To Use PYA Tool or Not for Learning Japanese Hand Alphabets

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ABSTRACT

We are developing an easy-to-use edutainment system: Practice! YUBIMOJI AIUEO (PYA). The objective is to promote basic expressions of Kana characters (AIUEO) of Japanese hand alphabets (YUBIMOJI) to ordinary children at elementary school age. PYA seems to work well from users’ behaviors and responses, however, the effectiveness has not been fully confirmed, so far. In this paper, we have carried out series of intensive experiments at Sumiyoshi Elementary School (7 or 8 years old; 83 subjects). The results are summarized as follows: 1) Devices the children use to learn do not affect the performance just after the study; 2) the PC use is effective when the target characters are complex and similar; and 3) The PC users keep remembering difficult shapes of characters after one month. These results have suggested that the use of PCs is superior to the ordinary oral lectures, however, it depends on the features of characters.

Categories and Subject Descriptors

H.5.2 [Information interfaces and presentation]: Graphical User Interface, Interaction Styles,

General Terms Human Factors


1. INTRODUCTION

Edutainment systems must provide users with fun and knowledge. Practice! YUBIMOJI AIUEO (PYA) is an edutainment system aiming at promoting basic expressions of Kana characters (AIUEO) of Japanese hand alphabets (YUBIMOJI) to children at elementary school age. Unlike other systems handling hand characters and sign languages, PYA is used by ordinary children without any hearing inabilities, because, in order to communicate hearing-impaired people, they should learn the basic expressions about the Japanese hand language system.

We believe PYA is a wonderful edutainment system [3],[7],[8]. However, so far, we have not succeeded in convincing that PYA is successful from rigorous manners: fine tuned experiment plans, simple but clear statistical analyses, and good results. In this paper, we report how PYA is good in edutainment objectives based on the series of experiments at classrooms of Sumiyoshi Elementary School, in Kobe, Japan. Although it is difficult to carry out experiments with small children less than 10 years old [1], the subjects of the experiments are 7 or 8 years old, because we would like to uncover the roles of the attractive visual interface of PYA through small children.

The rest of the paper is organized as follows: In section 2, we discuss the issues and principles of PYA. Section 3 describes how PYA works. In Section 4, we explain the experiment plans and in Section 5, we give experimental results and discussions. Finally, in Section 6, conclusions and future plans will follow.

2. ISSUES OF HAND LANGUAGE

LEARNING SYSTEMS AND PRINCIPLES

OF PYA

A hand language and hand alphabets are major tools to communicate among hearing-impaired and ordinary people. The forms of hand shapes of a hand language or sign language represent words or group of words of a given language, however, the forms of hand alphabets represent only characters. Hand alphabets are used as a media to speak their proper names or new concepts. Therefore, hand alphabets are more basic concepts for ordinary people to communicate with hearing impaired people. It is worth learning them even for school children.

Although the rapid development of computer technologies, until recently, the research on studying computer supports for hand languages or hand characters has not been a popular topic. Most of the current support systems focus on highly motivated users and/or hearing-impaired people themselves, therefore, they have a lot of sophisticated functions. Their digital contents are usually manipulated via keyboards and/or menus from the equipped dictionary keyed by specified words or verbs. Some systems display continuous animation images to display the contents. They often emphasize the importance of both the amount of contents and query processing functions.

For example, studies reported in [2], [5] or [9] emphasize on the network communication functionality to use hand language systems. Mimehand or Mimehand II system in [6] utilize language representation movement of animated agents, which also requires
very complex implementation. In S-Tel [10], they have implemented avatar type characters to transmit the representation of the hand language.

They often emphasize the importance of both the amount of contents and query processing functions. Such functions are adequate for motivated and advanced users, however, the beginners are very hard to understand the language system. Contrary to such conventional learning support systems, we would like to motivate, introduce, and promote ordinary people, especially elementary school pupils, to learn the Japanese hand language system. As the first stage of the education, we only focus on the Japanese Kana characters. The system must run on a personal computer without any additional special-purpose equipments. In the practical educational environments for the handicapped people, they really require the integration of ordinary Kana characters, finger shapes of the hand characters, corresponding mouth forms, and sounds. Especially, the forms of the hand characters must be understood by the standpoints of both speakers and listeners. We often forget the forms are in the opposite relations from the both sides. The same requirements also hold to PYA [7],[8].

Based on the discussion, the principles of PYA are summarized as follows:
(1) Visual representation of the characters from both sides of speakers and listeners;
(2) Simultaneous displays of the corresponding Kana characters, finger shapes, mouth forms, and sounds;
(3) Integration of finger shapes, sounding faces, and the corresponding animations;
(4) Animated graphics of the finger movement; and
(5) Explanation of the origin of the finger shapes of the characters.

3. HOW PYA WORKS
Implementing the five principles in the previous section, PYA works as shown in Figure 1 as reported in [3], [7]. The integrated look-and-feel visual interface supports the learning of the very beginners. A user is only required to point the display icons with a mouse or finger touch (if the PC is equipped with a touch screen).

The first display in Figure 1 is the main entry of PYA, which shows all the Kana characters and three kind shift icons. The characters are placed on the matrix form: each raw and column contains the same kind of characters. For example, the first row contains the characters corresponding to English letters: ‘W’, ‘R’, ‘Y’, ‘M’, ‘H’, ‘N’, ‘T’, ‘S’, ‘K’, and ‘A’ from the left to the right. The most right column contains the characters corresponding to English letters: ‘A’, ‘I’, ‘U’, ‘E’, and ‘O’. The name of PYA is taken from the column, which means the first five characters or very beginning phase of the edutainment. Each Kana character is an entry to show the corresponding Japanese hand characters.

The second display is shown when a user points the mouse to the place ‘A’. According to the user selection, the character images are moving as if they are rubber banded. These small movements of neighborhood characters suggest that ‘A’ is pointed by a user, then PYA automatically shows the third display for the detailed information.

The girl appeared in the third display pronounces the sound of ‘A’. At the same time, she shows the corresponding finger shape with appropriate movement. The center finger form represents the character from a listener, and the bigger finger form corresponds to the one from a speaker. This simultaneous finger form enables a user to easily understand the correct form of ‘A’. These displays are designed based on the principles of (1) through (4) in Section 2.

If there are hints about the origin of the finger shape, the puppy waggles its tail. Each character has a visual animated explanation about its origin, which is activated by pointing the puppy icon; The information on the specified finger character is shown to the user with the corresponding Kana character, finger shape, mouth forms, and sounds simultaneously. When the user points the puppy figure, then, the fourth display will appear to explain how the form is determined. In this example, the hint states that the hand alphabet ‘A’ comes from the form of the corresponding English letter.

In such a manner, even very young children are able to use PYA without any manual description nor help messages.

Figure 1. How PYA Works
4. EXPERIMENT PLANS OF PYA AT AN ELEMENTARY SCHOOL

We have carried out series of lectures and exercise with 90 minutes and performance tests as practical experiments at Sumiyoshi Elementary School in Kobe City, Japan. The experiments consist of three kinds of controlled oral lectures, a practice with PYA, and performance tests just after the lectures, one week later, and two months later. The oral lecture was given by the first author, who is an expert of lectures to hearing-impaired students at Tsukuba University of Technology. She has much experience on the lectures of information technology and design courses.

4.1 Experimental Setup

The 83 school children with 7 or 8 years old at the second grade of the elementary school are selected as the subjects of the experiments. The experiments have been conducted for three days: December 1, 2005, December 12, 2005, and February 14, 2006. The subjects are divided into the three groups (Groups A, B, and C) with the same number of children. The overall experiment plans are shown in Figure 2. The experiments consist of oral lectures with/without personal computers, PYA exercises, and performance tests. We design the series of experiments so that we evaluate 1) how easily they use PYA, 2) how well they understand the hand alphabets, 3) how they feel the use of PYA, and 4) how they memorize the character shapes for the future applications.

Figure 2. Experimental Plans

4.2 Description of the Performance Tests

During the experiments, we have carried out performance tests for four times in order to evaluate how the subjects learn and memorize Japanese hand alphabets. The first and second tests have been given on December 1, the third test have been carried out on December 12, and the forth test have been given on February 14.

Figure 3 displays the questionnaire form for the performance tests. The form is designed to easily answer by very young school children. These are designed based on the CHI handbook principles [1], [4]. Finger shapes appeared in the sheet with the check mark are the same ones used in both the lectures and PYA displays. Face shape grade marks are used to decrease the difficulty to answer. Free comments column are also designed to acquire text information to be analyzed.

Figure 4 shows the organizations of the problems given at the first, second, and third performance tests. The subjects are required to answer the meanings of the finger forms from three candidates. The test problems are designed to judge the difficulties of the finger shapes: In the first test (resp., the second test), (1) ‘a’ and ‘ki’ (resp., ‘o’, and ‘ha’) are easy to understand, (2) ‘u’ and ‘to’ (resp., ‘na’ and ‘ni’) are little difficult because they tend to confuse the finger faces and/or directions when they use two fingers to represent them, and (3) ‘si’, ‘ru’, and ‘su’ (resp., ‘wa’, ‘yu’, ‘ma’, and ‘mi’) are difficult because they must discriminate the finger faces and/or directions represented by three fingers.

The third test contains all the problems.
4.3 Design of Experiments
The first day experiments contain a fifty minutes oral lecture, two performance tests, and a fifty minutes PYA exercise. Group A children are given an oral lecture with a PC projector for displaying PYA and without personal computers. We give Group B children an oral lecture only with a paper sheet of the characters and without personal computers.

On the other hand, In Group C, A personal computer with PYA is given to every couple of children when they have an oral lecture. After oral lectures, they are given the same performance test problems. After the lectures, the children are allowed to freely use PYA for fifty minutes to self learn the hand alphabets. Then the second performance tests are given.

![Figure 3. Summary of Performance Test Problems](image)

Periods among the first, second, and third experiments, the hand alphabet sheet is given to the subjects in Group A and B in order to freely refer to the Japanese hand alphabets. The sheet is not given to the subjects in Group C. All subjects are allowed to use PYA on a personal computer in a classroom. We have allowed every subject to use PYA after the first test, because we are required from supervisors of the elementary school to give children equal chances to enjoy PYA edutainment system. This might cause the experiments unclear, however, we must follow the requirements.

Third tests have been given twelve days after the lectures. The test contains the problems already given in the first and second tests to specify the finger shapes mean. During the periods between the lectures and third tests, we do not control the subjects. Some of them use PYA and the others not.

The Forth tests are conducted about two months after the lectures. In the last test, the subjects are required to answer the questions shown in a demo video, in which the teacher show the finger shapes same in the previous tests and new two characters. The video contains the questions about specific characters and two typical persons’ names in Japanese. This is a very practical one to uncover how the children keep their understanding about Japanese hand alphabet system.

![Figure 4. Paper Sheet of Hand Characters Used in the Experiments](image)

5. RESULTS AND DISCUSSION
This section explains the results of the experiments and related discussions. The analyses consist of quantitative statistical tests and qualitative ones using text mining techniques. In the following, first we describe some of experiment snapshots, then statistical and text analysis to uncover the performance of PYA and the corresponding hand alphabet learning method.

5.1 Snapshots of the Experiments
The main differences among the series of the experiments are that the first lecture is to motivate school children in a different way and that the performance tests are to evaluate the recall of the first lecture. Thus, typical photos are displayed in the subsection. Snapshots of the first experiments are shown in the Figures 5, 6, and 7.

In Figure 5, one subject has made his own memo referring the projector screen, because he has not had any information on the finger shapes during the oral lecture. In Figure 6, during the oral lecture, the subjects are trying to communicate each other using the information given in the finger form sheet. Figure 7 depicts the pair-wise discussions during the oral lecture using PYA.
The first author gives brief explanations with entertainment flavors on Japanese sign language and the hand alphabet system: why it is necessary, how it is important for both hearing-impaired and ordinary people. The explanation attracts the subjects very much. During the first experiment, the very young subjects tend to be exciting against the new experience on Japanese hand alphabet system. From pedagogical point of view, the issue is how to keep their interests and motivations for a long time.

### 5.2 Analyses of the Experiments

#### 5.2.1 Summary of the Performance Tests

Figures 8, 9, and 10 summarize the ratio of correct answers of each character. Figure 8 (resp., 9, 10) contains the results of the first and the second tests (resp., third and forth). There observed some differences among the former three tests, however, statistically no significance differences in total. This means that the three teaching methods show no significance in total. As described elsewhere (e.g., in [4]), just after the any kinds of lectures, every subject will have some good understanding of the lecture topics. However, there is a statistical significance between Tests 1, 2, 3 and Test 4. The results will be discussed in the following.

![Figure 8. Results of Tests 1 and 2.](image)

![Figure 9. Results of Test 3](image)

![Figure 10. Results of Test 4](image)
5.2.2 Differences of Teaching Methods

To evaluate the difference of the three teaching methods in Groups A, B, and C. Using the data of Test 1 and Test 2, we have selected difficult characters with three fingers, which the subjects must understand the difference of finger faces and directions to answer. We have applied ANOVA test to evaluate the difference. The results from ANOVA test is in Table 1. In the table, A1, A2, and A3 respectively mean the teaching methods of Group A, B, and C. The difference is not so remarkable, however, in a statistical analytic sense; the results have suggested that the use of a PC with PYA is a little superior to the lecture only using a projector without PYA.

Table 1. Statistical Analysis of Teaching Methods

<table>
<thead>
<tr>
<th>A1 test</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38</td>
<td>4.3684</td>
<td>1.2653</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
<td>4.8421</td>
<td>1.1591</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>5.1892</td>
<td>1.0613</td>
</tr>
</tbody>
</table>

== Analysis of Variance ==

<table>
<thead>
<tr>
<th>S.V</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.7482</td>
<td>2</td>
<td>6.3741</td>
<td>4.57 *</td>
</tr>
<tr>
<td>Sub</td>
<td>153.5704</td>
<td>110</td>
<td>1.3961</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>166.3186</td>
<td>112</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

== Multiple Comparisons by LSD ==

(MSe= 1.3961, * p<.05)

A1 = A2 n.s. (LSD= 0.5422)
A1 < A3 * (LSD= 0.5458)
A2 = A3 n.s. (LSD= 0.5458)

5.2.3 Difference of Teaching Methods and Recalls

Table 2. Statistical Analysis of Recall

<table>
<thead>
<tr>
<th>A1 test</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>37</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>36</td>
<td>3</td>
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</tr>
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== Analysis of Variance ==

<table>
<thead>
<tr>
<th>S.V</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>137.592</td>
<td>2</td>
<td>68.7964</td>
<td>8.51 **</td>
</tr>
<tr>
<td>Sub</td>
<td>162.7386</td>
<td>112</td>
<td>1.4653</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>300.3308</td>
<td>114</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

== Multiple Comparisons by LSD ==

(MSe= 1.4653, * p<.05)

A1 = A2 n.s. (LSD= 1.0607)
A1 < A3 * (LSD= 1.2477)
A2 = A3 n.s. (LSD= 1.2477)

5.3 Discussion

From the experimental results in the previous subsections, the lessons learned from PYA use are summarized as follows:

1) Although we have not encouraged the subjects to use the pappy’s hints, the display of hints are effective for them to discuss the origin of the characters. Such comforted information is essential for an edutainment system.

2) The repeated performance tests with several time periods are beneficial to evaluate edutainment systems, although previous work on PYA experiments has not made the performance of subjects statistically clear [7],[8]. Usually younger children tend to learn and forget new pedagogical materials very soon, however, learning with PYA keeps their interests and learned materials in their mind.

3) An easy-to-use visual interface in an edutainment system for very young children lets them spontaneously communicate each other, although PYA is designed for rather individual learning objectives. This suggests that simple but attractive interfaces of edutainment system would help group learning without any supervisors.

4) the PYA design principles on an easy-to-use visual interface and attractive hints should be intrinsic to future edutainment systems especially for very young school children, who are not good at using PCs or working together.

6. CONCLUDING REMARKS

This paper has described the series of experiments to uncover the performance of PYA: an edutainment system for Japanese hand alphabet learning for school children. We have demonstrated the effectiveness of PYA, which enables very beginners of hand language systems. The conclusions are 1) even if the users do not like personal computers, they can use PYA and keep their interests, 2) PYA users keep the understanding about the hand A2, and A3 respectively mean the results of performance test of Group A, B, and C. This suggests that the use of PYA with a personal computer is clearly superior to the other methods, so that users with PYA can keep their interests in hand alphabets.

The results are also confirmed by the questionnaire data to answer the interests and group works. Subjects with PYA tend to learn the work with them selves and they lesser require works with their friends. This is very characteristic about PC-based learning assistances.

5.2.4 Analyses of Free Answers

Using the free description about the hand alphabet system, we have analyzed the characteristics of the groups. We have utilized significant keyword extraction system for Japanese language [11],[12]. The text mining method is effective to analyze qualitative descriptions of the questionnaire.

All the subjects (1) like to learn more about hand alphabets and/or sign languages, (2) know about the character shapes from the puppy hints, and (3) like to speak to hearing-impaired persons. Furthermore, the results also uncover the tendency that (4) Groups A children like to study the materials with more number of people, because they have too little information for the work that PYA has provided; (5) Group B children tend to loose their interests so fast, and (6) Group C children like PC-based systems and keep the interests in the work.
alphabets longer, 3) they love the puppy hints and they are affective, and 4) they can memorize the character shapes. In one sentence: to use PYA is definitive.

The future work related with the research is to develop a new learning course at elementary schools, in which school children systematically learn Japanese finger language system using PYA and non-expert teachers are able to guide the learning process. Further development of new materials for ordinary school children with hearing impaired people is a big challenge for future edutainment research.

7. ACKNOWLEDGEMENTS

The authors are grateful for the assistance of Ms. Kuroda, Mr. Yamashita, and Mr. Ichiwara, teachers at Sumiyoshi Elementary School. The research is supported in part by a Grant-in-Aid of Scientific Research (Number: 15300283) of the Ministry of Education, Science, Sports, and Culture of Japan.

8. REFERENCES