The Effects of a Self-designed Tabletop Game and Learning Achievement

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Abstract. Many students in technology universities are graduates of vocational high schools, who traditionally have lower levels of achievement and lack learning motivation. These students, like all college students in Taiwan, are required to take the course "Introduction to Computer Science". According to previous teaching experiences, most students have demonstrated a negative learning attitude toward this course, and thought it boring. As a result, the purpose of this research was to design an interactive tabletop game for students to involve them in learning more actively. The enjoyment of the games, learning motivation and achievement, and learning satisfaction were explored. This 10-week research adopted a single-group pretest-posttest design experiment, and forty-two participants were involved. The results showed the tabletop game was able to enhance students' learning, with positive results in terms of their evaluation of the enjoyment of the game, and significant differences achieved in their learning motivation and achievement.

Keywords: game-based learning, learning motivation, learning achievement, enjoyment of game

1 Introduction

The employment of the flip classroom model aims to make learning more student-centered. Game-based learning is one mode that has been widely discussed and employed by teachers. Like birds flying or fish swimming, having fun is human nature. The combination of the fun part of the games with learning has brought new opportunities for students [1]. According to research, learning motivation and achievement are enhanced with the integration of games into teaching. It also makes learning more connected to life [2]. In addition, the integration of the enjoyment and amusement of games enables learning to become interesting, instead of boring [3]. Many researchers indicate game-based learning is able to enhance students' learning motivation, promote the participation of courses, and further influence their learning achievement positively [3-7]. Particularly, when two players work together, interaction, including cooperation, competition, and talking with others, is initiated for communication purposes [8]. As a result, integrating the characteristics of games into the curriculum design may be able to enhance students' learning motivation and achievement, in contrast with theory-oriented lecture courses.

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On the other hand, students from technology universities have been found to have lower motivation and learning achievement [9]. Their learning tends to show surface motivation. What they learn is mainly for exams and diplomas [10], which corresponds to the authors' observations in real classrooms. What's more, technology university students are not good at reading and writing. Therefore, instead of lecture-based instruction, bringing multiple and multimedia teaching strategies will benefit the students more [11]. The course in this research was "Introduction to Computer Science" and the topics included study of computer concepts, computer applications, multimedia, internet, information security, virus protection, E-commerce and other basic computer related knowledge in order to develop their technology and IT capabilities. These topics were all related to the fundamental knowledge of smart living technique. In the theory-based course, Introduction to Computer Science, many teachers adopt a lecturing approach to explain the concepts and contents of the course. According to previous teaching experiences, most students have demonstrated a negative learning attitude toward this course, and thought this course boring. The reason for learning was because they had to take tests to earn credits. As a result, the purpose of this research was to design an interactive tabletop game for students to become involved in the learning instead of learning passively. Learning motivation, learning achievement, and the enjoyment of the games were explored. With higher learning motivation and learning achievement, it was beneficial for students to learn more advanced knowledge about smart living technique.

2 The Application of Tabletop Games to Enhance Learning Motivation and Achievement

2.1 The Use of Tabletop Games in Education

In terms of the integration of games and learning, flow experience is created by the enhancement of learning motivation in a game-oriented scenario. This kind of curriculum design enables learners to learn knowledge and skills naturally with enjoyment [12]. There are many different games and forms, and tabletop games have become the easiest operated learning activities in the classroom. There is no need to count on power or other equipment [1]. Tabletop games include board games, card games, dice games, miniatures wargames or tile-based games. It is a game that is implemented on the table or other flat surface. For example, Chess, Monopoly, and Poker are all examples of tabletop games, suitable for many players using strategic functions.

Recently, tabletop games have been employed by many teachers because they come with high interaction and ingenuity, which assist students to develop their critical thinking and problem-solving abilities. They will apply their knowledge to the game scenario and to solve problems generated from the games. This will make the new knowledge internalized [13], with the characteristics of activeness, a sense of immersion, and a sense of enjoyment [14]. This is beneficial for learners' cognition [15] and social abilities of interactive communication [16]. Students can challenge the aims, learn knowledge, and develop skills, which force learners to try new things or to self-correct. As a result, a kind of meaningful learning will be initiated [14]. From previous studies, there are two kinds of tabletop games commonly used in education – on-market ones and self-made ones [17]. These tabletop games have amusement value, making learners feel nervous and excited in a game atmosphere. In the process of positive interaction and competition, the scientific concepts, skills, and attitudes are passed in the game [18]. Hence, this study aims to investigate if learning motivation and achievement can be enhanced through the development of self-made tabletop game to help students learn the concepts and knowledge of computer science.

2.2 Empirical Studies on the Use of Tabletop Games in Education

Many researches have explored the influences of tabletop games in education from different domains. In the research of Shih and Tsay [19], there was a significant difference in the experimental group in terms of English engagement in the post test by using adapted tabletop games in the ninth graders' English course. In a self-developed "Ecological Mobilization" board game teaching aids in the sixth grade's "biological and environmental" unit, the results showed students were able to cultivate environmental literacy though the game. Their environmentally-friendly action was strengthened as well [20]. In a third grade math class, Wang and Leung [2] demonstrated how using self-developed tabletop games made students participate in the class more aggressively and generated higher motivation. The degree of

enjoyment of learning content was increased distinctly. Students were willing to learn math actively and their academic performance progressed significantly. Applying adapted tabletop games from the market to the fourth grade's Minnan Language in Tai and Cheng's research [21], it was found students' oral expression was promoted and the stress of speaking Minnan Language was relieved, too. The game also made the classroom lively and triggered learning interest. Chaung [22] designed a series of tabletop games to strengthen learning motivation and to help students to get involved in creating tabletop games. The objective of the research was to discuss if the tabletop games affected the personal interaction relationship and it received quite positive feedback. Students became more familiar, and believed the games helped to broaden the interpersonal relationships. An autistic student and an ADHD student were able to join the dialogues interactively. Besides that, Hsu and Yang [13] created a highly-interactive digital tabletop game to empower empathy and emotional decision-making styles of students, and it was found game-based learning facilitated learning in a stress-free environment and stimulated the potential advantages of learning. At the same time, it displayed each learner's empathy and emotional decision-making styles vary. Tseng, Weng and Yang [23] developed the iMonsters card game and applied it in a unit on Internet security, and led the elementary school students and junior high students in a summer camp to gain the basic concepts of Internet safety by means of designed game scenarios of hacker attacks. In Lu and Shih's study [18], the learning achievement of "scientific process skills" and "insect cognitive comprehension" were raised by a self-made "Insects Playing Board Games" used in an after-class extensive learning program in the fourth grade. To summarize, the combination of tabletop games and learning content has shown a positive effect in various research projects, including on learning motivation, learning attitude, interpersonal relationships, and learning achievement. However, the above studies were implemented in elementary schools or junior high schools. There is less research found for university students. Therefore, this research aimed to evaluate the effects of tabletop games in the course of Introduction to Computer Science in a technology university.

3 Methodology

3.1 Experiment

The purpose of this research was to design an interactive tabletop game for students to involve them in their learning instead of learning passively through lectures. According to the related literature review, it has been shown that game-oriented learning is able to enhance students' learning motivation if the learning content is combined with adequate game design. With the increase of learning motivation, learning achievement is able to be enhanced to meet the learning-enjoyment objective [12-15]. As a result, before the experiment started, a prototype of a table game was designed, and it was repeatedly tested and revised until it was confirmed. Then, the 10-week research adopted a single-group pretest-posttest experimental design, and focused on freshmen majoring in multimedia design in a private college in northern Taiwan as its research participants. Deducting the number of participants who did not participate in the pretest and posttest as well as invalid questionnaires, the completed statistical data included a total of forty-two participants. The researcher was the instructor in this "Introduction to Computer Science" course, and two hours of instruction were offered each week. The first 90-minute slot was lecture-based instruction along with group discussion and presentation. Then, a team-based competition of the tabletop game was implemented in the 30-minute slot. Three instruments, including a questionnaire of LM Scale, an ICS Test, and an ETG Scale were employed to evaluate students' learning motivation, learning achievement, and enjoyment of the game. In the beginning, all participants were given LM Scale and ICST to understand their starting level. After the experiment, the two instruments were given again to see if the learning had changed. Also, the ETG Scale was given to explore the participants' enjoyment and elicit feedback on the designed games.

3.2 The Self-Designed Tabletop Game: Battle of Warriors

In previous research results, the combination of learning content and game elements, including team cooperation, defense, and offense has been suggested to be able to promote learning motivation and effects. In the process of team cooperation and competition with other teams, the learning of knowledge, skills, and of strategies occurred naturally [18, 23]. Hence, the two key elements of team cooperation and

offense-defense were the guidelines for the tabletop game. The self-designed tabletop game employed in this research was named "Battles of Warriors," a tabletop roleplaying game with cards. It is a team competition, and each team was composed of four to five participants. Two teams, totally around eight to ten participants, compete with each other by using a set of the tabletop game. There are seven kinds of roles for the participants to play, including Hero, Warriors, Cleric, Wizard, Fighter, Rogue, and Dancer. Each team member can pick up one role only. Hero is equipped with both attack and healing skills. Warrior has both attack and defense skills. Cleric has healing skills mainly while Wizard has the ability to have multi-attacks simultaneously. Fighter is famous for the single-target attack. Rogue processes the ability of stealing. Dancer owns the ability to buff teammates, and to debuff opponents. Each team has to assign someone as a representative to roll the dice. When the numbers of the dice are from one to four, they have to pick up one attack card as the question card. Number 5 represents item cards, and number six is the divination card. Attack cards contain the content of the learning materials to be practiced. Hence, to gain good competition scores, the participants have to preview the learning materials. To increase the variety and the excitement of the game, the attack cards also cover the content that has been accumulated from the past few weeks to enrich the content of the games.

The main task is to eliminate the opponents within the time limit by asking them questions and obtaining the answers. The attacking team have to read aloud the course-related questions on the cards drawn from the game board. The defending team have to come up with correct answers in time to avoid attacks. By employing the attack-defense game form, students need to think and to apply the content or knowledge learned in class. To encourage intra-group cooperation and knowledge sharing, the honor of winning records is shared by the whole team. In addition, to stimulate inter-group competition, a leaderboard is set up to record the scores of each team. Each week, the competition results are announced to drive each team to accumulate higher scores. For university students, the records of the competition results may have less incentive. However, the incentives may be increased if the scores can be converted to bonus scores for the attendance part in their academic performance report.

Fig. 1. The attacking groups had to read aloud the course-related questions on the cards drawn from the game board.

Fig. 2. The defending team have to come up with correct answers in time to avoid attacks

3.3 Research Instrument

This study aimed to investigate if learning motivation and achievement could be enhanced through the development of a self-made tabletop game. Three instruments were used in this research. Learning motivation indicates the psychological process toward the objectives that the teacher sets to initiate and maintain the learning activities. With the increase of learning motivation, learning achievement is able to be promoted effectively [24]. A Learning Motivation Scale (LM Scale) was revised from the Motivated Strategies for Learning Questionnaire [25]. There were five dimensions, including Intrinsic Goal Orientation (IGO), Extrinsic Goal Orientation (EGO), Task Value (TV), Control Beliefs (CB) and Self-Efficacy for Learning and Performance (SLP). On the other hand, the enjoyment of the participants was also an important objective in the game. So, the integration of games and learning content is able to make learning become fun, resulting in an increase of learning motivation and achievement [3, 26]. An Enjoyment of Tabletop Game Scale (ETG Scale) was also developed based on Chou and Tseng's questionnaire for evaluating the enjoyment of digital casual games [26], including Simplicity, Player Skills, Accessibility, Immersion, Flexibility, Social Interaction and Challenge. In the second part of this scale, some open-ended questions were given to collect the participants' responses to the game. These two questionnaires adopted Likert's 5-point scale, ranging from strongly agree to strongly disagree. Six experts from professional fields of information management and of education were involved to check the questionnaires to construct expert validity. This was followed by a pilot study. Then, the reliability was evaluated and adjusted by deleting some questions. In terms of the LM Scale, 21 questions were maintained and the Cronbach's α of the measures of the questionnaire was 0.93. As for the ETG Scale, 19 questions were kept and the Cronbach's α of the measures of the questionnaire was 0.96, indicating high reliability. What's more, in this research, the learning content was offered by Tiked Books Co. [27]. The Test of Introduction to Computer Science (ICT Test) was also designed based on Tiked Books Co. [27] teaching materials as the pretest and the posttest papers.

4 Data Analysis and Discussion

4.1 How Effectively Does a Tabletop Game (Battles of Warriors) Enhance Learning Motivation?

To understand the use of the tabletop game (Battles of Warriors) in the enhancement of learning motivation, a LM Scale was used as a pre-test and post-test. The result is displayed in Table 1, showing that the participants' learning motivation was not very high before the treatment (M=3.44, SD=3.68). The mean scores of five dimensions were around 3.30 to 3.52, which corresponded to the researcher's observation. The learning motivation of students with a multimedia design background was not high enough. After the employment of the tabletop game, the data was analyzed by a paired-samples t-test and the result showed there was a significant difference in learning motivation (t=-4.24, p = .000). In addition, significant differences in the three dimensions were also demonstrated. The change in IGO dimension (t=-5.57, p = .000) indicated the participants were more willing to take the challenge of the course content and to give it a try. A different significance was also shown in the TV dimension (t=-2.08, p = .044), possibly because the participants started to feel interested in the content and believed it was useful. As for the significantly positive change in the CB dimension, the reason was likely that the participants were more confident in controlling the pace and in content mastery.

Table 1. Reliability Test and Paired Samples T-Test of Learning Motivation (N=42)

Dimension	No. of items	Mean (S.D.)		df	t	p	d
		Pretest	Posttest				
IGO	4	3.30 (0.42)	3.77 (0.52)	41	-5.57	.000	-0.94
EGO	3	3.42 (0.54)	3.55 (0.56)	41	-1.25	.218	-0.23
TV	5	3.49 (0.38)	3.66 (0.54)	41	-2.08	.044	-0.38
CB	3	3.52 (0.43)	4.14 (0.57)	41	-6.54	.000	-1.25
SLP	6	3.46 (0.41)	3.48 (0.46)	41	-0.28	.785	-0.07
Learning Motivation	21	3.44 (0.32)	3.68 (0.43)	41	-4.24	.000	-0.47

4.2 How Effectively Does a Tabletop Game (Battles of Warriors) Enhance Learning Achievement?

A paired samples t-test was conducted to analyze the data collected from the ICS Test in the pre-test and post-test. Table II showed a significant result (t=-16.03, p = .000) after the use of the tabletop game. The average scores in the post test were higher by 31.10. Also, 38 participants out of 42 passed the "Information and Communication Technology Programs Test-Essentials Level" held by Global Learning & Assessment Development. The pass rate was 81.60%. It is likely that the tabletop game was beneficial in helping students become interactive and triggering cognition. Once they had interaction with peers, they could observe peers' performance and get to know how to use the knowledge learned effectively. Also, problem-solving ability was possibly cultivated through the tasks of the game [4, 15].

Table 2. Paired Samples T-Test of Learning achievement (N=42)

Dimension	Mean (S.D.)		df	t	p	d
	Pretest	Posttest				
Learning Achievement	31.10 (7.70)	75.21 (15.85)	41	-16.03	.000	-3.54

4.3 How Effective is the Use the Tabletop Game (Battles of Warriors) in Increasing Enjoyment?

Table 3 displays the data of the enjoyment of the tabletop game from the ETG Scale, measured at the end of the treatment. The finding showed that most of the participants had positive responses (M=3.90, SD=0.55). The participants had fun and felt interested. As for the dimension of simplicity, the data revealed the game was considered simple and easy to master. (M=3.87, SD=0.55). Simple games enable participants to operate easily. A similar finding was shown in the accessibility dimension because the game rules were quite easy to understand. The participants knew what challenges in the game they were going to encounter (M=3.88, SD=0.67). In the dimensions of player skills, accessibility, and social interaction, more than 60% of the participants expressed agreement in the ETG Scale. The participants were able to get tips for playing the game and promote their skills. They understood. On the other hand, in terms of the immersion dimension, the result demonstrated a moderate response (M=3.51, SD=0.66), and the least percentage of the participants expressed agreement that they had experienced immersion in this game (33.3%). It is possible that this game was not attractive enough to most participants to make them spend time immersed in the game context. Compared to other types of online games with high-stimulation in sounds and images, there was no complex stimulation in vision and sounds to get the attention of these university-level participants. Only the game's rules, interaction, and atmosphere were the main factors to maintain the participants' attention in the tabletop game. In the dimension of challenge, the difficulty level was moderate and not so challenging. The participants could follow the pace of the game.

Table 3. Descriptive Statistics of Enjoyment (N=42)

Dimension	No. of items	Mean (S.D.)	Min	Max	M >= 4.0 (%)	M <= 3.0 (%)
Simplicity	3	3.87 (0.55)	3.00	5.00	54.8	16.7
Player Skills	3	3.97 (0.57)	3.00	5.00	64.3	9.5
Accessibility	2	3.88 (0.63)	3.00	5.00	64.3	21.4
Immersion	2	3.51 (0.66)	2.50	5.00	33.3	47.6
Flexibility	3	3.96 (0.59)	3.00	5.00	57.1	7.1
Social Interaction	2	4.00 (0.60)	2.50	5.00	71.4	9.5
Challenge	4	3.98 (0.49)	3.00	5.00	54.8	2.4
Enjoyment	19	3.90 (0.46)	3.21	5.00	38.1	4.8

In the second part of the ETG Scale, four open-ended questions were offered to investigate the responses and feedback that the participants had for Battles of Warriors, shown in Table VI. The positive responses offered support that the tabletop game brought enjoyment in class. All the responses were positive in Question 1, showing that they liked the game. As for the reasons they liked the game, around 57.14% participants stated that the game was exciting and interesting. It made the classroom relaxing and appealing when learning new content in the class. It relieved the tension and made dry concepts more

interesting as well. Hence, the feedback also supported the enhancement of learning motivation. The rest of the participants liked the game because they learned with peers and had more interaction with the team. The game unified the team members. As for Question 2 about the part that they disliked, 35.72% participants did not think they had any part they disliked. Others expressed the parts they disliked included the bad luck of drawing a negative card to discontinue the competition, unbalanced roles to influence the probability of victory, and the conflicts between role buffs and debuffs. Interestingly, these reasons were also the reasons that some participants liked the game, which made the game become quite exciting. Besides that, when asked if they would like to play the game again, 40 out of 42 participants gave positive feedback because the integration of game into the class made it quite different from the traditional lecture-based course. The employment of the game in this course could facilitate the acquisition of new knowledge, increase in confidence, and attainment of a sense of achievement. Only two participants did not want to play again because they did not want to experience the feeling of losing the game. The last question was about the correspondence of the learning objectives and the use of the game, and almost 98% (41 participants) agreed it was matched. The game assisted students to review the knowledge acquired in class and to pass the Information and Communication Technology Programs Test-Essentials Level, offered by Global Learning & Assessment Development. This feedback was consistent with the results in the enhancement of the learning achievement, a pass rate of 81.6% in the Information and Communication Technology Programs Test-Essentials Level. In addition, based on the teaching evaluation survey that students completed at the school-level at the end of the semester, a high satisfaction rate (4.33 out of 5 points) was given by the students, which was higher than the average of all courses in the entire school. This evaluation was used as an important bridge to offer learning motivation, teacher-student communication, and the interaction of students [28], with an evaluation from the students' viewpoint [29]. This evidence also triangulated the positive feedback of the course.

Table 4. Responses to Battles of Warriors (N=42)

Question	responses	N	%
1. What part of the game do you like? Why?	Excitement & fun	24	57.14
	Learning & peer interaction	18	42.86
	Total	42	100
2. What part of the game do you dislike? Why not?	N/A	21	35.72
	relying too much on probability	9	21.43
	unbalanced of the roles	6	14.29
	too slow	5	11.90
	complicated rules	4	9.52
	need to narrate attacking card (question card) to peers	3	7.14
	Total	42	100
3. Will you play this game again? Why?	Yes (fun, interesting, working in groups…)	40	95.24
	No (nervous)	2	4.76
	Total	42	100
4. Does this game correspond to the learning objectives? Why?	Yes (need to review the content, pass the test…)	41	97.62
	No	1	2.38
	Total	42	100

5 Conclusion

This study of teaching practice employed a self-designed tabletop game integrated into the learning content of the course. The participants reinforced what they had learned by means of a question-and-answer table-top game. In summary, the employment of the tabletop game was significantly helpful to enhance learning motivation, learning achievement, and the enjoyment of the game. Students had significant differences after the treatment. This is in accordance with the conclusions found in other studies [2, 14, 16, 18, 21, 30-31]. Accordingly, it is suggested that university teachers evaluate the effectiveness of employing a tabletop game in the curriculum design. Teachers can use more interactive activities for teams so that they can work together and then compete with other groups. Once they get familiar with each other, they have more opportunities to practice social communication skills. A sense of team bonding is created and learning motivation can be increased positively. Establishing a team chart

of points, announcing the top three teams weekly, and converting the scores into bonus points for "participation and attendance" are strategies that teachers can use. On the other hand, learning achievement is raised as well, since the team has to cooperate to figure out the answers or solutions to the questions from the game. The process functions to make students practice more and have their knowledge internalized. These pedagogical implications may be helpful.

Since Battles of Warriors was a self-designed tabletop game in this research, the enjoyment, interest, stimulation, and the tempos may vary for learners' of different majors, genders, or ages. Hence, the results should not be over-generalized due to the single group experimental design. It is suggested that further research involve a control-experimental group design to investigate learning motivation, learning experience, and learning achievement. In addition, there was no artistic design for this game, and only words were written on the cards. So, further research may be able to explore if artistic or visual factors may influence students' learning effectiveness.

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