

Redesigning the User Interface of Handwriting Recognition System for Preschool Children

Nur Sukinah Aziz
Kolej Universiti TATi (TATiUC)
Faculty of Computer, Media, and Technology
Jalan Panchor, Teluk Kalong,
Kemaman, Terengganu
E-mail : nursukinah@tatiuc.edu.my

Mohd Nizam Saad^a
Abd. Hadi Abd. Razak^b
Azman Yasin^c
College of Arts and Sciences
Universiti Utara Malaysia, Sintok,
Kedah, Malaysia
Email: ^anizam@uum.edu.my, ^bahadiar@uum.edu.my,
^cyazman@uum.edu.my

Abstract— Nowadays there are handwriting recognition systems that can be occupied to assist children learning how to write properly. However, one of the major barriers that hinders them using the system is its complex user interface where the designed is based on adult preferences. Therefore in this paper, we present the guideline to redesign the user interfaces via our experience developing a handwriting recognition system for pre-school children named Handwriting-based Learning Number (HLN). The redesign process has followed eight guidelines and rules as presented by Schniederman. The user interface satisfaction evaluation result done using Questionnaire for User Interface Satisfaction (QUIS) is very convincing where the users are almost satisfied with the redesign process that we did to the user interface. Hence we found that the guidelines are very useful and developers are all welcome to follow it if they intend to do similar system like us.

Keywords - User interface redesign; Handwriting recognition system; Preschool children learning, Questionnaire for User Interface Satisfaction.

I. INTRODUCTION

A preschool children learning curve normally starts with writing, reading, and calculating simple numbers. As they growing older, they will be taught with more advance skill to master these three basics knowledge. Once they manage to get along with the learning tempo, these children are all ready to face with more challenging subject which required additional cognitive understanding. Hence, the early stage of learning how to learn especially learning literacy is crucial for these children.

Learning to write is one of the most-essential skills children will ever learn. Typing on the keyboard is obviously a very useful skill but writing by hand is more important especially for preschool children [1]. This is because writing can develop sensorimotor and it must develop in the early aged. Research shows that in the most United Kingdom classroom, children spend between 30 % and 60 % of their school classroom time doing writing activities [2]. This is done due to the handwriting process needs attention, memory and cognition, and the motor skills.

All these elements must be blended together so that the children are able write properly.

The development of writing ability is not only important in building a child's self-esteem, but is considered an essential ingredient for success in school. This is due to handwriting performance has direct effect on academic performance [3, 4].

Illegible handwriting can create a barrier to accomplishing other higher-order skills such as spelling and story composition. Moreover, academic performance studies performed by [3] showed that those who have handwriting problem such as poor handwritten and slow to write words are causally difficult to form sentences, have limited vocabularies, and cannot writing a full sentence or paragraph. They also added that these children also will face complexity in mathematics where doing the math exercise seems to be a burden job for them. As a result, they are unable to score well in their examination.

In this paper we are going to share our experience on designing the user interface for the handwriting recognition system that we developed to assist preschool children learning how to write. The handwriting recognition system that we developed is called Handwriting-based Learning Number (HLN). Having a good user interface is essential for our system since it can ease the interaction processes between the children and the system. It is a challenging task since it involves children as the user which their behavior on using the computer sometime is difficult to expect. Handwriting recognition system is a system that automated process of turning handwriting work into a computer readable form [5]. When the handwriting is in the form of binaries, the computer able recognize them and this can ease the process of giving feedback to the children especially on how to improve their handwriting. We believed that by having the system, the children can boost up their time to learn how to write since the system can assist them whenever they learn. Additionally, we are concentrating on the offline handwriting recognition system. Off-line handwriting recognition involves the automatic conversion of text in an image into letter codes which are usable within computer and text-processing applications [6]. Most of the

time, the central tasks in off-line handwriting recognition are character recognition and word recognition.

This paper is divided into six sections; we start with the introduction as the first section. Section II will describe about the challenges the preschool children face to use the system. Meanwhile Section III talks about the guideline for user interface design for children. Section IV is about the HLN development which is the prototype system. Afterward, Section V will show the analysis that we did based on data gathered using QUIS (Questionnaire for User Interface Satisfaction) questionnaire. Finally we provide the conclusion for the paper.

II. CHALLENGES FACED BY PRE-SCHOOL CHILDREN ON USING THE HANDWRITING RECOGNITION SYSTEM.

In Malaysia, the preschool education is an informal program which is mainly established to provide the learning experience to children whose age between four to six years old. It is an early preparation before they enter the first grade in a formal school. Currently, the preschool education has already been instituted into the National Education System so that it can enhance the child's potential in all aspect as well as a good preparation before entering the school. As academicians, we want to contribute our expertise to help the preschool children education especially learning literacy. In order to do so, we create a handwriting recognition system as one of the tool that can we believe can help preschool children learning literacy faster.

When we first develop the system, we try to replicate the user interface with some of the existing handwriting system available. Although most the system is good in recognizing the handwriting, we found that the user interface is mainly design for adult. From our point of view, the children might have difficulties using the system since their mental model is different. The interaction process for them might not be as good as giving the system to adult. Our assumption is parallel with the work done by [7], where there is evidence that some children had poor understanding of what happening in the handwriting recognition system (in the study they use a software named Paragraph Pen Office 6) although they used it for months.

Secondly, most children want content that is entertaining, funny, colorful, and uses multimedia effects [8]. We found out that most the user interface for existing handwriting recognition system is too complex for the children. The system only emphasize on the complexity of the processing algorithms and the invisibility of the recognition process[5].

It is very rare to find handwriting recognition system that embedded with such entertaining features to attract children to use them. The condition might make the children to feel less attractive hence prevent them from using the system longer.

On the other hand, existing handwriting recognition system interface also does not consider on how children use the system in term of browsing, spelling, navigating, and using input devices. This is one of the three problems stated by [9] faced by children on searching and browsing the information in a system apart from limited motor skill, and inadequate knowledge criteria. The pre-school children knowledge and skills are not as good as adult since they are less experience using the system. Moreover, their cognitive way of thinking is also different that adult. Therefore they need a better user interface that can assist them using the system properly.

Based on the challenges mentioned, we strongly believe that the children will face with difficulties if we adopt the similar interface into our system, hence the need for new interface design is crucial for our handwriting recognition system.

III. USER INTERFACE GUIDELINES FOR DEVELOPING HANDWRITING RECOGNITION SYSTEM FOR PRE-SCHOOL CHILDREN

There are several researchers who have published excellent user interface guidelines for children so that other researchers can use them to conduct research. Among of them are [5],[8],[10],[11],[12] and [13]. They have provided a good path for the next researchers to do research especially on designing a good user interface for systems targeted to children. For the sake of this study, we adapted general interface design rules, presented by Schniederman. According to [5] Schniederman's general interface design rules include:

- Strive for consistency
- Enable frequent users to use shortcuts
- Offer informative feedback
- Design dialogues to yield closure
- Offer error prevention and simple error handling
- Permit easy reversal of actions
- Support internal locus of control
- Reduce short term memory load

The illustration for the guideline published can be referred in Fig. 1.

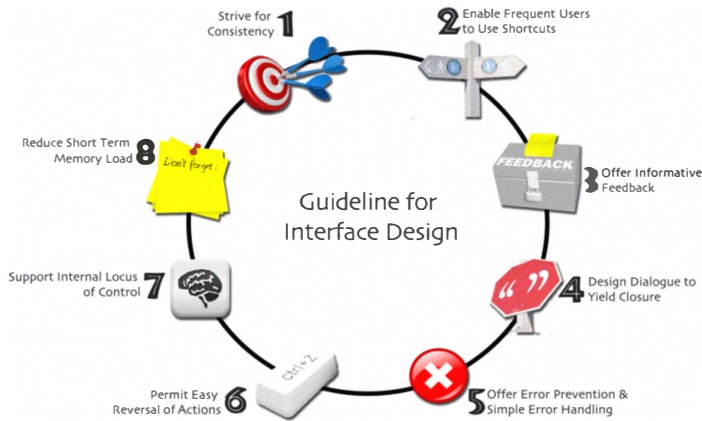


Fig. 1. Illustration for the guideline to design the user interface for children.

[5] also added that these rules are suitable to be adapted not only for ordinary type of system, but beyond than that, they are also suit when designing the user interface for children. Hence, we have followed the rules to design the user interface for our handwriting recognition system. We are also recommending readers who are interested to know further on the rules to read the book from the mention author for more detail.

IV. HLN DEVELOPMENT

Based on the guidelines and rules that identified, we started our work on developing the HLN. HLN is a handwriting recognition system developed mainly for preschool children. The language that we use for the system is Malay language. We choose Rapid Application Development (RAD) as the methodology for our system development. The RAD is a system development approach encouraging and facilitating re-use of software components [14]. It incorporates prototyping and user feedback as its main mechanisms. We divide the development phase into four stages. The first phase is analysis requirement. This phase defines the functions and data subject areas that the system will support and it also determines the system’s scope. We observed and interview the preschool children to get their opinion in the user interface design. Analysis for the interface of the existing handwriting recognition system such as CobWeb, Note Materials, Maths Materials and Kanji Practice Materials is also done to determine the benefits and weakness of the interface and the new system requirements.

After the requirements have been identified, the second phase is to start designing the interface. This design process is to determine the structure of the HLN and also known as the Functional Design Stage. We start the process by making the screen design using storyboarding approach. All design rules are taken seriously to get the most best design for the system. This screen design will determine the layout and element that should be included in the screen of the

system. Its include layout for text, animation, background and icon that use in HLN.

Once the design complete, we move on to the development stage. We start the development by making the prototype. When initial prototype is completed, the interview process with the children is still keep on going so that we can gather additional, more detailed requirements from them. Once we get the modified set of requirements, prototype will be updated to reflect the new set of requirements. For the HLN prototype, we used Microsoft Visual Basic as programming language to develop the recognition engine for the system. We choose Microsoft Visual Basic since it enables event-driven programming and it is very easy to use them for developing the system.

Although Microsoft Visual Basic is good for developing the recognition engine, we encountered that one of its drawback is it cannot fulfill the type of interface that we want. It has limited functions that enable us to create the system which contains entertaining features as what the children want. Hence to make the user interface more attractive, we use Macromedia Flash MX. Macromedia Flash is well known software that enables its user to create a catchy animation. The user interface of the system is in the shockwave file format. By using the software we can create dozens of the graphical element, animation, audio recording and embedded it in into the system. Our user interface design theme for the handwriting recognition system is learning in an orchard playground. Fig. 2 shows the some screen snapshot of the HLN.



Fig. 2. The HLN’s snapshot

As a brief description of the HLN, it allows the children to enter one number at one time (between 0 to 9) into the box. Since the system is executed in a tablet PC, it allows the children to use either a mouse or a tablet pen. If the children want a real writing experience, we recommend them to use the tablet pen. Hence, they can use in more meaningful way. The written number will be computed by

the recognition engine in order to determine how exact the handwriting with the handwriting pattern (in template form) that we have installed into the system. The similarities will be displayed in the form of percentage value.

Apart from the learning activities, we also included several leisure activities such as simple quizzes and games. By having such features, we believe that it can enable the children to use the system in longer time. Fig. 3 shows the screenshot of the activities screen.

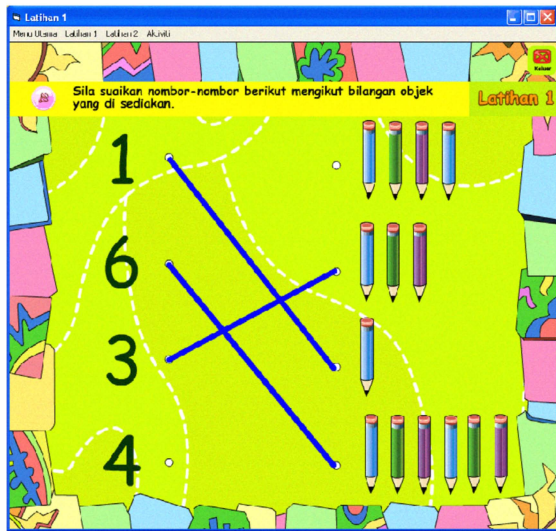


Fig.3. The screen activities in HLN

Finally, we test the prototype using to the children using the QUIS questionnaire. The next section will elaborate our finding.

V. USER SATISFACTION TEST

The evaluation is a very important since it will judge on the outcome of the development. We used the summative evaluation to test the prototype. The HLN user satisfaction evaluation was conducted on thirty children. Each of them was given brief explanation regarding the usage and the user interface of the prototype. Since we adopted the questionnaire without any modification from [15], we captured the children feedback by our own. We would be very please if we have enough time to modify the questionnaire and make it suitable for the children to express what they actually perceived about the system on their own. The QUIS can be accessed from the following website <http://oldwww.acm.org/perlman/question.html>.

The QUIS covers five dimensions which include: *Overall reaction to the software, screen, terminology and system information, learning and system capabilities*. All questions were intended to collect data on each user opinion regarding the HLN prototype. A 10 point scales were used in the questionnaire. Table I summarizes the mean score for the

users' satisfaction that we manage to gather from the users for each dimensions.

TABLE I. THE MEAN SCORE FOR USER SATISFACTION TEST

Item	Mean	Std. Deviation
OVERALL REACTION TO THE SOFTWARE		
This software is wonderful	4.0000	0.64327
This software is easy to use	3.9667	0.66868
This software is satisfying to use	3.5000	0.86103
This software is adequate as needed	3.6333	0.88992
This software is stimulate	3.8667	0.57135
This software is flexible to use	4.0667	0.58329
SCREEN		
Reading characters on the screen is easy	3.9000	0.75886
Highlighting simplifies task	3.9000	0.66176
Organization of information is clear	3.5333	0.62881
Sequence of screens is clear	3.7667	0.56832
SYSTEM INFORMATION		
Use of terms throughout system is consistent	3.5000	0.86103
Terminology always related to task	3.7667	0.50401
Position of messages on screen is consistent	4.0333	0.61495
Prompts for input is clear	3.7667	0.85836
Computer always informs about its progress	3.8000	0.55086
Error messages is helpful	4.0333	0.85029
LEARNING		
Easy to operate the system	3.7667	0.43018
Exploring new features by trial and error	3.8667	0.43417
Remembering names and use of commands	4.0333	0.76489
Performing tasks is straightforward	3.9667	0.61495
Help messages on the screen is helpful	4.0667	0.73968
Supplemental reference materials is clear	3.7667	0.77385
SYSTEM CAPABILITIES		
The system speed is fast	3.9000	.71197
The system is reliable	3.9667	.61495
The system tends to be quite	4.0667	.73968
Easy to correcting your mistakes	3.9667	.80872
Designed for all levels of users	4.0000	.87099

The overall mean score as shown in Table 4.3 indicates that most of the users are almost satisfied using the HLN prototype. The first dimension is about the overall reaction to the software. It include questions such as is the software is wonderful, is it easy to use, is the user satisfy using it, are it adequate as needed, and is it stimulate and flexible to use. The mean score is between 3.5000 and 4.0667. This condition indicated that the users are mostly agreed that they generally satisfied with the HLN prototype. This is because the HLN prototype has music to attract the children to use and the music can turn on or off.

Meanwhile, on the second dimension; screen, the mean score is between 3.5333 and 3.9000. This is also indicating that the user is also almost agreed that the screen has managed to satisfy them using the HLN. We design the

HLN's screen in a simple way yet it is so colorful and suitable for the children.

The third dimension is about system information. For this dimension, the feedback indicate that the mean score is between 3.5000 and 4.0333. This also implies that users were also almost satisfied with the terms of system information HLN.

On the other hand, for the fourth dimension; learning, the mean scores is between 3.7667 and 4.0667. This implies that users felt that the learning process to use the HLN is quite easy and highly satisfied with the system. Finally, the last dimension; system capabilities, the mean score is between 3.9000 and 4.0667. This condition is also implies that the HLN executed via Tablet PC has meet need on using the prototype. Overall, the results indicate that the users is almost agreed that the interface design for HLN prototype is good.

VI. CONCLUSION

In this paper, we presented our experience on developing a handwriting recognition system named HLN that mainly developed for preschool children. At the beginning of the paper we presented our main aim to develop the system, which is to assist the children to learn writing. Later, we discuss that when developing a complex system such as the handwriting recognition system for the children, the user interface plays a big role to ensure that the children can use it easily. If it is taken for granted, the children might face some challenges to use the system. Afterward, we talk about the importance of following a well established design rules and guidelines so that the design process of the system can become successful. We also presented the process of developing the HLN and some brief information about the system description. Finally, we present the result that concluded that the users are almost satisfied with the system.

On the other hand we admit that the HLN is still far from completed. There are several limitations for the prototype such as the prototype is not fully functional due to time constraints in developing the prototype. There are also features that did not implemented to this prototype such as visual and audio as a guidance to recreate the shape of the number whereby user can perform specific learning exercises without the presence of the tutor. For future development and expansion of this research, we can implement the visual and audio guided information to attract the preschool children to use it and enhance user learning by following step by step number formation and hopefully, we can enhance the system to online handwriting recognition.

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