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# Reason and Emotion: How They Drive Students to Play a Color Game

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**ABSTRACT**

Chromatics has been an important subject in design education since colors can make significant differences in the meanings and values of designed objects. However, only a few studies sought to assist students in learning chromatics, let alone to investigate their views on mobile game-based learning of this subject. To remedy these deficiencies, we firstly developed a color game to help students learn chromatics through color mixing. Then, drawing on reasonable and emotional factors, we designed a research model to investigate the students' decision-making about the game. After analyzing the feedbacks from a total of 205 students, this study showed that (1) perceived attractiveness was the most significant emotional factor behind the subjects' intention to play the game; (2) perceived usefulness was a reasonable factor that indirectly influenced the subjects' intention; (3) perceived enjoyment, as another emotional factor, exerted a significant and direct influence on the subjects' perceived usefulness. These findings indicated that emotional factors played not only a pivotal role in the subjects' intention to play the color game but also a leading one in their reasonable response to the game.

**Keywords:** color learning, mobile game, reasonable factor, emotional factor, intention

## INTRODUCTION

Chromatics has been recognized as one of the important subjects in design education (Holtzschue, 2011; Lányi, Kosztyán, Kránicz, Schanda, & Navvab, 2007). Colors have stimulating, calming, disturbing and symbolic functions and ergo may evoke our emotions (Holtzschue, 2011; Lányi et al., 2007). Besides, colors enable us to perceive meaningful information such as attractiveness, safety or danger (Gutsch, 2011). Accordingly, it is crucial for us to experience and interact with the objects we encounter in our daily lives through the mediation of colors. As a result, chromatics has been viewed as an indispensable tool in design education as the use of colors plays a vital role in determining the success of a product in the marketplace (Holtzschue, 2011).

Despite the significance of chromatics in design education, only a few studies tried to offer technology-based assistance for students to learn chromatics. A pioneering study was conducted by Lányi et al. (2007) in which a computer simulation system was developed to support students in understanding colors. They held that the traditional way of learning chromatics was inconvenient because it entailed paints or pigments. In view of this inconvenience, they developed an interactive simulation software with which students could learn chromatics by performing color experiments or color mixing. Similarly, Perge (2015) as well as Perge and Zichar (2015) built a multimedia system for students to learn various aspects of color theory. The system not only provided students with an introduction to color theory, but also enabled them to practice color mixing and matching.

Furthermore, the paradigm in technology-assisted learning has shifted from computer-based learning to mobile game-based learning (Huang & Huang, 2016). The latter not only possesses the advantage of mobile learning, but also allows students to carry out game-based learning. Kinzie and Joseph (2008) claimed that digital games have provided immersive and enjoyable virtual environments for students to achieve challenging targets by following a given set of rules. This means that students can manipulate virtual objects in the entertaining contexts created by


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**Contribution of this paper to the literature**

- This study develops a color game to help students learn chromatics through color mixing.
- The results show that perceived attractiveness is the most significant emotional factor behind the subjects' intention to play the game.
- The findings indicate that emotional factors played not only a pivotal role in the subjects' intention but also a leading one in their reasonable response to the game.

digital games, observing changes in those objects and thereby improve their own knowledge in an exciting way (Hwang & Chen, 2017). More importantly, such kind of educational games not only boost students' learning motivation and performance (Hwang & Wu, 2012), but also transform the traditional teacher-centered pedagogy into a student-centered one that facilitates students' engagement in effective learning (Hwang et al., 2013; Watson, Mong, & Harris, 2011). As technology improves every day, such kind of educational games have been gradually applied to mobile devices, insofar as to enable students to conduct game-based learning anytime and anywhere. Some studies also indicated that mobile games not only offer students multi-sensory (e.g. tactile, visual and auditory) experiences, but also motivate them to actively engage in immersive learning (Hung, Sun, & Yu, 2015). It is because the touchscreens of mobile devices serve as a congenial interface for students to intuitively interact with the virtual objects in the games simply by tapping and sliding on the screens with their fingertips (Hung et al., 2015).

Nowadays, examining students' intention to play educational games has become a vital issue due to the growing popularity of this type of games (Hong, Hwang, Chen, Lin, Huang, Cheng, & Lee, 2013; Hwang, Hong, Cheng, Peng, & Wu, 2013; Liao, Huang, & Wang, 2015). From the pedagogical perspective, such examinations are particularly important in integrating educational technology into learning for three reasons. First, they have been viewed as an important indicator for the success of any technology-assisted learning which depends heavily on students' intention to use the technology (Liu & Huang, 2015). Second, they help us understand students' response to the educational technology and facilitate the development of corresponding strategies to encourage students in using it (Huang, 2015; Tao, Cheng, & Sun, 2009; Wang & Huang, 2016). Third, they help developers grasp the insufficiency in terms of design and utilization of a specific educational technology, and then try to meet students' expectations by improving it (Huang, 2016, 2017; Liao et al., 2015). As a result, such examinations have been regarded as a vital step towards developing a new educational game (Liao et al., 2015; Tao et al., 2009).

Bearing these critical issues in mind, this study developed a color game to help students learn chromatics in an entertaining fashion and examined the key factors behind their intention to play the game. Then a questionnaire was designed to collect the students' opinions about the game. Finally, the collected data were analyzed to identify the factors that influenced the students' intention to play the game, according to which we offered some practical suggestions concerning the application and development of educational mobile games.

## COLOR GAME

The color game developed in this study is dedicated to helping students learn chromatics through color mixing, in which students can create a specific color by mixing primary colors. The methods of color mixing include additive and subtractive ones. The additive color mixing is usually performed by overlapping spotlights of red, green and blue colors. The subtractive color mixing is usually carried out by using paints and pigments of cyan, magenta and yellow colors. The latter was adopted as the principle of color mixing in this study, because it is a more common way to understand colors.

**Figure 1** is the main composition of the game. The scenario of the game is about a little witch who needs to process a variety of magic potions with the three primary colors represented in **Figure 1** by the three small pots that respectively produce bubbles in a random sequence. The player can mix the colors by clicking on these bubbles, and the big pot in **Figure 1** will show the result. The lollipop in **Figure 1** will randomly show the designated color, and the player will have to produce the designated color by mixing the three primary colors. The player will gain one point (shown on the upper left of the screen in **Figure 1**) if the result of color mixing is consistent with the designated color. The player can also refer to the color wheel in **Figure 1** when mixing colors. The color wheel is used to help students understand the relationships among different types of colors (i.e. primary, secondary and tertiary colors). For example, the secondary color, green, is created by mixing cyan and yellow. Students can ergo produce the designated color by utilizing the color wheel. In addition, the score will be raised (i.e. the Combo value) and reward or punishment may be evoked when the player produces correct colors for five consecutive times within the prescribed time frame. The reward and punishment will pop up on the screen randomly and temporarily. The player needs to identify whether it is a reward or a punishment and decides to click on it or not in a timely manner. The score will be reduced if the player mistakenly clicks on a punishment, while the time frame

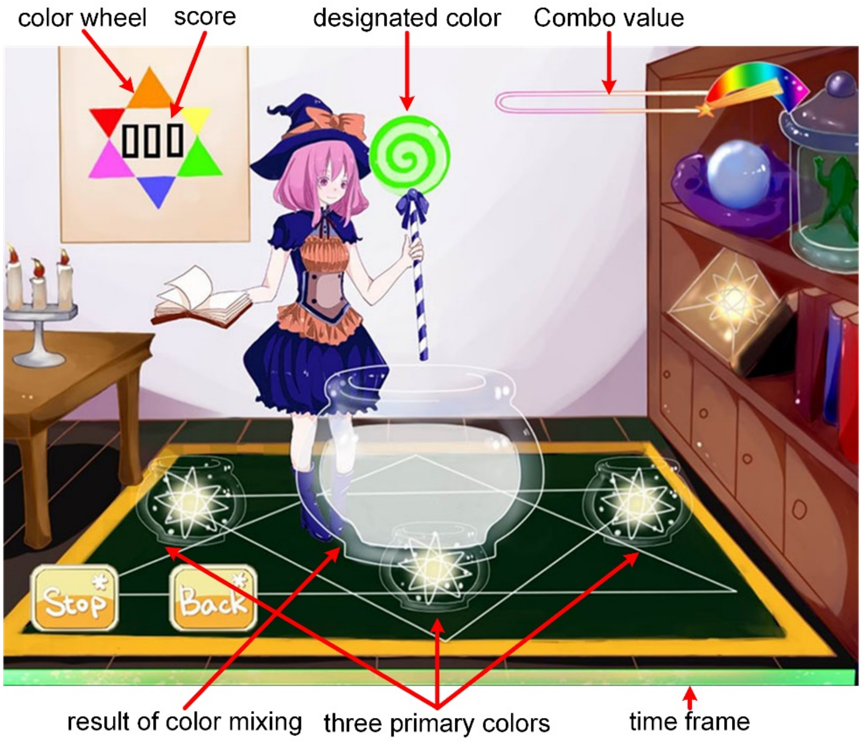
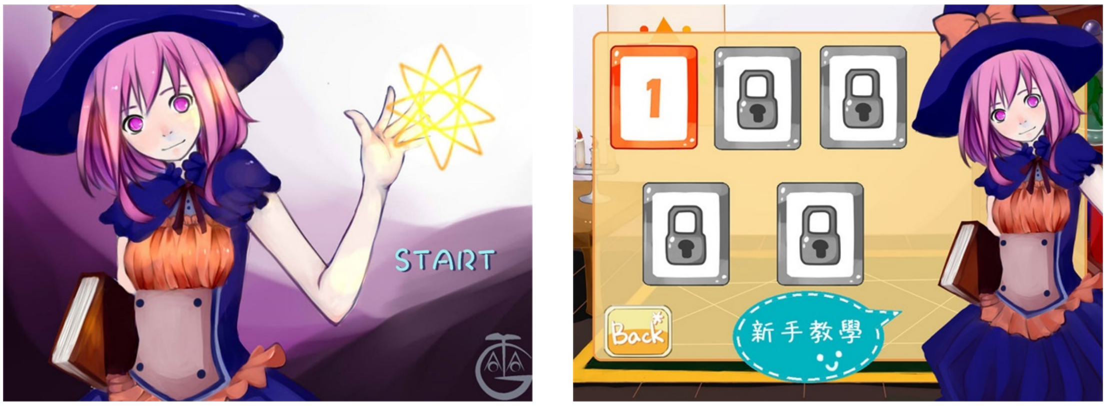



**Figure 1.** The main composition of the game

for going through this level will be extended if the player clicks on a reward. Finally, each level has a 60-second time frame to alert the player to the time limit. In other words, each level's termination condition is 60 seconds within which the player must complete correct color mixing as many times as possible to go through the level.

**Figure 2 (a)** is the main menu of the game. The player can enter the game by clicking on START. **Figure 2 (b)** shows the five levels of the game designed to be unlocked by the player. Specifically speaking, the player must go through the first level before they reach the following ones in a numerical order. Level 1 provides the player with basic practice of secondary color mixing, while Level 2 adds in a reward/punishment mechanism in addition to the practice of secondary color mixing. A reward or punishment will be evoked randomly when the player produces correct colors for five consecutive times. Level 3 provides the player with basic practice of tertiary color mixing, while Level 4 adds in a reward/punishment mechanism besides the practice of tertiary color mixing. A reward or punishment will be brought forth randomly when the player produces correct colors for five consecutive times. Level 5 requires the player to complete secondary or tertiary color mixing according to which a reward or punishment will be invoked, which renders it the most difficult of all the five levels. Going through these levels, the player may practice secondary and tertiary color mixing, and thereby know colors and their qualities in a progressive way.

**Figure 3** is a color mixing example of the game. **Figure 3 (a)** shows the designated color green and three bubbles of primary colors. The player thus needs to produce green color by clicking on the cyan and yellow bubbles. **Figure 3 (b)** shows that the cyan color appears in the big pot as soon as the cyan bubble bursts when the player clicks on it. **Figure 3 (c)** shows that the green color appears in the big pot immediately after the yellow bubble bursts when the player clicks on it. This means that the player gains one point and the Combo value increases to one. Within the prescribed time frame, the player has to produce the designated colors that appears continuously by clicking on the primary color bubbles and referring to the color wheel. Hence, the player can learn the knowledge of color mixing and understand the composition of different colors in the game-playing process.




(a) (b)

**Figure 2.** The menu of the game a) the main menu of the game b) the five levels of the game

(a) (b) (c)

**Figure 3.** An example of color mixing a) Designated color (green) appears b) The player clicks on the cyan bubble at first c) The player then clicks on the yellow bubble

## RELATED STUDIES

Raised by the studies on user acceptance of technology (Bourgonjon, De Grove, De Smet, Van Looy, Soetaert, & Valcke, 2013; Hong et al., 2013; Hwang et al., 2013; Tao et al., 2009), students' intention to use educational games has become an issue to be reckoned with in the field of educational technology. The purpose of such investigations is to identify what factors may influence users' intention to use a technology. Their results of these investigations can help researchers design and develop a more acceptable technology. More specifically, such investigations are usually conducted by using the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975), the theory of planned behavior (TPB) (Ajzen, 1985, 1991), or the technology acceptance model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) as the theoretical basis. Early on, the TRA was developed by Fishbein and Ajzen (1975) who proposed that attitude and subjective norm directly and significantly affect users' behavioral intention, which in turn affects their actual behavior. Attitude refers to "a person's general feeling of favorableness or unfavorableness toward a given stimulus object" (Fishbein & Azjen, 1975: 216). Subjective norm refers to "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Azjen, 1975: 302). Behavioral intention refers to "a person's subjective probability that he will perform some behavior" (Fishbein & Azjen, 1975: 288). Later, developed by Ajzen (1985, 1991), the TPB added perceived behavioral control to the TRA, in which perceived behavioral control is postulated to directly and significantly affect behavioral intention and actual behavior. Perceived behavioral control refers to "people's perception of the ease or difficulty of performing the behavior of interest" (Ajzen, 1991: 183). Similarly, developed by Davis and his peers (Davis, 1989; Davis et al., 1989), the TAM added perceived ease of use and perceived usefulness to as well as removed subjective norm from the TRA. As a result, the TAM includes four constructs, that is, perceived ease of use, perceived usefulness, attitude toward using, and behavioral intention. Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free from effort" (Davis 1989: 320), and perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989: 320). Attitude toward using refers to a person's general feeling of favorableness or unfavorableness toward using a particular system (Fishbein & Azjen, 1975), and behavioral intention refers to a person's subjective probability that he will use a particular system (Fishbein & Azjen, 1975). Nowadays, the TAM has been widely viewed as a theoretical basis to examine the factors behind users' intention to use any given technology.

Due to the successful development of the TAM, perceived ease of play (which is similar to perceived ease of use) and perceived usefulness are frequently used as the reasonable determinants of students' intention to play educational games (Bourgonjon et al., 2013; Chinomona, 2013; Ho, Chang, & Lee, 2014; Hong et al., 2013; Hwang et al., 2013; Tao et al., 2009). One of the objectives of educational games is to provide entertainment for students, so that a good educational game must be easy to play rather than the player entails a lot of time learning to play it. Nevertheless, the ease of play refers not so much to that the levels of the game are easy to walk through as to that the rules of the game are easy to understand. That is to say, students can play and immerse themselves in the game easily (Chinomona, 2013; Ho et al., 2014), advancing their skills by overcoming the challenges posed in the game. Facilitating students' learning activity is another objective of educational games, so a good educational game must perform this function. Perceived usefulness is thus widely recognized as a reasonable factor in designing educational games. For example, Tao et al. (2009) used the TAM and other theories to develop a research model on students' intention to play business simulation games, since such games have been increasingly applied to business and management institutions. Their research findings showed that perceived ease of use and perceived usefulness indirectly affected students' satisfaction, which in turn influenced their intention to continuously play these games. Similarly, Hong et al. (2013) and Hwang et al. (2013) developed two educational games to assist students in learning Chinese and engaging in museum learning. They further examined students' perspectives on the two games in terms of perceived ease of play and perceived usefulness. Hong et al. (2013) found that perceived ease of play indirectly affected students' intention to visit the science museum, while Hwang et al. (2013) showed that perceived ease of play directly influenced students' perceived usefulness, which in turn affected their attitude toward playing the game.

On the other hand, emotional factors such as perceived attractiveness and perceived enjoyment have also been increasingly employed to examine students' intention to play educational games. Perceived attractiveness refers to the visual and acoustic appeals of a game (Ha, Yoon, & Choi, 2007). Perceived enjoyment refers to the degree to which the activity of playing a game is perceived as enjoyable in its own right, apart from any performance consequences that may be anticipated (Davis, Bagozzi, & Warshaw, 1992). Previous studies have proved the roles of the two emotional factors as crucial in affecting players' intention to play games (Ha et al., 2007; Merhi, 2016; Tao et al., 2009; Tao, Cheng, & Sun, 2012). On a more specific basis, players being willing to play a game implies that they are attracted by the game in general and by its interface, chromatic combination or incidental music in particular. To put it differently, it means that the players have a positive first impression of the game. They find delight in playing the game and are therefore willing to immerse themselves in the learning environment it created. In sum, perceived attractiveness serves to spark players' curiosity or interest in playing a specific game, and perceived enjoyment relays the former's influence by bringing players continuous delight or excitement during the game. As a result, perceived attractiveness and perceived enjoyment have been gradually identified as main determinants of players' intention to play a digital game. For example, Ha et al. (2007) employed perceived attractiveness, perceived enjoyment and other factors to develop an extended TAM to explore players' perspectives on mobile games. Their research findings indicated that perceived attractiveness and perceived enjoyment exerted direct influences on players' attitude toward playing mobile games. Tao et al. (2009, 2012) also developed an extended TAM by integrating perceived attractiveness, perceived enjoyment (defined as perceived playfulness in their study) and other factors to examine students' intention to use business simulation games. They found that perceived attractiveness not only directly influenced perceived enjoyment, but also indirectly affected perceived enjoyment through the mediation of perceived ease of use and perceived usefulness.

However, the influence of reasonable and emotional factors on students' intention with regard to educational games have so far received little scholarly attention, despite the considerable effort devoted to this field. Specifically speaking, educational games should offer students not only knowledge but also enjoyment during the game-playing process. In other words, a good educational game facilitates students' learning activity and brings them enjoyment. The literature review illustrated that the reasonable factors embedded in educational games contribute to students' easy and useful learning, and the emotional factors embedded in the games help students learn with attractiveness and enjoyment. However, there is a general lack of knowledge about the relative significance of reasonable and emotional factors to students when they play educational games. To close this gap, this study developed a research model by incorporating the two types of factors, aiming to assess the influence of reasonable and emotional factors on students' intention to play educational games.

# RESEARCH DESIGN

## Research Model and Hypotheses

**Figure 4** shows the research model developed on the basis of the literature review in section 3. This model contributes to the growing field of study on students' intention to play educational games by introducing and

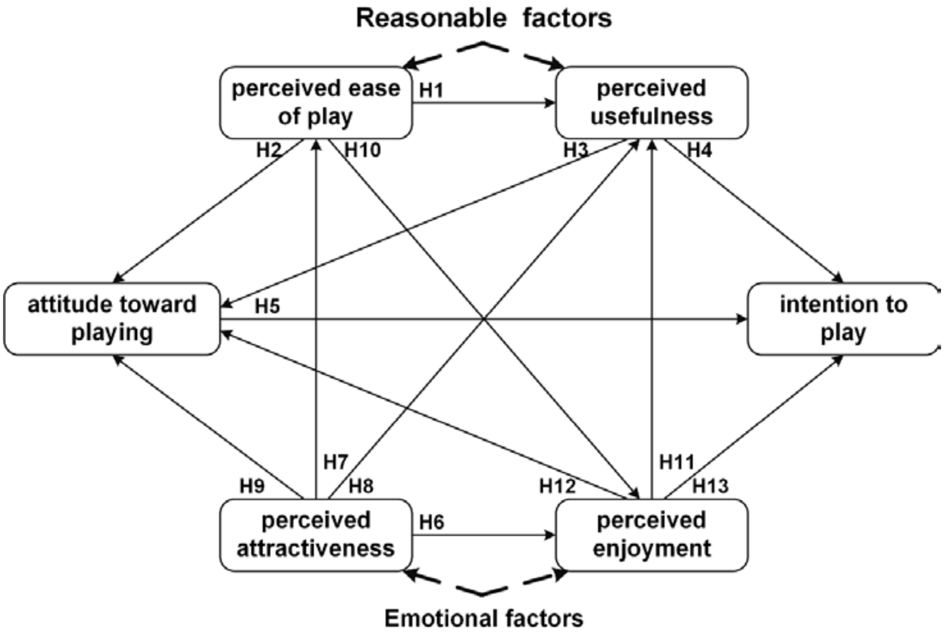



**Figure 4.** Research model

comparing the effect of reasonable and emotional factors on students' intention concerning color games. The model consists of thirteen hypotheses explained in detail below.

Perceived ease of play and perceived usefulness have been identified as important determinants of attitude toward playing and intention to play, and the relationships among these constructs have been widely examined (Bourgonjon et al., 2013; Chen & Lin, 2016; Ha et al., 2007; Ho et al., 2014; Hwang et al., 2013). These studies showed that users tend to think a game as enjoyable or beneficial to their learning when it is easy to play, namely they need not to spend too much time and energy understanding how to play the game. Then, they will have a positive attitude toward the game when they regard it as useful for their learning. Finally, their positive attitude toward the game will exert a significant influence on their intention to play it. For example, Ha et al. (2007) found that perceived ease of play (i.e., perceived ease of use) directly and significantly affects perceived usefulness and attitude toward playing. Later, Hwang et al. (2013) indicated that perceived usefulness directly and significantly influences attitude toward playing, while Bourgonjon et al. (2013) as well as Chen & Lin (2016) found that perceived usefulness directly and significantly affects intention to play. In addition, Ho et al. (2014) showed that attitude toward playing plays a mediating role that directly and significantly affects intention to play. Accordingly, the first five hypotheses are formulated as follows:

**H1.** Perceived ease of play positively affects perceived usefulness.

**H2.** Perceived ease of play positively affects attitude toward playing.

**H3.** Perceived usefulness positively affects attitude toward playing.

**H4.** Perceived usefulness positively affects intention to play.

**H5.** Attitude toward playing positively affects intention to play.

Perceived attractiveness and perceived enjoyment have also attracted greater academic attention. Studies have started to investigate the two emotional factors' relationships with perceived ease of play, perceived usefulness, attitude toward playing and intention to play. Their research findings suggested that users tend to regard a game as entertaining, easy to play and helpful for their learning when they find its audio-visual effect fascinating, and they will have a positive attitude toward the game. In other words, perceived attractiveness has a direct influence on perceived enjoyment, perceived ease of play, perceived usefulness, and attitude toward playing at the beginning (Ha et al., 2007; Merhi, 2016; Tao et al., 2009). These studies also demonstrated that, in addition to its audio-visual effect, the ease of play of a game will influence its attractiveness. When users find delight in playing a game, they tend to believe that the game will facilitate their learning or bring them enjoyment. They will have a positive attitude toward the game and are willing to play it. That is to say, perceived attractiveness and perceived easy of play directly influence perceived enjoyment (Ha et al., 2007; Tao et al., 2009), while perceived enjoyment directly affects perceived usefulness, attitude toward playing, and intention to play (Ha et al., 2007; Merhi, 2016). Accordingly, the last eight hypotheses are formulated as follows:

**Table 1.** The final questionnaire

| Construct | Item | Reference |
|---|---|---|
| Perceived ease of play | (PEP1) I think that the game is easy to play.<br>(PEP2) It is easy for me to familiarize myself with the game.<br>(PEP3) It is easy for me to handle the game. | Hong et al., 2013; Huang, 2015 |
| Perceived usefulness | (PU1) I think that the game is useful to assist me in learning color mixing.<br>(PU2) I think the game makes me more interest to learn color mixing.<br>(PU3) If I use the game to learn color mixing, I can learn better. | Huang, 2015; Hwang et al., 2013 |
| Perceived attractiveness | (PA1) I am attracted by the visual appeal of the game.<br>(PA2) I am attracted by the acoustic appeal of the game.<br>(PA3) I am attracted to the game as a whole. | Tao et al., 2009 |
| Perceived enjoyment | (PE1) I feel that the game is interesting.<br>(PE2) I feel that the game is exciting.<br>(PE3) I feel that the game is pleasant. | Zhou, 2011 |
| Attitude toward playing | (AT1) I am interested in playing the game.<br>(AT2) I like using the game to learn color mixing.<br>(AT3) Playing the game is the best way to learn color mixing. | Huang, 2015; Hwang et al., 2013 |
| Intention to play | (IP1) I will recommend others to play the game.<br>(IP2) I predict I would play the game in the future. | Huang, 2015 |

**H7.** Perceived attractiveness positively affects perceived ease of play.

**H8.** Perceived attractiveness positively affects perceived usefulness.

**H9.** Perceived attractiveness positively affects attitude toward playing.

**H10.** Perceived ease of play positively affects perceived enjoyment.

**H11.** Perceived enjoyment positively affects perceived usefulness.

**H12.** Perceived enjoyment positively affects attitude toward playing.

**H13.** Perceived enjoyment positively affects intention to play.

### Participants

The subjects recruited by using the convenience sampling method were students from the department of multimedia design of a university in Tainan, Taiwan. Specifically, these students have a general need to learn color mixing and they were informed about the purpose of this study by their teacher beforehand. A total of 205 students volunteered to participate in this study.

### Measurement

In order to collect the data on the subjects' perspectives of the proposed color game, a structured questionnaire was developed on the basis of an extensive review of previous studies (Hong et al., 2013; Huang, 2015; Hwang et al., 2013; Tao et al., 2009; Zhou, 2011). The questionnaire has six constructs, including perceived ease of play, perceived usefulness, perceived attractiveness, perceived enjoyment, attitude toward playing, and intention to play. **Table 1** shows the final questionnaire distributed to the subjects who were asked to give their level of agreement or disagreement with the items using a seven-point Likert scale.

### Experimental Procedure

The experiment in this study proceeded in three phases. In the first phase, we recruited students who were willing to participate in this study, since the game has not yet been incorporated into the formal curriculum. The teacher had to explain the purpose of this study and introduce the color game to students. Those who were interested in participating then registered with their teacher. In the second phase, the teacher introduced the goals and rules of the color game to the subjects and showed them how to play it before they began to play the game. These subjects were required to go through as many levels as possible, and they were allowed to ask for the teacher's advice if they had any question regarding playing the game. In the last phase, the subjects were asked to fill in a questionnaire indicating their opinions on the game right after they finished playing it.

## RESULTS

The partial least squares (PLS) approach was adopted to analyze the data collected from the questionnaire, in which its minimum sample size was determined by "10 times" rule. Specifically, the sample size should be much

**Table 2.** The item loadings of the measurement model

| Construct | Items | Loading | Standard error | T-value |
|---|---|---|---|---|
| Perceived ease of play | PEP1 | 0.91 | 0.02 | 50.06 |
| | PEP2 | 0.94 | 0.01 | 75.91 |
| | PEP3 | 0.92 | 0.01 | 64.14 |
| Perceived usefulness | PU1 | 0.92 | 0.01 | 63.59 |
| | PU2 | 0.94 | 0.01 | 76.78 |
| | PU3 | 0.95 | 0.01 | 140.37 |
| Perceived attractiveness | PA1 | 0.86 | 0.02 | 37.46 |
| | PA2 | 0.89 | 0.02 | 41.97 |
| | PA3 | 0.89 | 0.02 | 38.46 |
| Perceived enjoyment | PE1 | 0.95 | 0.01 | 104.85 |
| | PE2 | 0.94 | 0.01 | 91.33 |
| | PE3 | 0.95 | 0.01 | 72.00 |
| Attitude toward playing | AT1 | 0.94 | 0.01 | 102.07 |
| | AT2 | 0.95 | 0.01 | 90.63 |
| | AT3 | 0.94 | 0.01 | 70.20 |
| Intention to play | IP1 | 0.98 | 0.01 | 215.51 |
| | IP2 | 0.97 | 0.01 | 190.42 |

**Table 3.** The reliability of measures and convergent validity of the measurement model

| Construct | Reliability | | Convergent validity |
|---|---|---|---|
| | Composite reliability | Cronbach's alpha | AVE |
| Perceived ease of play | 0.94 | 0.91 | 0.85 |
| Perceived usefulness | 0.96 | 0.93 | 0.88 |
| Perceived attractiveness | 0.91 | 0.85 | 0.77 |
| Perceived enjoyment | 0.96 | 0.94 | 0.90 |
| Attitude toward playing | 0.96 | 0.94 | 0.89 |
| Intention to play | 0.97 | 0.95 | 0.95 |

larger than ten times the number of items for the most complex construct, or the sample size should be much larger than ten times the largest number of independent variables that a dependent variable involved (Chin, 1998; Marcoulides & Saunders, 2016). In this study, the most complex constructs such as perceived ease of play involved 3 items, and attitude toward playing was the dependent variable involving the largest number of independent variables (i.e., 4 independent variables). As a result, the minimum sample size of this study should be 30, which was way exceeded by the actual one (205). In this study, the SmartPLS 3 software was applied to perform the PLS, which includes the measurement model and the structural one.

## Measurement Model

This study assessed the measurement model in terms of item loadings, reliability of measures, convergent validity, and discriminant validity. An item would be viewed as reliable if its loading is greater than 0.70 (Chin & Newsted, 1999). The reliability of measures was evaluated by composite reliability with its minimum value of 0.7 and Cronbach's alpha with its minimum value of 0.6 (Hair, Black, Babin, Anderson, & Tatham, 2006). We employ the average variance extracted (AVE) to assess the convergent validity, and the value has to exceed the standard minimal level of 0.5 to make the assessment significant and acceptable (Hair et al., 2006). The discriminant validity was assessed by the square root of AVE and latent variable correlations. To make the assessment significant and acceptable, each construct's square root of AVE must exceed its correlation coefficient with the other constructs in the model (Fornell & Larcker, 1981). In addition, the discriminant validity was also assessed by examining the loadings of each item that should be more than their cross-loadings on all other constructs. **Tables 2**, **3**, **4**, and **5** indicate that the results delivered by the measurement model are significant and acceptable, since all the values meet the required standards.

**Table 4.** The discriminant validity of the measurement model

| | | Discriminant validity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Latent variable correlations | | | | | |
| **Construct** | | **1** | **2** | **3** | **4** | **5** | **6** |
| Perceived ease of play | 1 | 0.92 | | | | | |
| Perceived usefulness | 2 | 0.72 | 0.94 | | | | |
| Perceived attractiveness | 3 | 0.63 | 0.73 | 0.88 | | | |
| Perceived enjoyment | 4 | 0.57 | 0.79 | 0.85 | 0.95 | | |
| Attitude toward playing | 5 | 0.63 | 0.88 | 0.79 | 0.83 | 0.95 | |
| Intention to play | 6 | 0.57 | 0.80 | 0.77 | 0.81 | 0.87 | 0.97 |

**Table 5.** The cross-loadings of the measurement model

| | Perceived ease of play | Perceived usefulness | Perceived attractiveness | Perceived enjoyment | Attitude toward playing | Intention to play |
|---|---|---|---|---|---|---|
| PEP1 | **0.91** | 0.64 | 0.58 | 0.54 | 0.56 | 0.50 |
| PEP2 | **0.94** | 0.67 | 0.59 | 0.53 | 0.60 | 0.54 |
| PEP3 | **0.92** | 0.67 | 0.56 | 0.51 | 0.59 | 0.52 |
| PU1 | 0.74 | **0.92** | 0.68 | 0.70 | 0.75 | 0.71 |
| PU2 | 0.63 | **0.94** | 0.69 | 0.75 | 0.86 | 0.76 |
| PU3 | 0.67 | **0.95** | 0.69 | 0.76 | 0.85 | 0.77 |
| PA1 | 0.54 | 0.64 | **0.86** | 0.69 | 0.68 | 0.68 |
| PA2 | 0.53 | 0.61 | **0.89** | 0.70 | 0.67 | 0.66 |
| PA3 | 0.58 | 0.68 | **0.89** | 0.83 | 0.73 | 0.70 |
| PE1 | 0.57 | 0.77 | 0.81 | **0.95** | 0.79 | 0.75 |
| PE2 | 0.49 | 0.69 | 0.79 | **0.94** | 0.76 | 0.76 |
| PE3 | 0.57 | 0.78 | 0.81 | **0.95** | 0.82 | 0.78 |
| AT1 | 0.59 | 0.81 | 0.78 | 0.80 | **0.94** | 0.86 |
| AT2 | 0.59 | 0.85 | 0.73 | 0.80 | **0.95** | 0.84 |
| AT3 | 0.62 | 0.83 | 0.75 | 0.76 | **0.94** | 0.78 |
| IP1 | 0.57 | 0.79 | 0.78 | 0.80 | 0.86 | **0.98** |
| IP2 | 0.53 | 0.76 | 0.72 | 0.77 | 0.85 | **0.97** |

## Structural Model

Based on the path coefficients and the $R^2$ values, the structural model was employed to test the hypotheses formulated in this study. The path coefficients served as the indicator for the statistical significance of the hypotheses, and the $R^2$ values indicated the model's ability in explaining the variation in the dependent variables (Chin & Newsted, 1999). **Figure 5** shows the results of the structural model that highlighted the rejection of H2, H4, H8 and H10, and confirmed the other nine hypotheses. It also illustrates that this model explained 39% of the variation in perceived ease of play, 73% in perceived usefulness, 72% in perceived enjoyment, 83% in attitude toward playing, and 79% in intention to play.

This research summarized the direct, indirect, and total effects of each construct on continuance intention and attitude toward using in **Table 6** to facilitate the exploration of the factors that significantly predispose the students to play the color game. **Table 6** shows that (1) perceived attractiveness is the most significant factor behind intention to play, and attitude toward playing has the most direct influence on intention to play; (2) perceived attractiveness is also the most significant factor behind attitude toward playing, and perceived usefulness, followed by perceived enjoyment, has the most direct influence on attitude toward playing; (3) perceived enjoyment, followed by perceived ease of play, has the most significant and direct influence on perceived usefulness; and (4) perceived attractiveness has the most significant and direct influence on both perceived enjoyment and perceived ease of play.

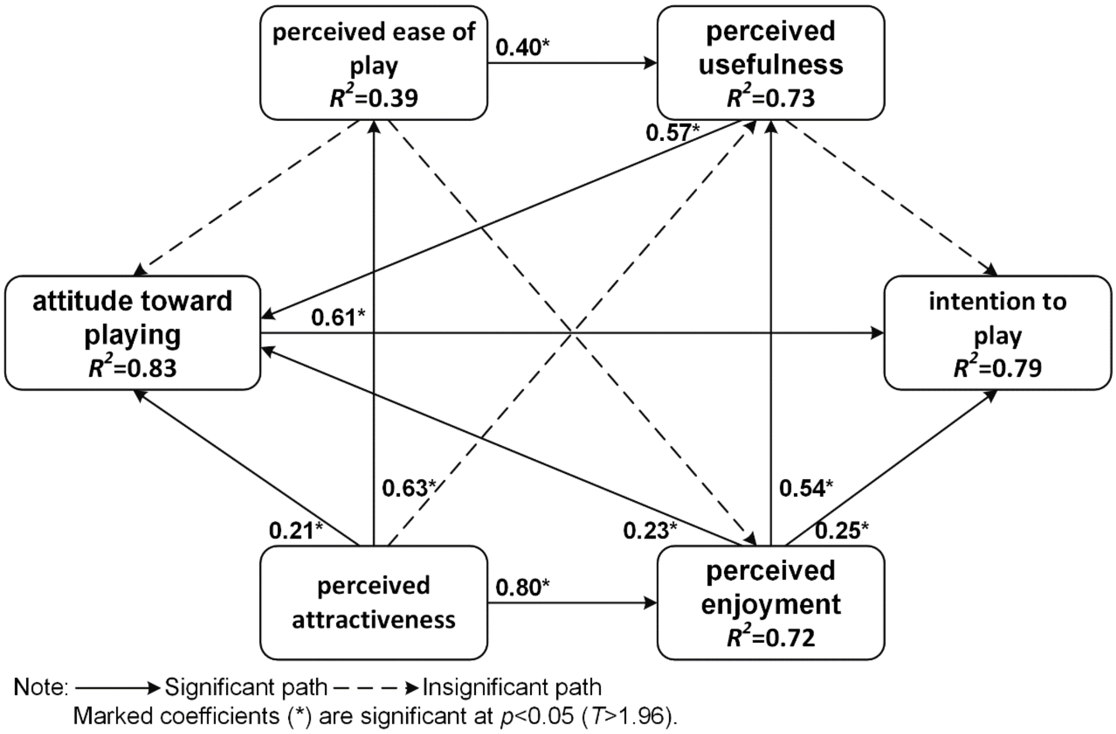



**Figure 5.** The results of the structural model

**Table 6.** The direct, indirect, and total effects of the research model

| Dependent variable | Independent variables | Indirect effects | Direct effects | Total effects |
|---|---|---|---|---|
| intention to play | perceived ease of play | 0.14 | - | 0.14 |
| | perceived usefulness | 0.35 | non-significant | 0.35 |
| | perceived attractiveness | 0.68 | - | 0.68 |
| | perceived enjoyment | 0.33 | 0.25 | 0.58 |
| | attitude toward playing | - | 0.61 | 0.61 |
| attitude toward playing | perceived ease of play | 0.23 | non-significant | 0.23 |
| | perceived usefulness | - | 0.57 | 0.57 |
| | perceived attractiveness | 0.57 | 0.21 | 0.78 |
| | perceived enjoyment | 0.31 | 0.23 | 0.54 |
| perceived usefulness | perceived ease of play | non-significant | 0.40 | 0.40 |
| | perceived attractiveness | 0.68 | non-significant | 0.68 |
| | perceived enjoyment | - | 0.54 | 0.54 |
| perceived enjoyment | perceived ease of play | - | non-significant | - |
| | perceived attractiveness | non-significant | 0.80 | 0.80 |
| perceived ease of play | perceived attractiveness | - | 0.63 | 0.63 |

## DISCUSSIONS

**Table 6** demonstrates the first finding of this research; that is, perceived attractiveness is the most significant yet indirect factor behind attitude toward playing and intention to play. Specifically speaking, the perceived attractiveness of the color game exerted a significant and indirect influence on the subjects' attitude toward playing and intention to play it. This was a very important finding, since it remedied the deficiency of previous studies that focused simply on the direct influence of perceived attractiveness on perceived ease of play, perceived usefulness, perceived enjoyment, or attitude toward playing, but ignored the indirect influence of perceived attractiveness on attitude toward playing and intention to play (Ha et al., 2007; Merhi, 2016; Tao et al., 2009). Our analysis demonstrated that perceived attractiveness is not so much the most significantly direct factor as the most significantly indirect one behind attitude toward playing and intention to play. It implied that the audio-visual effect of a game does not wield a significantly direct influence but a significantly indirect one on students' attitude toward the game and their intention to play it. For instance, the fabulous scene of a game is not the determinant of students' positive attitude toward playing because the game might be boring at all or it might be difficult to play. Nevertheless, the fabulous scene will definitely bring students enjoyment and thereby fosters their positive attitude toward it or enhances their intention to play it. The result is in general consistent with that of human emotion studies, namely people's emotions significantly shaped their decisions (Donovan & Rossiter, 1982; Zaltman, 1995), and perceived attractiveness is one of the key factors that influence their emotions (Ha et al., 2007; Tao et al., 2009).

**Table 6** also shows the second intriguing finding of this study; that is, perceived usefulness has the most significant and direct influence on attitude toward playing rather than on intention to play, which made attitude toward playing the most significant and direct factor behind intention to play. This implies that the usefulness of a game does not directly influence students' intention to play it, but achieves it by significantly and directly affecting students' attitude toward the game. This result contradicted those of most previous studies (Bourgonjon et al., 2013; Davis, 1989; Davis et al., 1989; Huang, 2017), that is, perceived usefulness is simultaneously an indirect (through the mediation of attitude toward playing) and direct factor behind intention to play a game. A plausible explanation for this is that students regard the game as entertaining rather than educational in nature, which is why its usefulness in learning does not directly influence their intention to play it. Nonetheless, its usefulness still fosters students' positive attitude toward it, because, comparing with other entertainment-oriented games, it has additional value in terms of learning chromatics. As a result, its usefulness will significantly influence students' attitude toward it. From the perspective of motivation theory, perceived usefulness belongs to the category of extrinsic motivation, meaning that individuals carry out an action because they perceive it as useful to acquire a valued outcome that is distinct from the action itself (Davis et al., 1992; Huang, 2017; Ryan & Deci, 2000). The subjects were recruited to play the color game, which implied that this game has not yet included in their curriculum. This fact unfortunately led to a general lack of extrinsic motivation among the subjects because they deemed the game as unnecessary to their learning of color mixing, which was why their perceived usefulness of the game had no significant influence on their intention to play it.

The third finding of this study revealed by **Table 6** is that perceived enjoyment is the most significant and direct factor behind perceived usefulness. It implies that students will believe the game as beneficial to their learning when they enjoy the game-playing process. Flow theory and cognitive dissonance theory explain such a result. According to flow theory (Csikszentmihalyi, 1975; Koufaris, 2002), the term "flow" refers to "the holistic sensation that people feel when they act with total involvement." In more specific terms, people tend to immerse themselves totally in the activity without noticing irrelevant things. This is the so-called "flow state" in which people gain the optimal experience. According to cognitive dissonance theory (Festinger, 1976), people have the predisposition to rationalize their behavior for the purpose of avoiding uncomfortable feelings. Cognitive dissonance is a psychological state referring to the sense of discomfort caused by two contradictory beliefs, ideas, or values, and one of them will be discarded or modified so as to solve the mental conflict and achieve internal consistency. For example, people will suffer from cognitive dissonance when they loathe working overtime but have to do so. They will begin to rationalize their behavior of working overtime, say, making more money, to mitigate the impact of their cognitive dissonance. Accordingly, the subjects in this study also tried to rationalize their behavior of playing the color game when they found it enjoyable and invested significant effort in playing it, which is to say, they believed that playing the game is useful for their learning because they were informed at the beginning that the objective of the game is to help them learn chromatics.

## CONCLUSIONS

This study firstly developed a color game to help students learn chromatic. The game was based on the knowledge of color mixing, and the subjects were required to produce the designated colors in a limited time frame. The subjects could refer to the color wheel when mixing colors, through which they understood that all colors are derived from the three primary ones. Subsequently, this study established a research model that incorporated reasonable and emotional factors to investigate the influences of these factors on the subjects' intention to play the game. The research findings showed that (1) perceived attractiveness was the most significant emotional factor behind the subjects' intention to play the game; (2) perceived usefulness was a reasonable factor that indirectly (i.e. through their attitude toward playing) influenced the subjects' intention to play the game; (3) perceived enjoyment, as another emotional factor, was the most significant and direct factor behind the subjects' perceived usefulness. To sum up, we expected this study to contribute to the body of literature by (a) designing a color mixing game to assist students in learning chromatics; (b) developing a systematic model that integrates reasonable and emotional factors to investigate students' intention of playing the game; (c) revealing the fact that emotional factors wielded the most significant influence on students' intention to play the color game, and reasonable factors exerted the most direct and significant influence on their attitude toward playing the game.

The research findings of this study carried three major implications. Firstly, students' first impression of a game dictates their intention to play it. It implies that teachers should demonstrate the audio-visual effect of the game as much as possible when they plan to apply it to their teaching. A positive first impression leads to stronger intention to play the game. For educational game developers, the success of an educational game lies in students' intention to play it, and the game's audio-visual effect is vital to attract their attention. Hence, the developers need to take the game's audio-visual effect into account in addition to its effectiveness in facilitating students' learning activity. Otherwise the game will be unattractive no matter how useful it is for students.

Secondly, the usefulness of a game is not a direct factor behind students' intention to play it but a critical factor that indirectly influences students' intention through the mediation of their attitude toward it. In other words, the usefulness of the game does not directly influence students' intention to play it but will do so by fostering their positive attitude toward it. This implies that teachers should introduce both the learning and entertaining features of the game when they plan to apply the game in their teaching, because most students still understand games as entertaining tools rather than learning facilitators.

The final implication of this study is that the amusement quality of a game is the most significant factor behind its usefulness. For educational game developers, it implies that they should first of all give their games an entertaining effect, and learning effect second. Because, as far as students are concerned, the amusement quality of a game determines whether they view the game as useful or not. To put it differently, students' feelings of a game dictates their rational opinions about it. Based on this implication, a successful educational game must be designed from a sentimental perspective so as to evoke students' positive feelings of the game that prompt them to recognize its usefulness for their learning activity.

Although the research findings contribute to the development and application of mobile game-based learning in the field of design education, they do have some limitations. Firstly, the color game developed in this study focused only on learning the knowledge of color mixing. We plan to develop other color games that allow students to learn more about colors such as the change of light and shadows in our future research. Secondly, since the game has not been introduced into the formal curriculum yet, students' opinions about the game might sway as a consequence. On a more specific basis, students may have stronger extrinsic motivation because they want to pursue higher learning achievement after the game being applied to the course. In this case, reasonable factors such as perceived usefulness may become a more important factor behind students' intention to play the game. In our future research, we plan to identify the key factors that influence students' intention to play the game when it is introduced into the formal curriculum. Third, this study focused only on the investigation of students' initial intention rather than continuance intention. In fact, the latter has gradually replaced the former as the focus of investigations on students' acceptance of educational technology, because students would discontinue their usage if they are dissatisfied with the technology even though they accepted it in the first place. In our future research, we plan to construct a systematic model to investigate students' continuance intention to play the color game. Fourth, this study was conducted in Taiwan, in which all the subjects were from the same cultural background. This means that the samples used in this study were drawn from a relatively homogeneous group. In our future research, we plan to select students from different cultural backgrounds as the sample candidates, so as to investigate whether cultural differences have any influence on students' intention to play the game. Finally, this study focused only on the students in the same department without examining whether their backgrounds such as age, gender, specialty and learning style may influence their intention to play the color game. Accordingly, there is a continuing need for a larger sample and additional consideration on students' backgrounds to strengthen and advance the arguments developed in this study.

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