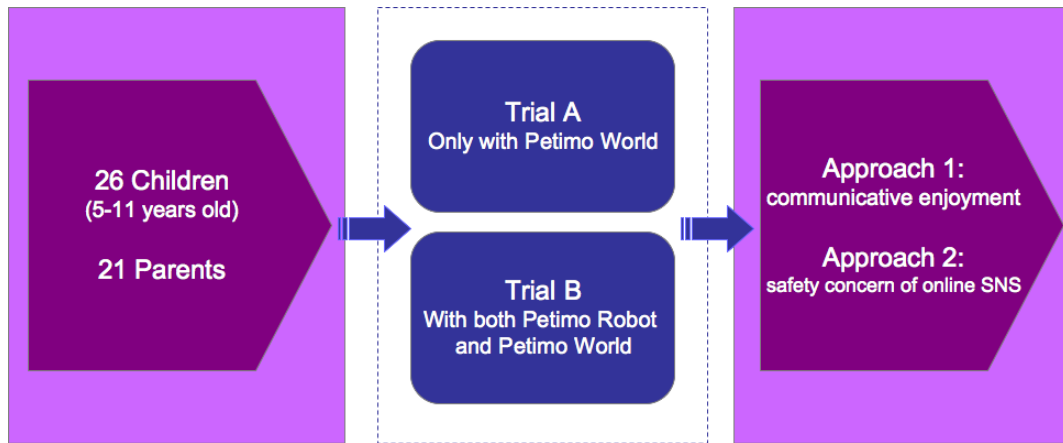


Figure 4.1: Framework of Evaluation

4.2. Participants

Forty-seven participants (26 children and 21 parents) took part in the user study. The target age group of children is from 7 to 11 year old. This age group was chosen based on the psychosocial theory of children development [13] and recent researches of social development for young kids [48] [49]. The literatures show the importance for children to learn social skills and rules in this period, and also, for today's younger generation, they increasingly visit social networking sites and use online communication tools to build their social groups.

There were 19 children from the target age group, and since current researches indicated the use of new technology is widely used in learning environment for preschool kids [50], this study also invited 7 children around 5 to 6 years old for the



Figure 4.2: Study in Lab



Figure 4.3: Study in Community Center

further observation of children social development. 19 percent of the children were recruited through contact database of Mixed Reality Lab of National Singapore University, as shown in figure 4.2; the other 81 percent of children were recruited through the community of Punggol from Singapore government, as shown in figure 4.2. There were almost equal numbers of males and females (16 girls and 10 boys). Most of participants are Singaporean (80 percent). There were also two Indian families, two American families and one Chinese family.

For the parents' part, their median age was 41 years ranging from 35 to 45 years. There were 9 fathers and 12 mothers participated in the study and they were from different cultural and occupational background. Therefore, they provided their perspectives as a parent without bias from any specific group.

Table 4.1: Two trials for experiment of Approach 1

Trial	Petimo World	Petimo Robot	Task
A (μ_1)	O	X	Let children play with Petimo world only without giving Petimo Robot.
B (μ_2)	O	O	Let children play with Petimo World and Robot in the same time.

4.3. Hypotheses Statement

Approach 1: Communicative Satisfaction with Petimo

The experiment for this approach was a within-subject 2 x 2 factorial design, as shown in Table 4.1. The independent variables were different prototype configurations: Petimo World only and Petimo World + Petimo Robot. The study gave two trials and let children compare with two different experiences from interacting with Petimo system. The duration of each trial was approximately 20 minutes and we ask questions about their feelings and impression of Petimo experience soon after they interact with our system.

Null Hypothesis: The satisfaction (Y) is the same for both two trials. ($\mu_1 = \mu_2$)

Research Hypothesis: The satisfaction (Y) is not the same for both two trials. ($\mu_1 \neq \mu_2$)

$$Y = \mu_i + \varepsilon_i$$

H1: Children are more satisfied when using physical interaction with Petimo Robot in Petimo World than only playing in Petimo World. (Trial B > Trial A)

The model of this approach hypothesized that compared to only using Petimo World, children can receive more pleasure and satisfaction in communication by

interacting both with Petimo World and Petimo Robot. In Trial A, when children wanted to add friends, they had to type their friend's name in Petimo World and clicked on the friend's icon on the screen. They could only send or receive gifts and emoticons by clicking the icons in computer-based environment. On the other side, in trial B, children used the physical friends adding feature by touching each other's Petimo Robot. They would experience sending or receiving gifts and emoticons by using mouse to click on the screen or using their fingers to touch the icons on the handle device. The hypothesis is to verify whether the extension of physical interaction can enhance the experience when children engaging with online SNS.

The questions, as shown in Appendix A, were designed based on Overall Flow-State Measure [51] to measure the scale of enjoyment, interest, and control. Each question was rated on a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The interviewer asked children to give 1 to 5 stars for rating their feelings and experience, and used Think-aloud Method [52] to help children verbalize their thoughts. The collected data from this part would be analyzed in quantitative and qualitative ways.

Approach 2: Safety issues with online social networking system for parents

In this approach, for understanding parents' general attitudes about online SNS and their perspectives on Petimo system, an open-ended survey was conducted to ask all adult participants. The questions, as shown in Appendix B, were designed into two parts: the first part mainly inquired for parents' attitudes about present online SNS and the impact on children's social activities; for the second part, parents were asked to provide their perspectives about Petimo system after they interacted or observed their children interacting with Petimo. The interview process was recorded by audio and the collected data were analyzed by following the coding method suggested by Berkowitz (1997) [53].

H2: Parents feel safer when their children use physical interaction with

Petimo than when they normally interact with SNS.

H3: With Petimo, it will increase parents' intention to allow their children engaging in SNS.

4.4. Procedure

For children, the study duration was 1 hour maximum and any time they may suspend if they feel uncomfortable. They were asked to interact with our Petimo system and after each trial, they were asked with survey questions (approach 1) about their experiences. During the interview with their parents, children would be placed to the other room and one administrator would asked them to draw down anything related to their Petimo experiences. Art crafts and color pencils were provided to them. Administrator would ask some questions according to their painting and took notes of the sharing from children. In the end of the study, participants will be provided an honorarium in form of restaurant vouchers.

For parents, the study duration was 50 minutes maximum and any time they may suspend if they feel uncomfortable. They were also asked to interact with our Petimo system and get familiarize with it. After that they are interviewed about their interaction and their feelings when they observe their children interact with Petimo. In the end of the study, they were also provided an honorarium in form of restaurant vouchers. The detail of time duration and flow of study's procedure shows in the Figure 4.4.

4.5. Methodology

4.5.1 Overall Flow-State Measure

The research survey for approach 1, the communicative enjoyment with Petimo, is designed as a series of questions to evaluate children's attitude when interacting

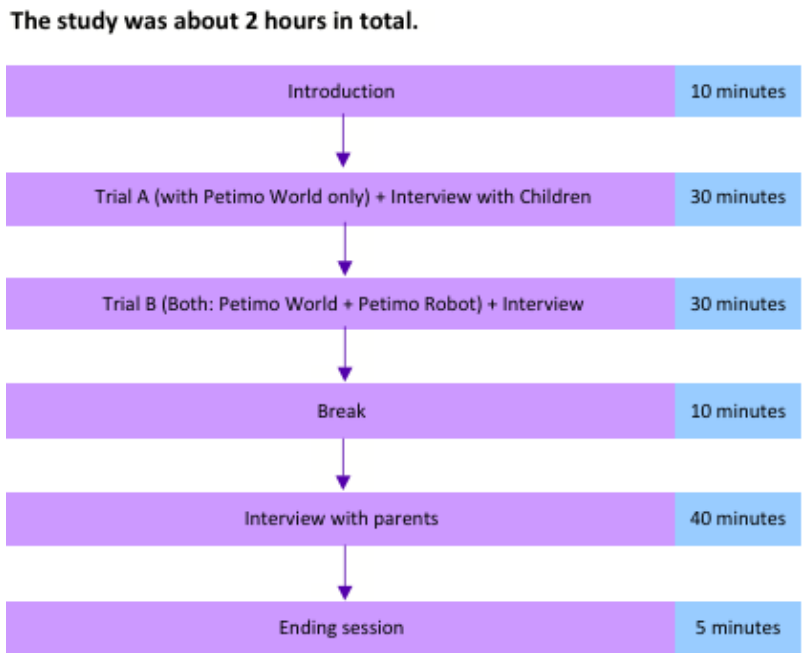


Figure 4.4: Procedure of Evaluation Study

with Petimo system. This survey was designed based on the principle of Overall Flow-State Measure [51]. Pearce and the colleagues used an alternative overall-state measure of flow, and it was obtained using a survey which administered at the end of the user test. Every question was designed to rate the experiences of engagement, enjoyment, and perceived control using 5-point Likert scale. The survey questions were shown in Table 4.2, and were separated into three categories: control, concentration, and enjoyment.

Petimo system is a social networking game for children. It does not lead to any specific ending, and the users could not earn the points or visual money in Petimo World. In the other way, users are rewarded by exchanging gift or emoticon and by sharing their feelings with their closed friends and family. Since Petimo has a goal for social networking, the evaluation test was not designed to identify users as being “in flow” through interview about the activities with Petimo. In spite of using traditional flow scale model [54], the evaluation test did not try to

Table 4.2: Survey questions of Overall Flow-State Measure

Survey questions used to measure control, interest and enjoyment	Categorized by this research [51]
1. I felt in control of what I was doing.	Control
2. I was absorbed intensely by the activity.	Concentration
3. I found the activities enjoyable.	Enjoyment
4. I thought about other things.	Concentration
5. I found the activities interesting.	Enjoyment
6. I was frustrated by what I was doing.	Control
7. The activities bored me.	Enjoyment
8. I was aware of distractions.	Concentration
9. The activities excited my curiosity.	Enjoyment
10. I knew the right thing to do.	Control
11. It required a lot of effort for me to concentrate on the activities.	Concentration

estimate the balance between challenge and skills. By using the method of Overall Flow-State Measure, the survey was designed into seven questions for measuring children’s attitudes toward three tracks: enjoyment, control, and concentration. The details were presented in Table 4.3.

4.5.2 Think-aloud Method

The think aloud method has its roots in psychological research. It was developed from the older introspection method. Introspection is based on the idea that one can observe events that take place in consciousness, more or less as one can observe events in the outside world. [55] Think-aloud method requires participants to verbalize their thoughts. Users are asked to say whatever they are looking at, thinking, doing, and feeling while they interact with the product or do the task. As discussed by Ericson and Simon [52], in general, talking out loud does not interfere with the task performance. This method is widely used as the most valuable usability-testing method [56] in the field of human-computer interac-

Table 4.3: Categories of survey questions in this research

Categories	Questions
(A).Enjoyment	1. I really enjoyed the experience. 3. I found the experience extremely rewarding. 7. I loved the feeling of that performance and want to capture it again.
(B).Control	4. I feel it is easy to add friends. 5. I like to send a gift or emoticon to friends. It is easy to express my feeling. 6. I like to receive a gift or emoticon from friends. It is easy to understand.
(C).Concentration	2. I was only thinking about this, while I was interacting.

tion. Also, think-aloud has been applied in research with children in educational settings, for example, using think-alouds to improve reading comprehension or mathematical problem solving [57].

Applying this method for testing interactive product with children, especially younger children addressed some difficulties which are discussed by researchers. For example, children may find it hard to express their thinking clearly because their language skills are still not fully developed. And also, many children are shy to adults and will find it more difficult to verbalize their thoughts when trying to learn to use an unfamiliar product. This issue has been considered in recent years, and one study by Markoporlos established the feasibility and effectiveness of think-aloud method for adapting to usability evaluation with children [6]. Researchers also provide many guidelines for instructing children to think aloud:

- Immediately before the session, a small example which performed by administrators can help to motivate children to think aloud, and show the desired form of think-aloud and even counter-examples [58].
- The administrator can provide small warm-up tasks [52] where it is easy to do think-aloud, such as exercises or small games. During this session, the

administrator can encourage children to speak and perhaps ask questions to indicate the types of things that the research might need to collect.

In this research, the evaluation test is based on the principles of think-aloud method and the guidelines provided by previous researchers on designing for children. This research used think-aloud method to motivate children to verbalize their thoughts clearly and to help children express more details about their feelings. By using this method, it was helpful for children to evaluate more clearly to rate their answers in quantitative survey. And the collected data were directly used and analyzed as the qualitative results.

4.5.3 Statistical Approach for quantitative data

Nonparametric tests were used for tests of statistical significance of much of the categorical data. When testing for differences in children's responses between Trial A (only with Petimo World) and Trial B (with both Petimo World and Petimo Robot), the results were compared within subject using the Kruskal-Wallis test and the Wilcoxon two-sample test. The Kruskal-Wallis test is a method of nonparametric one-way procedure for testing equality of population medians among groups. It is used to compare sets of scores that come from different groups. The Wilcoxon two-sample test is a procedure used to compare the medians of two samples, and for small numbers with unknown distributions, this test is more sensitive than t-test. However, if the samples are more than two trials, Kruskal-Wallis test could not show the difference among each group. Meanwhile, for further information, a repeated measures general linear model was used and the Duncan's multiple range test in the general linear model procedure was applied to compare the range of a subset of the sample means with a calculated least significant range.

Chapter 5

Results

In this chapter, the research results were analyzed by using mixed research method. The quantitative results and qualitative findings would be showed in the following analysis. According to two approaches, communicative satisfaction with physical interaction and safety concerns of parents, these results verified three main hypotheses and gave further information to extending topics.

5.1. Communicative Satisfaction with Physical Interaction

5.1.1 Results of Research Problem

A nonparametric test designed with 95 percent confidence level was applied on seven questions for testing the difference between Trial A (only with Petimo World) and Trial B (with both Petimo World and Petimo Robot). The research hypothesized that children will be more satisfied when using both Petimo Robot and Petimo World to communicate with friends. For analyzing, the questions were separated into three tracks: enjoyment, control and concentration. Question 1, 3 and 7 were indicated to measure children's enjoyment when using Petimo. Question 4, 5, and 6 were referred to the understanding of each communicative feature when children interact with Petimo system. Question 2 was intended to ask whether children get distract from Petimo system during the experiment.

H1: Children are more satisfied when using physical interaction with Petimo Robot and Petimo World than only playing in Petimo World. (Trial B > Trial A)

(A). Enjoyment

Question 1

Trial a1: I really enjoyed playing in Petimo World. It was fun!

Trial b1: I really enjoyed playing with both Petimo Robot and Petimo World. It was fun!

Table 5.1: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q1)

Trials	N	Mean	Mean Score	Z value	Probability
a1	26	3.38	19.6923077	Z = -3.40516	0.0007***
b1	26	4.46	33.3077923		

From Table 5.1, the mean of trail b1 is larger than the mean of trial a1 (4.46 > 3.38). After ranking by using Wilcoxon scores, the result indicated a significant difference between question a1 and b1, and two trials are significantly different even under the 99 percent confidence level ($p = 0.0007 < \alpha = 0.01$).

Table 5.2: GLM Procedure: Duncan's Multiple Range Test (Q1)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a1	19.602	26	3.38	B	F = 14.82	0.0003***
b1	33.308	26	4.46	A		

From Table 5.2, the result also showed the significant difference in Duncan's Multiple Range test between two trials under the 99 percent confidence level ($p = 0.0003 < \alpha = 0.01$). From Duncan's test, the result indicated that the trial a1 and b1 belonged to different groups. It revealed that children more enjoyed playing with both Petimo Robot and Petimo World than only playing in Petimo World (Duncan grouping: $A > B$)

Question 3

Trial a3: I found the experience extremely rewarding. It is very interesting playing in Petimo World!

Trial b3: I found the experience extremely rewarding. It is very interesting playing with both Petimo Robot and Petimo World!

Table 5.3: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q3)

Trials	N	Mean	Mean Score	Z value	Probability
a3	26	3.27	21.6538462	$Z = -2.40548$	0.0162**
b3	26	3.92	31.3461538		

From Table 5.3, the mean of trail b3 is larger than the mean of trial a3 ($3.92 > 3.27$). After ranking by using Wilcoxon scores, the result indicated a significant difference between trial a3 and trial b3 under the 95 percent confidence level ($p = 0.0162 < \alpha = 0.05$).

Table 5.4: GLM Procedure: Duncan's Multiple Range Test (Q3)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a3	21.654	26	3.27	B	$F = 6.46$	0.0142**
b3	31.346	26	3.92	A		

From Table 5.4, the result also showed the significant difference in Duncan's Multiple Range test between two trials ($p = 0.0142 < \alpha = 0.05$). For more detail information, the result indicated that trial a3 and b3 belonged to different groups. From Duncan's test, the result revealed that children felt more rewarding and interesting when playing with both Petimo Robot and Petimo World than only playing in Petimo World (Duncan grouping: $A > B$).

Question 7

Trial a7: I loved the feeling of using Petimo World. I want to do it again!

Trial b7: I loved the feeling of using Petimo Robot and Petimo World. I want to do it again!

Table 5.5: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q7)

Trials	N	Mean	Mean Score	Z value	Probability
a7	26	3.46	18.1538462	Z = -4.21076	0.0001***
b7	26	4.62	34.8461538		

From Table 5.5, the mean of trail b7 is larger than the mean of trial a7 ($4.62 > 3.46$). After ranking by using Wilcoxon scores, the result indicated significantly different between trial a7 and trial b7 under the 99 percent confidence level ($p = 0.0001 < \alpha = 0.01$).

Table 5.6: GLM Procedure: Duncan's Multiple Range Test (Q7)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a7	18.154	26	3.46	B	F = 26.84	0.0001***
b7	34.846	26	4.62	A		

From Table 5.6, the result also showed the significant difference in Duncan's Multiple Range test between two trials under the 99 percent confidence level (p

= 0.0001 < α = 0.01). The result indicated that trial a7 and b7 belonged to different groups. From Duncan's test, the result revealed that children preferred to do the Trial B and use physical interaction again then only playing in Petimo World (Duncan grouping: A > B).

(B). Control

Question 4

Trial a4: I feel it is easy to add friends in Petimo World.

Trial b4: I feel it is easy to add friends by using Petimo Robot.

Table 5.7: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q4)

Trials	N	Mean	Mean Score	Z value	Probability
a4	26	3.35	19.000	Z = -3.75421	0.0002***
b4	26	4.54	34.000		

From Table 5.7, the mean of trail b4 is larger than the mean of trial a4 (4.54 > 3.35). After ranking by using Wilcoxon scores, the result indicated a significant difference between question a4 and b4, and two trials are significantly different even under the 99 percent confidence level ($p = 0.0002 < \alpha = 0.01$).

Table 5.8: GLM Procedure: Duncan's Multiple Range Test (Q4)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a4	19.000	26	3.35	B	F = 19.23	0.0001***
b4	34.000	26	4.54	A		

From Table 5.8, the result also showed the significant difference in Duncan's Multiple Range test between two trials under the 99 percent confidence level (p

= 0.0001 < α = 0.01). From Duncan's test, the result indicated that the trial a4 and b4 belonged to different groups. It revealed that children felt easier when using physical interaction (Petimo Robot) to add friends than searching names to add friends in Petimo World (Duncan grouping: A > B).

Question 5

Trial a5: I like to send a gift or emoticon to friends in Petimo World. It is easy to express my feeling.

Trial b5: I like to send a gift or emoticon to friends by using Petimo Robot or Petimo World. It is easy to express my feeling.

Table 5.9: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q5)

Trials	N	Mean	Mean Score	Z value	Probability
a5	26	3.50	20.4423077	Z = -3.04416	0.0023***
b5	26	4.46	32.5576923		

From Table 5.9, the mean of trail b5 is larger than the mean of trial a5 (4.46 > 3.50). After ranking by using Wilcoxon scores, the result indicated a significant difference between question a5 and b5, and two trials are significantly different even under the 99 percent confidence level ($p = 0.0023 < \alpha = 0.01$).

Table 5.10: GLM Procedure: Duncan's Multiple Range Test (Q5)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a5	20.442	26	3.50	B	F = 11.19	0.0016***
b5	32.558	26	4.46	A		

From Table 5.10, the result also showed the significant difference in Duncan's Multiple Range test between two trials under the 99 percent confidence level (p

= 0.0001 < α = 0.01). From Duncan's test, the result indicated that the trial a5 and b5 belonged to different groups, and b5 has higher evaluation than a5. Compare to only using Petimo World, children liked to send gifts or emoticons and felt it is easier to express their feelings and thoughts by both using Petimo Robot and Petimo World (Duncan grouping: A > B).

Question 6

Trial a6: I like to receive a gift or emoticon from friends in Petimo World. It is easy to understand.

Trial b6: I like to receive a gift or emoticon from friends through both Petimo Robot or Petimo World. It is easy to understand.

Table 5.11: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q6)

Trials	N	Mean	Mean Score	Z value	Probability
a6	26	3.50	22.6730769	Z = -1.90322	0.0570
b6	26	4.00	30.3269231		

From Table 5.11, the mean of trail b6 is larger than the mean of trial a6 (4.00 > 3.50). After ranking by using Wilcoxon scores, the result indicated that there was no significant difference between question a6 and b6. Under the 95 percent confidence level, two trials did not show significant difference between groups ($p = 0.0570 > \alpha = 0.05$).

Table 5.12: GLM Procedure: Duncan's Multiple Range Test (Q6)

Trials	Mean Score	N	Mean	Grouping	F value	Prob > F
a6	22.673	26	3.50	A	F = 3.86	0.0549
b6	30.327	26	4.00	A		

From Table 5.12, the result also showed that there is no significant difference in Duncan's Multiple Range test between two trials under the 95 percent confidence level ($p = 0.0549 > \alpha = 0.05$). From Duncan's test, the result indicated that the trial a6 and b6 belonged to the same groups. It revealed that there are no difference from both ways, Petimo Robot or Petimo World, children liked to receive gifts and emoticons from their friends, and children understood what their friends wanted to say behind those icons (Duncan grouping: AA).

(C). Concentration

Question 2

Trial a2: I was only thinking about this, while I was playing in Petimo World.

Trial b2: I was only thinking about this, while I was playing with Petimo Robot and World.

Table 5.13: NPAR1WAY Procedure: Wilcoxon 2-Sample Test (Q2)

Trials	N	Mean	Mean Score	Z value	Probability
a2	26	3.04	24.2307692	Z = -1.14487	0.2523
b2	26	3.38	28.7692308		

From Table 5.13, the mean of trail b2 is slightly larger than the mean of trial a2 ($3.38 > 3.04$). After ranking by using Wilcoxon scores, the result indicated that there was no significant difference between question a2 and b2. Under the 95 percent confidence level, two trials did not show any difference between groups ($p = 0.2523 > \alpha = 0.05$).

From Table 5.14, the result also showed that there is no significant difference in Duncan's Multiple Range test between two trials under the 95 percent confidence level ($p = 0.2522 > \alpha = 0.05$). From Duncan's test, the result indicated that

Table 5.14: GLM Procedure: Duncan's Multiple Range Test (Q2)

Trial	Mean Score	N	Mean	Grouping	F value	Prob > F
a2	24.231	26	3.04	A	F = 1.34	0.2522
b2	28.769	26	3.38	A		

the trial a2 and b2 belonged to the same groups. It revealed that children could concentrate on playing Petimo system, and there were no difference whether they were using both Petimo Robot and Petimo World or only Petimo World (Duncan grouping: AA).

(D). Discussion

Table 5.15: Summary of result of Approach 1

Categories	Q	Result
(A).Enjoyment	1	Children enjoyed the experience of Trail B more than Trial A.
	3	Children thought the experience is extremely rewarding with Trial B than Trial A.
	7	Compared with Trial A, children preferred the feeling of play in Trial B and want to capture it again.
(B).Control	4	Children felt it is easy to add friends by using Petimo Robot than searching in Petimo World.
	5	Children liked to send a gift or emoticon to friends. It is easier to express their feeling in Trial B than Trial A.
	6	There is no difference whether children receive a gift or emoticon from Petimo Robot or Petimo World.
(C).Concentration	2	It is hard for children to concentrate on both trials in 15 to 20 minutes.

As shown in table 5.15, the results of analysis on enjoyment track indicated that children received much more pleasure from Trial B than Trail A. All three

questions gave strong results and revealed that there are significant difference between two trials. According to the mean comparison and the result of Duncan's grouping, three questions of Trial B show higher scores than other three questions of Trial A. It is addressed that, compared with only playing in Petimo World, engaging both with Petimo Robot and Petimo World satisfied children and brought more enjoyment to them when they communicated with their friends or family.

About control part, the results showed children's understanding and cognition toward communicative features of Petimo Robot and Petimo World. For friends adding feature, children preferred using physical touch to add friends with Petimo Robot than searching names in Petimo World. Also, the result indicated that children liked to send gifts and emoticons to their friends not only in online Petimo world, but they preferred to send those visual messages by using both physical device, Petimo Robot, and online game, Petimo World. However, the last result of analysis referred that children felt and understood it in the same way when receiving gifts or emoticons in Petimo World or in Petimo Robot. There were no difference between Trial A and Trial B, and children can understand the meanings behind those visual messages sended from friends. Overall, children can easily use Petimo system to make friends and to communicate with others, and they liked better using both Petimo Robot and Petimo World than only playing in Petimo World.

From the analysis of concentration track, the results indicated that there are no difference between Trial A and Trial B. And, to look into the mean value of both trials, the score were both small and showed children might not be extremely concentrated during the test. There were two main messages revealed from the result. First, children's concentration in Petimo system was the same in both trials. Second, the mean values of two trials were slightly different, but both showed the scores around 3 ($a_2 = 3.04$; $b_2 = 3.38$). Children did not agree but also not disagree with the question 2, which was asked children to rate their concentration during the test. One reason for this result might be the time duration of the experiment was too short to evaluate participant's concentration. Especially for younger children, 15 to 20 minutes experiment could be too short

for children to go into the flow or fully concentrate on the activity. For another reason, it might not be easy for young children to rate their own concentration on the activity and to remind themselves whether they thought about other things during the test.

It is found that, with physical feature, children did not just received more communicative enjoyment, but they understood more how to control the system and they can explore the new online environment by their own knowledge they have learned from real world. Based on the theory of play, the result indicated that physical interactive feature in Petimo allowed children to involve in some pure assimilation by using their own imagination to play in Petimo World. Petimo provided a situation that children can play and accommodate to outer reality, for example, physical friend-adding or gift-sending features. The environment of Petimo system allowed children to grow their imagination and the accommodation to outer reality. Children can control the features and learn to develop their social skills, meanwhile, they can be enjoyed and satisfied in the whole communicative process using Petimo.

Since physical interactive features are very essential to enhance the enjoyment of communication for children, more implementation for physical interactions are expected being improved in the future works. For example, the system can add squeezing as another interaction method. This can be used as a meaningful input to the system. For instance, selection of an option in Petimo can be made by squeezing the robot. Furthermore, this can also be used as more playable features such as generating sounds, or playing simple interaction games with Petimo.

5.1.2 Qualitative Findings

Many children replied that they loved to use Petimo Robot to communicate with their friends. They liked the giggling sound when sending and receiving gifts or emoticon, and the further cover of Petimo Robot made children feel they were playing with a pet, not just using a digital device. Some children responded that they prefer to use Petimo Robot to send gifts to their friends, because they

feel limited when only communicating in Petimo World. Also, many participants responded that they preferred to use their fingers and choose the emoticon on the touch screen of Petimo Robot. According to the feedbacks, it is more interesting for children physically touching the gift icons on Petimo Robot than using mouse to choose icons on computer screen.

I like to use this (pointed to the Petimo Robot). And it does not seem like a robot to me. It's like my teddy bear at home. And it is fun to use a bunny to give a gift to my friends. (Girl, 9 years old.)

It was interesting when I touched a cheese (an gift icon) and it came out with the sound. And it could be sent directly into computer. My friend's princess (the Berina avatar) looked happy and she danced because of my sending gift. (Girl, 10 years old.)

Figure 5.1 was the drawing from one girl participant, who is 11 years old, and she had experience of using Facebook. This participant used Facebook to mainly play Pet Society with her friends who lived in different countries now. She responded to interviewers that she wanted to use Petimo system, because if she could have Petimo Robot, then she would be able to send a gift to her friends anytime, anywhere. This girl said Pet Society is fun but she can only see the gifts from her friends when she log into Facebook at home. She told interviewer if she could have Petimo, she can send a smile whenever she felt happy. The immediateness of communication in Petimo system satisfied children's needs for social networks.

On the other hand, after observing from the recording videos, the results indicated that children were excited about using Petimo Robot to send a gift, and then see the avatar's reaction in Petimo World on computer's screen. Some participants would keep sending gifts by using Petimo Robot, and act excited when they found their friends' screen popped out the gift and the avatar jumped when the gift was received. From videos, compared to girls, boys would be more attracted by the interaction between visual world and physical device. In general,

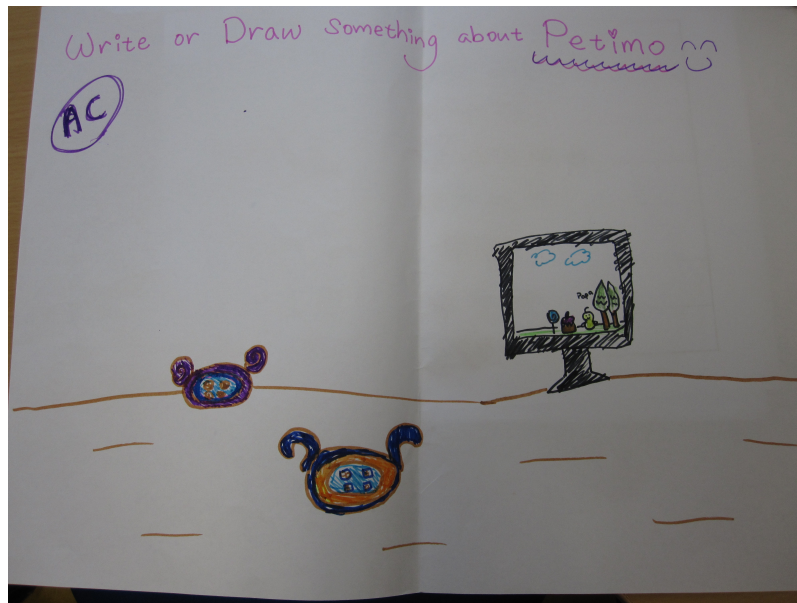


Figure 5.1: Drawing about Petimo (Girl, 11 years old)

boys also liked to control the avatars and make it moving around in Petimo World.

I like to send gifts. Amy (one avatar's name) will jump up and down if I keep sending gifts to her. And it is fun that make them (avatars) walking around in the field and forest. We can play hide and seek! That is really fun! (Boy, 8 years old)

From the participant who drew the picture as shown in Figure 5.2, she told the interviewers that she liked the avatars' action when receiving a gift or emoticon. She described to interviewers that made she felt the visual world were connected to the real world. Even though the program did not have any application games yet, this participant and her brother created and played the hide-and-seek game by moving the avatars around in the Petimo World.

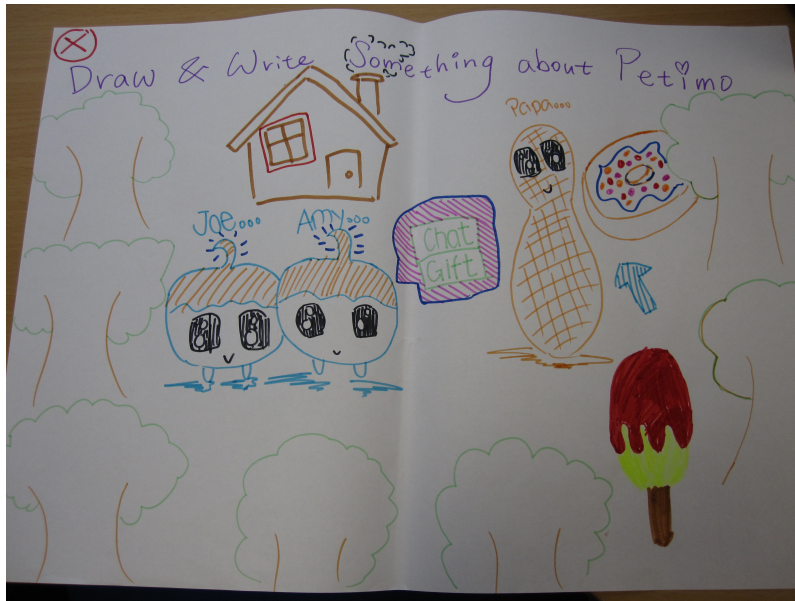


Figure 5.2: Drawing about Petimo (Girl, 9 years old)

5.2. Safety Concern of Parents

5.2.1 General Attitude toward Online SNS

Parents' attitudes toward current online social network system was discussed in the beginning of interview. The researchers asked three open-ended questions to 21 parents: The first question is about their personal use of online social network; the second question is asking parents' opinions about children using online SNS; the last question was conducted to go deep into parents' perspectives whether allowing their children to use online SNS or not. In analysis, the interview results are grouped into three categories for interpreting parents' different attitudes.

(A). Apprehension of children's isolation from family

Three participants responded to researchers that they are worried that if their children use online SNS, they will be more isolated in their own social world and will intend to not interact with their family or friends in the real world. Two

participants with this response did not currently use online SNS in their personal life. They indicated that online environment is not secured enough for them to let their children interact with someone behind the screen. And online game or related social networking website may drift apart their family, especially between parents and children. Below are some responds from our participants:

It is an unknown environment for my children to interact and grow up. When I imagines them use online SNS, it makes me feel uncomfortable. It will cause isolation. We want our children to interact more with people in real world. . . like. . . go to the playground talking and playing with other kids. We don't want our kids only spending time on Internet. (Female, 36 years old)

There is another place for social networking. . . for children. They can interact through this kind of environment, like classroom. Me and my husband. . . we will not allow our child to use online SNS. Because we can not know and control whom they make friends with. The access on Internet can not be controlled. At least when they are in primary school, we will not allow. Maybe when they all attend to secondary school. . . we might reconsider about this. (Female, 44 years old)

(B). Worry but accept children using online SNS

Most of the participants (14 parents) answered that they understand children might have to engage in online social network in today's Internet world. The responses indicated that these parents viewed this situation as an inevitable trend for children to engage in online social network. However, they still worried about the negative effects with networking websites and feel anxious about their children's safety. The results are presented below.

It (online SNS) might not be necessary needed, in my opinion. It is quite an unknown place and not very safe. But I wont prohibit it. You have to accept this kind of thing in the Internet era. (Male, 44 years old)

For my kids, they use email but not very often, and they have e-learning

class at school. I understand they might want to use for maintaining friendship. But the problem is it has to be used through Internet, and there is an adult's world. it is not quite safe for kids. (Male, 43 years old)

Sometimes kids might feel they need to use online SNS, because of peer pressure. But it might not be necessarily good. People who are using it might not be mature, or some may be over-mature. (Female, 41 years old)

I don't want my kids to use it. But I know they eventually will ask. I heard my friend's kids. . . she is 12 and she asked her parents for using online SNS. Kids want to use it and had more friends. (Male, 38 years old)

Many interviewees replied that there are too many unknown problems and anonymous strangers in online social networks. Parents with older children said they noticed their children had more and more online activities and they believed children would ask them for using online SNS in the near future. They had mixed feeling about Internet and online SNS, but they accept and stand on a relatively positive position when viewing their children to use online social networks.

(C). Allow children to use online SNS under supervision

There were four participants responding that they will allow their children to use online SNS, but all of them had the same opinion that children must be under parent's supervision when engaging in online social networks.

I will not be afraid to let my children use online social websites. I will watch them and teach them to use it. But I still more prefer them to interact with people in the real world and to have some physical activities. (Male, 39 years old)

It is okay to use online social networks for maintaining friendships. But parents should monitor the situation if they are online. I will allow them to use, but will let them know what happen if they post something online. (Male, 45 years old)

One of the participants who replied that he agreed his daughter to use Facebook from the age of nine. This father is the first and the only parent in this study who had an experience that his child asked him to use online SNS and his decision was allowing his child to use Facebook but under his supervision. He is 35 years old and his daughter now is 11 years old. He works in an online company and he has engaged in many online social networks like Facebook, LinkedIn, Twitter, Second Life, and My Space. It is a very interesting result and here attached more details in this interview:

Participant (followed as P): My daughter used facebook, but we don't let her use it by herself. We watch her. If she used it, me or my wife will watch her while she is on facebook. Oh! But we do let her play Pet Society (on facebook) by herself, so she can start the game and we will let her play. But if she is just on the facebook, then we will be watching her.

Interviewer (followed as I): Does she have an account on Facebook?

P: Yes, she does. She has her own account.

I: When you say you and your wife watched her while she used facebook, can you explain more?

P: We did all her setting, her privacy setting. So that means, for instance, she cannot be found from search. And, mostly, we talked to the parents of the other kids, first to know which kids are on facebook. She is just connecting with those kids. So we do control it quite a bit.

I: Is she okay with this?

P: She is okay with it. She doesn't complain about this. Actually, she's never had, so far, somebody she doesn't know requesting to add her.

I: What is the main reason you would like to allow your child to use Facebook? Did she ask you? When is the age she asked for using Facebook?

P: Well... mainly because she has her friends in another countries, and we found that is an easy way for her to connect to those friends. And... I think she asked... when she is about 9 years old. Because she has a friend, a good friend who was moving to Indonesia in the end of last year, they wanted to stay in contact.

I: Do you mean you know all of friends on her list? Are you also her friend on Facebook? Does she only have friends who now lived aboard on Facebook?

P: Ummm... she does have a couple of friends here, but just recently. So she has maybe ten friends on facebook, and 8 are overseas, and 2 are here in Singapore. They are all in the same age... 9, 10 or 11 years old... on yah! Me and my wife. So that will be 12 friends on her friend list. And there are two little kids who live on the next building. They are the only two local friends Lina has on facebook. And then me and my wife are also on her list, so we can watch her profile and see everything happened.

I: What does she do in Facebook? What functions does she use?

P: She and her friends play in Pet Society on Facebook. They sent each other gift and so on. But Pet Society is not really real time. You can not really play with your friends in the same time, or chat with your friends while you are playing. And she sent messages through facebook, like emailing. I don't think she use wall post... I've never seen her use. And uh... no chatting.

The reason the participant's daughter asked him to use Facebook is that she had a friend who was moving to the other country and the children wanted to keep in touch by using Facebook. He and his wife agreed to let their daughter to have an account on Facebook, but they decided to do all the privacy setting of her account. He and his wife supervised their daughter and set many rules

for her to use Facebook. His daughter can only log into Facebook unless one of her parents was beside her. She now can play in Pet Society and send messages to her friends. Both these two features do not include real time chatting, so it prevented the problems caused by free text chatting. The participant and his wife know and control the child's friend list, and all her friends now are children in the same age. Also, they both are friends on her facebook. This could help the parents checking their child's profile and current status when she is offline or when they could not around her.

Discussion

Most of the participants viewed the situation of children using online SNS as an unavoidable trend, and they accept that it might become an important medium for children when they develop their social networks. The main concerns that parents care about online SNS are safety problems, isolation, and online bullying carried by unknown strangers. Some participants worried that children would spend too much time on visual world instead of having physical activities.

For parents, many of them are also very unfamiliar with the online SNS, and do not understand the security mechanism of online environment. From the comments received, if there are certain ways to supervise or protect children on their online activities, parents will be more released to allow their children engage in such an unknown place. As same as parents' perspectives toward children's social activity in the real world, parents want to know how to instruct their children to develop the social network with the new media. Less understanding and education for giving instruction are the main reasons for parents feeling insecure to online SNS.

5.2.2 Results of Research Problems

H2: Parents feel safer when their children use physical interaction for SNS than when they normally interact with SNS.

Most of parents felt safer when they observed their children using physical interaction with online SNS than normally interacting in SNS on Internet. There were 8 parents responded to interviewers that they felt more relieved when observing their children playing in Petimo World with Petimo Robot. 10 participants replied that they felt safer with Petimo system, but they still have some different concerns on online SNS with children. Three participants indicated that they do not feel any difference between Petimo and other online SNS. No matter that it is with or without physical interaction, online networks existed some fundamental problems that will lead to a dangerous social environment for children.

(A). Physical friends-adding feature makes me feel relieved.

The result indicated that 8 participant considered the physical interaction as a main factor to protect children and make the Petimo system become much safer than other online SNS. Some parents thought, by using Petimo Robot, it could encourage children to make friends face to face in the real world. Some responses of participants are shown below.

Petimo is definitely safer than other online SNS like facebook etc. It is a controlled environment and it does not expose to any outer world by using physical touch. My husband and I could be aware of all our kids' friends. (Female, 42 years old)

With physical interaction, it is much safer game than the other online games or SNS. The feature is easy to use for kids, and it is quite natural. (Male, 44 years old)

I think the physical friends add is a nice and safe access for SNS, especially for small children. This feature can also encourage children to make more friends

in their real life. Not just in the online game. (Female, 41 years old)

(B). It is safer but I still have concerns.

In the responses of this part, there are 10 participants answered that they agreed Petimo system could be safer compared with other systems. However, they still have different worries and concerns about Petimo online platform. Some participants replied that if there are more different ways for parents to supervise children activities on Petimo World, they will feel more relieved to let their children engage in this kind of online communication environment. Participants had positive attitude of physical friend adding feature, but they thought since Petimo World is an online platform, it still includes some potential dangers for children.

Mostly safe. But you should know I also work for an online company, so I am quite familiar with these topics. You do have free text search for finding other players. So it is quite easy for someone to try out bunch of names and add players. And you do have free text chat, which means you could say any words or anything. So it is safer I think, but I didn't feel it is 100 percent safe. The point is that the chat and search are free texts. However, if you would turn that off (block the free text functions), it could be much safer. It will be very safe if children can only use physical feature to add friends. (Male, 35 years old)

It is much safer with the physical part, and I think children love the physical friends adding. But I still worried that some strangers might buy the robot and become friends in their world. I will still want to know my children's activity in Petimo World. (Female, 41 years old)

(C). I do not feel relieved even with the physical feature.

Three parents responded that even if Petimo system includes physical friend adding feature, there is the same risk between Petimo and other social networking websites. It is hard to say that the system is 100 percent secured once the platform went online. Furthermore, from the other point of view, one participant replied

that it is unsafe in the real world same as in the online world. The most important thing is that parents should educate their children to select their friends and to recognize bad people who want to interact with them.

I felt the same. It is the same whether they used Facebook or Petimo. And it is the same risk we have to face whether they engage in online world or real world. Parents still have to take care of their kids while they build their networks. (Male, 38 years old)

They are not much different for me. In my opinion, there are many risks when kids make friends online. And it is hard to reduce the risk once the system gets on Internet. There are too many ways on Internet for the adults to get into the children's network. For me, it is better they only make friends at school. (Female, 43 years old)

H3: With Petimo, it will increase parents' intention to allow their children engaging in SNS.

With Petimo, it will increase parents' intention to allow their children engaging in online SNS. However, most of participants replied that they still have certain concerns about Petimo system. Some parents responded that since Petimo includes communicative features like current online SNS, they worried that eventually there would be another way adults will target the Petimo World and get into children's social environments.

(A). I will allow my children to engage in Petimo online system.

There are four participants replied that if Petimo will be launched as a real product, they are willing to let their children use Petimo as a social networking tool. Physical friend adding access is the main reason they would agree their children engaging in Peitmo system. These parents thought this feature could protect children from many dangerous problems occurred in current online social

websites.

We (My husband and I) will allow them to use Petimo, because it is safe. It can encourage children to use physical interaction, even when using online SNS. (Female, 43 years old)

I think my children will be very happy using Petimo to make friends and to maintain friendships. Me personally, I will prefer them to use Petimo, because it is much safer than facebook or other networking sites. (Why do you feel safer about Petimo?) Because the physical part, yah, I think it is the key to make Petimo safer. (Male, 45 years old)

(B). I will allow but I still have some other expectation or concerns.

Most of the participants (16 parents) responded that they will allow their children using Petimo, but there still are many problems included in Petimo system. Some parents agreed that Petimo is a safer environment for online social networking, but if Petimo could provide educational solution to teach children how to protect themselves and interact safely in online SNS, that would be better and valuable for children's social experience. Two parents said the size of Petimo Robot is hard for children carrying it around. Physical interaction is the main safety factor of Petimo, but it can also occurred a limitation of this system to create network effect since every user should buy one robot in order to make friends o Petimo system. Meanwhile, some parents thought Petimo is a safe networking medium for children; however, it still includes an online and visual platform. That feature might urge children spending their time more in front of screen. Many participants expected that it would be better for parents to allow their children using Petimo, if Petimo could have more features to encourage children to engage more in physical activities.

I agree to let my child use Petimo, but it would be better if the system could educate children how to use Internet safely and teach them why it is better for them to make friends face to face. (Female, 42 years old)

I will allow them to use, because it seems quite safe. But if it can include more activities that have to be played physically, it will be better. I think our children should do more physical activities than just sitting there for a long time. (Male, 44 years old)

For me, I will allow her to use if she asked, and I will understand it first too. For my daughter, she might feel limited because she has to add friends only through physically touch. But it is probably more acceptable for other kids or slightly younger children. (Male, 35 years old)

The problem for Petimo I could see is... one is you have to carry Petimo everywhere. And then it becomes a job for the parent in the end. Uhhh..... because the kids will forget, or they would lose it..... etc. And each kid needs to have one in order to make friends, and it is very hard to let every kids to buy one. But Petimo will certainly be safer compare to other online social network. It has pros and cons... and that is my opinion. (Female, 41 years old)

(C). I will not allow my children to engage in Petimo online system.

Two participants replied that they do not think physical interaction will reduce the risks when children interact with people in the Internet world. Once the social networks get online, unknown adults or other potential dangers will use many different ways to approach to their children. The core problem is really hard to avoid, especially in the online world. One parents replied that education is very essential when children develop their social network. The most critical point is to teach our next generation how to choose their friends with their own judgments.

I don't think it can perfectly protect kids from other strangers. The strangers may still find another ways to add friends with them. I expect my kids will be intelligent enough to identify their good friends. Parents should always know whom their children are interacting with. When the kids are making friends or

*building their social network, parents should assist them to learn how to select their friends. That is important whether in the real world or the visual world.
(Male, 38 years old)*

Discussion

Most of the parents replied that even with physical interaction, they were still worried about the essential problems among the Internet environment. However, some of them also stated that the risk in the real world is as high as the online world. Meanwhile, almost all of the parents realized that there is no way to prohibit their children to use Internet and make friends through online networks, because, sooner or later, their primary school children would like to engage in varied social network websites. Same as the other online SNS, the main concern of Petimo online World for parents is still the unknown factors like anonymity or free text feature. These functions were hard to be controlled and there revealed a risk that adult strangers could find a way to enter children's networks.

Parents will allow their children to use Petimo as a social medium to maintain their friendships and develop their social network. However, they all have many different expectations and concerns about Petimo for being a social networking platform for children. Many parents gave similar feedbacks about the expectation of the extending security of Peitmo. For example, they thought if Petimo could include some monitoring ways for parents that will make parents feel more relieved. Also, if there could have some educational program or tutorial features in Petimo system, that would be better for taking Petimo as the first social networking system for children. Some parents responded that Petimo system could increase more physical interactive features, since it is very helpful and they observed they children also prefer to use physical interaction than only play in front of computers.

From the comments received, increasing the parental authentication should be the first thing to do for improving Petimo system. For example, a notification to the parent is sent informing about the awaiting friend requests. This feature

aims to provide parents the missing moral link with their children in the virtual world. Another good approach in the future is to limit the free text chatting function and change into the fixed messaging feature. In this way, children can be protected from the potential dangers like sexual message or online bullying. Thus, Petimo system can be improved to provide the capability for parents to supervise their children's online behaviors in a friendly way through its parental authentication module which enhances not only children's online security but also the relationship between children and parents.

Also, according to the results, security in both real world and online environment is very important for parent and children. Many parents replied that it would be better if Petimo can not only protect children in the online environment, but also have some solutions to help children in the real society. For the future design, the research is aiming to add the Global Positioning System (GPS) to Petimo. One of the primary GPS function is designed to enable parents to keep track of their children's physical locations. This upcoming feature cannot only help to find your children when they are getting lost, but also protect them from dangerous situations and criminals. For example, parents will receive an alert message if their children's located position is off their regular routine. With this new function, Petimo can provide a more comprehensive security to children in both virtual and real world.

With GPS, Petimo cannot only enhance the security service, but also increase entertaining interaction between users. For example, children can join in a collaborative game by using the GPS locating system. In this game, the first user will buy a special gift (shared as an RFID key) and can add the gift into her Petimo. The main goal of the game is passing the special gift to others as more as possible. When the first player passes the gift to the second player, she will receive a point icon (emoticon, gift or message image) from the server system. If the second player passes the gift to the next player, then not only the second player will receive a new point icon, but also the first player will receive another. In this scenario, if the gift is kept passing to the next player, it will naturally build up a network by sharing the same gift. Users can see and track the location of

the gift and feel connection from the route which is linked by all players. The gift might have a chance to travel through towns, cities, or even countries. Children can feel that they are actually connected with people through this network by sharing a special gift between each other, and they will receive worldwide point icons of giving and sharing.

Chapter 6

Conclusion

6.1. Conclusion and Limitation

Children learn how to make friends and develop their social skills through play. However, the environment for children to play and develop their skills becomes very complicated and dangerous in this digital age. Based on the review of related research works and children's development theories, Petimo is designed as a key to assist young generation to make friends easily in a more protected and safe social networking environment. In this research, a formal evaluation study is conducted by following the main principle of children's development theory. With 47 participants, 26 children and 21 parents, the aim of this research is to evaluate that Petimo system can enhance the communicative satisfaction for children and release parents' anxiety about online SNS.

According to the results, many children reported that, compared with only using computer and playing in Petimo World, it is more satisfied to engage with both Petimo Robot and Petimo World. Children preferred using physical touch to add friends than typing names and searching friends online without face-to-face interaction. With physical feature, children did not just received more communicative enjoyment, but they understood more how to control the system and they can explore the new online environment by their own knowledge they learnt from real world. Children can control the features and develop their social skills with Petimo; meanwhile, they can be enjoyed and satisfied in the whole commu-

nicative process using Petimo.

From the comments received, many parents are also very unfamiliar with the online SNS, and do not understand the security mechanism of online environment. The participants indicated that if there were certain ways to supervise or protect children on their online activities, parents would be more released to allow their children engage in such an unknown place.

This research found that, as same as parent's perspectives toward children's social activity in the real world, parents want to know how to instruct their children to develop the social network with the new media. Less understanding and education for giving instruction are the main reasons for parents feeling insecure to online SNS.

6.2. Future Works

From the comments received, increasing the parental authentication should be the first thing to do for improving Petimo system. For example, a notification to the parent is sent informing about the awaiting friend requests. This feature aims to provide parents the missing moral link with their children in the virtual world. Another good approach in the future is to limit the free text chatting function and change into the fixed messaging feature. In this way, Children can be protected from the potential dangers like sexual message or online bullying. Thus, Petimo system can be improved to provide the capability for parents to supervise their children's online behaviors in a friendly way through its parental authentication module which enhances not only children's online security but also the relationship between children and parents.

The research aims to make Petimo be used in different approaches with different scenario. For example, in education, Teachers can use Petimo as means of promoting social interaction among children in class. Children could be rewarded for the most social capital gained which would encourage them to interact with

their friends frequently. Also teachers could reward children with social capital, for good performance, using Petimo as a tool to develop in-class skills. This toy can also be used as a learning companion in primary schools to help and enhance the learning styles of children and encourage positive thinking via the interactive fun learning techniques available. One of our aims is to use Petimo as a connecting tool for a more closer teacher-child relationship in a way that children will be motivated to communicate frequently and build strong associations with their teachers and this will help teachers to understand and monitor their students easily and closely.

In the future, Petimo is aiming to be mass manufactured and commercialized as a real product. Petimo was designed as a commercially oriented product / service, and it is adequate for dealing with demand changes and large product variety without needing reconfiguration. The research team are planning to actively work with VC's in the future including VCs in Japan and Singapore. With the high expectation, Petimo will assume an important role in creating a safer playing environment. Petimo will dramatically change the younger generation's tendency of being disconnected from family and loved ones by bridging the gaps of existing social network security issues and acting as a powerful means to support a child's safe path toward a secured and personally enriching social networking experience.

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Appendix

A. Survey questions for Approach 1

Trial A (Let children play with Petimo World only without giving Petimo Robot.)

1. I really enjoyed the experience.
2. I was only thinking about this, while I was interacting.
3. I found the experience extremely rewarding.
4. I feel it is easy to add friends in Petimo World.
5. I like to send a gift or emoticon to friends. It is easy to express my feeling.
6. I like to receive a gift or emoticon to friends. It is easy to understand.
7. I loved the feeling of that performance and want to capture it again.

Each question will be rated by giving 1 - 5 stars.

Trial B (Let children play with Petimo World and Petimo Robot in the same time.)

1. I really enjoyed the experience.
2. I was only thinking about this, while I was interacting.
3. I found the experience extremely rewarding.
4. I feel it is easy using Petimo Robot to add friends in both Petimo World and Petimo Robot.
5. I like to send a gift or emoticon to friends. It is easy to express my feeling.
6. I like to receive a gift or emoticon to friends. It is easy to understand.
7. I loved the feeling of that performance and want to capture it again.

Each question will be rated by giving 1 - 5 stars.

B. Interview questions for Approach 2

General Attitude about online SNS

1. What are the online social networks (SNS) you have used?
2. What do you think about online social networks for children?
3. Would you allow your children to use online SNS? If yes, why? If no, what is the reason? What is your concern? What is the best age to allow your child to use SNS?

About Petimo

1. What do you observe when you see your child interact with Petimo? How do you feel?
2. Will you feel safe when you see your child play with Petimo? Why do you feel relieved / still feel insecure when seeing your child play with Petimo?
3. What do you feel about the feature of adding friends through physical interaction? Do you think it is natural? Do you think it is safer than the other online SNS?
4. Would you allow your child to engage in the social network system of Petimo? Why would you allow?

C. Publications of Petimo Project

Book Chapter

Adrian David Cheok, Owen Noel Newton Fernando, Charith Lasantha Fernando, Michelle Narangoda, Nancy Lan-Lan Ma, Miyuru Dayarathne, Roshan Lalintha Peiris, Isuru Sawbagya Godage, Anusha Indrajith Withana, Chamari Priyange Edirisinghe, Nimesha Ranasinghe, Kenning Zhu, Yukihiro Morisawa, Makoto Danjo, Timothy Merritt, Dilrukshi Abeyrathne, “Cute Interactive System”, Art and Technology, Springer (Accepted for publication).

Conference Papers

- Adrian David Cheok, Owen Noel Newton Fernando, Charith Lasantha Fernando, Kenning Zhu, Anusha Indrajith Withana, Nimesha Ranasinghe, Yukihiro Morisawa, Kasun Karunanayaka, Makoto Danjo, Isuru Sawubhagya Godage, Michelle Narangoda, Nancy Lan-Lan Ma, Miyuru Dayarathna, Roshan Lalintha Peiris, James Keng Soon Teh, Dilrukshi Abeyrathne, Chamari Priyange Edirisinghe, Kris Hoogendoorn, Junsong Hou, WeiWang Thang. Petimo: Enhanced tangible social networking companion for children, ACE’09 2009 Poster, Athens, Greece. October 29-31. (Accepted for publication).
- Adrian David Cheok, Owen Noel Newton Fernando, Charith Lasantha Fernando, Kenning Zhu, Anusha Indrajith Withana, Nimesha Ranasinghe, Yukihiro Morisawa, Kasun Karunanayaka, Makoto Danjo, Isuru Sawubhagya Godage, Michelle Narangoda, Nancy Lan-Lan Ma, Miyuru Dayarathna, Roshan Lalintha Peiris, James Keng Soon Teh, Dilrukshi Abeyrathne, Chamari Priyange Edirisinghe, Kris Hoogendoorn, Junsong Hou, WeiWang Thang. Petimo: Children’s companion for safe social networking, ACM SIGGRAPH Asia 2009 Emerging Technologies, Yokohama, Japan. December 2009 (Accepted for publication).
- Adrian David Cheok, Owen Noel Newton Fernando, Charith Lasantha Fernando, Kenning Zhu, Nimesha Ranasinghe, Michelle Narangoda, Isuru

Sawubhagya Godage, Roshan Lalintha Peiris, James Keng Soon Teh, Chamari Priyange Edirisinghe, Kasun Karunanayaka, Timothy Merritt, Dilrukshi Abeyrathne, Yukihiro Morisawa, Miyuru Dayarathna, Anusha Indrajith Withana, Nancy Lan-Lan Ma, Makoto Danjo, Junsong Hou, Wei Wang Thang 2009. Petimo: Safe Social Networking Robot for children. 8th International Conference on Interaction design and children (Como, Italy, June 3-5, 2009). IDC '09.

Awards prices and nominations

- Petimo: Safe Social Networking Robot for children short listed at the Como for Children (C4C) Competition at the 8th International Conference on Interaction design and children in Como, Italy, June 3-5, 2009. IDC '09.
- The First prize in Milan International InventiON competition. 2010, April, Italy.

Media

- Petimo was aired on Discovery Science “Popular Science’s Future Of Communication” TV programme on 17th August 2009.
- Headline: Get Pet, Ready, go... Online Source: The Straits Times, Home, pB5 Date: 16 June 2009.