Kansei Color Associations for an Interactive Learning Environment for Children

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Abstract—Many computer-based educational programs are designed with more consideration on their functionality, whereas very little consideration is given to the aesthetic needs of the users. This on-going research attempts to explore the color preferences of children and discuss how a designer can choose preferable colors for interactive learning environments using Kansei Engineering techniques with the aim to provide visual aesthetics while increasing the usability.

Index Terms—colors, interactive learning environment, kansei engineering.

I. INTRODUCTION

COlors contribute strongly to the aesthetic value of the design while acting as an agent to improve the quality of the communication. In this paper, we attempt to find children’s color choices using kansei engineering to design a better interactive learning environment for school children. Color choices that we make have the ability to enhance or to impair a learning environment. Studies have revealed that colors can influence human both in their psychological and physiological activities. Early research has exposed that part of the human response to colors occur due to psychological matters and the other part due to cognitive matters. As a dominant visual element of a visual design, colors can be utilized as to improve the verbal and non-verbal communications. Using colors properly is able to enhance and simplify a presentation, while using colors poorly can lead to miscommunication.

Color associations in our day today lives can be recognized as learned and innate. These color associations human has have ability to increase or decrease the liveliness of our working environment. The results of the Sedighian et al, Department of Computer Science, The University of British Columbia, Canada, reveals that a larger majority of the students either loved or liked having bright, colorful backgrounds and multi-colored environments in the educational software they used. In the study the mentioned research, a group of children were asked to rank the importance of colors and graphics in an educational interactive environment, among other elements such as learning, challenge, score, music and sound effects. Most of the children considered learning as more important than good colorful environments, but several of them stated that nice colors and graphics add flavor to the learning activity.

Though there are many generic color pallets and schemes in the market place which can cater for our designing needs, this paper attempts to propose a way in kansei engineering, to research and find out appropriate color scheme to designing an interactive learning environment for a specific user group.

II. THE EFFECT OF COLOR IN A LEARNING ENVIRONMENT

Colors can be used in a certain way when designing learning materials which can lead to certain behavioral outcomes. In general, vivid colors such as bright reds and yellows can promote idea generation and activity, whereas darker colors may evoke feelings of anger [8]. And also if learning environment is to be appealing especially to girls, it is important to consider visual imagery [12]. Though designers question the effectiveness of colors, in improving the usability of a display, according to Studies [7] and [11] it has shown that color has improved performance of the display and also studies by Christ [3] and Carter [2] have revealed that color has an ability to improve the visual search.

Educational software is designed and developed to provide an environment where students can construct knowledge and acquire it. In designing educational software, generally priority is given to its functionality, rather than to its appearance. However user’s aesthetic need is also equally important as its
functionality. Interactive Learning environment is a virtual classroom. It is a place a user spends considerable amount of time as a student in his learning process. If the learning environment is not pleasing and comfortable, there is a high possibility of students to getaway from that place. Therefore when designing an interactive learning environment, it is important to consider not only its functional but also its aesthetic point of view.

III. CHILDREN’S COLOR CHOICES

It’s imperative to consider audience and purpose when selecting colors. Especially design for children designer should use colors careful consideration. Wrong selection and use of color for learning materials can be so distracting and the intended messages can get lost. For an example if a designer or the instructor use ten different colors in one screen to explain particular scenario, there is a high possibility of overwhelming the reader.

Children are very easy to impress but sometimes they are not that easily pleased. Children get bored very easily in one thing and quickly get interested in something else. Children’s patterns of attention and interaction are quite different from those of adults. Children are easily distractible. The experiment which was done using a funny noise as an error message, resulted in children repeatedly generating the error to hear the noise [6]. Some children develop sentimental feelings about their little belongings and it is almost difficult to part these objects of delights away from them. Since children demonstrate this dynamic likes and dislike patterns, it is almost difficult to keep up with them. When designing a interacting environment for children, the design need to have features that draws the attention of this dynamic mind and keep up with it. For an example interesting visualizations, dynamic screen layouts, good quality images and pleasing color schemes, should be selected with care.

Though children are not matured like adults and not always share the same taste with adults we shouldn’t treat them less. They also have their choices of color. They are also equally important as choices that adults make. It is important to understand that children must not be treated as short adults. What we design as adults may not attract children’s mind. In other words, what we think right for children may not be right for them. Most of the adults in general think that children like loud colors but research has found out that children don’t like loud colors. They also like appropriate colors just like adults [5]. In order to make children’s educational software effective, designers need to adopt a child-centered approach. Software should be designed in a way that addresses children’s cognitive, affective, and behavioral needs [9].

Children have their own likes, dislikes, and needs, which may not be same as those of adults. When a designer wants to define a color scheme for children’s learning materials it is essential to listen to them. According to the survey conducted by Borgers and Hox [1], “Researchers are realizing that the information on children’s opinions, attitudes and behavior should be collected directly from the children; proxy-reporting is no longer considered good enough.”

Experiment through observation and interactive question and answer sessions designer can understand, what are the colors children prefer? Do they like bright colors? What do they think about color choices in existing interactive learning materials? What colors make leaning environment more comfortable more interesting? Does color make remembering process easier? In the following section authors attempt to describe a method which uses Kansei Engineering techniques to find out more about children’s color choices. In the process main goal is to bring children’s wishes, suggestions, and ideas to select appropriate color scheme to develop an interactive environment for them.

IV. METHOD

Test subject are selected from Japan and Sri Lanka. They are both male and female 50 students from St. Thomas’ College, Pittakotte, Sri Lanka and 27 students from Iwatate Elementary school, Kita Aizu, Fukushima Prefecture, Japan. Children are from 10 -12 year of age. They have participated in Interactive and written sessions. Research was conduct in normal daylight conditions. According to research that already has been done on categorical color perception, only a limited number of colors can be absolutely identified across different culture which is also frequently used in color design. We also have chosen these 11 colors which also known as the universally color which “almost never confused” (red, pink, purple, blue, green, yellow, orange, brown, white, grey, black) [4] as our testing color palette. Color is able to generate emotions. [13] Emotions play a major role in human behavior, which in other words, color have an impact on peoples decision making process, to or not to select, to proceed or not to proceed. This is similarly applicable in children’s too. This direct relation that color has with emotions makes it a better test case for kansei engineering. In a kansei processing system, designers acquire information from the people and recognizing, filter, Estimate, modeling, making relationship, producing, giving information and finally presenting them in a special way to design right feelings in the product.

A. Kansei Engineering Process

In a very special way, kansei engineering is able to capture the information which we sense from five sensory organs such as light, shape, color, temperature, fragrance, touch, etc. as inputs and use filters such as culture, emotion, gender, sense, etc to create the final output. In other words kansei engineering process has a behavior of a sense maker. The engineering
process is a network which is interconnected and it recognizes the right functions to generate interrelationships and produce the output with sense. Kansei engineering uses kansei words which are usually adjectives or sentences of feeling, as parameters. Kansei engineering, designer collect kansei words or adjective related to the product domain (in this case color), and categorize these adjectives which represent feelings that represent the user needs in the particular interface, and test them against the 5 or 7 point of Semantic Differential scale (SD) [14]. After gathering data by analyzing questioners, most frequently used adjectives can be selected to design SD scales. After gathering SD results it can be analyzed using various statistical methods to find a meaningful pattern in the test case.

Figure 1, elaborates the kansei engineering process, which has been employed in this research. After designing the main strategy for the research, Subjects has to go through interactive brainstorming session, and three levels of questionnaire sessions.

B. Scope of the Research

![Fig. 1. Kansei engineering color selecting process](image)

C. Introduction to Colors

This exercise is important both in the user and the designer point of view. This session offers an opportunity to the child to look at color in different perspective which is at the same time beneficial for the designer. Main objective of this session is to stimulate user’s mind to think about what they feel about color. A presentation about colors; for all the observers an introductory color presentation can be done. Presentation included an informal question and answer session. Selected colors can be presented on the white screen and randomly selected observer from the audience has to select one of the colors from the display. Once he/she selected it he/she has to tell the audience reasons for his selections. This can be done number of times until observers are able to come out with reasonable answers.

This interactive exercise can be used as a warm-up session for forthcoming color experiments. Theoretically this exercise is used in this section to stimulate children’s mind to think about color. This interactive brain storming sessions can be used to study how children think and feel about color. For an example, two sample questions in the Interactive session are; which circle do you like most from the circles displayed on the screen? Why do you like that particular color? (fig. 2)

![Fig. 2. Color circle display in the screen interactive session](image)

D. Color Questionnaire: Matching Colors with Adjectives

After brainstorming sessions, in this phase children require to respond for three different types of questions. Sample questions are displayed as follows. (Q1, Q2, Q3)

Q1. Please select colors that you like most in the list and write why you like those colors in the space provided.

1. Red
2. Blue

Q2. Please match the colors with adjectives using arrows as shown in the example (fig. 3)

![Fig. 3. Color matching questionnaire](image)

Q3. How do these colors make you feel? Please write in the blank space provided below

![Fig. 4. Color matching questionnaire](image)
E. **Colorful vs. Black and white Interactive Interfaces**

In this phase children need to observe 2 very colorful and less colorful computer interfaces; screen shots of interactive environments. These are learning environments that use different backgrounds; text color combinations etc and children need to answer the questions provided in the questionnaire, studying the web interfaces. For an example, Q1. Please select one of the screens displayed and answer the following questions. Sample questions such as, which picture does you like most? What are the colors do you like most in that picture?

F. **Colorful Interactive Interfaces**

In this phase children need to observe one colorful computer interface; screen shot of colorful interactive environment. As mentioned in the previous stage, children need to answer the questions provided in the questionnaire, studying the picture. Eg: Q1. Please look at the picture and answer the following questions such as, Do you like the background color of the picture, Do you like the color of the text?

G. **Testing Colors with Bipolar Adjectives**

After selecting the most frequently used adjectives in the previous sessions, SD scales can be defined. These scales should be tested against the selected eleven colors and selected 5 computer interfaces. Since normal SD scales are complicated for children SD scales are prepared as 5 choices of a MCQ question. There are 5 different SD scales for each color and each computer interface. Therefore there are two categories of questions in this session.

In the first category, color can be tested in the size of 1.5”x1.5” square in the top of the A4 sized paper and students require to select one answer from the given choices (fig. 6). Only one color is displayed in one paper and a color is tested against 5 different SD scales. Same set of SD scales would be tested again with the other colors. Sample question as follows; Q1, Select one of the answers which describe your feelings for color yellow.

![Fig. 6. Color squares testing with bipolar adjectives](image)

**SD1:**
- a. Very happy
- b. Happy
- c. Neither happy nor sad
- d. Sad
- e. Very sad

H. **Data Analysis and Presentation**

After gathering SD data, it is analyzed statistically using various statistical models to find a meaningful pattern in usage of colors in interactive educational materials and how children feel about them. Once data is analyzed the output result can be employ to design an interactive learning environment for children.

V. **Result and Discussion**

In the subsequent sections result of the first three phases has been analyzed and visually represented. As displayed in the figure 8, Sri Lankan children’s main favourite theme colors for their Interactive learning environment are, blue, pink, green and red. On the other hand as displayed in the figure 9, Japanese children’s main favourite theme colors for their Interactive learning environment are, blue, orange, green, black and white. Result shows that the children’s color preferences change according to their personal preferences and culture values. Thus beyond all these changes students has given priority to blue and green as their most favorite colors.

![Fig. 8. Favorite colors of Sri Lankan children](image)
Fig. 9. Favorite colors of Japanese children

Following charts display the children’s color preferences for respective feelings (Fig.11). 17 out of 50 Sri Lankan children has selected color of happiness as blue. Almost all the children selected color of sadness as white, anger as red and color of affectionate as pink. On the contrary Japanese students, as fig. 12 shows, highest number of students; 12 out of 27 selected color of happy as yellow, 18 out of 27 children selected color of sadness as blue. Almost all the children selected color of anger as red, many selected color of affectionate as pink.

All the Sri Lankan children think color is essential for their learning environment while 19 Japanese students out of 27 selected colorful interfaces as their preferred choice. 7 Japanese students prefer mono color or less color interfaces. All children from both countries disliked having loud colors. They say it distract them, make their eyes tired quickly and want to get away from the site. Almost all the children in each country considered good functionality is more important than good visual presentation but nice visual environment, color add excitement and flavor to the learning activity. Colors make things memorable; also can be utilized to draw attention to particular areas of the environment.

Color makes the interactive environment a pleasing place to study it reduces boredom and make the reader enthusiastic and fresh. On the contrary results reveal that wrong use of color has an ability to make the environment more complex and noisy and lead to miscommunication. If the color does not fulfill the intended purpose or deliver the right message, it can affect the credibility of the content and disturb greatly the aesthetic value of the interactive environment. Unnecessarily use of color design may lead to unattractive interactive interfaces where user is not willing to communicate with. Finally it is very important to accommodate color deficiencies; color itself should not be used to convey important messages it is always better to accompany them with text. In brief the children believe that color has an ability to motivate, excite, draws attention to a particular matter and provides emphasis.

Moreover aesthetics in an interactive environment does not only provides a user a pleasing environment to work it also assist with enhancing the usability of the environment Most of the color emotions are learned and it can be different from culture to culture. Hence people’s natural associations with color are universal and timeliness. Therefore, when designing any computer interface designer should be careful when accommodating already defined rules of color aesthetics.

Since Kansei engineering acquire the prospective user’s feelings about the existing products and localize or individualize it to user’s needs, it has an ability to come out with better solution for a special design for a particular user group. Inconclusion this research reveals that it is important to acquire prospective user color aesthetic needs before designing a learning environment for them. After all they are the real
users and designer has a responsibility to fulfill their needs. Results of this research reveals that all children preferred blue and green as theme colors for their computer interface. All liked dark color fonts in light color background. Almost all preferred color environment to black and white. Moreover all rejected unnecessary colors, complicated environments and wrong use of color may make the reading and working tiresome.

VI. CONCLUSION
The main purposes of this study is to select a color scheme for interactive learning environment for primary school children using kansei engineering techniques. The importance of this research is, children selecting color to determine the color scheme for their learning environment. Using color in a meaningful way we can design a better interactive learning environment which children would enjoy engaging with. In this paper we are attempt to find a children’s color preferences using Kansei Engineering techniques furthermore using that knowledge we hope to extend our research to broader aspect of designing a interactive environment for children.

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