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Effects of the Design Factors of Skill Training Games on Learning Performance and Emotion: English-Language Typing Games

技能型訓練遊戲的遊戲設計要素對於學習成效與情緒的影響：以英文打字遊戲為例

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【摘要 Abstract】

Skill training games are one kind of educational games, but they differ from the educational games that aim at promoting cognitive or affective effects. The design of skill training games

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prioritizes assisting learners to learn facts and knowledge and train learners in some skill via repetition and practice. To design a skill training game that supports effective learning, one must explore how the key design factors, including concentration, feedback, challenge that matches player skills, control, and immersion, affect learning performance and emotions. Thus, this study chose two online English typing game sites with significantly different game design factors to investigate the effects of game design factors on the emotions and learning performance of users. Moreover, correlations among game factors, emotions and learning performance of users were explored. The group using Fast Typing Master (FTM) had significantly higher evaluation scores in five design factors than the group using Internet Typing Classroom (ITC). Analytical results show that both sites yielded the same learning performance. However, the FTM site was superior to the ICT in terms of learning performance for males, but no significant difference existed for female learners. Moreover, this study further confirmed that the FTM leaded to significantly more negative emotion for the female learners than the ITC, but no significant difference existed for male learners. The game factor of feedback was significantly correlated with emotion and learning performance of users under most of the considered grouping conditions. Therefore, this study suggests that the most important design factor in English-language typing games is the feedback mechanism. Research results provide valuable references for game designers developing skill training games, and further clarify what is the most important factor in the games.

技能訓練遊戲為教育遊戲的一種，但是有別於提升認知及情意面向的教育遊戲。技能型訓練遊戲的設計目的在於輔助學習者學習事實與知識，以及幫助學習者透過重複性的訓練而習得有用的技能。本研究主張要設計能夠有效支援學習的教育遊戲，必須探究包括專注力、回饋、符合玩家技能挑戰性、控制感及沉浸度等遊戲設計要素如何影響學習成效與情緒。因此，本研究選擇快打高手（Fast Typing Master, FTM）及網路打字教室（Internet Typing Classroom, ITC）兩款在上述五種遊戲設計要素上具有顯著差異的線上英語打字訓練遊戲，探究其遊戲設計要素對於學習成效與情緒的影響。此外，本研究亦探究遊戲設計要素、學習成效與情緒彼此之間的關聯。結果顯示 FTM 在五個遊戲設計要素上均顯著高於 ICT，並且兩款打字遊戲均具有顯著學習成效。然而 FTM 在男性學習者上的學習成效上顯著優於採用 ICT 的男性學習者，但是女性學習者採用這兩款遊戲在學習成效上則無顯著差異。此外，FTM 導致女性學習者產生明顯較高的負面情緒，但是男性學習者採用這兩款遊戲之情緒則無顯著差異。重要的是遊戲設計要素中的回饋顯著相關於學習成效與情緒。因此，本研究歸納回饋為英語打字訓練遊戲最重要的遊戲設計要素。本研究之研究結果提供發展技能型教育遊戲有價值的設計參考，也歸納得出技能型遊戲最重要的遊戲設計要素。

Keyword 關鍵詞

educational game；skill training game；game design factor；learning performance；positive emotion；negative emotion；gender difference；physiological signals

教育遊戲 技能訓練遊戲 遊戲設計要素 學習成效 正面情緒 負面情緒 性別差異 生理訊號

Introduction

Playing digital games has become a common recreational activity for young people. Since well-designed educational games rely on some edutainment, game-based learning is widely used to promote learning performance and motivation (Keller, 1987; Sweetser & Wyeth, 2005; Kickmeier-Rust et al., 2005; Feinberg & Batson, 2006). Alessi and Trollip (1985) demonstrated that game-based learning can facilitate active participation and promote competitive learning. Moreover, when games are fun, game-based learning can increase the attention span of students, exceeding that associated with traditional instruction methods (Ellington, Adinall, & Percival, 1982; Alessi & Trollip, 1985). However, several studies (Brave & Nass, 2002; Norman, Ortony, & Russell, 2003; Laarni, 2004) indicated that emotions may change with design factors and emotional responses may promote or interfere with learning performance. Thus, how learners' emotions and learning performance are affected by game design factors is an important research issue.

Skill training games were developed to improve learning outcomes in terms of technical or motor skills (Garris, Ahlers, & Driskell, 2002; Liu, Lin, Yeh, Tsai, & Hwang, 2017). Typing skills particularly have become necessary in this digital landscape. Thus, improving typing skills is very important because it helps students control computers and complete tasks efficiently (Lin & Liu, 2009). Generally, typing games can be divided into drill-based and game-based software (Lin & Liu, 2009). To the best of our knowledge, no study has explored how the different design factors of typing training games, including concentration, feedback, challenge that matches player skills, control, and immersion, affect learning performance and emotions, as well as whether game factors are correlated with emotions and learning performance. Several studies (Durndell & Thomson, 1997; Whitely, 1997; Mitra *et al*., 2000; Chou & Tsai, 2007; Wang & Wang, 2008; Wang, Wu, & Wang, 2009; Vasileios & Economides, 2011) confirmed that gender differences exist in the behaviors, motivation, perception, acceptance, and attitudes in playing computer games. Also, computer skills and typing skills may affect the emotions and learning performance of learners. Thus, this study confirmed whether two typing skill game sites with significantly different game design factors generate different effects on emotions and learning performance for males and females, as well as whether correlations among game design factors, learners' emotions and learning performance exist.

To explore these research questions, the questionnaire enjoyment of e-learning games

(QEEG), which has satisfactory reliability and validity (Fu, Su, & Yu, 2009), was applied to assess differences in the game design factors of two English typing training games. Moreover, the emWave system (McCraty, Attinson, Tiller, Rein, &Watkins, 1995), which can recognize positive, peaceful, and negative emotional states using physiological signals, was employed to accurately identify the emotional states of learners. Research results provide valuable references for game designers seeking to develop effective typing training games, and further identify the most important factor in these games.

Literature Review

Game-based Learning and Skill Training Games

The current trend in modern education system emphasizes fun in learning. Ellington *et al*. (1982) argued that playing games can help students maintain their attention to the learning process. Alessi and Trollip (1985) indicated that games can promote the active participation of learners, as well as promote competitive learning. Many studies have confirmed that game-based learning can improve learning motivation and learning performance (Prensky, 2001; Asgari & Kaufman, 2004). Game-based learning has become popular in the education field. Kebritchi, Hirumi and Bai (2010) examined the effects of a computer game on students' achievement and motivation in mathematics. They demonstrated that the group of learners who played the game improved their math skills more significantly than the non-gaming group. Papastergiou (2009), who utilized digital game-based learning for a high school computer science class, indicated that game-based learning can effectively promote the knowledge of computer memory concepts of high school students and their learning motivation when compared with a non-gaming approach. According to Wen (2011), who investigated learners' goal-setting activities and cognitive loads in an online game-based learning environment, a significant correlation exists between learners' motivational and cognitive processing. Vos, Meijden, and Denessen (2011) recruited 235 primary school students to assess whether constructing a game promotes learning motivation better than playing the existing version of a game. They confirmed that constructing a game is better and makes learning easier than playing the existing version of a game. Young *et al*. (2012) conducted a meta-analysis of the effectiveness of game-based learning in more than 300 articles and studies. Many findings supported the effectiveness of using video games for language learning, history, and physical education. Erhel and Jamet (2013) also identified the effects of game-based learning on learning performance and motivation by analyzing the effects of instruction and entertainment.

They claimed that a serious game environment can increase learners' motivation and learning performance.

Garris, Ahlers and Driskell (2002) argued that games can improve skill-based outcomes, cognitive outcomes, and affective outcomes. Skill-based outcomes include the development of technical or motor skills. Cognitive outcomes are typically declarative, procedural, and strategic, whereas affective outcomes include beliefs or attitudes. Skill training games generally differ from the educational games that aims at promoting cognitive or affective effects. Skill training games not only assist learners to learn facts and knowledge, but also train learners in some skills using repetition and practice. A number of skill training games are available. For example, Kazimoglu, Kiernan, Bacon and Mackinnon (2012) developed a serious skill training game, Program Your Robot, which was developed to teach Computational Thinking (CT) skills and introductory computer programming to university students. This game helped students learn problem-solving skills. Moreover, Akcetin and Akcetin (2012) investigated the effects of a business simulation game on the understanding of international trade for maritime business students. They confirmed that this game enhanced participants' knowledge and skills related to international trade, as well as motivation to play the game. Several other studies (Rosenberg, Landsittel, & Averch, 2005; Rosser, Lynch, Cuddihy, Gentile, Klonsky, & Merrell, 2007) have demonstrated that video games can help players develop surgery-related cognitive skills; surgical ability and video game play were correlated. Lin and Liu (2009) evaluated the effect of game-based and drill-based typing software in terms of improving the English-language typing speeds of students. Both the game- and drill-based typing software improved typing speed. Importantly, students engaged with the game software more than the drill software. However, to the best of our knowledge, no study has determined how to develop game-based typing software that can promote emotion and learning performance for students. This study thus explored how game design factors of the two typing game sites affected emotions and learning performance of students, as well as whether game design factors, learners' emotions, and learning performance were correlated.

Game Design Factors and Flow Experience

Song and Lee (2007) indicated that one major problem in game design processes is user satisfaction; that is, whether a game is fun. To assess whether experiences for game players were enjoyable, Sweetser and Wyeth (2005) proposed a validated model, the GameFlow model, which can be used to design, evaluate, and understand enjoyment in games. The GameFlow model consists of 36 criteria and eight dimensions: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Jegers (2007) developed a Pervasive GameFlow (PGF) model based on the GameFlow model. The PGF model is composed of the same eight dimensions as the original GameFlow model, but some new criteria are added to assess player enjoyment in games. Fu et al. (2009) proposed a more rigorous scale, the EGameFlow model, to evaluate user enjoyment in e-learning games. This model was also based on the GameFlow model. Fu et al. then surveyed 166 university students in an online learning course, and demonstrated that the EGameFlow model is an effective tool for evaluating player enjoyment in an e-learning game.

To explore how game design factors affect the flow experience of a game player, Kiili (2006) used a problem-solving game. Analytical results indicated that challenge-matching a player’s skill level, clear goals, unambiguous feedback, a sense of control, and playability dimensions can evoke flow experiences. Moreover, Kiili (2006) confirmed that flow experience is independent of gender, age, and gaming experience. According to Jegers’s PGF model, the top three dimensions that affect fun in a game are concentration (games should require concentration and players should be able to concentrate), challenge (games should be sufficiently challenging and match a player’s skill level), and immersion (players should experience deep but effortless involvement). Although several studies proposed validated models (GameFlow, Pervasive GameFlow, and EGameFlow), each of which can be used to evaluate game-related enjoyment, few studies have explored how game design factors affect emotions and learning performance, or whether emotions, learning performance, and game design factors are correlated. This study adds to current knowledge about game skills training, and identifies important factors for designers of skill training games.

Methodology

Research Architecture

This study used two online English typing game sites with significantly different game design factors. The sites have same learning objective: training users in English-language typing skills. How game design factors affect learners’ emotions and learning performance and whether correlations exists among game design factors, learners’ emotions, and learning performance exist are the two main questions this study attempts to answer. Additionally, whether male and female learners and learners with different computer skill levels and typing skill levels are affected differently is also assessed. Figure 1 shows the research architecture. Learner emotions are recognized by the emWave system. The assessment of typing skill is based on typing scores via Speedtest, a typing speed test.

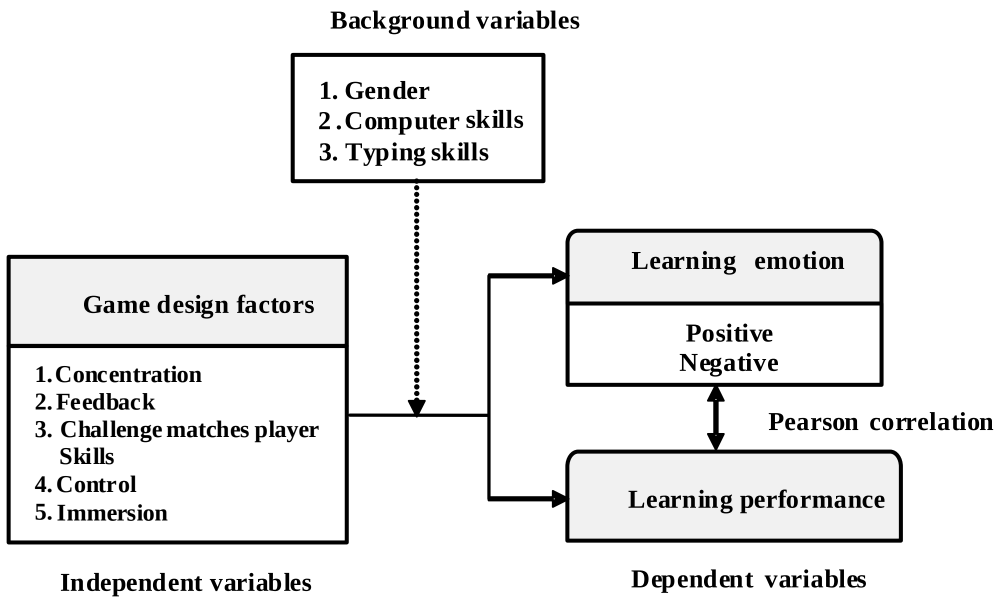

Figure 1 Research architecture of the study

Experimental Design

To identify possible problems with the experimental design and assess whether there are significant differences in the five game design factors (concentration, feedback, challenge matches player skills, control, and immersion) existing between the game sites, a pilot study was conducted before the formal study. Also, the reliability of the enjoyment questionnaire employed to assess the strength of game design factors was also confirmed in the pilot study. The pilot study adopted a repeated-measures design; that is, all participants used the two game sites to improve their English-language typing skills. In total, 30 elementary school students from Kaohsiung city, Taiwan, participated in the pilot study. The pilot study took five minutes to explain the experimental procedures to all participants. Next, all participants played the game on each site for 10 minutes. Finally, all participants then filled out the enjoyment questionnaire.

Participants for the formal study were also recruited from the same elementary school, but they did not participate in the pilot study. In total, 97 elementary school students were recruited to take part in the formal experiment. These students were randomly assigned to the Fast Typing Master (FTM) group (n=48) and the others were assigned to the Internet Typing Classroom (ITC) group (n=49). Initially, all participants were informed about all experimental steps. English typing skill levels were assessed using Speedtest and computer skills were assessed using self-efficacy questionnaire. Learners in the two groups then played the assigned typing game for 15 minutes. All participants wore an emWave earplug that collected data for emotions while they played the games. To avoid possible interference, each learner had an assigned seat and used an assigned personal computer to play the game. After 15 minutes, a posttest, the Speedtest, that assessed learning performance was immediately conducted and all learners filled out the enjoyment questionnaire. Finally, several learners who significantly improved their typing scores were subjected to perform semi-structured interview.

Research Participants

This study recruited 30 elementary school students, 11 males and 19 females, from Kaohsiung city, Taiwan, to take part in the pilot study. Research participants were students in grades 2, 3, and 4. Table 1 lists the number of participants and genders distribution of these participants.

Table 1

The number of participants and the gender distribution of participants in the pilot study

<table>
<tr><th>Gender</th><th>Grade</th><th>Number of learners</th><th>Percentage</th><th>Total</th></tr>
<tr><td rowspan="4">Male</td><td>Grade 2</td><td>3</td><td>27.3%</td><td rowspan="4">36.7%</td></tr>
<tr><td>Grade 3</td><td>2</td><td>18.2%</td></tr>
<tr><td>Grade 4</td><td>6</td><td>54.5%</td></tr>
<tr><td>Total</td><td>11</td><td>100%</td></tr>
<tr><td rowspan="4">Female</td><td>Grade 2</td><td>7</td><td>36.8%</td><td rowspan="4">63.3%</td></tr>
<tr><td>Grade 3</td><td>6</td><td>31.6%</td></tr>
<tr><td>Grade 4</td><td>6</td><td>31.6%</td></tr>
<tr><td>Total</td><td>19</td><td>100%</td></tr>
<tr><td>Total</td><td></td><td>30</td><td></td><td>100%</td></tr>
</table>

The 97 students, 51 males and 46 females, in the formal study were from the same elementary school. They were also in the same grades. Since typing skills and mental maturity of students from different grades may differ, students in the same grade were randomly and averagely assigned to one of the two groups to ensure that group composition was similar. Table 2 lists the number of participants and gender distribution of participants in the formal study.

Table 2

The number of participants and the number of gender distribution of the participants in the formal study

Gender	**Grade**	**Number of learners**	**Percentage**	**Total**
Male	Grade 2	22	43.1%	52.58%
	Grade 3	13	25.55	
	Grade 4	16	31.4%	
	Total	51	100%	
Female	Grade 2	11	23.95	47.42%
	Grade 3	11	23.9%	
	Grade 4	24	53.2%	
	Total	46	100%	
Total		97		100%

Research Instruments

The research instruments were Speedtest, FTM and ITC (two online English typing game sites), an enjoyment questionnaire for e-learning games, a questionnaire to assess computer skills, and the emWave system.

Typing speed test software for English–Speedtest

Speedtest (http://speedtest.10-fast-fingers.com/) assessed the typing speed of individual learners using typing score, words per minute (WPM), number of keystrokes, number of words typed correctly, and number of words typed incorrectly within one minute. Also, to understand how the initial typing skills affect the emotions and learning performance of students, Speedtest measured the initial typing skills of participants. Number of keystrokes used to correctly type words was the initial skill level. Based on average speed, learners in the top 50% for average keystroke speed were classified as having good typing skills, and the other 50% were classified as having poor typing skills.

Online typing game sites

Generally, a typing game site includes three learning phases: demonstration phase, exercise phase, and assessment phase. On the FTM game site, a learner can choose to practice typing words organized in an alphabetical order. The FTM's learning phases are as follows.

(1) Demonstration phase

This site does not provide text descriptions or demonstrations.

(2) Exercise phase

This site provides uppercase and lowercase practice. When a letter appears, the analog keyboard will display the correct location of letters, such that learners can locate the right key.

(3) Assessment phase

This site offers three typing games: FTM-1, FTM-2, and FTM-3. The FTM-1 game (Figure 2) is designed to help students learn the locations of alphabet letters on the keyboard. Before the game starts, a learner can select an appropriate level according to her/his typing speed and typing ability. A learner can reset the test back its original state at any time. Typing scores, number of wrong letters typed, and the number of missing letters are dynamic feedback for each learner during playing the game. The FTM-2 game uses a racing car to teach alphabet typing. Accurate typing speed is reflected in car speed; that is, when a learner types the wrong letter, the car slows. Once the car arrives at the finish line, the game is over and the player's rank in typing speed is displayed. The FTM game 3 is like the game of hits the mole. The FTM-3 game shows typing scores, number of missing letters, and number of incorrectly typed letters during the game.

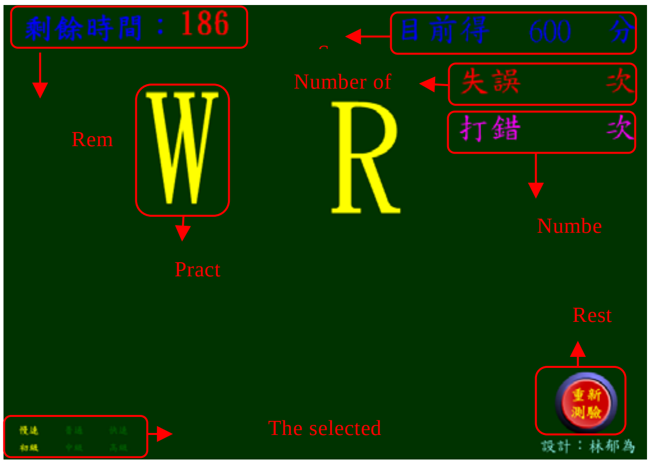

Figure 2 English typing game of FTM 1

In addition, ITC website functions (http://www.englishfree.com.tw/typefree_web/tw/index_2.asp) are divided into three parts: demonstration, online games, and score rank.

The learning phases are as follows.

(1) Demonstration phase

In this phase, how to practice typing on a computer keyboard is demonstrated. Via an animated audio explanation, learners become familiar with the correct positions of fingers when typing.

(2) Exercise phase

This site provides different games as exercises for learners. During this phase, the system uses different colors to distinguish between correct the incorrect typing and provide tips to learners.

(3) Assessment phase

This site offers three different typing games. The first game is to practice typing letters (Figure 3), the second is for practicing words, and the last is for typing articles. Table 3 compares the two games in terms of concentration, feedback, challenge matches player skills, control, and immersion.

Figure 3 English typing game of ITC

Table 3

Comparison of game features

Game design factor	FTM	ITC
Concentration	1. Typing games that assess typing skill are competitive games that garner a learner's concentration and attention	1. Typing games that assess typing skill are self-assessment games, not easily garnering learners' concentration and attention
Feedback	1. Feedback include sounds, text reminders, remaining time in a game, times words are typed correctly, times words are typed incorrectly, and score during play. 2. The feedback includes total score and rank on a list when the game ends.	1. Feedback includes rate of typing words correctly, remaining game time, typing speed, and score during play. 2. Feedback includes encouragement when a game ends.
Challenge that matches player skills	Learners can select the challenge level in the typing assessment game, including duration of practice time, typing speed, and difficulty level.	Learners must start the typing assessment game at the most basic level. If learners pass this level, the game at the next level starts.
Control	1. Competitive assessment typing games increase feelings of control. 2. Learners can set game duration, typing speed, and difficulty level, and restart a game.	1. Self-assessment typing games likely reduce feelings of control. 2. Learners can use the functions to start/stop/suspend a game.
Immersion	Competitive typing games easily generate a feeling of immersion.	Self-assessment typing games do not easily generate a sense of immersion.

Questionnaire for enjoyment of e-learning games

The questionnaire for enjoyment of e-learning games (QEEG) with satisfactory reliability and validity (Fu *et al*., 2009) was applied to assess differences in game features. The QEEG, developed based on GameFlow model (Sweetser & Wyeth, 2005), measures user enjoyment while playing e-learning games. The QEEG has eight dimensions: concentration (6 items); goal clarity (4 items); feedback (5 items); challenge matches player skills (6 items); control (7 items); immersion (7 items); social interaction (6 items); and knowledge improvement (7 items). Responses to items are on a Likert-type scale, with 1 and 7 respectively representing the lowest and highest degree. Several modifications were made to the QEEG to coincide with study purposes. First, dimensions goal clarity, social interaction, and knowledge improvement were removed for the following reasons: the English-language typing games have very clear goals—enhancing typing skills, and the two games do not have functions for social interaction and knowledge improvement. Second, items were modified so that the young students could understand them. Finally, the rating scale was reduced from 7 to 4 points because respondents typically have difficulty using a scale with more than five possible responses (Devlin & Dong, 1993), especially elementary school students.

The modified QEEG had 28 items in 5 dimensions: concentration; feedback; challenge that matches player skills; control; and immersion. Each dimension had four to eight items and responses were on a 4-point Likert-type scale, ranging from 1 for "strongly disagree" to 4 for "strongly agree." Since the questionnaire contained only some dimensions in the original QEEG (Fu *et al*., 2009) and some statements were modified for the elementary school students. Therefore, the reliability of the modified QEEG must be assessed. In the pilot study 30 recruited elementary school students played the FTM and ITC games for 10 minutes, and filled out the questionnaire. Cronbach's alpha was the reliability metric.

Questionnaire of computer skill

To assess how computer skills affect emotion and learning performance, the computer skills of participants were assessed with a modified version of the computer skills questionnaire by Fu *et al*. (2009). The questionnaire had five dimensions: mouse operation, cursor movement, clicking to open a program, using the keyboard to type, and toggling the use of language. Item responses were on a 4-point Likert scale: 1 point, "not very confident"; 2 points, "neutral"; 3 points, "confident"; and 4 points, "very confident." as a score increase, confidence in their computer skills increases. The top 50% of students were assigned to the group with good computer skills and the remaining participants were assigned to the group with poor computer skills.

Emotion recognition by emWave

This emWave system was developed by the Institute of HeartMath for measuring change in learners' emotional states. An ear sensor determines heart rate variability (HRV) based on pulse signals. The emWave software is easily used, as is the heart rhythm monitor and emotion-recognition algorithm (Fig. 4). The emWave system uses power spectral density analysis of the heart rate to identify human emotional states (McCraty *et al*., 1995). Figure 4 shows a heart rate as a curve of cumulative heartbeats per minute. The coherence ratio, derived from the power spectral density analysis of heart rate, is under the figure. In this analysis, the coherence ratio corresponds to different states, which are identified by three color-rendered indexes. The red index is the low-frequency zone of the power spectral density, representing change in sympathetic activity; according to analytical results, it also represents a negative emotional state. The blue index is the medium-frequency zone of the power spectral density, representing changes in parasympathetic nervous activity, or changes to a peaceful emotional state. The green index is the high-frequency zone of the power spectral density, representing parasympathetic nervous activity changes, or changes to a positive emotional state. Chen and Wang (2011) utilized emWave to identify the emotional states of learners in order to assess how different multimedia materials with the same content affect emotions and learning performance. The detailed methods for computing the percentage of positive and negative emotions were addressed in a previous study (Chen & Wang, 2011).

Figure 4 Emotion analysis interface of the emWave PC stress relief system based on human physiological signals

Experimental Analysis

Pilot Study Results

QEEG reliability

The pilot survey results show that global Cronbach's alpha values of the FTM and ITC games for all 28 items assessing enjoyment were 0.882 and 0.872, respectively. Furthermore, Cronbach's alpha values for the five design features of concentration, feedback, challenge matches player skills, control, and immersion were 0.825, 0.815, 0.785, 0.739 and 0.739, respectively. As all values exceeded 0.7, the modified QEEG had satisfactory reliability (Nunnally, 1978).

Differences in design factors

This study applied the independent samples *t*-test to determine whether the five factors in the two games differed significantly (Table 4). Three dimensions, concentration, challenge that matches player skills and control, were significantly different (t=2.484, p=.019<.05; t=2.183, p=.037<.05; t=2.451, p=.021<.05). The three dimensions of the FTM were better than those of the ITC in terms of enjoyment, but the dimensions feedback and immersion were not significantly different (t=1.584, p=.124>.05; t=1.997, p=.055>.05). In other words, the pilot study confirmed that the two typing game sites differed significantly in their design elements, and they are suitable for the formal study.

Table 4

Summary of dimensions analysis in game design for both game sites

Factor	Group	Number of learners	Mean	Standard deviation	*t*	Sig. (two-tailed)
Concentration	FTM	30	16.53	3.589	2.484	.019*
	ITC	30	14.03	3.891		
Feedback	FTM	30	13.40	2.978	1.584	.124
	ITC	30	12.07	2.993		
Challenge that matches player skills	FTM	30	25.70	5.059	2.182	.037*
	ITC	30	22.77	5.056		
Control	FTM	30	19.63	3.508	2.451	.021*
	ITC	30	17.17	4.356		
Immersion	FTM	30	15.63	3.368	1.997	.055
	ITC	30	13.57	3.857		

$^*p$<.05

Differences in Game Factors in the Formal Study

The formal study first explored the differences in game factors on the two game sites using the modified QEEG. A statistical program performed quantitative analysis using the independent samples *t*-test to determine whether the factors differed significantly. Analytical results show that all five dimensions of game design, concentration (p =.008<.05), feedback (p =.007<.05), challenge matches player skills (p =.015<.05), control (p =.003<.05) and immersion (p =.011<.05) were significantly different (Table 5). Analytical results also indicate that the FTM site generated higher scores in the five dimensions than the ITC site, meaning that the two game sites are very suitable as research instruments.

Table 5

The independent samples t-test in game design factors between the two selected typing game sites

Feature	Group	Number of learners	Mean	Standard deviation	*t*	Sig. (two-tailed)
Concentration	FTM	48	17.29	2.440	2.695	.008**
	ITC	49	15.67	3.387		
Feedback	FTM	48	14.50	1.516	2.779	.007**
	ITC	49	13.04	3.341		
Challenge that matches player skills	FTM	48	27.69	3.365	2.473	.015*
	ITC	49	25.47	5.244		
Control	FTM	48	20.67	2.785	3.020	.003**
	ITC	49	18.57	3.937		
Immersion	FTM	48	16.69	2.983	2.578	.011*
	ITC	49	14.80	4.138		

*$p<.05$，**$p<.01$

Analysis of Learners' Emotions

Differences in emotions

Table 6 shows the independent samples *t*-test results for emotions of all learners. The test results indicate that whether an emotion was positive (t=-1.883, p=.063>.05) or negative (t=1.844, p=.069>.05) the difference between the two sites was not significant.

Table 6

The independent samples t-test results of emotions for all learners who respectively used the distributed typing game site to promote English typing skills

Type of emotion	Group	Number of learners	Mean	Standard deviation	*t*	Sig. (two-tailed)
Positive emotion	FTM	48	3.94	2.93	-1.883	.063
	ICT	49	5.36	4.36		
Negative emotion	FTM	48	88.09	6.65	1.844	.069

	ICT	49	85.04	9.42

Gender differences in emotions

This study explored whether the emotions of males and females differed significantly. The independent samples *t*-test results show that the magnitude of negative emotions of female learners differed significantly when playing the two games (t=2.244, p = .030<.05). The effect of negative emotions derived from the FTM game was significantly higher than those derived by the ITC game, meaning that the FTM game factors more easily lead to nervousness or stress for female learners than the ITC game (Table 7). Additionally, no significant differences existed between the two games in terms of positive and negative emotions for males.

Table 7

The independent samples t-test results of emotions for the learners with different genders who respectively used the distributed typing game site to promote English typing skills

Emotion type	**Gender**	**Group**	**Number of learners**	**Mean**	**Standard deviation**	***t***	**Sig. (two-tailed)**
Positive emotion	Male learners	FTM	34	4.11	2.87	.285	.777
		ICT	17	3.876	2.82		
	Female learners	FTM	14	3.52	3.14	-1.857	.070
		ICT	32	6.15	4.85		
Negative emotion	Male learners	FTM	34	86.94	5.91	-.123	.993
		ICT	17	87.17	6.97		
	Female learners	FTM	14	90.88	7.71	2.244	.030*
		ICT	32	83.91	10.41		

*$p < .05$

Differences in emotions for learners with different computer and typing skills

The question of whether significant differences existed in the emotions of learners with different computer skills and typing skills while playing the two games was addressed. The percentages of positive emotions and negative emotions induced by the two games were not significantly different whether learners had good computer skills or poor computer skills. Similarly, the percentage of positive and negative emotions induced by the two games did not differ significantly for learners with good typing skills and poor typing skills, meaning that computer skills and typing skills do not alter emotions while learning.

Learning Performance

The paired samples *t*-test was applied to determine whether the two typing sites significantly improved typing skills. Moreover, the independent samples *t*-test was applied to examine whether both learner groups differed significantly in learning performance.

Learning performance for both groups

First, the paired samples *t*-test was used to assess significant differences between posttest and pretest scores for both groups. Table 8 shows paired samples *t*-test results. Test results confirm that learning performance for both groups significantly was improved (t=7.828, p=.000<.05; t=6.629, p=.000<.05).

Table 8

The pair samples t-test results of the learning performance for the learners who respectively used the distributed typing game site to promote English typing skills

Group	Number of learners	Item	Mean	Standard deviation	*t*	Sig. (two-tailed)
FTM	48	Pretest	17.00	20.526	7.828	.000***
		Posttest	28.60	25.353		
ICT	49	Pretest	15.20	17.352	6.629	.000***
		Posttest	26.57	21.580		

****p* <.001

Difference in learning performance for the two groups

Next, the independent samples *t*-test results demonstrate that the pretest typing scores of both groups were not significantly different (t=.217, p=.642> .05). Moreover, the independent samples *t*-test result indicates that posttest typing scores for both groups were not significantly different (t=.426, p=.671> .05). Thus, the two game sites promoted typing skills equally well.

Gender differences in learning performance in both groups

Table 9 shows independent samples *t*-test results for learning performance of males and females. Test results show that a significant difference existed between the two games in learning performance for males (t=2.934, p=.005<.05), but not for females (t=-1.399, p=.169>.05). The FTM site improved the learning performance of males better than the ICT site.

Table 9

The independent samples t-test results of the learning performance of the learners with different genders who respectively used the distributed typing game site to promote English typing skills

Group	Game site	Number of learners	Mean	Standard deviation	*t*	Sig. (two-tailed)
Male learners	FTM	34	30.47	25.542	2.934	.005**
	ICT	17	11.71	8.630		
Female learners	FTM	14	24.07	25.230	-1.399	.169
	ICT	32	34.47	22.296		

$^{**}p < .01$

Difference in learning performance for both groups of learners with different computer skills and typing skills

The independent samples *t*-test was applied to confirm whether learners with different computer skill levels and typing skill levels differed significantly in learning performance. Analytical results show that computer skill levels and typing skill levels did not affect learning performance.

Correlation Analysis of Research Variables

Pearson product-moment correlation analysis was employed to determine whether learners' emotions and game design factors were correlated, whether learning performance and game design factors were correlated, and whether learners' emotions and learning performance were correlated. Table 10 shows correlation analysis results for learners who used the FTM and ICT games under the different grouping conditions. Analytical results show that learning performance and the game design factor of feedback ($r=0.287$, $p=.004<.05$), challenge that matches player skills ($r=0.243$, $p=.017<.05$) and control ($r=0.213$, $p=.037<.05$) were significantly correlated for all learners. Moreover, no correlations existed between learning performance and the game design factors of concentration and immersion for all learners. Moreover, no significant correlations existed between learners' emotions and any game design factor.

Analytical results also reveal that for learners who used the FTM game, learners' emotion, learning performance, and game design factors were not correlated. In contrast, learning performance and the game design factors of concentration (r=0.302, p=.035<.05), feedback (r=0.358, p=.012<.05), challenge that matches player skills (r=0.302, p=.035<.05) and immersion (r=0.286, p=.046<.05) have significantly positive correlation for the learners who used ICT game. Also, a significant correlation existed between the positive emotion and the game design factor of feedback (r=0.299, p =.037<.05).

In addition, negative emotion and the game design factors of feedback (r=-0.296, p=.030<.05) were negatively correlated for learners with good computer skills who used the distributed typing game to promote English typing skills. However, learning emotion was not correlated with any game design factor for learners with poor computer skills. These analytical results indicate that learners with good computer skills had stronger negative emotions *via* the feedback mechanism than *via* other game factors. Additionally, learning performance and feedback for male learners who used the FTM game were correlated (r=0.330, p=.018<.05). But no correlation existed between learning effectiveness and any game factor for female learners who used the FTM game, meaning that the feedback mechanism had a greater impact on the learning performance of males than females.

Moreover, learning performance and the factor challenge that matches player skills (r=0.410, p=.006<.05) and immersion (r=0.407, p=.007<.05) were correlated for learners with poor computer skills who used the distributed typing game to promote English typing skills. However, learning performance and design factors were not correlated for learners with good computer skills who used the distributed typing game to promote English typing skills. These analytical results demonstrate that the game design factors had a greater impact on learners with poor computer skills than on learners with good computer skills. Moreover, learning performance and the negative emotion were correlated for learners with poor typing skills who used the distributed typing game to promote English typing skills (r=-0.284, p=.048<.05). In contrast, learning performance and the positive emotion were correlated for learners with poor typing skills who used the distributed typing game to promote English typing skills (r=0.331, p=.020<.05). Thus, a positive emotion leads good learning performance for learners with poor typing skills. In conclusion, developing a typing skill game with edutainment features is difficult. Based on the correlation analysis results, we conclude that the most important design factor when developing English-language typing games is feedback because this factor is a unique factor simultaneously affecting learning performance and emotion under the considered grouping conditions, followed by challenge that matches player skills, and immersion.

Table 10

Summary results of the correlation analyses among learners' emotion, learning performance, and game design factors for the different grouping conditions

Group	Correlation Item					
	Concentration	**Feedback**	**Challenge that matches player skills**	**Control**	**Immersion**	**Learning performance**
All learners who respectively used the distributed typing game	-	(r=0.287) Learning performance	(r=0.243) Learning performance	(r=.0.213) Learning performance	-	-
Learners who used FTM typing game	-	-	-	-	-	-
Learners who used ITC typing game	(r=0.302) Learning performance	(r=0.358) Learning performance (r=0.299) Positive emotion	(r=0.302) Learning performance	-	(r=0.286) Learning performance	-
Male learners who respectively used the distributed typing game	-	(r=0.330) Learning performance	-	-	-	-
Female learners who respectively used the distributed typing game	-	-	-	-	-	-
Learners with poor computer skills who respectively used the distributed typing game	-	-	(r=0.410) Learning performance	-	(r=0.407) Learning performance	-
Learners with good computer skills who respectively used	-	(r=-0.296) Negative emotion	-	-	-	-

the distributed typing game

Table（Continued）

Group	Correlation Item					
	Concentration	**Feedback**	**Challenge matches player skills**	**Control**	**Immersion**	**Learning performance**
Learners with poor typing skills who respectively used the distributed typing game	-	-	-	-	-	(r=0.331) Positive emotion (r=-0.284) Negative emotion
Learners with good typing skills who respectively used the distributed typing game	-	-	-	-	-	-

Discussion

First, experimental results indicate that both typing game sites, which have significantly different game factors, can efficiently promote learning performance. Further, no significant difference existed between the typing games in promoting learning performance. These analytical results are consistent with those by several studies, confirming that game-based learning can help users improve learning performance (Prensky, 2001; Asgari & Kaufman, 2004; Papastergiou, 2009; Vos *et al*., 2011). In other words, digital game-based learning can be regarded as a novel option for learning typing skills. Interview results also indicate that learners frequently cared about their game scores when playing the game sites. That is, most learners were encouraged to improve their English typing skills by playing the two games. However, gender differences in learning performance existed in the two considered typing game sites with significant differences in game design factors. The FTM game, which yielded higher evaluation scores for game design factors than the ITC game, promoted learning performance of male learners better than that of female learners. We infer that the likely reason is that male learners prefer typing game sites with exciting elements compared with female learners. The finding is consistent with those in several other studies, confirming that gender differences exist in the perception and acceptance of online games (Wang & Wang, 2008; Wang et al, 2009; Vasileios & Economides, 2011). Previous research also indicated that gender differences existed in attitudes toward the use of computers for learning activities (Durndell & Thomson, 1997; Whitely, 1997; Mitra *et al*., 2000).

Additionally, several studies demonstrated that emotions are directly related to learning performance (Piaget, 1989; Goleman, 1995). In this study, for learners with poor typing skills, learning performance and the positive emotion were correlated, but not for those with good typing skills. That is, a positive emotion leads to improved learning performance for learners with poor typing skills. Also, analytical results demonstrate than that the emotional state of female learners was more easily affected by the two typing game sites that of males. Namely, the FTM game, which had higher evaluation scores in the five design factors, generates significantly stronger negative emotions than the ITC game for female learners. This finding is consistent with those in previous studies, confirming that females are more emotional and emotionally expressive than males (Blier & Blier-Wilson, 1989; Kring & Gordon, 1998). We logically infer that the stronger negative emotion generated by the FTM game may derive from nervousness or stress because the FTM game has strong design factors in terms of concentration, challenge that matches player skills, and control. Importantly, learners' emotion and learning performance were correlated, suggesting that the most important design factor is feedback because this factor was correlated with learning performance and emotions for the considered grouping conditions. The other four design factors were only correlated with learning performance. Entertainment is obviously not a major concern when designing educational games for learning. To create edutainment effects, we strongly suggest that an educational game consider how to simultaneously promote learning performance and learners' emotion during learning. Therefore, educational games should pay increased attention to designing feedback mechanisms. This viewpoint is also supported by Song and Lee (2007), who indicated that gamers who are given important feedback regarding their game play will experience significantly more fun while playing.

Finally, some study limitations merit consideration. First, this study focused only on assessing the effects of two typing games on learning emotion and performance for children in a particular age range. Thus, whether research results can be extended to other age groups with different cognitive skills needs further study. Second, whether research results can be applied to other skill learning games also warrants further study. Third, learners were only allowed to play the games for 15 minutes due to time constraints. Thus, extending the time spent playing the games may lead to different research results.

Conclusions and Future Work

This study explored whether game design factors of two typing games affect learners' emotion and learning performance, as well as whether the design factors, learners' emotion, and learning performance were correlated. The major findings are summarized as follows. First, analytical results demonstrate that both typing game sites improved the typing skills of learners. Moreover, experimental results show that the FTM game, which had higher evaluation scores for the design factors, is superior to the ICT game in improving typing skills for males. Gender differences in causing negative emotion exist while using the two typing game sites with significant difference in game design factors to promote English typing skills. The FTM game with higher evaluation scores for the design factors more easily lead to negative emotion for females than the ITC. Additionally, feedback was correlated with learning performance and learners' emotion, but the other game factors were only correlated with learning performance. In considering the effects of edutainment, we conclude that the most important factor in games is the feedback mechanism. Further, learning performance and positive emotion were correlated for learners with poor typing skills.

Finally, additional studies are warranted. Gender differences should be considered when designing skill training games to enhance learning performance and positive emotion. Second, developing effective feedback mechanisms for skill training games based on intelligent technologies should be considered. Also, further study should consider study how cognitive and affective learning games that have the same learning goals and are significantly different in their game factors affect learners' emotion and learning performance.

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