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GAMIFICATION: USING GAME PLAY PROCESS FOR LEARNING 3D COMPUTER SOFTWARE

Yu-Cheng Lee[1,*], Hung Sun[2,3,*], Yung-Piao Chiu[2,3] and Pin-Yuan Chiu[4]

[1]Department of Technology Management
[2]Ph.D. Program of Technology Management
Chung Hua University
No. 707, WuFu Rd., Sec. 2, Hsinchu 30012, Taiwan
*Corresponding author: drlee168@gmail.com

[3]Department of Digital Media Design
Hwa Hsia University of Technology
No. 111, Gongzhuan Rd., Zhonghe Dist., New Taipei City 23568, Taiwan
*Corresponding author: arionsun@cc.hwh.edu.tw; frank@cc.hwh.edu.tw

[4]Taipei Municipal Jianguo High School
No. 56, Nanhai Road, Taipei City 10066, Taiwan
a0963871279@gmail.com

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Abstract. *3D computer graphic software is crucial for learning to make digital media-based creations. Numerous studies have shown that by adopting a gamification-based course design, students' participation and learning effectiveness can be improved. In order to gamify a course, some key rules must be followed. However, this increases the complexity of the course design as well as subsequent implementation. Therefore, in this study, a game procedure-based concept was incorporated into the gaming design. In addition, design samples from 3D software education were used to create an example-based learning (EBL) environment to lower the difficulty of gamification learning designs and maintain course appeal. Furthermore, the MOOCs platform was utilized to facilitate blended-based learning, which improved students' learning satisfaction. Finally, the Likert scale was used to design a questionnaire to assess students' learning motivation and investigate the effect of applying a game play process and gamification examples in course planning on students' 3D software education learning results. Improve two-semester course shortened to one term, and maintain the effectiveness of student learning.*
Keywords: Gamification, Game play, Example-based learning, Blended-based learning, 3D education

1. **Introduction.** The purpose of providing technical and vocational education is to build a bridge between students and the professional industry. School departments, their curriculum, and the professional industry should be closely related [1] and schools should focus on providing practical skill-related education.

In this study, the application of the concept of the game, is in order to improve students' motivation to learn, by the course of the game plan to make the learning process as a flow of the game. A blended-based learning (BBL) environment was developed by integrating gamification learning with example-based learning (EBL) as well as a school's online education platform that featured massive open online courses (MOOCs) [2] to facilitate students' favorable learning motivation and results. The teaching objective of the MOOC taught in this study was defined as follows: to act as a bridge to subsequent unity game engine [3] courses so that students possess the necessary art and technical skills to create game-related materials on their own. On the basis of the said teaching objective, topics planned for the course (which was taught over two semesters and total 108 h) were determined. By making adjustments to learning processes, design samples,

and supplementary e-learning materials as well as providing an instant messaging system, students' learning motivation was stimulated and optimal and accelerated course progress was achieved. Next, a questionnaire was designed using the Likert scale to analyze the effect of the gamification learning process on learning. The results showed that by using the gamification learning method to design samples and teach classes, students' learning motivation was elevated.

2. Problem Statement and Preliminaries.

2.1. Motivation.

3D computer graphics software features powerful functions, complex commands, and varying application usages, which easily frustrate students and lower their learning motivation during the early stage of learning. The gamification learning method applies interesting and appealing game-based elements (e.g., game art and game mechanisms) to real-world learning activities [4,5]. Commercialized games use competition-based elements (e.g., scores and rankings) to stimulate players' external motivation and playfulness to drive their internal motivation. Similarly, external elements (e.g., grades and rankings) and internal elements (e.g., interest in 3D computer graphics) can be used to spark students' learning motivation. The gamification learning method uses game mechanisms to spark students' internal and external motivations. In this study, two concepts were referenced to develop the gamification learning method, which were "include fun elements in learning" and "avoid a slow learning progress that leads to boredom" [6]. Samples were designed and course schedule was adjusted to lower the number of mechanism-based designs in the gamification learning method to elevate students' overall learning motivation and learning results.

2.2. Literature review.

(1) Gamification

The application of game-based formats in education has been widely studied. Examples include game-based learning and gamification learning, in which the former converts game content to education-related content and adopts a computer game-based mechanism and a game-like method to teach knowledge to learners [7].

By contrast, "gamification" is a term coined by a British game programmer named Nick Pelling in 2004. Gamification is not a game, at the most fundamental level; gamification is using game elements and game design techniques in non-game contexts [8,9]. Table 1 shows the differences between gamification learning and game-based learning.

Table 1. Differences between gamification learning and game-based learning [10]

Gamification learning	Game-based learning
Game elements are added to the course.	Games that meet the learning objectives are used.
Game mechanisms are added in a non-gaming environment to enhance learning.	Course is completed by playing games.
Points, badges, and rankings are generally used.	Game-based learning is achieved through commercial games (AAA level) or original education games.
Traditional scores are replaced by experience points (XPs).	Critical thinking and problem-solving skills are promoted.
Students choose their learning method.	Gamebased learning can be achieved through digital or nondigital games.
	Students learn and experience via simulations.

Gamification impacts students with different types of motivation differently [11], showing that the use of the gamification design elevates students' learning motivation and that the said effect is more pronounced in students with internal motivation. Gamification indicates the design outline pointed at giving game-like experiences to users, normally with the objective of influencing users' behavior [12,13].

Gamification Framework Octalysis [14] introduced "the 8 core drives of gamification".

1. Epic meaning and calling
2. Development and accomplishment
3. Empowerment of creativity and feedback
4. Ownership and possession
5. Social influence and relatedness
6. Scarcity and impatience
7. Unpredictability and curiosity
8. Loss and avoidance

Concerning gamification-related game mechanisms, they include collecting XPs and badges as well as getting top grade rankings, which enhance learners' gamification learning experience. However, regarding grade rankings used in traditional courses, because only talented, hardworking students rank at the top, such rankings have the minimal effect on motivating academically challenged students. Therefore, this study used game art and game play process as the primary gamification mechanisms.

(2) EBL & BBL

EBL (example-based learning)

EBL refers to the use of operation demonstrations or work examples to enable learners (novices) to understand and emulate; instruction that relies more heavily on studying worked examples than on problem solving is more effective for learning, as well as more efficient in that better learning outcomes are often reached with less investment of time and effort during acquisition [15,16]. EBL is widely used in computer software-based learning environments.

BBL (blended-based learning)

E-learning is an important method currently applied in education. By combining e-learning with face-to-face lessons, students' satisfaction can be improved [17]. Mixed-method learning includes the combination of online and face-to-face-based learning, in which resources are favorably used to facilitate meaningful student-teachers interactions [18].

Regarding BBL, it features the following advantages: students are able to use their time flexibly outside of class to learn the course materials; this type of teaching method is suitable for teaching technical skills, in which students are allowed to learn and practice on their own and teachers are able to keep up with their course schedule. Using MOOCs e-learning platforms provided by schools, software operating procedures are recorded into 10-15 min-long videos for students. This enables students to decide for themselves how to use their time and resources.

3. **Methodology.**

3.1. **Gamified learning.**

(1) Game play process

A game-like teaching method was adopted in class. Table 2 shows that game mechanisms have matching concepts in real-world learning activities. Figure 1 shows a comparison between the gaming process of massive multiplayer online role playing games (MMORPGs) and the education process of school classes. This study designed the course content by creating learning activities that matched the gaming activities. A number

TABLE 2. Game mechanisms and matching concepts in real-world learning activities

In real-world class	Game concept
Learning	Gameplay
Homeworks	Mission
Scores	Reward
Exams	Level
Course passed	Defeated boss

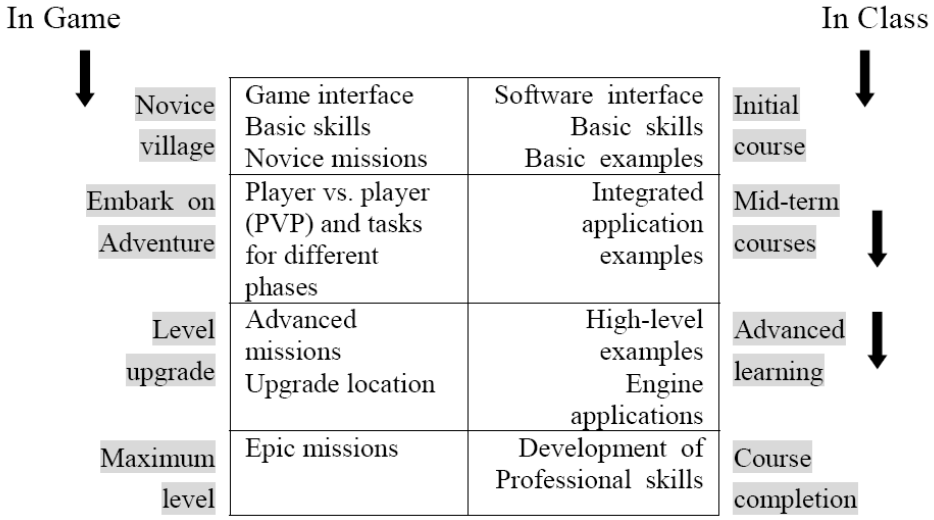

FIGURE 1. Relationship between a course design and a gaming process

of concept modules were used to create the learning process, enabling students to learn various 3D graphics software-related functions.

(2) Novice village

In MMORPGs, a novice village in which players create a new character can be found. In the novice village, the players learn how to operate their characters to play in the game as well as acquire knowledge about various functions and interface. From non-player characters, the players accept missions, familiarize themselves with combat methods, enhance the character's basic skills, make friends, develop a team, and learn about professional skill tree settings. 3D graphics software education adopts a similar concept in its design, in which software features are schematically presented, functions and applications are explained (through basic examples), milestones are set (using integrated examples), and samples are designed (using integrated applications), enabling learners to develop various types of professional skills.

(3) Skill tree

In games such as World of Warcraft and Diablo (both of which were created by Blizzard Entertainment [19]), mastery trees or skill trees are designed for different game races or classes. 3D computer animation software learning employs the same logic, in which learning objectives and function structure are used to form a learning map and the number of study hours invested by students are utilized to determine their skill development directions. Students may refer to the skill tree concept and develop professional skills such as building models or materials, providing lighting, rigging, and taking actions.

(4) Game walkthrough

Topology modeling and art-based anatomy were employed to improve teaching and incorporated into design samples [20,21], in which polygon modeling was first used to design furniture, machinery, and cartoon characters, after which topology modeling was used

to create complex organisms, perform teaching demonstrations, and combine game and cartoon-based education materials that meet students' interest to facilitate an integrated education design.

Players who have no patience or time will play games by using strategy guides to enable them to complete the games in a smooth and quick manner. Players' learning motivation or enthusiasm will drop quickly if they continue to feel frustrated or helpless. In e-learning, when step-by-step demonstration videos are used, the videos are lengthy and boring when all the video segments are added together. Therefore, in this study, only the operating procedure was presented during the education process prior to assignment submission to allow students with a low attendance rate, insufficient practice, and/or poor enthusiasm to finish their assignments step by step. This helped them build confidence and experience a sense of accomplishment, allowing them to transit smoothly into subsequent learning.
(5) Immediate feedback

Traditional education is unable to offer the following game-like characteristics: instant interactions and feedback. In this study, instant messaging software such as Facebook and Line were incorporated into the course design, enabling students to ask questions online any time and receive replies almost instantly. This lowered the learning difficulties that students encountered and motivated them to continue practicing outside of class.

3.2. **Data collection.** During the late stage of the course (two semesters and total 108 h), students were asked to complete a course design and learning experience-related questionnaire. The questionnaire adopted a Likert-scale format [22].

In this study, a survey was distributed to students who studied in foundational and advanced 3ds Max courses. A total of 48 questionnaires were collected, in which males and females accounted for 64.6% and 35.4%, respectively. The students' attendance rate, amount of exercise, English ability, and basic 3D knowledge are shown in Table 3. According to the table, most of the students (79.1%) were unfamiliar with the 3D graphics software.

Table 3. Demographic information of students learning foundational and advanced 3ds Max courses

Topic	Comparisons	
Sex	Male: 64.6%	Female: 35.4%
Attendance rate	50%<: 83.3%	50%>: 16.7%
Amount of exercise	6 h<: 18.7%	6 h>: 81.3%
English ability	Good: 62.5%	Poor or very poor: 37.5%
Basic 3D knowledge	Have basic 3D knowledge: 20.9%	Do not have or are unfamiliar with basic 3D knowledge: 79.1%

4. Main Results.

4.1. **Method of evaluation.** Concerning the relationship between gamification learning and students' learning results, it was identified by performing an exploratory factor analysis, in which topics were selected using the indefinite factor extraction method. The Kaiser-Meyer-Olkin (KMO) and Bartlett's test showed a KMO value of 0.880, indicating that the results were meritorious. After reducing the number of topics, three factors displayed eigenvalues of 6.591, 2.549, and 2.000, and the cumulative variance explained was 74.260, as shown in Table 4.

The varimax method was employed to identify the component matrix after rotation. When the number of factors was not restricted, three factors had an eigenvalue greater than one. After removing items of discrepancy and those that demanded technical knowledge, three constructs and 15 items were obtained. Table 5 shows the reliability analysis of

TABLE 4. Total variance explained

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	8.561	57.075	57.075	6.591	43.939	43.939
2	1.384	9.227	66.302	2.549	16.991	60.930
3	1.194	7.958	74.260	2.000	13.330	74.260

Extraction method: principal component analysis.

TABLE 5. Reliability analysis of the three factor constructs

Factor 1		Factor 2		Factor 3	
Cronbach's alpha	No. of items	Cronbach's alpha	No. of items	Cronbach's alpha	No. of items
0.960	9	.795	3	.578	3

Factor 1: Relationship between learning and self-development
Factor 2: Relationship between learning and self-satisfaction
Factor 3: Relationship between course design and learning motive

the three factor constructs. Factor 1 featured nine items and a Cronbach's alpha of 0.960; Factor 2 featured three items and a Cronbach's alpha of 0.795; and Factor 3 featured three items and a Cronbach's alpha of 0.578 (< 0.6). (The reliabilities and alpha coefficients of most constructs were higher than the benchmark of 0.6 suggested by Bagozzi and Yi (1988)) and the scale showed an overall Cronbach's alpha of 0.937, indicating favorable scale reliability.

4.2. **Result.** Students' attendance rate, amount of exercise, English ability, and basic 3D knowledge were set as the grouping variables for an independent sample t-test, in which the results showed that the effect of combining BBL and gamification in the course design was not significantly correlated with students' sex or attendance rate. Concerning the relationship between amount of exercise and "group competition and learning motivation," it was $p = 0.039$ (< 0.05), indicating that the two were significantly correlated and that group competition influenced amount of exercise. Regarding English ability, it was significantly correlated with the nine items in the course design construct, suggesting that favorable course design elevated learning motivation and reduced language barriers. With respect to basic 3D knowledge before class and "sense of accomplishment from learning 3D software," it was $p = 0.040$ (< 0.05), which indicated positive correlation. The statistical results are shown in Table 6.

5. **Conclusions.** The use of gamification-based learning can enhance students' learning motivation and results. However, preparing game mechanisms such as course design missions, points, rankings, and squads adds burden on teachers. Therefore, in this study, animations, game-based samples, and game-based procedure were included in the course schedule to lower the complexity involved in gamification learning designs and improve their feasibility in class. This effectively elevated the learning motivation and sense of accomplishment of students who had weaker basic skills and language abilities. Concerning the students, group competitions and assignments successfully improved their learning progress by 30%, enabling them to complete the 2-semester long course in one semester.

Regarding the item "use of animations and game art as sample topics" in the questionnaire, it displayed a positive response of 70.8% in the scale. Therefore, a factor analysis was performed before removing the item. Concerning the gamification materials to be used for the students in class, animations, games, and comics were used for digital media department students because they indicated that such materials were a part of their

Table 6. Independent samples test

Form	Issue	Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
The amount of exercise	C2.	2.020	.162	−2.130	46	.039	−.850	.399	−1.653	−.047
English ability	A1.	5.200	.027	−4.730	46	.000*	−1.082	.229	−1.542	−.621
	A2.	.000	.991	−4.147	46	.000*	−1.127	.272	−1.674	−.580
	A3.	2.604	.113	−4.286	46	.000*	−.985	.230	−1.447	−.522
	A4.	.920	.343	−3.579	46	.001*	−.770	.215	−1.204	−.337
	A5.	.978	.328	−3.130	46	.003*	−.753	.241	−1.238	−.269
	A6.	.030	.863	−3.485	46	.001*	−.844	.242	−1.332	−.357
	A7.	2.366	.131	−3.322	46	.002*	−.839	.252	−1.347	−.331
	A8.	2.911	.095	−3.764	46	.000*	−1.004	.267	−1.541	−.467
	A9.	1.976	.166	−2.333	46	.024*	−.588	.252	−1.096	−.081
	B1.	.581	.450	−.681	46	.499	−.188	.276	−.743	.367
	B2.	.323	.572	−1.226	46	.226	−.374	.305	−.988	.240
	B3.	.312	.579	−1.712	46	.094	−.455	.266	−.991	.080
	C1.	.101	.752	−.591	46	.558	−.167	.283	−.736	.402
	C2.	1.060	.309	−1.756	46	.086	−.554	.316	−1.189	.081
	C3.	3.364	.073	−2.255	46	.029*	−.607	.269	−1.149	−.065
3D knowledge e base	A1.	.027	.871	−2.116	46	.040*	−.663	.313	−1.294	−.032

*Statistically significant at the 0.05 level.

daily activities. However, such materials were less likely to incentivize the students. This study also showed that gamification and blended-based learning enhanced students' satisfaction and learning results. In the future, this education method may be introduced to three-year, six-semester long courses to test its effectiveness. In addition, virtual reality equipment may be utilized in the education environment to enable students to create their "playable" course materials.

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