Metaphor and Typeface Based on Children's Sensibilities for e-Learning

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Abstract: Children exhibit different behaviors, skills, and motivations. The main aim of this research was to investigate children's sensibility factors for icons, and to look for the best typeface for application to Web-Based Instruction (WBI) for e-Learning. Three types of icons were used to assess children's sensibilities toward metaphors: text-image, representational, and spatial mapping. Through the factor analysis, we found that children exhibited more diverse reactions to the text-image and representational types of icons than to the spatial mapping type of icons. Children commonly showed higher sensibilities to the aesthetic-factor than to the familiarity-factor or the brevity-factor. In addition, we propose a collaborative-typeface system, which recommends the best typeface for children regarding the readability and aesthetic factor in WBI. Based on these results, we venture some suggestions on icon design and typeface selection for e-Learning.

Keywords: *e-Learning, Sensibility Factor, Metaphor, Typeface, Collaborative Recommending*

1. Introduction

Unlike adults, who typically use the Web for business and for goal-oriented tasks, children often use the Web for entertainment, schoolwork and community-related activities. The principles of menu design for children are as follows [8]:

- Icon: children prefer animated icons
- Color: gender choice
- Typeface: readability
- Interaction style: drag and drop

Children react positively to elements such as animation, sound effects and geographic navigation metaphors (e.g. the pictures of rooms, villages, 3D maps). Also, they are willing to scrub the screen with the mouse, read instructions, and rarely scroll pages [7].

Recently there has been increasing interest in the development of WBI contents for elementary education. WBI requires learners' active participation in learning. Thus, in developing WBI content, the previously mentioned characteristics of children need to be considered in order to help learners to maintain a positive attitude toward learning.

On this point, it is critical to evaluate learners' sensibilities toward icons and to the typeface of instructional contents. In this study, we investigated children's sensibilities toward icons through a factor analysis, and compared them with adults' sensibilities. We also examined which typeface in WBI is the best for children by using a collaborative recommending system.

2. Related Work

Generally, users identify a design model through the interface and the documentation, which are referred to as the "system image" as shown in [15]. A main goal of GUI in WBI design is to develop a system image that maps the designer's model onto the user's model. The effects of using a multimedia program depend on the interaction between the loci of the instructional control of the program and the learner characteristics [4].

This is especially true in programs for elementary schoolchildren, because target users are very young, and there can be a large gap between the characteristics of children and adults (i.e. the instructional designers who design the programs or the teachers who use them) [7]. Such a gap may have a great impact on the instructional effects [9]. In designing programs to reflect learner characteristics, instructional designers should bear in mind that learners' affective characteristics tend to be neglected [1, 3, 6]. Also, among the various affective characteristics of learners, learners' sensibilities should be emphasized; because they have a great influence on one's information-processing activities, sensibilities are recognized as an important factor in understanding human behavior [5]. A user interface can be intuitive, easy to use, and efficient when learners feel positive sensibilities.

Osgood developed the "Semantic-Differential (SD)" method whereby sensibilities are evaluated by plotting the differences between individuals' connotations for words and by mapping the psychological 'distance' between the words [11, 14]. Due to the importance of sensibilities, considerable effort has been devoted in the marketing research sector to analyzing consumers' sensibilities to products and to designing products to satisfy those sensibilities. In developing an educational multimedia program, designers also need to pay attention to learners'

sensibilities. However, unlike the marketing area, few attempts have been made in the education area to investigate design strategies that satisfy users' sensibilities.

Among the metaphors for GUI, icons in particular have become commonplace because they can communicate complex ideas in a simple and efficient manner [2]. In designing icons that reflect learner characteristics, it should be considered that learners perceive visual images through their eyes and then interpret them on their own in the course of the cognitive processes as summarized in [13]. Therefore, children's sensibilities for icons need to be considered important.

Typefaces are also as important as icons in WBI materials. Typefaces existing in GUIs have been developed and disseminated continuously by typeface-makers. Designers want to pick up the best typeface to produce their materials among the many typefaces spread out on the Web. They can select the best from the recommending services, such as Myfonts, Identifont, TypeXplorer, WhatTheFont, etc [16, 17, 18]. However, most of them are for adults' materials. Thus, through this research, we have attempted to design and develop a typeface-recommending system based on children's collaborative readability and sensibilities to children's materials.

3. Characteristics of Icons for Children

The main purpose of this research was to investigate the differences between elementary schoolchildren and adults with regard to their sensibilities toward the icons presented in multimedia programs by looking for the sensibility factors of the icons. The adult group comprised teachers who design or use the programs. We intended to accomplish the following purposes:

1) To investigate the existence of differences between children and teachers in the richness of their sensibilities.

2) To look for children's sensibility factors of icons in multimedia programs.

3.1 Differences between Children and Teachers

In order to assess and compare children's and teachers' invisible sensibilities, the SD method was adopted. 415 children and 95 teachers were randomly selected and asked to write down as many adjectives as they could think of upon seeing the icons selected from 30 educational programs. In order to examine whether there is a difference between children and teachers in the richness of their sensibilities, a comparison was made between the two groups in the number of written adjectives through the T-test.

Table 1. T-test on the number of adjectives

Variable	No.. of Cases	Mean	Std. Dev.	t value	DF	significance
Children	415	8.81	5.02	6.39	174	.0001
Teachers	95	5.82	3.88			

A significant difference was found between the two groups (See Table 1). The average number of children's adjectives was 8.81 and that of teachers' was 5.82. Children showed richer sensibilities than teachers. Furthermore, concerning the deviation of the number of adjectives, the deviation of the children's group was larger than that of the teacher's group. This result indicated that children had more diverse sensibilities than teachers. Therefore, in designing multimedia programs for elementary schoolchildren, children's sensibilities must be taken into account as their sensibilities differ considerably from those of adults'.

3.2 Children's Sensibility Factors for Icons

In order to extract the factors of children's and teachers' sensibilities, the SD method and factor analysis were adopted. The research was conducted in the following sequence: 1) the selection of pairs of adjectives representing sensibilities; 2) the selection of icon samples; 3) the design and development of an online survey system; 4) the conduct of the survey to collect information on sensibilities; and 5) the analysis and comparison of children's and teachers' sensibilities.

First, in order to select pairs of adjectives representing sensibilities, the adjectives collected in the first phase of the research were ordered according to their frequency of use, and matched in pairs in terms of their positive and negative meaning. Icon samples were selected from educational programs recommended by teachers and research institutes. The samples were selected on the basis of 3 types of icons as classified in [10] and [12]. The 3 types are text-image type (text, image, and the combination of text and image), representational type (resemblance, exemplar, symbolic, and arbitrary), and spatial mapping type (diorama image map and peep show image map) as shown in Table 2. Four icons were selected for each subtype, and thus the total number of icons used in the research was 36.

Table 2. Icon samples for each type

Classification	Selected Icon Samples
Text-image Icon	
Representational Icon	
Spatial Mapping Icon	

Then an online survey system was developed with MySQL and PHP. It consisted of two parts: one for the respondents' background information and the other for the evaluation of their sensibilities. The research participants

were randomly selected from elementary schools located in 2 provinces. 775 children and 34 teachers participated in the research.

The survey data were used in extracting sensibility factors. We used the varimax-rotation of factor analysis with SAS. The factors were compared between children and teachers according to the types of icons, and Table 3 shows the results for the three types of icons by children.

Table 3. Factor analysis for three types of icons

Type	Adjectives	Factor 11	Factor 12	Factor 13
Text-Image type	Good	**0.80630**	-0.0238	0.10335
	Pretty	**0.79427**	-0.06283	0.06739
	Interesting	**0.79061**	0.02879	-0.09885
	Cute	**0.78671**	-0.00398	-0.01621
	Nice	**0.72322**	0.01167	0.12394
	Fanciful	**0.6746**	0.24434	-0.07924
	Dull	**-0.50977**	0.39308	0.45428
	Weird	-0.0068	**0.87327**	-0.03076
	Neat	0.37628	-0.0397	**0.77608**
	Complicated	0.35502	0.47165	**-0.51513**
Type	Adjectives	Factor 21	Factor 22	Factor 23
Representational type	Good	**0.80753**	-0.01140	-0.02426
	Pretty	**0.78918**	-0.04362	0.00293
	Cute	**0.76534**	0.06883	-0.05814
	Interesting	**0.72456**	0.13724	-0.22855
	Nice	**0.72033**	0.04823	0.00631
	Fanciful	**0.57885**	0.38642	-0.10197
	Dull	-0.07803	**0.82945**	0.20148
	Complicated	0.23327	**0.6188**	-0.35567
	Weird	-0.38220	0.14684	**0.68163**
	Neat	0.48735	-0.19011	**0.63732**
Type	Adjectives	Factor 31	Factor 32	Factor 3
Spatial Mapping type	Pretty	**0.78562**	-0.08409	-
	Good	**0.77422**	-0.11078	
	Cute	**0.76921**	-0.08372	
	Interesting	**0.76219**	-0.01811	
	Nice	**0.74422**	-0.13057	
	Fanciful	**0.63614**	0.06675	
	Weird	**-0.37850**	0.20991	
	Complicated	0.1181	**0.81171**	
	Dull	-0.10761	**0.71724**	
	Neat	0.45485	**-0.50465**	

Concerning the text-image type of icons and the representational type of icons, the first sensibility factor was related to the adjectives reflecting the aesthetic aspects of sensibilities, such as 'good', 'pretty', 'cute', 'interesting' and 'nice'. The second factor consisted of adjectives of familiarity such as 'weird', and the third factor consisted of adjectives of brevity such as 'neat' and 'complicated'. However, unlike the other two types of icons, only two factors, the aesthetic aspects and the combined aspects of familiarity and brevity, were found for the spatial mapping type of icons. Among the sensibility factors, the aesthetic factor was found to be the most influential factor across all three types of icons. The familiarity and the brevity factors were also found to be influential on children's sensibilities, although the level of influence differed according to the types of icons.

3.3 Children's Preference for Spatial Mapping Icons

The results of the factor analysis on children's and teachers' sensibilities are summarized in Figure 1. We found that teachers showed fewer sensibility factors than children for both the text-image and the representational types of icons. In contrast with this result, teachers showed more sensibility factors than children for the spatial mapping type of icons.
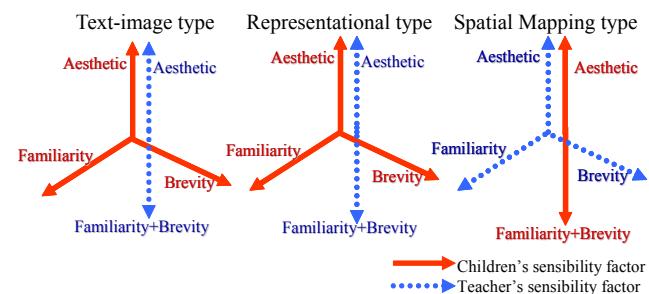

Fig. 1. Factors for the types of icons

Children's sensibilities are limited in comparison with those of the adults for the spatial mapping type of icons. Such a difference may be explained by the Piagetian theory on the cognitive developmental stages of children. It is possible that children may be more curious about the spatial mapping type of icons than teachers, because they recognize them intuitively on lower dimensions of the sensibility factor.

4. Collaboratively Recommended Typefaces

In order to make sure that learners can easily read what teachers have written - whether it is online or in print, typefaces must be considered important. Text on the computer screen is hard to read because of the low resolution of today's computer screens. The typeface for which teachers choose to develop WBI affects not only the readability but also the entertainment value. Many typefaces are developed continuously and rapidly disseminated on the Web. The more typefaces spread out on the Web, the greater the need for a system for recommending typefaces. Teachers want to be able to easily pick out the best typeface available from among the many types to produce their WBI.

So we developed and distributed a typeface-recommending system based on children's collaboration called the TRSCC. It has been designed to automatically survey children's reactions to web-based materials in terms of readability and the aesthetic factor. Thus it collaboratively recommends the best typeface based on readability and sensibilities. Its processing flows are shown in Figure 2.
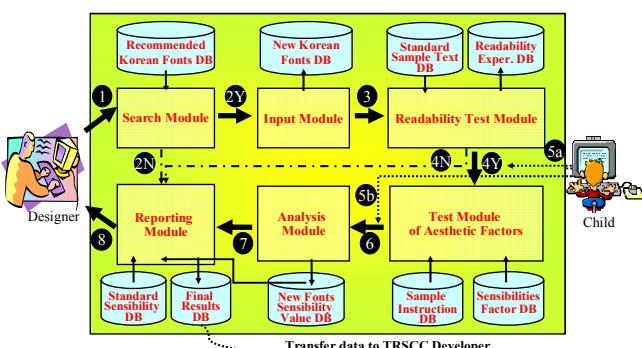
Fig. 2. Architecture of the TRSCC

- In the **search module**, a teacher queries whether a new typeface is included in the recommended typeface database or not. If it is included, the TRSCC will suggest using it directly for the WBI material.
- The teacher can go to the next **input module** to register a new typeface in order to evaluate its readability.
- The **readability test module** generates sample texts to read, which are written in 4 randomly selected typefaces and the new typeface. It also surveys the readability of the typeface by children.
- The **test module of aesthetic factors** surveys children's sensibilities by producing a questionnaire from the sample instructional contents database and the adjectives database using the SD method. Then, it surveys children on the sensibilities of the 4 randomly selected typefaces and the new typeface to extract children's sensibilities and store the results in the database.
- The **analysis module** compares the designers' intended characteristics with the children's. It also analyzes and reports the results of the comparison graphically**.**
- The **reporting module** recommends the typeface that is the best and most appropriate to the WBI for children.

437 children and 30 teachers used the TRSCC services. Table 4 shows the recommended ranking of Korean typefaces for the children's group (C) and the teacher's group (T). Obvious differences were found between the two groups. The best recommended one was found to be 'Headline (헤드라인)'.

Table 4. Recommended rankings for the two groups

Ranking for Readability			Ranking for Elegance		
C	Korean typeface	T	C	Korean typeface	T
1	**헤드라인**	14	1	**헤드라인**	6
2	굴림체	1	2	돋움체	4
3	**견고딕**	4	3	**견고딕**	7

TRSCC can be a useful tool when a designer wants to select the best typeface for children based on children's responses.

5. Conclusion

This study examined the metaphor and typeface of GUI components which can be used in e-Learning contents for children.

First, considering that children and adults have different sentimental models of metaphor, we investigated and compared their sensibilities for the three types of icon by the SD method and the varimax-rotation of factor analysis. Both children and adults commonly showed higher sensibilities to the aesthetic factor than to the familiarity factor and the brevity factor, but they exhibited different factors for the types of icons. Children had only 2 factors for the spatial mapping type of icons. We may infer from this why it is that children prefer the spatial mapping type (geographic navigation metaphor) such as the diorama map type or piped show type in e-Learning contents. Thus, these results indicate that instructional designers should consider the evident difference in sensibilities between children and adults.

Second, many typefaces are developed continuously and rapidly disseminated on the Web. The more typefaces spread out on the Web, the greater the need for an expert system that recommends ideal typefaces. So we designed an expert system that automatically produces WBI materials to evaluate the readability and the elegance of randomly selected typefaces, and recommends the best typeface for children. As with the results of previous studies, the TRSCC system gave a high rank to the Sans-serif type. However, it also provided information on children's preferences regarding typefaces, which were different from adults'. This result can provide a useful guideline for the design of metaphor and typeface in GUI for children in elementary schools.

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