Exploring the Technology Acceptance and Flow State of a Chamber Escape Game - Escape the Lab© for Learning Electromagnet Concept

Huei-Tse Hou[a*] & Yi-Shiuan Chou[b]
[a]*Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taiwan*
[b]*Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan*
[*]hthou@mail.ntnu.edu.tw

Abstract: Utilizing digital games to assist students with simulation manipulation and problem-solving may help them deeply explore and construct scientific concept and relevant procedural knowledge. The chamber escape games are the game type of problem-solving, involving challenges, adventures, and uncertainty elements. This study developed a chamber escape game-*Escape the Lab*© to assist in learning the concepts of electromagnet and electromagnet assembly skills. We empirically explored 100 high school students' technology acceptance of this game and the differences of flow state between different genders. This study discovered that students have a high degree of acceptance toward this game, and the males have higher flow experience during playing this game.

Keywords: Chamber-escape game, Game-based learning, Science education

1. Introduction

In recent years, the development, application, and research of digital educational games are gradually emphasized. To promote the learning of scientific concepts and experimental skills, utilizing digital games to assist students with simulation manipulation and problem-solving may help them deeply explore and construct scientific concept and relevant procedural knowledge. Learners can reflect and adjust their problem-solving strategies to reach more effective learning during the problem-solving process in the game tasks [1] [2]. Besides, to promote learners' learning motivation, it's quite important to embed the game elements such as suitable challenges, adventures, and uncertainty in an educational game [3]. The chamber escape games are the game type of problem-solving, involving challenges and adventures, and uncertainty elements. The application of chamber escape games to the learning of scientific concepts is worth researching. Also, to evaluate chamber escape educational game, learners' acceptance of the games and their flow states [4] are important indicators. Therefore, the objectives of this study are to develop a chamber escape game-*Escape the Lab*© to assist in learning the concepts of electromagnet and electromagnet assembly skills, and to understand learners' technology acceptance and the differences of flow states between different genders.

2. Escape the Lab©

Escape the Lab© is an educational chamber escape game, developed by our research team-NTUST MEG (Mini-Educational Game development Group in E-learning Research Center in National Taiwan University of Science and Technology). The scenario in this game: a researcher is poisoned by his colleague who is also a member of a criminal group, and is stuck in her own lab. The player has to observe and search for the useful objects (shown as Figure1) in the lab before the researcher is poisoned to death. Also, based on electromagnetism concepts, the player has to assemble an electromagnet correctly (shown as Figure2), utilize magnetism to pick up the key from the hole in a secret cabinet, and then escape the room. This game provides not only nervous but adventurous problem-solving tasks which allow learners to observe and explore, and simulate and manipulate to reach the learning objectives.

Figure. 1 Screenshot of Escape the Lab©: Search for the environment and cues

Figure. 2 Screenshot of Escape the Lab©: Simulation manipulation and Feedbacks

3. Method

There were 100 senior high school students participated in this study, including 50 males and 50 females. The average age of the participants was 16. All the students finished the electromagnet course before this study. This paper referred to the technology acceptance model [5] and the elements of digital instructional games [3, 6] to make a preliminary evaluation of learner's attitudes toward perceived usefulness, perceived ease-of-use and game elements. The questionnaire was scored on a 4-point Likert scale (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree). To evaluate the flow state when learner play the game, this paper also referred to Killi's Flow Scale for Game [4] (translated to Chinese by this study). The questionnaire was scored on a 5-point Likert scale (5 = agree, 1 = disagree). The student were asked to play *Escape the Lab*© (10 minutes) once, and then fill out the above two questionnaires.

4. Results

This study conducted a preliminary descriptive statistical analysis. We discovered that 75% of the students agree or strongly agree that this game can help them understand the concept of the electromagnet; 73% of the students agree or strongly agree that this game can help them understand the procedures of assembling electromagnet; 74% of the students agree or strongly agree that this game helps them understand the concept of the electromagnet more than paper textbooks; 54% of the students agree or strongly agree that

the operation of this game is easy; 74% of the students agree or strongly agree that the story of the game is easy to understand; 54% of the students agree or strongly agree that the operating process of this game is smooth without any errors; 83% of the students agree or strongly agree that the game is entertaining; 93% of the students agree or strongly agree that the game is challenging; 88% of the students agree or strongly agree that they feel the uncertainty of adventure and fantasy when they play the game; 49% of the students agree or strongly agree that the design of the mechanism of the interactive rules this game is appropriate.

Table 1 Evaluation questionnaire on the technology acceptance and game elements

Dimension	Item#	Item	strongly agree (%)	agree (%)	disgree (%)	strongly disagree (%)	References
Perceived usefulness	T1	This game can help you understand the concept of the electromagnet?	13.0	62.0	23.0	2.0	Davis (1989)
	T2	This game can help you understand the procedures of assembling electromagnet?	11.0	62.0	24.0	3.0	
	T3	Compared with the paper textbooks, you think this game helps you understand the concept of the electromagnet more.	13.0	61.0	23.0	3.0	
Perceived ease of use	T4	The operation of this game is easy.	22.0	32.0	37.0	9.0	
	T5	The story of the game is easy to understand.	26.0	48.0	22.0	4.0	
	T6	The operating process of this game is smooth without any errors.	10.0	44.0	30.0	16.0	
Game elements	T7	The game is entertaining.	25.0	58.0	11.0	6.0	Prensky & Thiagarajan (2007); Alessi & Trollip (2001)
	T8	The game is challenging.	40.0	53.0	5.0	2.0	
	T9	When you play the game, you feel the uncertainty of adventure and fantasy.	29.0	59.0	9.0	3.0	
	T10	The design of the mechanism of the interactive rules this game is appropriate.	6.0	43.0	36.0	15.0	

In addition, this study conducted an independent t-test to explore the gender differences of the flow state base on the collected data. We discovered that males had more flow experience than females when they play this game (t=2.46, p<.05), but there is no significant difference in the phase of flow antecedents.

Table 2 Gender independent T-test

	Gender				
	Male (n=50)		Female (n=50)		
Flow state (Kiili, 2006)	M	SD	M	SD	t
Flow Antecedents	3.75	.79	3.49	.75	1.66
Flow Experience	4.10	.62	3.79	.65	2.46 *

* p <.05

5. Discussions and Conclusion

The research results showed that most students have highly positive attitudes toward perceived usefulness of this game, indicating that learners confirm this game has the utility of electromagnet-related knowledge instruction. However, in terms of perceived ease of use, there's still room for improvements in this game (e.g., interactive mechanism and user interface). As for flow, the males can get more flow experiences in this game, indicating that this game helps the males' learning engagement more. By analyzing learners' behavioral patterns more deeply (e.g., [7]), this study expects to explore and understand their problem-solving processes in the future and improve the ease of use of *Escape the Lab*©.

Acknowledgments

This research was supported by the projects from the National Science Council, Republic of China, under contract number NSC-100-2628-S-011-001-MY4, NSC-100-3113-S-011-001, NSC-100-2631-S-011-002 and NSC -99-2511-S-011-007-MY3.

References

[1] Kiili, K. (2007). Foundation for problem-based gaming. *British Journal of Educational Technology, 38(3),* 394-404.
[2] Lee, C. Y. & Chen, M. P. (2009). A computer game as a context for non-routinemathematical problem solving: The effects of type of question prompt and level of prior knowledge. *Computers & Education, 52* (3), 530-542.
[3] Prensky, M., & Thiagarajan, S. (2007). Digital game-based learning (Paragon Houseed.). St. Paul, MN: Paragon House.
[4] Kiili, K. (2006). Evaluations of an experiential gaming model. *Human Technology, 2*(2), 187-201.
[5] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13 (3), 318-340.
[6] Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development*. MA: Allyn and Bacon.
[7] Hou, H. T. (2012). Exploring the behavioral patterns of learners in an educational massively multiple online role-playing game (MMORPG), *Computers and Education, 58,* 4, 1225-1233.