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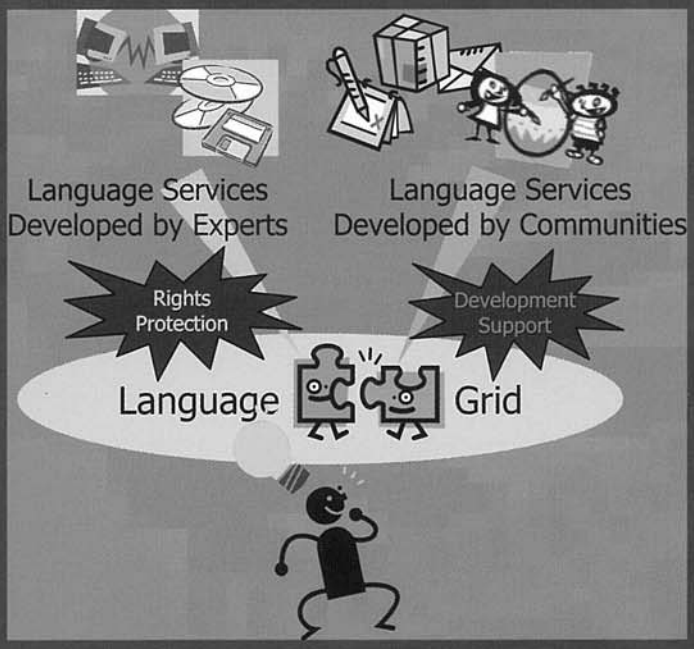

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Design and Development of a Pictogram Communication System for Children Around the World

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Abstract. Pangaea develops an intercultural collaboration environment using ICT (Information and Communication Technology) called the Universal Playground where children around the world can foster personal bonds regardless of their location, language, and cultural background, through a playful activity called "Pangaea Activity." Pangaea is a unique organization in that it has ongoing global fields for local children and has developed its own ICT system. This case paper reports how the Communicator, the pictogram communication software, was designed and developed. Development of the software and ICT system comes together through the Pangaea Activity menu, facilitation know-how, and field operation flow in order to bring the best performance toward its mission. As human-resources, funding, and time are limited, internal qualitative evaluations were conducted actively and quantitative evaluations were done in cooperation with external research groups.

Keywords: pictogram, intercultural communication, graphical user interface, usability, development process.

1 Introduction

1.1 Overview

We humans experienced the tragedy of *9/11* at the start of the twenty-first century. Although we should have learned, from our long history of war, to avoid war and instead take action for peace, there is still much strife and conflict in the world today. One of the fundamental reasons for this ongoing strife includes stereotypical threats resulting from the interactions of different religions, races, and nations. Meanwhile, science and technology has advanced rapidly and we now have a borderless cyber world, the Internet. The Internet enables people to obtain information instantly and to communicate with people worldwide through email and by web cameras. The cost of intercultural collaboration by ICT, Information and Communication Technology, is much cheaper than intercultural exchange which requires physical travel. Hence, the opportunity to communicate across cultures is increasing incessantly. In order to reduce the threats mentioned above, we have been making an effort to create the Universal Playground, where children from all around the world can create personal

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bondings through ICT regardless of their language, physical separation, cultural background and financial state. This paper is a case study in which we demonstrate the design and implementation of a pictogram communication media for use with the Universal Playground. Specifically, we will discuss our choice of pictograms over other media, our choice not to restrict the placement of pictograms in any specific layout, and finally, we will discuss the classification scheme employed by the pictogram dictionary to store the pictograms.

2 Background

2.1 Pangaea

Pangaea is a non-profit research and development project with the goal of creating a 'Universal Playground' for children. It creates an ICT environment where children, aged between nine and sixteen, can develop a personal and emotional 'bond' with each other around the world [15]. Geographical and language barriers as well as differences in social background are major factors that limit the opportunities for children to experience these 'bond.' Pangaea develops an online environment and tools through which children can spontaneously enjoy getting to know each other, share their experiences, and collaborate despite being physically separated. Using the Internet as a catalyst and connector, Pangaea provides a range of opportunities for children to 'bond' through Peace Engineering.

It also creates and implements playful and collaborative activity menus called Pangaea Activities at Pangaea's various local offices. By the end of 2006, Pangaea Activities take place at five locations in Japan; Nairobi, Kenya; Vienna, Austria and Korea. Both simultaneous and non-simultaneous activities are available in these locations. "Meeting", "Communicating", and "Connecting", Pangaea aims to develop content and tools to make these tasks enjoyable to the young participants. As a non-simultaneous activity platform, we have developed PangaeaNet, which is an online Universal Playground where children can communicate with each other and can share their work.

2.2 Pictogram Communication

The Communicator is a communication system made for the purpose of exchanging pictograms in the context of the various Pangaea Activities. Communicator enables children from different countries to communicate with each other in their own mother tongues, develop bonds, and to express their cultural and individual uniqueness freely. Communicator uses expressive and succinct pictograms. We named these pictograms in "pictons" (Fig. 1). More than five hundred pictons have been designed by the Picton Design Team, which consists of thirty volunteers mainly from Tama Art University in Tokyo. Presently, four hundred and fifty pictons are registered in the Picton Dictionary.

The Communicator also facilitates cultural diversity; when a child receives a message containing pictons, the *Picton Translation Function* [18] is invoked, by which the message is displayed in both the recipient's and sender's picton sets. By looking at two picton messages which have the same meaning, yet possibly a different representation, it is possible for children to learn the cultural and personal background of their partners.

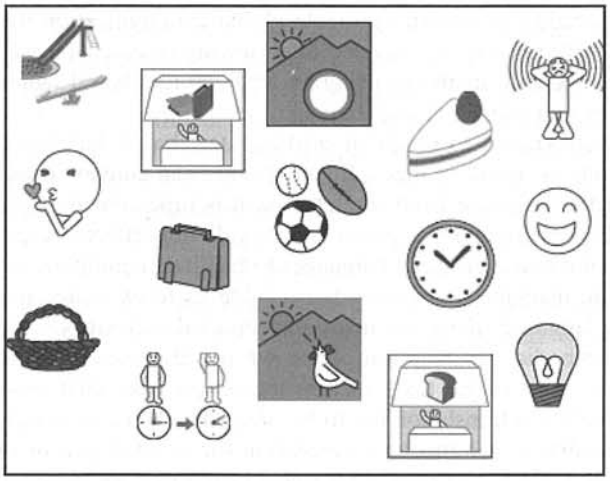

Fig. 1. A random sampling of pictograms designed by Pangaea

3 Case1: Communication by Pictograms

This chapter shows how we decided on pictogram as a shared communication method in Pangaea.

3.1 Motivation

In order to realize communication among Pangaea participants, a common language was needed. In international exchange and intercultural collaboration as well as in international commerce and politics, English is commonly used as a universal language. However, according to the statistics of Global Reach 2005, 64.8% of the users of the Internet have mother tongues other than English, which means that there are probably just as many children that do not understand English. In addition, the dependence on the English language suggests that there exist superior and inferior languages. In the past, we could do no better than to use English as a global language. However, we believed that we could change this with the help of the current ICT. In order to let children foster create bonds amongst themselves, the ideal language to use would be accessible to people around the world, would include rich emotional expressions, and would allow for the inclusion of the cultural identity of each group of participants.

3.2 Preliminary Survey

Before deciding on a specific communication method for the communicator, we set the following standards which the method must fulfill:

(1) It realizes heart-to-heart communication.
(2) It respects cultural diversity and self-identity.
(3) It is realized without learning new languages.
(4) It is made possible by computers and can be transmitted over the Internet.

We then proceeded to evaluate possible global communication methods on these specific points. By reading articles and interviewing researchers, we concluded that there are three candidate methods: using an artificial text-based language, using machine translation, and using a visual language.

First, one well known example of artificial text-based languages is Esperanto. Though Esperanto is useful in that a fluent speaker can convey ideas in detail, it requires learning the language from scratch. As it is time consuming to learn another language like Esperanto, and also given that they do not reflect any culture in particular, we decided not to use artificial languages to facilitate communication.

Second, while machine translation does enable us to exchange messages without learning a new language, there are many unsupported languages such as Khmer, the language of Cambodia. In addition, when we tested Japanese to English machine translation services on vulgar texts such as transcripts from chat sessions and email, we found the quality of translation not to be adequate. Thus, we concluded that while it would be possible to use machine translation for isolated portions of the Pangaea systems (perhaps the UI), we came to the conclusion that we risked losing too much meaningful content if we used machine translation as an exclusive communication tool.

We also evaluated using visual language [12]. We found that the main communication systems which use pictograms can be placed into three categories: universal signs, signs for the handicapped, and smilies. Good examples of universal signs are road signs, direction boards at airports, and the symbols of each sport played in the Olympic games. The second category of pictographic languages includes systems for Augmentative Alternative Communication (AAC) such as Blissymbolics [1, 16], PIC [13], and Elephant memory[8]. AAC assists people with severe communication disabilities to be more socially active in interpersonal interaction, learning, education, community activities, employment, volunteering, and care management. The third category includes pictograms that decorate text messages [17] such as emoticons and pictograms in cell phone. Some teenagers in Tokyo are reported to send email messages only using pictograms with rich emotional expressions. In comparison, Blissymbolics are relatively abstract, and they have a grammar which is more defined than emoticons.

After reviewing the aforementioned communication methods, we determined that a pictographic system would be the most practical and realistic system for Pangaea participants. Although a pictogram system is not as good at conveying precise information, it can be useful to facilitate heart-to-heart communication.

3.3 Pictogram Creation Activity

We conducted pictogram activities to investigate the feasibility of pictogram communication in the context of Pangaea Activities. The subjects were approximately fifty Japanese students nine to fifteen years of age. They drew pictograms on paper about prescribed themes, while the drawing process was overseen by Pangaea staff.

Their drawings expressed concrete images such as pictures and included more information by having more colors and lines than existing pictograms and symbols, in which redundancy is eliminated through simple design. While drawing, subjects started to show curiosity in the pictograms of the people around them as they began to

ask each other, "What do you think this pictogram means?" Amongst themselves, they answered correctly more than 60% of the time, implying that more than 60% of the content of the pictograms was readily conveyable to other people. Furthermore, if they were allowed to guess thrice, the percentage of correct answers rose to 85%. When the children combined more than two pictograms to compose a message, we observed that the correct comprehension of the individual pictograms increased.

Also, we observed that some subjects did not like drawing and that they were not interested in drawing pictograms. However, most of them were interested in seeing each other's pictograms. For example, an eleven year old girl commented that she enjoyed pictographic communication much more than text communication. And a thirteen year old boy commented that he would like to communicate with pictograms as he cannot master all of the languages in the world.

3.4 Lessons Learned

As a result of field testing the use of pictograms to convey meaning among children, we decided to go forward with our plan to use pictograms as the main vehicle of communication in subsequent Pangaea Activities. Though the correct answer rate of pictogram interpretation was high, when we asked a professional book editor to join the activity as a facilitator, the pictograms that he drew were incomprehensible to the children, although the pictograms were carefully and precisely drawn. The opposite also held: some facilitators and staff had trouble understanding the meaning of the children's pictograms, while the children amongst themselves had much less difficulty understanding what they drew. It is plausible that this is due to the fact that the children are of a younger generation which differs in its ideology and depth of expression from that of the facilitators.

Some people argue that we should have conducted in-depth quantitative testing concerning the feasibility of pictogram communication. Pangaea has an on-going implementation fields almost every week so that we should provide a practical quick and reasonable solution. Based on qualitative observation and comments from children in Japan and some in Austria and Kenya, we had to take into account that there are children who are not good at drawing pictures and that visual representation of pictogram designs depends on cultural or social background [10, 11]. To deal with children who were not good at drawing, we decided to form a pictogram design team to make a standard pictogram set. To deal with social and cultural differences which caused unintended interpretation of some pictograms, we used an online pictogram survey to analyze the role that cultural differences plays in the interpretation of pictograms, as well as to determine which kinds of pictograms were more susceptible to misinterpretation than others.

4 Case2: Pictogram Message Rule

In this chapter, we discuss our decision to give more freedom of expression to children by allowing them to form pictographic text laid out both horizontally and vertically.

4.1 Motivation

After we decided to use pictograms as the communication method in Pangaea Activities, we started to develop a pictogram communication platform on a computer. We designed the overall system architecture, the back-end systems including the pictogram dictionary database and user management. In designing the user interface, one of the most important decisions made was the layout of the pictogram message pane. We had to decide how pictograms were to be laid out on the pictogram message pane. To that end, we had to learn how children compose pictogram messages. In addition, we had to consider if we needed to establish rules such as a grammar for pictogram communication.

4.2 Preliminary Survey

We conducted preliminary survey on the layouts of existing pictogram systems. We surveyed the pictogram systems in cell phones, emoticons, PIC, Blissymbolics, and ASCII Art. We found that cell phones, emoticons, and PIC employ text-editor style layouts. Blissymbolics defines a specific grammar which includes overlapping individual symbols to express new meanings. And a reconstruction idea of Blissymbolics was proposed which provides communication software with GUI [4]. ASCII Art is drawn on a multi-line text field; while some people include it in their email signatures, others use them on newsgroups and bulletin boards.

4.3 Pictogram Message Activity

We found that most editing layouts employ a text-editor style. This style is easier and simpler to develop and implement because the system doesn't need to retain the location data (coordinates) of each pictogram. However, some input methods displayed a canvas-style or extended text-editor style such as ASCII Art. The canvas style gives users the freedom of message composition compared to the text-editor style. And this freedom might induce creative and fun element of message composition and message interpretation for children. Therefore, we decided to introduce the pictogram message activity as a Pangaea Activity in order to observe how children compose pictogram messages, which would serve as a basis for deciding the layout of the interface of the pictogram messaging system. The test subjects were Japanese participants between nine and sixteen years of age. They composed pictogram messages on paper according to prescribed topics. The topics were varied and included "a memory from summer vacation," "a favorite story", "commenting and inquiring about overseas participants pictured in a Pangaea video letter" and also "making comments to the authors of animations created by overseas teenagers." Subjects composed pictogram messages by mounting Post-its (sticky) of their original pictogram designs and/or printed pictogram-cards designed by Pangaea on A3 or A4 paper. Both horizontal layouts and two-dimensional layouts were observed. In the horizontal layout case, pictograms were laid out horizontally in sequence and a new line was started when they have more than two messages, which was a form of the text-editor style.

As for the two-dimensional layout case, some subjects laid out pictograms both horizontally and vertically to indicate spatial relationships between the various

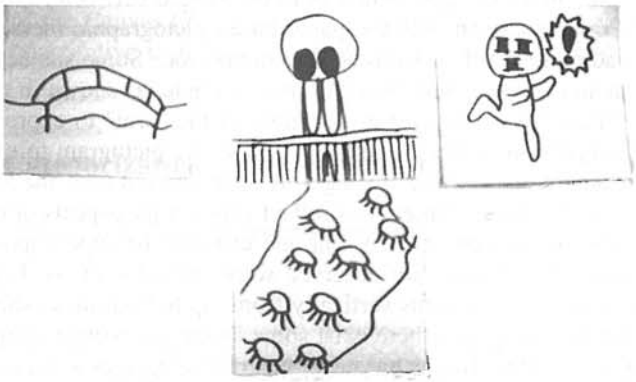

Fig. 2. This is an example of a pictogram message of two-dimensional layout. It means "I was surprised to see smack of jellyfish under a bridge."

concrete and abstract concepts as shown in Fig. 2. We found that pictographic messages with a two-dimensional layout took more time to compose than simply horizontal messages, though the time required also depended on the number of pictograms being used. However, it seemed that the process of thinking through the layout of pictograms in two-dimensions was enjoyable to the subjects and the ones who composed two-dimensional layouts felt like showing the message to other participants willingly. As a result, we decided to implement a Canvas style editor as we believed that a greater variety of creative and fun messages could be made, leading to more positive communication among participants.

4.4 Prototyping

After deciding the message layout style, we started implementing a prototype version of the Communicator, the software for pictographic message exchange. Since the PangaeaNet system was in its design phase, this prototype was implemented as a stand-alone Windows client application using the .Net framework. This prototype allowed users to compose pictographic messages by placing pictograms on the screen using drag-and-drop operations from the pictogram dictionary palette to the Pictogram Message Canvas. In this prototype, users could send and receive pictographic messages as email which is implemented using the SMTP/POP3 protocols. The header pane of the Message Canvas always shows the facial portraits of both sender and recipient to facilitate mutual awareness of the other.

4.5 User Testing

The prototype of the Communicator was introduced as a Pangaea Activity menu, and we observed participants who exchanged pictogram messages internationally by using the software. The subjects were approximately 30 children, aged between eight and seventeen, in Japan and Korea. This Pangaea Activity was carried out with a combination of other Pangaea Activity menus, which facilitates participants to learn about each other by sharing their vital information as well as their daily life.

The pictographic message logs, which were exchanged between Japan and Korea, were reviewed. In comparison with the paper based pictographic messages, the participants appeared more satisfied with the Communicator. Some subjects overlapped some pictograms to express a new meaning. For example, as shown in Fig. 3 right, a pictogram of a "Palm" was put over a pictogram of the "arm" to express "bye-bye." Besides, some subjects used lots of copies of a specific pictogram to express a new meaning. For example, many "tree" pictograms were laid out over the Message Canvas to express "forest." These expressions reflect very unique aspects of utilizing digital images, which can be made transparent and can also be superimposed over any number of images. In addition, we observed some empathic cases. For example, a participant who laid out pictograms vertically from top to bottom, as shown in Fig. 3 left, and said that he knows that there exist some languages written from right to left in the world such as Arabic. But he has never heard of languages written from the bottom up. He would like to show his message to everybody so he laid out pictograms from top to bottom." This subject was aware and considerate of the existence of others who had different languages, cultures, and social backgrounds, which is essential to intercultural collaboration. These observation results and comments convinced us to use a "Canvas-style" layout for the Communicator.

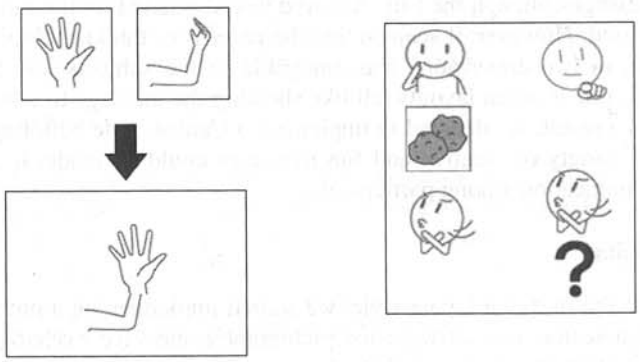

Fig. 3. Left: This is an example of overlapping pictograms. A "Palm" pictogram was put over an "arm" pictogram to express "bye-bye." Right: This is an example of empathic process of composing a message. This participant was aware of the right-to-left languages and laid out pictograms from top to bottom vertically.

4.6 Lessons Learned

We decided to use the Canvas style layout to the message pane of the Communicator based on data gathered from a paper-based activity of pictographic message composition, prototyping the Communicator, and from user experiments. We are still actively getting feedback from users. For example, some users requested that they be able to rotate pictograms freely on the Canvas, and others requested that they be able to scale pictograms freely. We are working on implementing these ideas. On the other hand, research partnerships were established with a number of academic institutions to conduct quantitative usability testing. This testing has already been conducted with

respect to exploring the optimal size of pictograms and the canvas on screen, and the usable shape of the Canvas [7]. By merging results from qualitative observation of Pangaea and quantitative evaluation done by other research, Communicator is continuously evolving.

5 Case3: Categorization of Pictograms

This chapter explains the decisions made when creating the pictogram dictionary.

5.1 Motivation

The prototype version of the Communicator described earlier had a Pictogram palette which showed a list of pictograms. A user could drag a pictogram from the palette and drop it onto the message canvas. However, the Communicator at that time did not have any search capacities such as natural language queries. The pictogram palette only showed 200 pictograms from top to bottom with a vertical scroll bar (Fig. 4). As we were planning to increase the number of pictograms, we realized that it may become more difficult for a user to find a specific pictogram. Therefore, we decided to categorize the pictograms and implement more accessible palette.

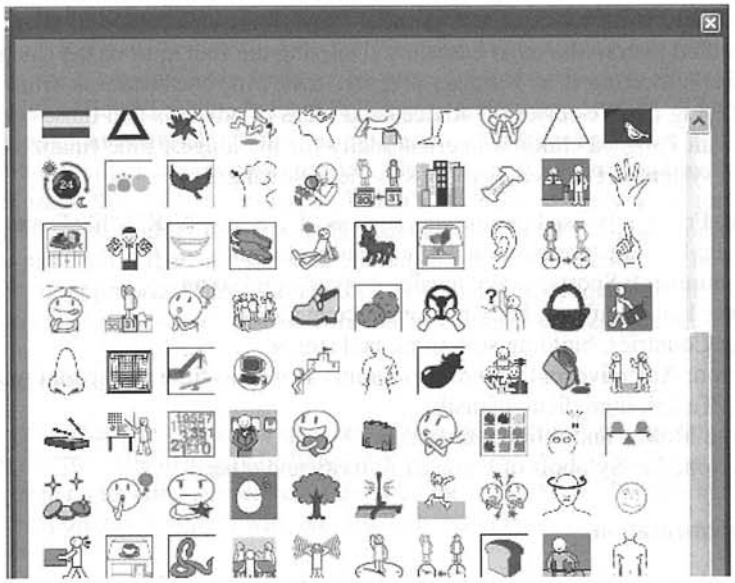

Fig. 4. Pictogram palette of the Communicator prototype

5.2 Preliminary Research of Categorization for Children

First, we surveyed existing classification systems tailored to both general audiences and children with advice from educators, usability researchers, AI researchers, and pictogram designers. We reviewed the aforementioned PIC, portal websites for

children such as Yahoo! Kids, encyclopedias for children, categorization theories in cognitive science as well as classic categorization systems such as the Dewey Decimal system, thesauri, and ontology. This survey showed that a categorization system geared for children should prioritize popular topics among children such as entertainment and food.

5.3 Specifying Categorization

Although by this survey and by listening to advisors, we found abundant references to existing categorization methods, standardized categorization systems did not exactly fit our goals. Therefore, we set out the following guidelines characteristic of an ideal categorization system for children's pictograms:

(1) The categorization system should be defined from a children's point of view.
(2) The number of the primary categorizations should be between five and nine, based on the magical number seven theory [14].
(3) The fact should be kept in mind that a categorization system may depend on culture specific subtleties.

The third directive differs from the first two cases mentioned above in a way that this decision was not between the two choices such as "deciding if pictogram communication works" and "deciding horizontal-layout or two-dimensional-layout." Furthermore, there is no standardized method. Therefore, we decided to take more empirical method than in the other cases, by finalizing the first draft of the categorization system, implementing it at Pangaea activity, reviewing the feedback from children, and modifying it. We reviewed advices and ideas of advisors and those who had interacted with Pangaea children internationally for the longest time finalized the categorization system at Pangaea Activities as the following:

(1) Basic: Frequently-used pictograms such as "I", "you", "OK", "like", and so on
(2) Feeling: Facial expressions and emotional pictograms
(3) Entertainment: Sports, game, music, shopping and so on
(4) People: Family, friend, body part, and occupations
(5) Place: Countries, building structures, and stores
(6) Relation: Adjective and adverb pictograms as well as time and spatial pictograms
(7) Food: Tastes, ingredient, utensils
(8) Action: Motion and action pictograms
(9) Encyclopedia: Symbols of Pangaea Activity and others

5.4 Implementation

We applied this categorization to the pictogram palette of the Communicator as shown in Fig. 5. After completing the design and review process, 450 pictograms were placed on the pictogram palette. Pictograms with a clearly defined relationship, such as "small" and "big" or "brother" and "sister", were placed next to each other. The Communicator was implemented as an Adobe Flash based web application. Not only did we develop the software, we also provided laminated-cards which display a list of pictograms and their categorization.

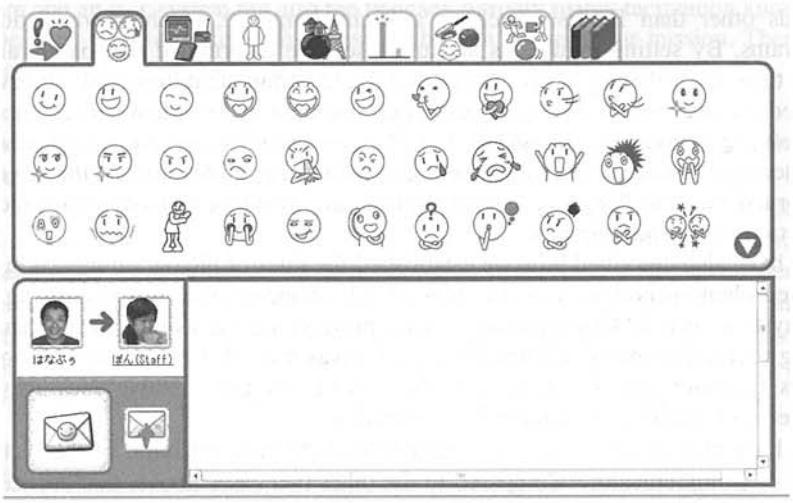

Fig. 5. This is a screenshot of updated Communicator, which consists of the pictogram categories on the top and a message canvas at the bottom. In this particular case, the "Feeling" category is selected.

The Communicator has been used by 120 children in Japan, Korea, Austria, and Kenya during Pangaea Activities. At every Pangaea Activity, we have collected feedback about the Communicator from participating children through feedback forms. We have also collected feedback from facilitators and technical staff. The feedback showed three main points. First, the current palette enables users to see and find pictograms more easily than previous versions. Second, as children spend more time using the program, they become more comfortable with the categorization method, and ultimately better at finding pictograms. Third, categorization of the pictograms helps to identify pictograms that are essential, yet missing from the dictionary. In case users cannot find an appropriate pictogram, we made a pictogram request form with which the user may request new pictograms from the NPO Pangaea R&D center.

5.5 Lessons Learned

We have described the processes of categorizing pictograms and implementing the pictogram palette. The method of categorization is still in the development stage. We also have been conducting academic research on the text search of pictograms, as well as on the categorization system with our research partners.

6 Conclusion

The first case showed the decision making process of selecting pictograms as the shared communication method in Pangaea Activity, which was during the beginning phase of pictogram project.

We have described the process by which we selected pictograms to be the communication method in the Pangaea Activity. We surveyed possible communication

methods other than English, such as artificial language, machine translation and pictograms. By setting guidelines and priorities, we determined that pictograms are better than the other systems. Paper-based pictogram activities and observations revealed the positive feasibility of pictogram communication when participants share common generational traits, tasks such as Pangaea Activity, and curiosity toward others. Therefore, we decided to implement a system using pictograms. At the same time, we learned that the Pangaea Activity reflects an abundance of communication and interaction among participants.

We have also described how we established the rules of pictogram messaging. We surveyed phenomenon such as the rules of cell phone emoticons and existing pictogram system such as Blissymbolics. After prototyping the Communicator and conducting user experiments, we decided on a Canvas style that defines almost no rules. This is because empathic messages along with fun and creative messages were considered essential to intercultural collaboration.

We have also described the reasoning behind the categorization of the pictogram palette of Communicator. Compared to the other two cases above, this decision was the most empirical. This is because, though there were clear differences in each possible solution in the other two cases, as in a multiple-choice question, defining categorization was more of an open-question. Also, we found that a standardized categorization system which exactly fit to our purpose does not exist. Therefore, we gathered ideas and advice from advisors, prioritized the Pangaea participants' point of view, and made up our mind to decide on our own categorization system. In addition, we prepared a feedback form for participants and a Pangaea Activity Report form for facilitators and technical staff. After implementing the Communicator with a categorized pictogram palette, we gathered feedback from Pangaea participants. In fact, our development process was turned out to be an effective and practical UI design method with children according to usability researches [2, 5].

As NPO Pangaea, with limited resources, has on-going field-activities for children worldwide, we have developed and delivered each Activity content and software and have received feedback from participants without forgetting the overall mission of the entire NPO Pangaea operation. Therefore, we evaluate feasibility qualitatively through an empirical approach. At the same time, as described above, we have kept partnerships with academic research institutes to conduct qualitative researches deeply on specific topics such as usability of Communicator and a search system for pictograms [3]. In the middle of our development, the Language Grid Project, started in NICT (Japan). It aims to create a global language platform by connecting language resources, such as machine translation and dictionaries [6, 9]. We developed a partnership and started testing a multilingual system for the communication among international Pangaea facilitator staffs. In the near future, we may utilize this system by combining it with the pictogram communication system. This may lead to further possibilities of future communication in intercultural collaboration.

This is on-going project. As we have tested with the Japanese and Korean children, as well as some Austrian and Kenyan children, we should observe more users' interaction cases among various cultures and refine the user interface as well as pictogram design. One of the most important practices of ours is that we have developed not only

software and an ICT system but also the Pangaea Activity menu, facilitation know-how, and operation flow to make the most use of them in pursuing our mission. These non-ICT elements are indispensable in implementing the Universal Playground.

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