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Extending the Technology Acceptance Model to Investigate Impact of Embodied games on Learning of Xiao-zhuan(小篆)

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Abstract

This research focuses on topic of e-learning of Xiao-zhuan through digital Embodied games as a brand new way of creative learning method for Xiao-zhuan. TAM, Technology Acceptance Model, is the methodology in this research. Theory of perceived playfulness is also adopted to analyze the learning of Xiao-zhuan. Subjects in this research are 45 sophomores of the Department of Chinese Literature in National Taiwan Normal University. This research adopts questionnaire survey method, then refers to students' paper scores on the test. The results of this research are as follows: Firstly, "Perceived Usefulness" has the significant influence on "Learning Effectiveness" and "Attitude toward Using the Embodied games". Secondly, "Perceived Ease of Use" has the influence on "Perceived Playfulness". Thirdly, "Perceived Playfulness" has the significant influence on "Attitude toward Using the Embodied games".

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Keywords: Xiao-zhuan(小篆), Interactive games, Technology acceptance model, Playfulness.

1. Introduction

Xiao-zhuan is a complete writing characters after the Ching Dynasty (221 B.C.-207 B.C.) unified as one nation. It has two thousands and two hundreds history, and according to the development of Chinese characters, Xiao-zhuan plays the key role of continuing the progress. If learners can have basic knowledge about the formation of Xiao-zhuan, it will only take half the work, but twice the effort in learning Chinese characters. For the beginning Chinese character learners (including beginning learners in

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Taiwan and Chinese as second language beginning learners), the pictograph specialty of word forms of seal character always helps Chinese character beginning learners quickly get into the Chinese characters world. For example, this word ‘川’ in Xiao-zhuan is written as ‘𠩺’ which is transformed by the shape of the zigzag river. For people who already learned three thousands five hundreds to four thousands five hundreds Chinese characters (including primary school and junior high school students), the structure teaching of six categories of Chinese characters must use Xiao-zhuan to define and explain. The reason is very simple, it is because Hsu Shen edited the first dictionary, the “*Shuo Wen Jie Zi*” (說文解字, A.D.100-A.D.121), by using the Chinese radical as dictionary section headers in Eastern Han Dynasty. In this dictionary, it analyzed the structures, sounds, and meanings of Chinese characters by using Xiao-zhuan as, and it shows the importance of Xiao-zhuan for the structures of Chinese characters. For the university and college learners whose major are related to art, Xiao-zhuan (or known as seal character) is one of the chirography of Chinese calligraphy, so when the learners have certain level about learning calligraphy, they must learn the structures of word form of seal character in order to expend self chirography categories. To learn the structures of word form of seal character must begin with the Xiao-zhuan in order to have a better foundation, especially for the artists who love seal carving(篆刻). For the university and college learners whose major are related to Chinese literature, learning Xiao-zhuan must give a better understanding about the structures of Chinese characters, and it helps to know the speciality of Chinese characters structures which is based on the shape. To sum up, Xiao-zhuan did not disappear in the mighty torrent of history, and it has its pivotal position and significance on the learning progress of Chinese characters, calligraphy and seal carving.

By and large, learners of word forms of Xiao-zhuan mostly start from the book, *Shuo Wen Jie Zi*. The linkage of sentence patterns of “*Shuo Wen Jie Zi*”, 540 radicals(部首) unified 9353 words included. The 540 radicals at “*Shuo Wen Jie Zi*” as the learning cut-points to learn Xiao-zhuan. The qualities of editions of “*Shuo Wen Jie Zi*” have influence on the learning effects so it is important to have good one. According to the researcher’s study on the book of “*A study on digital content value-added applications of Paleography*”, in light of comparing the 540 radicals, the book of “*Shuo Wen Jie Zi*” which was published from Jigu bookstore(汲古閣) is the best version (Lo, F. C., 2010). As mentioned above, this research choose “*Shuo Wen Jie Zi*” which was published from Jigu bookstore as the textbook of learning Xiao-zhuan. In addition, the researcher published an article “*The research on glyph recognition of teaching skills based on Xiao-zhuan.*” in a journal. The character and structure of word form of seal character of Jigu bookstore was analyzed for learners to realize the foundation knowledge of word forms of seal character (Lo, F. C., 2012). With the advent of digital times, the learning skills tend to multiple. The module of webcam with Embodied games was developed by Professor Hong to employ in this research. Xiao-zhuan as the materials of Embodied games for university students to learn.

2. Research background

2.1 Technology acceptance model (TAM)

Davis et al. (1989) developed the TAM by adapting the Theory of Reasoned Action (TRA). This model was to interpret and predict the influential factors used in IT. The TAM demonstrated in Figure 1. TAM offers a theoretical foundation to understand external variables have influence on user’s beliefs, attitude and intention to the situation of technology used. The two significant individual factors are “Perceived Usefulness(PU)” and “Perceived Ease of Use(PEU)” to the technology acceptance behavior. Davis (1989) designed the TAM to predict computer use based on the three primary factors as following. Firstly, the “Behavioral Intention to Use” can predict the use of computers. Secondly, the “Perceived Usefulness” is the most important factors of computer intention to use. Thirdly, the “Perceived Ease of Use” is the second decisive factors of computer intention to use.

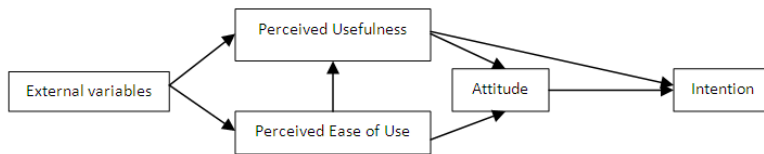


Figure 1. Technology Acceptance Model (TAM) (Davis, 1989)

Chiu and Fang (2005) found abundant literature in explaining and predict the use of Information Technology (IT) by TAM (Davis,1989; Davis et al.,1989; Haynes and Thies,1991; Mathieson,1991; Adams et al.,1992; Bagozzi et al.,1992; Taylor and Todd ,1995; Igarria et al.,1995; Szajna,1996; Hendrickson and Collins,1996 ; Chau,1996 ; Morris and Dillon,1997 ; Gefen and Straub,1997 ; Thompson,1998; Teo et al.,1999; Lederer et al.,2000; Lin and Lu ,2000; Moon and Kim,2001). Some scholars were adopt “Perceived Ease of Use” and “Perceived Usefulness” to interpret the intention of users to use technology (Straub et al.,1995). Chang et al.(2009) revised the TAM to add “Perceived Playfulness” to enhance the interpretation ability and the research results presented the positive effects. .Hong et al.(2011) analyzed the intention of uses to browse the websites in light of the National Digital Archives Program (NDAP), TAM is the theoretical foundation in research. The results reveled interface design is the key to uses to browse the websites. This issues should be considered to enhance the use intention.

As aforementioned TAM related-research indicated the “Perceived Ease of Use” and “Perceived Usefulness” of technology products will influence the user’s acceptance of products. In this aspect, “the Embodied games of Xiao-zhuan” can be regarded as the digital technology products. Its “Perceived Ease of Use” and “Perceived Usefulness” will also influence students’ learning effects at the Departments of Chinses Literature.

2.2 Playfulness

Playfulness is a spontaneous attitude toward individual. The individual performance on game situation will be influenced by the “Perceived Playfulness” (Lieberman, 1975; Barnett, 1990). Therefore, “Perceived Playfulness” is the intrinsic motivation which was influenced by individual spontaneity. The individual who is equipped with “Perceived Playfulness” will create more stimulating, enjoyable and entertaining contexts (Barnett, 2007) to learn happily. Compare with uninterested users, they interested users would have show positive attitudes and strong motivations to interact with Information Technology (IT) (Chang et al. 2009). Hong et al. (2009) thought Playfulness steering is an emerging approach to educational game design. The playfulness design of an evolutionary game is influenced by the degree of uncertainty, flexibility in decision making, the level of challenge, equal conditions for fair play, opportunities to compete/cooperate, and the level of interactivity. Finally, the Perceived playfulness is the vital keys of digital education game. To sum up, in terms of current research results, the games (e.g., digital games) inspired the demonstration of “Perceived Playfulness” to improve knowledge learning.

2.3 Embodied game

In this study, we used the Embodied Interactive Video website (<http://www.eivg.org>) which was built by digital learning lab leading by professor Hong to precede the development of Embodied games of Xiao-zhuan. The teaching of Xiao-zhuan combining digital technology and Chinese language includes the integration of disciplines and the interdisciplinary collaboration. Hope that the use of Embodied games’ teaching method, students can get in the field of Xiao-zhuan forms and calligraphy. By using digital interactive teaching and learning environment, learners can learn radicals of Xiao-zhuan in a relaxed learning environment. A good Embodied game can cause students’ playfulness and joyfulness and create

the willingness of active learning. The Xiao-zhuan Embodied games also provide competitive learning, for passing the game, for getting the place in the competition; students want to learn Xiao-zhuan actively.

3. Research Methodology

3.1 Research Framework and Hypothesis

The research foundation was the TAM supported by Davis (1989) (see Figure 1). According to the dimension of TAM, the “Attitude” was revised to “Attitude toward Using the Embodied games (ATUEG)”. The Embodied games of Xioa-zhuan in this research were students’ homework. Each student must to use Embodied games of Xioa-zhuan as an aided learning tool. The “Intention” in Davis’ TAM was omitted from this research. For midterm variables, the “Perceived Usefulness (PU)” and “Perceived Ease of Use (PEU)” from Davis’ TAM are adopted in this research. Finally, the TAM diagram also added the variable “Learning Effectiveness (LE)”. This research adopted students’ paper scores on the test to examine the “LE”.

Besides, the TAM in this research also referred to the revised version from Chang, C. T. et al. (2009) to add the “Perceived Playfulness” to suitable for this research. Therefore, the independent variables of revised TAM in this research are PU, PEU and “Perceived Playfulness (PP)”. In terms of research hypothesis, three dimensions (variables) have significant influence on ATUEG and LE. According to the mention above, the Research Model and Research Hypothesis are shown in Figure. 2.

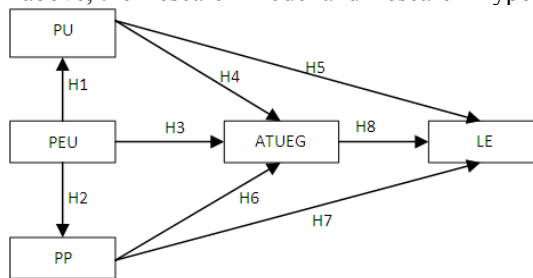


Figure 2. Research structure

Hypothesis 1(H1): PEU has significant positive effects on PU.

Hypothesis 2(H2): PEU has significant positive effects on PP.

Hypothesis 3(H3): PEU has significant positive effects on ATUEG.

Hypothesis 4(H4): PU has significant positive effects on ATUEG.

Hypothesis 5(H5): PU has significant positive effects on LE.

Hypothesis 6(H6): PP has significant positive effects on ATUEG.

Hypothesis 7(H7): PP has significant positive effects on LE.

Hypothesis 8(H8): ATUEG has significant positive effects on LE.

3.2 Subjects and Samples Collection

The subjects in this research were sophomores in National Taiwan Normal University enrolled in Chinese Philology. The questionnaire consisted of two sections, the first of which was intended to elect demographic information on the respondents. The second section was designed to many dimensions (variables) in this research, including PU, PEU, PP, and ATUEG.

The questionnaire used in this research was the five-point Likert Scale (strongly agrees = 5, agrees = 4, undecided = 3, disagrees = 2, strongly disagrees = 1). The subjects respond to the questionnaires according to their perceptions and situations. 45 questionnaires were returned, including 40 valid

specimens and 5 invalid specimens. Gay and Airasian (2003) addressed the formal specimens of questionnaire survey take up the 10 percent of population at least. If the numbers of population is less than 500, the specimens takes up 20 percent at least is better. Neuman (2003) argued the number of population is less, the specimens takes up 30 percent at least is better. Now, the sophomores of the Department of Chinese Literature in National Taiwan Normal University were 130. According to the Neuman's opinion, the 30 percent of 130 are 39, the valid specimens in this research were 40, and it is suitable for the demand of analysis specimens.

Retrieve 40 valid specimens, for genders, 67.5 percent were female and 32.5 percent were male. In terms of grades, the majority of subjects were sophomores (80%). For subjects, the majority of subjects can surf the internet at home (98%). For subjects who take the credits of courses related to information technology (IT), all subjects takes the courses related to IT before. The majority of subjects were takes 1-4 credits (95%).

4. Results

4.1 Reliability & Validity Analysis

In reliability analysis, Cronbach's alpha coefficient is employed to measure the internal consistency and reliability of multiple item scales. Cronbach's α for a questionnaire between 0.35 to 0.70 is acceptable, and between 0.70 to 0.80 is highly acceptable (Nunnally and Berstein, 1994). The questionnaire consisted of 20 items and was divided into four dimensions, including PU (7 items), "Perceived Ease of Use" (3 items), PP (7 items) and "Accept Attitudes" (3 items). The analysis results of Cronbach's alpha coefficient were summarized at Table 1. Four various dimensions of the questionnaire measurement were designed to calculate Cronbach's α coefficient. The mean (m) and Standard Deviation (SD) of each items also presented (see Table 1). In the present study, the Cronbach's Alpha for each dimension, reaching the acceptable level of reliability (over 0.74), indicating that the questionnaire was equipped with consistency and reliability.

In validity analysis, this research adopts expert validity to examine and revise questionnaires. The value of KMO (Kaiser-Meyer-Olkin) and Bartlett Sphericity Test were measured in this research. The KMO was addressed by Kaiser-Meyer-Olkin (1974). $KMO > 0.8$ indicated meritorious, $KMO > 0.7$ indicated middling, $KMO > 0.6$ indicated mediocre and $KMO > 0.5$ indicated unacceptable. Bartlett (1950) addressed the Sphericity Test to examine whether the data have common factors., the significant level (p) < 0.05 indicated there is a significant common factor. In short, the results of reliability and validity analysis of this research are shown in Table 1 below:

Table 1 Summary table of reliability and validity analysis

Dimension	KMO value	Bartlett's test of sphericity	Cronbach's α
Perceived Usefulness	0.894	261.212	0.948
Ease of use	0.678	26.101	0.746
Playfulness	0.899	166.570	0.920
Acceptant Attitude	0.676	56.903	0.852

4.2 Effect Analysis on Learning of Xiao-zhuan

The procedure of this research based on the implementation of Chinese Philology course. The paper book instruction was proceeded to instruct the 540 radicals of Chinese characters of Xiao-zhuan. In the midterm semester, the pretest scores of Embodied games of Xiao-zhuan were acquired in advanced. The full marks are 30. Next, learners use Embodied games of Xiao-zhuan to precede the individual learning. Finally, the final paper scores were acquired to assess the learning effectiveness. The full marks are 30. The paired-samples t test was calculated to compare the mean midterm exam scores and final exam scores, these results are summarized in Table 2 and Table 3.

Table 2 Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Midterm	20.93	40	4.660	.737
	Finalterm	24.20	40	3.353	.530

Table 3 Paired Samples Test

Pair 1	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Midterm-Finalterm	-3.275	5.223	.826	-4.945	-1.605	-3.966	39	.000

As aforementioned table 2 and 3, the paired mean differences of the mean on the midterm exam scores and final exam scores is -3.275(20.93-24.20), the $t=-3.966$, $df=39$, the significant level is $p<0.05$. Students’ performances on final exam are better than midterm exam (there is a significant differences between the mean scores of midterm exam and final exam). In terms of the 95% Confidence Interval of the Difference (-4.945, -1.605), the value of 0 is not concluded so null hypothesis ($H_0: \mu_1=\mu_2$) was rejected and accept alternative hypothesis ($H_1: \mu_1\neq\mu_2$) indicated the midterm exam scores and final exam scores have significant differences. The scores of final exam demonstrate positive results.

4.3Path analysis

In order to explore the relationships among PU, PEU, PP and ATUEG. The SPSS statistic package for Windows 19.0 was used in this research to conduct the path analysis of regression to retrieve standardize regressions coefficient as the path coefficient (see Figure 3 below).

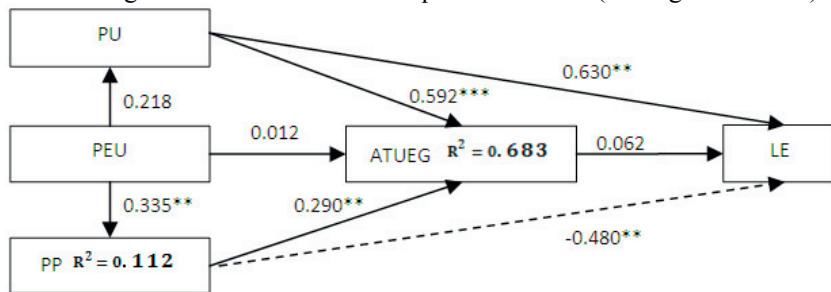


Figure 3. Path analysis chart of the research results (**implies that $p<0.05$, ***implies that $p<0.01$)

Error of estimate:

- PU: $R^2=.112$ $S_e=\sqrt{1-R^2}=\sqrt{.888}=.942$
- PP: $R^2=.112$ $S_e=\sqrt{1-R^2}=\sqrt{.888}=.942$
- ATUEG: $R^2=.683$ $S_e=\sqrt{1-R^2}=\sqrt{.317}=.563$
- LE: $R^2=.224$ $S_e=\sqrt{1-R^2}=\sqrt{.776}=.881$

As mentioned above, the variable interpretations (R^2) of the explain levels indicated the results among "Perceived usefulness", "Perceived Ease to Use" and PP to explain the variables of ATUEG are 68.3% and the results among PU, ATUEG and PP to explain the variables of LE are 22.4%. Some factors have effect on the ATUEG, PU, PEU and PP.

In addition, the effect analysis of Regression Path Analysis aims to explain the direct effect, to explain the indirect effect and total effect on Path Analysis Model (see Table 4 below).

Table 4. Path Analysis

independent variable		dependent variable: endogenous variable			
		PU	PP	ATUEG	LE
exogenous variable					
PU	direct effect	.218	.335	.012	.086
	indirect effect	-	-	-	.001
	total effect	.218	.335	.012	.087

endogenous variable					
PEU	direct effect	-	-	.592	.037
	indirect effect	-	-	-	.630
	total effect	-	-	.592	.667
PP	direct effect	-	-	.290	-.480
	indirect effect	-	-	-	-
	total effect	-	-	.290	-.480
ATUEG	direct effect	.592	.290	-	.062
	indirect effect	-	-	-	-
	total effect	.592	.290	-	.062

According to the table 4, two results are summarized.

Firstly, PEU had effect upon LE.

- direct effect: PEU→ LE: .086
- indirect effect: PEU→ PEU→ LE: .218*.630=.137
- indirect effect: PEU→ PP→ LE: .335*(-.480)=-.160
- indirect effect: PEU→ ATUEG→ LE: .012*.062=.001
- total effect: .086+.137+(-.160)+.001=.064

Secondly, PEU had effect upon “Acceptant Attitude”.

- direct effect: PEU→ATUEG: .012
- indirect effect: PEU→ PU→ATUEG: .218*.592=.129
- indirect effect: PEU→ PP→ATUEG: .335*.290=.010
- total effect: .012+.129+.010=.241

4.4 Results of Hypothesis Testing

Based on the results of path analysis and hypothesis testing, results in this research are provided.

Firstly, PU has direct effect on ATUEG, PP and LE, the β coefficient are 0.592($p<0.05$) and 0.630($p<0.05$). Therefore, the hypothesis 4 and hypothesis 5 are supported. However, the ATUEG has no significantly direct effect on “Learning effectiveness” ($\beta=0.062, p>0.05$). Hypothesis 8 is not supported.

Secondly, PEU has no significantly direct effect on the ATUEG ($\beta=0.012, p>0.05$). Hypothesis 3 is not supported. PEU has no significantly direct effect on PU ($\beta=0.218, p>0.05$). Hypothesis 1 is not supported; however, PEU has a significantly direct effect on PP. Hypothesis 2 is supported.

Thirdly, PP has direct effect on the ATUEG and PP. The β coefficient is 0.290 ($p<0.05$); therefore, the hypothesis 6 is supported. PP has direct effect on LE; however, the effect is negative and the β coefficient is -0.480 ($p<0.05$). That means the more PP students have, and the less LE students do.

Table 5 summarize the results of path of relationship, path analysis and the supported or not are summarized.

Table5. A study of whether the hypotheses, β coefficients and significance of constructs are supported or not

Hypothesis:Path of Relationship	β coefficient	Supported or not
H1:PEU → PUs	0.218	Not supported
H2:PEU → PP	0.335**	supported
H3:PEU → ATUEWG	0.012	Not supported
H4:PUs → ATUEWG	0.592***	supported
H5:PU → LE	0.630**	supported

H6:PP → ATUEG	0.290**	supported
H7:PP → LE	-0.480**	supported
H8:ATUEG → LE	0.062	Not supported

Note. (**implies that $p < 0.05$, ***implies that $p < 0.01$)

5. Discussion and conclusion

The purpose of research was to offer students of Department of Chinese Literature with the interactive e-learning system of Xiao-zhuan and adopted TAM to understand learners' attitude toward the acceptance attitude and effects on learning of Embodied games and E-learning System of Xiao-zhuan.

Four results of this research are stated as followings. Firstly, PEU has the positive significant influence on PP. Secondly, PU has the positive significant influence on ATUEG and LE. Thirdly, PP has the positive significant influence on ATUEG. In addition to above-mentioned results of research, this research also found that PEU has no positive influence on PU and ATUEG. However, PP has the significant negative influence on LE. The results inferred that this aforementioned negative influence has much to do with the learning habits of students of the Department of Chinese Literature which has a long history. The reading paper book is still the traditional learning ways so these students are accustomed to reading paper books to promote their grades and effects on Xiao-zhuan. They did not totally accept and adopt the new ways of e-Learning. According to the path analysis in this research, these students at the Department of Chinese Literature demonstrated the PU has positive attitudes towards Embodied games of Xiao-zhuan. Moreover, their grades of Xiao-zhuan have significantly improvements. As a result, we believe that Embodied games of Xiao-zhuan still facilitate the LE.

Based on the research, some limitations include the following. Firstly, Only 40 valid specimens are analyzed and investigated so the number of specimens is insufficient. The further research can cooperate with Departments of Chinese Literature from other schools. The regions can be extended to other areas such as north, south or east Taiwan to warrant further research. Much more also can be known about the regions or genders' effects on the interactive e-learning system of Xiao-zhuan. Secondly, Embodied games of Xiao-zhuan, are just one sample of e-learning, at the Character Course, at the Department of Chinese Literature, National Taiwan Normal University. It is not fully explain the other types of learning situation at the Department of Chinese Literature. Subsequent researches can focus on other related e-learning of the Department of Chinese Literature. Thirdly, the methodology of this research focuses on TAM and education theory of perceived playfulness is included. Subsequent researches may be able to integrate some other education theories. Fourthly, webcam was utilized to precede the Embodied games of Xiao-zhuan of this research. If the multiple interactive interfaces (ex: touch screens, mouse click etc.) are added in the future, the effects of perceived playfulness on Embodied games of Xiao-zhuan will be enhanced. In addition, if high-quality Embodied games on the cloud services platform are developed well, then we can expect that PP will have the significant positive influence on LE in the future.

E-learning is the modern teaching trend. If traditional academic courses at the Department of Chinese Literature intend to combine with e-learning successfully, the Information Literacy and IT related course should be increased to precede the integration between courses. We believe that the results of this research on the Embodied games of Xiao-zhuan can be a good e-learning research sample of the Department of Chinese Literature to combine IT with course teaching.

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