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Introduction

This book constitutes the proceedings of the 8th International Conference on Intelligent Human Computer Interaction, IHCI 2016, held in Pilani, India, in December 2016. The 22 regular papers and 3 abstracts of invited talks included in this volume were carefully reviewed and selected from 115 initial submissions. They deal with intelligent interfaces; brain machine interaction; HCI applications and technology; and interface and systems.

Keywords

HCI information security machine learning recommender system software development classification algorithms compression techniques decision support graphical user interface human robot collaboration mobility neural network nonlinear systems privacy reinforcement learning semantic soft computing software quality support vector machine user interface

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M-Learning Interface Design Based on Emotional Aspect Analysis

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Abstract. Positive emotional conditions are influenced or generated by internal or external stimuli. Design elements, such as colours and shapes, are potential stimuli that can influence human emotion. The study is devided into two experimental stages. The first stage employs design elements, i.e. colours and shapes. The colours used are red, green, blue and yellow with round and angular shapes. While the second stage is testing the mobile learning prototype that applies the design elements as the results of the experiment in the first stage. The testing employs 41 SAM Questionnaire by measuring 41 respondents' perception towards design element stimuli and m-learning prototype and, later, the results are analyzed with the use of One-Way Anova. The results of the two experiments show that red, green and blue generate positive energy while yellow generates negative emotion. On the other hand, round shape can result in positive emotion and the angular shape is neutral.

Keywords: Positive emotion · Design elements · Mobile learning

1 Introduction

Emotion is a psychological and physiological condition as a reaction to stimulus received by human senses. Emotion can also be considered as a result of thinking illustration that takes place when there is an internal or external emotional stimulus [1]. Emotions are frequently considered as identical or closely related to feelings [2]. In general, emotions can be categorized into: positive and negative. The state and the role of one's positive emotion can influence the action or activity and will result in better learning [3]. When one is studying, the positive emotional state prior to the learning will help the person to understand better [4].

E-learning system that has been developed to enhance learning process can operate on desktop or mobile computer interface to enable users to interact with the system which employes design elements such as colours, shapes, sizes, etc. These factors can strongly generate a certain secondary emotion or aesthetical response when a person interacts with the interface system [5]. Among design elements stated above, colours

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and shapes have the most potential emotional influence on a person. Colours are frequently associated with positive and negative emotions [6, 7] depending on the sensation generated. On the other hand, other factors such as sexes, ages, and cultures can influence the perceptions and responses towards certain colours [8–10]. Colours can also influence attention, behaviors and achievements in a student's learning process [11]. Just as design elements like colour and shapes influence human emotion, shapes and characteristics such as round, angular, simplicity, and complexity can also influence human emotional response in visual arts and psychology [12].

Currently, there have been previous researches focusing on emotion and computer. However, mobile technology as a platform of m-learning is advantageous and it is still an infant that can develope further [13, 14]. Therefore, it is still necessary to research on how to develop m-learning, especialy in order to reduce the limitation of mobile technology. This limitation of the problem in this paper is to explore the use of mobile device particularly on human computer interaction. Shortly, this research studies colour and shape in design elements needed in m-learning by taking emotional aspects into consideration in designing interface mobile learning application.

2 Previous Work

This research refers to a previous research carried out by Abegaz [15], which tested the influence of the colour and shape design elements towards emotion in designing an interface search engine to improve comfort for adults when using the search engine. In his research, Abegaz used red and yellow and round and angular characteristics and also the combination of the two. Abegaz found out that colour and shapes able to influences emotions of the user.

Another research was carried out by Plass and friends to students in German University [16]. The results show that a combination of design elements of warm colours and round characteristics on multimedia learning interface can generate positive emotions, reduce difficulties and increase the motivation in learning. Certain colours, especially blue and yellow in the background can influence the process of learning through a computer. The results show that blue background generates a more positive influence than the yellow one [17].

The researches above employed different measuring instruments in accordance with the purposes of the study. The instruments are to measure emotional responses towards design elements such as colours and shapes. Furthermore, Self-Assessment Manikin (SAM) Questionnaire in measuring respondents' emotion perception towards the stimuli given via computer [18–20] is also used.

3 Research Methodology

Due to the aim of the research some definitions are used, i.e. colour, shape and SAM Questionnaire. Colour is a certain spectrum resulted from a perfect light. A colour is determined by the length of light. There are three main colours (red, green and blue), known as additive primary colours. The mixing of additive colours results in primary

subtractive colours, such as magenta, cyan, and yellow [21]. Shape is a two dimension basic geometry, such as a dot, line, curve, field (i.e. square or circle). It can also be something explained by three dimension solid substance, such as a cube or a ball, or round and angular with simplicity or complexity [22]. SAM Questionnaire is a non-verbal picture oriented measuring technique that directly measures pleasure, arousal, and dominance related to a human affective reaction towards some stimuli [23].

Research design stage was caried out by studying the existing literature and previous study on colours and shapes [15]. It was held to get a reference on colours and shapes to use as models that would be tested and measured to design the interface mobile learning. Our research design is divided in two stages which are carried out sequentialy. To give clear explanation of both stages, the results and discussion will be described separately. This research carried out two experiments, the first is to measure and find out the emotional responses towards colour and shape design elements. The second is to measure and find out the emotional responses towards colours and shapes that have been shown as potentials in experiment one to generate states of positive emotion when applied on interface mobile learning. Each of the two experiments has four stages, research design, model design, data collecting and data analysis.

4 Methodology in Experiment One

The model design consists of two important parts employed as variables of the experiment i.e. shape and colour. Model designing is to create a colour and shape model used as a stimulus for the respondents. There are three models: colours only, shapes only, mix between colours and shapes. There are four chosen colours to test: red, green, blue and yellow. These four colours are combination of primary addictive and subtractive colours and considered as generating certain emotions [24]. The colour model also splits colours into some shades since colour dimensions such as hue, saturation and brightness potentially influence human emotions [25]. Shape Model is made by applying two characteristics of shapes, i.e. round and angular, and shapes that combine both characteristics.

Using random sampling, data were collected from 41 s semester Informatics Department students from batch 2015 of University of Palangkaraya Indonesia. There were 21 male and 20 female respondents ranging from 18–21 years old. The experiment was carried out indoors with sufficient light and air conditioner in the morning between 09.00–10.30 Indonesian Western Time. The purpose of this condition is to eliminate external factors that can influence the respondents' attention and emotional state while the data were taken.

Quasi was given to the 41 respondents to find their emotional tendency by using PANAS questionnaire as an instrument. The questionnaire that covers positive and negative effects is to determine emotional experience that each individual has had [26]. The quasi test shows that 87.8% or 36 respondents have positive emotional tendency while 12.2% or five respondents experience negative tendency. The experiment data is collected by using android smartphones to present colour and shape models and applying SAM Questionnaire to measure their emotional responses towards the stimuli. SAM Questionnaire was applied especially to measure pleasure dimension (see Fig. 1).

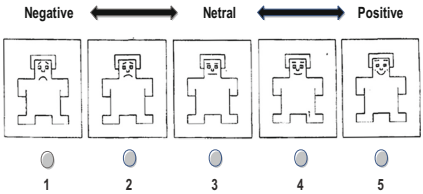

Fig. 1. Instrument SAM Questionnaire to measure pleasure dimension [23]

SAM Questionnaire used expression illustration to represent the states of emotion from negative, neutral and positive in showing pleasure dimension. The process of data collecting was carried out in three stages as shown in the following Fig. 2. The first and the second stages were in the form of application while the second, rating the emotion, was paper-based by using SAM Questionnaire. The first stage shows the models to the respondents within 1000 ms. This duration is considered sufficient to generate respondents's emotions either when they were aware or not [27]. In the second stage, after looking at the models in stage one, respondents were given SAM Questionnaire to choose one of the five available pictures that represents their emotion when they saw the model. In the third stage, the respondents were to look at the running application, in this stage the application did not present models, but a white blank screen for 2000 ms. The blank white screen is to neutralize the given stimuli to the eyes after looking at models in stage one. After stage three, the experiment proceeded to stage one to evaluate the following models. These three stages were repeated until all the models were displayed and given score by the respondents.

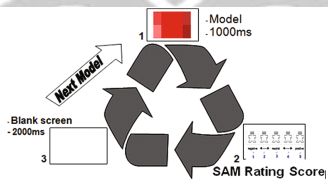

Fig. 2. Stages on data collecting process [15]

4.1 Data Analysis and Results of Experiment One

The data analysis employs One-Way Anova (OWA) to test the mean score comparisons that each model has achieved. The models are analised by using OWA to see which colours and shapes that give positive, negative or neutral emotions to respondents. Prior to data analysis, reliability test is carried out to the questionnaire data. It is necessary to make sure that all questionnaire items are consistent and reliable. The reliability test of 19 item model questions given to 41 respondents, is done by using Cronbach Alpha test. The reliability shows the score of Cronbach Alpha (0.812). By using *r-table* vales for $df = 39$ (0.3081) (*significant level* 0.05), the questionnaire is

Table 1. One-Way anova analysis of colour variable

	Sum of squares	df	Mean Sq.	F	Sig.
Between groups	32.604	3	10.868	13.261	.00
Within groups	131.122	160	.820		
Total	163.726	163			

reliable since the value of Cronbach Alpha (0.8012) > *r-tabel* (0.3081). Furthermore, the result OWA of the collected data can be seen in Table 1.

Then, comparative study was carried out to see the significant gap between the mean values by employing LSD (least significant difference) post-hoc test. The results showed that three colour models: red, green and blue have significant average gap towards yellow since the comparation of the value is *sig*(0,000) < 0,05, so it can be concluded that red, green and blue models have different mean emotion rating value towards yellow (let see Tables 2 and 3). On the other hand, red, green and blue models have no significant emotion rating mean scores since the three have values of *sig* (0.465) > 0.05, *sig*(0.331) > 0.05 dan *sig*(0.808) > 0.05.

Table 2. Post hoc test LSD of colour variable (with 95% Conf Int)

Colour 1	Colour 2	Mean diff.	Std Err.	Sig	Low bnd.	Upp bnd.
Red	Green	.1463	.1999	.465	−.2485	.5412
	Blue	−.0487	.1999	.808	−.4436	.3461
	Yellow	1.0487*	.1999	.000	.6539	1.4436
Green	Red	−.1463	.1999	.465	−.5412	.2485
	Blue	−.1951	.1999	.331	−.5900	.1997
	Yellow	.9024*	.1999	.000	.5076	1.2973
Blue	Red	.0487	.1999	.808	−.3461	.4436
	Green	.1951	.1999	.331	−.1997	.5900
	Yellow	1.0975*	.1999	.000	.7027	1.4924
Yellow	Red	−1.0487*	.1999	.000	−1.4436	−.6539
	Green	−.90244*	.1999	.000	−1.2973	−.5076
	Blue	−1.0975*	.1999	.000	−1.4924	−.7027

Table 3. Descriptive analysis of colour variable

Variable	N	Min.	Max	Mean	Std Dev.	Emotion
Red	41	3	5	4.0244	.7241	Positif
Green	41	2	5	3.8780	.9272	Neutral/Positif
Blue	41	3	5	4.0732	.8772	Positif
Yellow	41	1	5	2.9756	1.0603	Negatif/Neutral

The results show that yellow is able to stimulate negative emotion. Possibly it reflects the sad-perception of Dayak culture in Central Kalimantan since they use yellow flag in the Tiwah, a ritual held for the deceased.

As decribed before, we made use of two (2) variables in experiment one. When we used shaped variable, the result shows that there is no emotion affected by shape variable. It is seen from OWA analysis when the value of F_{measure} as which is as much as 1,057 will, then, be compared with the scores of F_{table} (2;120; 0,05) which values 3.07. It is found that $F_{measure} < F_{table}$ and the comparative value *sig* (0.351) > 0.05. Thus we will not apply LSD post-hoc test. It reflects that the three shape models have the same average emotional rating. Shortly, variable shape has no effects on the emotion as seen on Table 4.

Table 4. Descriptive analysis of shape variable

Variable	N	Min.	Max	Mean	Std Dev.	Emotion
Angular		41	2.00	5.00	3.3659	Neutral
Round		41	2.00	5.00	3.6098	Neutral
Mix	41	1.00	5.00	3.3415	1.03947	Neutral

The next experiment explores on how both of shape and colour variables affect emotions. After the data are collected and processed, One-Way Anova Analysis of the Combination of Shape and Colour is performed. Table 5 shows results of this experiment. $F_{measure}$ (4,196) < F_{table} (11;480;0,05), and the comparative value *sig* (0,000) < 0,05). Therefore we need to apply post-hoc test LSD.

Table 5. One-way anova analysis of combination of shape and colour

	Sum of Sq.	Df	Mean Sq.	F	Sig.
Between groups	44.998	11	4.91	4.196	.00
Within groups	467.902	480	.975		
Total	512.900	491			

Due to the limitation of space, we can only show the OWA analysis of the combination of colour and shape variables (let see Table 5), and the final result, a descriptive analysis of both variable, is presented in Table 6, while Post Hoc Test LSD is not. The summary of the table can be also used to confirm the conclusion that yellow has strong effect on the emotion.

Based on One-Way Anova Analysis of Combination of Shape and Colour and the LSD post-hoc test, the results of the mix models can be taken. The LSD post hoc test showed that there is significant difference between mixed models all those of the colours (red, green, blue) with the shapes (angular, round, mixed), yellow, and shape (angular, round and mixed. The results of the mixed model show that blue and round edge can potentially generate positive emotion in the respondents since it gets the highest mean (3,8780) although the standart deviation is 0,92723. While yellow combined with all kinds of edge tend generate negative emotions. The mixed models effects and the result analysis of this experiment is displayed in Table 6 as below.

Table 6. Descriptive analysis of combination of shape and colour

Variable	N	Min.	Max.	Mean	Std Dev.	Emotion
RedAngular	41	1.00	5.00	3.5854	1.0948	Neutral
RedRound	41	2.00	5.00	3.6098	.8330	Neutral
RedMix	41	1.00	5.00	3.4634	1.0270	Neutral
GreenAngular	41	2.00	5.00	3.7317	.9226	Neutral/Positive
GreenRound	41	2.00	5.00	3.6585	.8249	Neutral
GreenMix	41	2.00	5.00	3.5854	.9993	Neutral
BlueAngular	41	1.00	5.00	3.7561	.9945	Neutral/Positive
BlueRound	41	1.00	5.00	3.8780	.9272	Neutral/Positive
BlueMix	41	1.00	5.00	3.5854	1.0241	Neutral
YellowAngular	41	1.00	5.00	2.9512	1.0235	Negative/Neutral
YellowRound	41	1.00	5.00	3.0244	.9614	Neutral
YellowMix	41	1.00	5.00	3.0000	1.1619	Neutral

5 Methodology in Experiment Two

According to the purposes of the experiment two, three applications of m-learning prototype are designed and used to collect data. The result of experiment one is applied to select the design element of the prototype. Since this research is limited on mlearning, the interface mobile learning application prototype is limited on the standard learning activities, i.e. page on learning material selection, page on learning material presentation, and page on learning evaluation process via test or quizes. However in order to enrich the prototype, some rules of the design pattern from Mobile Design Pattern Gallery [28] are applied i.e.: menus, the use primary navigation and secondary navigation patterns. An example, when we design the form menu, we use the subject selection which rely on menu list mode. In the main menu form, the menu-list presents options of materials, quizes, and other features. Besides, it also uses icons in accordance with the name of the title which function aesthetically and enable users to understand and remember the menu presented (see Fig. 3). For the second primary navigation pattern, control tab is used to navigate and to present another page without accessing or opening another visual control. Control tab can ease users in accessing the main menu since it shows the options in the main menu of the application even though the users have moved to other pages.

In designing the content, secondary navigation is employed to expand list pattern. Expanding list is useful for managing and presenting information based on the information group that the users need to see. As a menu expanding list can be opened and closed so we can input the necessary information. To make easier, a sign of status, an arrow, is implemented. When the arrow faces down, it shows that the expanding list is closed, while facing up means it is open and showing the contained information. An arrow icon is also used to make easier. It helps users to go back to the previous pages. The title bar is given a label that informs the page being accessed by the users.

The evaluation form was designed in accordance with multiple choice evaluation pattern in general. There is only one question within one page and it is used to fit the

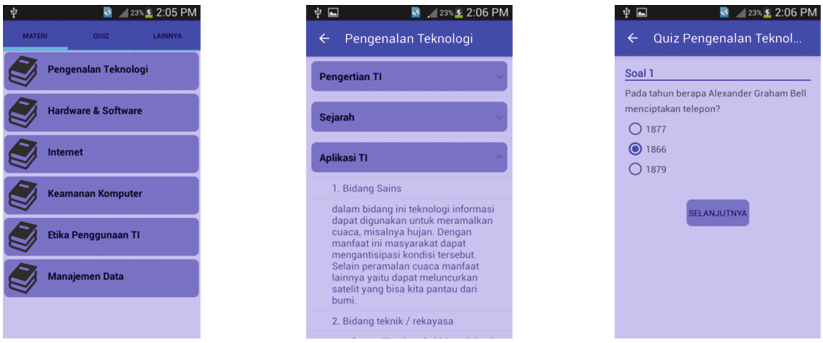

Fig. 3. Interface Design of prototype mobile learning in blue colour (The other element design i.e. colour and shape is also applied, this illustration is only one example of prototype using the blue colour and round shape) (Color figure online)

screen limitation of smartphone dimension. Radio control button is used to answer the question. Radio control button serves the function to choose one among some options provided. A "next" button is provided to present the following question, moreover it will enables users to choose their answer for the question. An arrow is provided on the left or upper left of the title bar which is used to move to the previous pages. The title bar also shows the location of the page being accessed by the users.

The result of experiment one i.e. the colours (blue, red and green) and round shape are potentials in generating positive emotion. So, this result will be implemented in the interface mobile learning prototype especially in the designs of background, foreground, and buttons. Monochromatic technique is used to combine the colours by mixing one colour with white or black. The more white is used the colour will be lighter while more black will bring darker colour. Ilustration 3 shows the detail of the mock-up of the model which use blue colour and round shape as the element design.

5.1 Data Collecting

Data were collected from 41 respondents who had been involved in the first experiment. The second experiment employed an android smartphone as a medium to run mobile learning application prototype and used SAM Questionnaire to find out the respondents' responses towards the stimuli. Data-collecting process is started when respondents operated m-learning application prototype. While the application was running, the respondents were asked to do five sequential activities. The first is to access three main menu in Tab Menu: Materials, Quizes, and Others. The second is to choose the material of menu list "PengenalanTeknologi Informasi". The third is to open the sub-material "Pengertian TI" and read the content presented. The fourth activity asks respondents to access quiz menu tab "Quiz Pengenalan Teknologi Informasi". The last activity required respondents to answer the multiple choice questions provided. Furthermore The data collection follow the Fig. 2 where the model is the prototype of m-learning.

5.2 Data Analysis and Results of Experiment Two

This stage employed OWA to analyze the data and to test the average mean of each mobile learning prototype model. Furthermore, OWA is used to find which prototype generates the positive, negative or neutral emotions. This experiment went through reliability test by using Alpha Cronbach technique towards three questions of prototype given to the 41 respondents. The reliability test which showed the score of Cronbach Alpha (0.812), was then compared with the r-table score for $df = 39$ which is 0.3081 (significance level 0.05), so it can be concluded that the questionnaire employed here is reliable since the score of Cronbach Alpha is (0.318) > *r-Table* (0.3081). The OWA of thir experiment is listed in Table 7.

Tabel 7. Frequency analysis of prototype M-Learning

Prototype	Very negative		Negative		Neutral		Positive		Very positive		Total
	F	%	F	%	F	%	F	%	F	%	N (%)
Blue	0	0	0	0	7	17.1	17	41.5	17	41.5	41 (100)
Red	0	0	0	0	8	19.5	23	56.1	10	24.4	41 (100)
Green	0	0	8	19.5	19	46.3	13	31.7	1	2.4	41 (100)

Using Homogeneity of Variances we found that value $sig = 0{,}173$, since $sig > 0{,}05$ which means there are varians among prototye. Therefore the analysis is followed by OWA, and the result of OWA is showed in Table 8.

Table 8. One-way anova analysis of prototype

	Sum of sq.	Df	Mean sq.	F	Sig.
Between groups	26.797	2	13.398	25.412	.000
Within groups	63.268	120	.527		
Total	90.065	122			

Using OWA analysis it is known that the value of $F_{measure}$ (25.412) is the compared with the value of $F_{table(2;120;0,05)}$ (3.07) it is found that $F_{measure} > F_{table}$ and the value of the comparison $sig(0.000) < 0.05$. It states that the three prototypes reach different emotional rating averages. The further observation, the average differences of the emotion rating scores of the three prototypes, is performed by LSD Post Hoc Test and is presented in Table 9.

As presented in Table 9, LSD post hoc test shows that the significant gaps in the rating average scores in mobile learning prototype happen between blue and green prototype, red and green prototypes. *sig* score for blue and green prototypesis *sig* $(0.000) < 0.05$ so it can be concluded that blue and green prototypes has different emotion rating mean scores. The same applies to red and green prototypes with *sig* score $(0.000) < 0.05$, so red and green prototypes has different emotion rating scores.

Table 9. Post hoc test LSD of three prototypes (with 95% Conf Int)

Colour 1	Colour 2	Mean Diff.	Std Err.	Sig	Low Bnd.	Upp Bnd.
Blue	Red	.19512	.16037	.226	−.1224	.5126
	Green	1.07317*	.16037	.000	.7556	1.3907
Red	Blue	−.19512	.16037	.226	−.5126	.1224
	Green	.87805*	.16037	.000	.5605	1.1956
Green	Blue	−1.07317*	.16037	.000	−1.3907	−.7556
	Red	−.87805*	.16037	.000	−1.1956	−.5605
Blue	Red	.19512	.16037	.226	−.1224	.5126
	Green	1.07317*	.16037	.000	.7556	1.3907

While blue and read prototypes has no significant difference in the emotion rating scores since the *sig* score is (0.226) > 0.05.

6 Discussion

From the colour model analysis, it is concluded that red, green and blue generate positive emotional state in respondents as there is no significant average gaps among the three models. However, when considering the average scores achieved by each colour, blue reaches 4.07372 (Positive) with the deviation standard of 0.87722 is the most effective in generating positive emotion, followed by red averaged in 4.0244 and deviation standard of 0.72415. While yellow tends to generate negative emotion.

The shape models conclude that there is no significant difference among the mean of emotion rating of each of the models. When considering the mean of the shape model, it is concluded that there are no differences among the emotion rating average in each shape model and when looking at the mean score, the round model with the average of 3.6098 potentially generates positive influence to the respondents. The three shape models tend to give neutral influence to the respondents emotion as shown in the average score that range between the scores of three to four.

Another conclusion from this experiment is that the blue colour and round shape tend to make positive emotion. The conclusion is represented by the average value has average value 3.8780 and standart deviation 0.92723. It is very contrast if we compare with green colour. From the analysis on the prototype mobile learning, it can be concluded that blue and red prototypes potentially generate positive emotions, proven by the inexistence of significant mean gap between the two prototypes. However, seen from the mean scores, blue is 4.2439 (Positive) and deviation standard of 0.73418 is the most effective colour that generates positive emotion followed by red with mean score of 4.0488 and deviation standard of 0.66900. On the other hand, green prototype tends to generate neutral emotion to the respondents.

7 Conclusion and Suggestion

The research on colour design element of red, green, blue and yellow, and shape design element of round, angular and combination of round and angular in experiment one shows results as follow. The colours in design element that tend to generate positive emotion are blue The shape design elements that generates positive emotion is round Experiment two proves that the combination of colours applied in visual of interface system generating positive emotion is blue and red prototypes.

To design an interface mobile learning it is necessary to consider emotional aspects based on the results of design elements of colours and shades that potentially generate positive emotions in experiment one. It is also necessary to apply a guideline of designing interface mobile application. The application of emotional aspects such as colours and shapes in designing interface mobile learning are in the interface components such as the background, foreground and buttons.

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