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Digital Game's Impacts on Students' Learning Effectiveness of Correct Medication

Ya-Ming Shiue[1]
[*]Yu-Chiung Hsu[2]

[1]Dept. of Applied Informatics and Multimedia, Chia-Nan University of Pharmacy of Science, Taiwan
[2] Dept. of Public Relations & Advertising, Kun-Shan University, Taiwan

In recent years, considerable concern has arisen over the use of digital games as instructional tools in educational research. However, game-based learning not only enhances students' learning motivation and effectiveness, but also fosters knowledge transfer. Taiwanese people living in rural areas often receive health-related information through television and radio advertisements. However, a lack of correct information leads to incorrect medication usage. Therefore, the purpose of this study is the practical development of a digital game related to correct medication usage. The technology acceptance model was applied to examine the impact of the game-based learning experience. The results showed that the post-test scores for correct medication usage were significantly higher than those obtained in the pre-test and indicated that the digital game could enhance students' learning effectiveness. In addition, perceived ease of use and usefulness had significant impacts on attitude toward the correct medication usage digital game. In conclusion, game-based learning significantly enhanced students' knowledge and abilities related to the correct usage of medication.

Keywords: Game-based learning, correct medication use, health literacy, technology acceptance model

Health education is a crucial component of the delivery of health knowledge and improves both mental and physical health. Research on this topic has indicated that health knowledge can be a good indicator of patient health behavior (Chou, 2013). Health literacy, as defined by the World Health Organization and Nutbeam, can be summarized to include to an individual' s reading, writing, listening, expressing, and information search capabilities (WHO, 1998; Nutbeam, 2000). Efforts to accurately measure individual health literacy have been gaining attention, yet few appropriate instruments to do so are available in Taiwan. Pan initiated the development of a health literacy scale, which reflects the health literacy status of an adult who has interacted with healthcare environments in Taiwan (Pan et al., 2010). Tsai surveyed health literacy in Taiwan and concluded that one third of the subjects under consideration had inadequate health literacy and

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*Corresponding author: ychsu@mail.ksu.edu.tw

also suggested that inadequacies related to correct medication usage are more likely to occur in younger individuals (Tasi et al., 2011). Hsiao also pointed out that problems have been documented concerning the use of medication that include a lack of knowledge and poor attitudes and practices related to the safe use of medications (Hsiao et al., 2006). However, there are few correct medication usage instruments that are specific for Taiwanese residents. Chi and colleagues applied a six stage approach to develop, disseminate, and evaluate the integrated core ability of correct medication usage in Taiwan. (Chi et al., 2012). They proposed five core abilities of correct medication usage, including the ability to clearly express personal conditions to one' s physicians, the ability to check the information on the medication packages, the ability to correctly take medications as prescribed, the ability discipline oneself in regard to taking medications, and the ability to consult comfortably with pharmacists and physicians.

Due to the fast development of information and communication technologies (ICT), e-learning has had a positive impact on both teachers and students in that it positively affects the duration of their attention, their learning and training tenacity, and their attitudes towards collaboration and interaction (Chen & Tseng, 2012). As Li, Duan, Fu, and Alford (2012) noted, it is essential to examine the relationship between e-learners' experiences, perceptions, and their behavioral intentions toward use, because system use is an important indicator of system success. However, only a limited number of published works have applied an integrated technology acceptance model (TAM) to explore e-learning usage drivers in the context of medical learning contexts. This study attempts to fill this research gap by addressing the effects of ease of use and usefulness on attitude toward learning medical contexts.

It is widely recognized that game-based learning (GBL) makes the attainment of educational objectives and learning process easier, more student-centered, more interesting, and more effective (Rosas et al., 2003). Pesare proposed that GBL approaches could be a promising solution for medical contexts since there is abundant experimental evidence that proves their effectiveness (Pesare et al., 2006). Furthermore, GBL combines learning contents and digital games, which enhances interest in learning and improves knowledge acquisition (Mayer, 2003). GBL not only helps to increase students' learning motivation, but also helps spread and promote accessibility to correct medication information.

The purpose of this study is applying GBL in the specific context of correct medication usage in order to investigate the learning outcomes. The paper is organized as follows: first, a literature review related correct medication usage and the technology acceptance model (TAM) is provided in the next section. This is followed by describing GBL approaches and the development of the digital game, as well as the presentation of the research hypotheses, a discussion of the findings, conclusions, and finally, recommendations for future studies.

LITERATURE REVIEW

Correct Medication Usage

Taiwan is one of the most advanced countries in terms of its National Health Insurance program, and it is well-known in providing quality health services at a relatively low price. In other words, Taiwanese residents can access comprehensive treatments and easily obtain medicine from different health sectors. In order to enhance individual health literacy, the health promoting school (HPS) program was launched in 2009 by the Taiwan Food and Drug Administration in cooperation with the Ministry of Education. The correct medication use health promoting school (HPS) program was implemented in 14 cities in Taiwan. Teachers and pharmacists together developed different kinds of teaching materials and activities based on correct medication usage.

Chi evaluated the effects of the HSP program in Taiwan on enhancing students' health knowledge, and the results indicated that implementation of correct medication usage through the HPS program had significantly enhanced students' knowledge and abilities related to correct medication usage (Chi et al., 2014). Lee's study stressed that correct medication use is an essential component of health education and suggested that it has beneficial effects on health behavior and health conditions (Lee et al., 2008). While everyone seems to agree that correct medication usage is important, further efforts are needed to strengthen and promote health education in this area. The purpose of this study is to apply GBL to expand and expedite the transmission of correct medication usage information when communicating with healthcare professionals with the end result of gaining sufficient health information to be able to do so.

Technology Acceptance Model

The technology acceptance model (TAM) (Davis, 1989) is the most frequently cited and most influential model for explaining technology acceptance and adoption. Davis (1989) first introduced the TAM as a theoretical extension of the theory of reasoned action (Fishbein & Ajzen, 1975) and found that it could better explain user acceptance that its counterparts. TAM proposes that two particular beliefs, perceived usefulness and perceived ease of use, are the primary drivers for technology acceptance, where perceived ease of use is theorized to be a direct determinant of user attitude. In addition, researchers found support for an indirect relationship between perceived usefulness and user attitude through perceived ease of use. That is, perceived usefulness mediates the effect of perceived ease of use on behavioral intention.

As the body of research indicating the potential educational value of games grows, the interests for including digital game learning in educational contexts is increasing in popularity (Pontiggia & Virili, 2010). Digital game learning refers to the use of games to enhance the learning experience while maintaining a balance between content and the game (Prensky, 2001). The most relevant advantages of GBL include promoting a positive attitude towards learning and developing memory skills, along with its potential to connect learners and help them build self-constructed learning (Wouters et al., 2013). In this study, we designed a digital game focusing on the correct usage of medication and attempted to create learning materials that would positively influence learner motivation. Thus, we posited that:

H_1: The implementation of GBL has a positive influence on students' knowledge of correct medication usage.

Researchers have recently applied the TAM model in connection with digital game acceptance. For example, Park et al. (2013) found that perceived ease of use and usefulness are the major factors influencing user acceptance of mobile games. Bourgonjon et al. (2010) further found that student preferences for using video games were affected directly by usefulness, ease of use, learning opportunities, and personal experience. Pando-Carcia et al. (2016) examined a business game and suggested that perceived ease of use and usefulness has significant effects on attitude. Therefore, the effective implementation of a correct medication usage game depends on its acceptance on the part of students. Thus, we posited that:

H_2: Perceived ease of use has a positive influence on the perceived usefulness of a correct medication usage game.

H_3: Perceived ease of use has a positive influence on attitude to using a correct medication usage game.

H_4: Perceived usefulness has a positive influence on attitude toward using a correct medication usage game.

METHODOLOGY

-Research Design

The data for this study were collected using a survey comprising demographics and item scales intended to measure the different variables included in the research model. Descriptive statistics were used to investigate the results of five core abilities related to correct mediation usage. Likely associations and differences in the correct medication usage scores between the pre-test and post-test were examined with a *t*-test. The structural education model (SEM) was used to analyze the influences of ease of use and perceived usefulness on attitudes toward the digital game and the interrelationships between these variables.

-Procedure

The subjects included two classes of first year university students who took a course in introduction to health education in Tainan City, Taiwan. The students who participated in this study received an introduction by a researcher regarding the purpose of the study and filled out the pre-test for the correct medication usage instrument. The role of the instructor was to provide learning guidance that would facilitate learning progress and resolve learning problems. Subsequently, the subjects played the digital game individually in computer labs. After the subjects completed two consecutive GBL courses, a post-test was administered. A total of 78 students participated, of which 56.4% were male (n = 44) and 43.6% were female (n = 34), aged from 18-22 years.

-Instruments

The questionnaire consisted of three parts: demographic information, TAM-related variables, and correct medication usage. Demographic information included variables such as age, gender, and experience with GBL. The second part of the instrument was a 9 item questionnaire including three factors: ease of use, perceived usefulness, and attitude toward GBL, as revised from Davis (1989). The third part of the instrument was a 24 item questionnaire including five core abilities related to correct medication usage, as revised from Chi et al. (2014).

The measure of students' knowledge of correct medication usage was based on Chi' study and consisted five core abilities related to correct medication usage (Chi et al., 2014). The first dimension, with four questions, was the ability to clearly express personal conditions to physicians. The second dimension, with five questions, was the ability to check the information on the medication package. The third dimension, with three questions, was the ability to correctly take medications as prescribed by a physician. The fourth dimension, with nine questions, was the ability to describe where the medicine was obtained. The fifth dimension, with three questions, was the ability to notice and use physicians and pharmacists contract information.

The correct medication usage game provides students with knowledge related to the relevant literature, as shown in Figure 1. At first, we presented the related medical contexts necessary for mastering correct medication usage. After finishing the learning materials, the students had to answer a number of questions testing already-acquired knowledge. Overall, it has been suggested that GBL holds some promise as an effective learning tool to increase a wide variety of cognitive and perceptual abilities, among which may be the goals of this study.

DATA ANALYSIS AND RESULTS

Students' core abilities related to correct medication usage included five components. In this study, we compared the mean score of students' core abilities concerning correct medication usage before and after utilization of GBL, and used a t-test to determine whether there were significant differences among these five core abilities. Statistical significance was determined to be $p < 0.05$. Table 1 showed that all of the students' abilities related to correct medication usage had increased significantly after implementing GBL.

Figure 1. Correct Medication Usage Game

	Pre-test		Post-test		*t*-test	
	Mean	**SD**	**Mean**	**SD**	***t*-value**	***p***
Talk to physicians	0.70	0.30	0.81	0.25	11.38	< 0.05
Read medication package	0.82	0.20	0.88	0.17	3.21	< 0.05
Medication adherence	0.67	0.31	0.71	0.28	5.72	< 0.05
Buy/obtain medicine from	0.88	0.17	0.93	0.15	6.05	< 0.05
Consult pharmacists/physicians	0.60	0.32	0.68	0.33	9.83	< 0.05

Table 1. Students' Knowledge Concerning Correct Medication Usage

In addition, we evaluated the structural model to examine the strength and direction of the relationships among the TAM constructs. The partial least squares (PLS) technique was applied for model analysis because our sample size was relatively small. Table 2 provides an overview of the path coefficients. Both perceived ease of use and usefulness appear to be significant predictors of student attitude toward digital games. In addition, perceived ease of use also influenced the learners' perceived usefulness of digital games. In summary, all hypotheses constructed in the original TAM (H2, H3, H4) were confirmed in this study.

Hypothesis	Effect	Coefficient	S.E.
H_2	Ease of use → usefulness	.39 **	.035
H_3	Ease of use → attitude	.21 *	.065
H_4	Usefulness → attitude	.28 *	.043

* $p < 0.05$, ** $p < 0.01$

Table2. Test of Hypotheses

CONCLUSION

This study examined the effects of a digital game on enhancing students' ability to use medication correctly and investigated the influences of ease of use and usefulness on attitude toward GBL. The results indicate that the use of a digital game with TAM model is an effective teaching and learning method to traditional instruction and could be promote meaningful learning. Through an empirical analysis, several suggestions were obtained. First, the present findings contributed more broadly theoretical knowledge on understanding of enhancing the ability to correctly use medication as we implemented in educational instruction.

Second, the results of this study support the use of the TAM (Davis, 1989) in the context of GBL environments, as both ease of use and usefulness appear to be important predictors of student attitude. In addition, usefulness directly influenced attitude, and both factors were found to affect continued intention to use GBL. These findings are similar to other research in game acceptance in education settings (Bourgonjon et al., 2010).

Finally, the results showed that the students' ability to use medication correctly could be significantly improved through GBL environments. Improvement in health literacy is essential for health promotion and disease prevention (Berkman et al., 2011). Thus, digital games could be designed to provide this type of information, not only to improve health literacy, but also to allow students' access to the rich entertainment experiences that digital games can provide.

IMPLICATIONS

GBL has been used in a number of areas at various different levels of education and perceived as a potential approach to supplementary learning. The study showed that the use of a digital game can enhance students' ability to use medication correctly, therefore, digital games could be utilized to promote health-related

knowledge. Further efforts could encourage both teachers and community pharmacists to collaboratively develop pedagogical health digital games and apply GBL to teach people at communities about medical contexts to enhance, strengthen, promote, and transmit medication knowledge in the current information age.

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