THE CONSTRUCTION OF AN ONLINE COMPETITIVE GAME-BASED LEARNING SYSTEM FOR JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT
The purpose of this study aimed to construct an online competitive game-based learning system by using freeware for junior high school students and to assess its effectiveness. From the learning standpoints, game mechanisms including learning points, competition mechanism, training room mechanism, questioning & answering mechanism, tips, and feedback mechanism are taken into consideration while constructing the system. The system contains screens of Log-in, Game lobby, Waiting room, Player's room, Question & Answer, and Scoring. After the system was established, it was implemented in a 10 week teaching experiment. A total of 35 junior high school students participated in this teaching experiment. Both pre-test and post-test were administered and analyzed. A 5-point Likert scale questionnaire, containing domains of system operation, learning effectiveness, competition and incentive, and training room learning was also included to assess user's satisfaction. Descriptive analysis and independent t test were used to analyze the collected data. The findings of the study show that most students are satisfied with the four domains of the freeware constructed online competitive game-based learning system. Meanwhile, the online competitive game-based learning system is effective for junior high school students' learning.
Keywords: freeware, online competitive game-based learning, junior high school student

INTRODUCTION

In recent years, online games have grown rapidly and received an increasing attention from the educators and game-related industry (Chiang et al, 2011). Some studies indicate that online game playing has expanded its segment of media usage in our daily life. In addition, the positive effects of online game playing have been concerned and explored (Robert, 2000; Chiang et al, 2011). Game-Based Learning (GBL) is an increasingly popular learning mode in recent years (Gendron, Carron, & Marty ,2008; Jarmon et al.,2009; Johnson et al., 2009; Proberta, 2009; Şendağa & Odabaşıb, 2009), as the game-based multimedia elements, such as characters, voice and images, are combined to enhance the attention of students and foster their concentration, interest, creativity and social skills (Raessens & Goldstein, 2003). It is commonly observed that students often become addicted to computer games, especially to Internet-Based games. One major reason behind the phenomenon is that Internet-Based games are usually characterized by a communicative mode that produces a unique kind of social relationships. Given the interaction, cooperation and competition amongst individuals in the game context, people are often called upon to form virtual communities, thereby giving rise to an instant sense of belonging. In this way, suppose teaching materials are woven into the role play or cooperative tasks of the online games, with students given access to the Internet, they might make impressive progress and even achieve higher educational goals (Tuzan, 2004).

Game-Based learning (GBL) is a type of serious games that lead to positive learning performance. Its effectiveness and education potential have been confirmed in research. GBL is designed to reach a balance between game-play and teaching, and enable the players to apply their knowledge to a real environment. Different stages in the games target the single or multiple learning objectives in natural settings. Therefore, the players are learning while playing. By the time they complete the missions in the games, they also acquire the targeted skills. Despite the potential of its acousto-optic effect as an educational tool, games have a high elimination rate. If not put to proper use, they will disappear quickly from the market. Therefore, it is important to pay equal attention to education and fun in game-based learning (Kiili, 2005).

However, this study aimed to develop a competitive gaming and learning system suitable for junior high school students, by working in collaboration with education experts who are in charge of designing the teaching

materials, and with art designers that create characters and scenarios. The proposed system is similar to a commercial game system which is characterized by online multi-player competition, though eliminating problems arising from the intrinsic novel effects of GBL. Finally, in accordance with the spirit of freeware, this system will be shared with the frontline teachers of all subjects, in hopes of enhancing motivation and promoting a cooperative way of learning through GBL games.

LITERATURE REVIEW

Many scholars (Jenkins, 2002; Squire et al., 2003) suggest that the challenging, unpredictable and competitive nature of digital games is the driving force behind game-playing. A player's curiosity and motivation are stirred by their determination to challenge the various levels and prevail (Tsai et al., 2010). Interestingly, Vandale and Bingham (2000) also found that educational methods include brief lectures or discussions, video clips, and interactive activities ("hands-on" exercises) involving case studies, games, and role-playing. Students learn from their errors, and there is a high degree of interaction. In fact, a game can provide a meaningful environment for problem-based learning in so far as problem-solving in games involves striving for a remote and not immediately attainable goal. In this way, game-based learning, when it incorporates problem-solving as part of its natural environment, is deemed to have the power to improve students' abilities in this area (Kim, Park, and Baek, 2009). After all, the ability to solve problems is one of the most important of human skills (Holyoak, 1991). Prensky (2001) mentioned that a good Game-Based Learning program should include at least three components:

1. the fusion of learning activities and games;
2. a variety of interactive processes;
3. the integration of multiple teaching approaches, of which highly contextual learning is preferred.

Due to the implicit educational function, games with narrative scenarios or stories enable players to absorb knowledge unconsciously during the gaming process. Young students, attracted to these educational computer games, will develop their cognition and experience as the games unfold (Barab et al., 2005). In view of the wide-ranging social relationships built in at different levels of the games, the students could improve their social skills; for example, the children can share and help to solve the learning problems encountered by themselves or their groups. Youth often join Internet-based communities or groups during the games (Lenhart et al., 2008), and experience the interaction. Additionally, Yien et al (2011) addressed that games have been recognized as good means to promote learners' active participation in learning activities and game-based learning could be the best way to trigger students' learning motivation by many researchers. Furthermore, many studies indicate that games can help learners develop their problem-solving skills and games are easily to be accepted and closer to children (Yien et al, 2011; Lee & Chen, 2009).

Recent GBL (Game-based Learning) studies probe hitherto uncharted dimensions such as development cost and framework, integration of complex game features, quantified assessment and continuing education (Michael & Chen, 2006). The design framework (Raybourn, 2007) proposed by Raybourn is shown in Figure 1, wherein this framework is composed of four dimensions, each of which includes two interactive layers. In the internal layer, the game level is associated with the development of the scenarios and presentation of contents. The interaction of the games relies on dynamic contents and roles. Generally, stories are a major part of the common games along with scenarios and a series of challenges, which constitute the specific gaming objectives, helping the players indulge themselves quickly into the digital gaming environment. In these games, sound/visual effects, interactive objects, environment and lighting are added to strengthen the sensory input of the players (Lee & Chen, 2009). Computer Aided Instruction (CAI) is produced in such a manner that sound effects, characters, diagrams and pictures (Lee & Chen, 2007) or even cartoons are used to represent the teaching contents (Dalacostaa et al., 2009). An efficient game is designed to stimulate the players taking part in the games proactively. Through real-time assessment of feedback and after action review (AAR), it is believed that the players could gradually pick up new concepts and attitudes (Raybourn, 2007; Annetta et al., 2009).

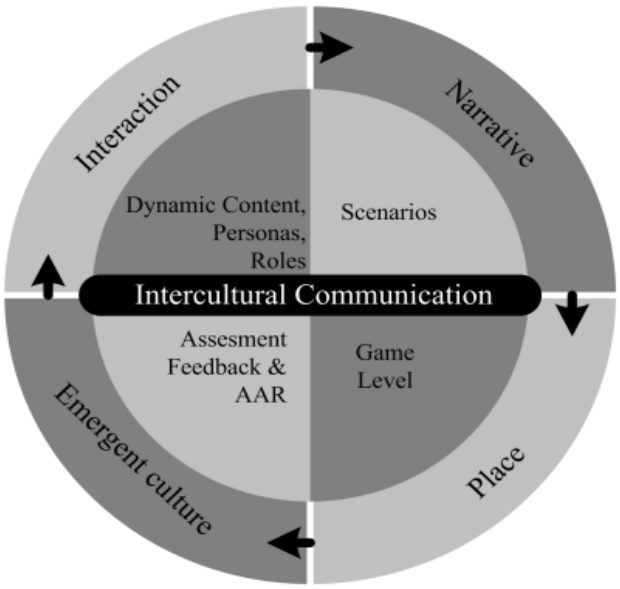

Figure 1: Design Framework of Simulated Experience

In summary, online gaming environment with educational components provides students with more in-depth and meaningful knowledge acquisition. Unlike traditional teaching methods, a successful GBL program features an ingenious design to translate the gaming experience into learning, a user-friendly graphical interface, and an effective strategy to promote participation and interaction. Actually such educational tools are already popular among well-educated elite, who are often observed to indulge themselves in games with similar features (Johnson et al., 2009).

RESEARCH METHOD

The research method of this study contained two phrases: (1) the construction of an online competitive game-based learning system for junior high school students and (2) the implementation of a teaching experiment for exploring the effect of the online competitive game-based learning system. After the construction and validation of the online competitive game-based learning system was completed, a survey questionnaire was developed and validated for assessing the students' learning effect after the experimental study was completed. SPSS statistical analyses were employed to analyze the responses to the survey questionnaire, such as descriptive analysis and independent t test.

1. The Construction of an Online Competitive Game-Based Learning System

Game Development

Two major problems are likely to arise during system development; one is mapping while the other involves Internet connection and multithreads processing. Take Windows for example, textures must be processed in conjunction with the game programming interface (DirectX) developed by Microsoft, if the development is conducted without game engines. However, the establishment of the entire window and the development of user's graphical interface must be considered as well. The game engines offered by free software online provide some very useful tools to develop games in a short time, such as 3D images, collision detection and user's graphical interface modules.

Game Engines

Table 1 shows the three widely-used and well-known game engines based on the support language C/C++ and Windows OS.

Table 1 Comparison of Game Engines

Name	Graphical API	Support language	Efficacy	Stability	Ease-of-use	Support
OGRE	OpenGL, DirectX	C/C++	80	80	70	80
Irrlicht	OpenGL, DirectX, Software	C/C++,C#, VB.NET	80	80	90	80
Crystal Space	OpenGL, Software	C/C++	90	80	70	90

Devmaster is an exchange platform of international game engines, onto which an extremely powerful retrieval system is established. When the game engines of the top three open sources are compared, it is discovered that, regardless of their respective advantages and disadvantages, they are all developed with the major purpose of saving the development time and cost. Besides, they all make great effort to be user-friendly. Due to the constraint of budget, the computer classrooms of most schools are generally equipped with all-in-one embedded devices. In the absence of independent display cards and sufficient computer capacity, the graphical API delivered by the game engines is of utmost significance. Without this support, the games cannot run smoothly, because of poor display capacity, inability to support Alpha Channel or lower FPS (Frames per second).

Internet engines

The games are often networked by 2 modes: Peer-to-Peer and Client/Server. However, no matter which mode is chosen, they can be implemented via many methods (including the RakNet network engine). Generally, the servers are equipped with computers of the quickest processing and networking speed, while the clients with other kinds of computers. Today, the files are transferred by either UDP or TCP. TCP is very efficient in file transfer, but often yields numerous transfer delays in games because of streaming (not packeting).The RakNet network engine (http://www.jenkinssoftware.com/index.html) plays the basic roles of providing a complete UDP transfer environment and helping the developers in solving problems. In such a case, the developers are only required to put their focus on the games. The RakNet network engine can provide the following assistance in game development: (1) automatically re-sending packets not successfully delivered; (2) automatically sending the packets in sequence or in order to increase transfer efficiency; (3) automatically notifying the programmer any time when the packets are tampered externally during the sending process; (4) providing a quick and simply interface, as well as restricting unauthorized transfer; and (5) efficiently solving network problems, such as control and collection of streams.

It is time-consuming both to enable the bit streams and packets in an effective bandwidth and to provide a great number of network control functions. The RakNet network engine guarantees easier and more efficient networking with its many functions, such as remote functional calling, bit stream types, and automatic object synchronization. The network engine not only saves the development time, but also offers such functions as encryption, resources management, packet transfer and multithread management, making it possible to bring the functions of network elements into full play.

Based on the mapping and environment establishment functions offered by the Irrlicht game engine (http://irrlicht.sourceforge.net/) and the networking control functions offered by the RakNet network engine, this paper attempts to build an online competitive gaming and learning system to reduce the time and resources required for game development.

System analysis and framework

This system is an online multi-player competitive gaming and learning system. After successful logging, players can enter the gaming room, or activate a new game at their own discretion. Every game can be accommodated with 2 to 4 persons. For instance, in the Monopoly puzzle game, the chief of the gaming room can select a map, and every participant can select a role at the waiting room. The game starts after the chief and all participants press the OK button. When the game begins, every participant rolls the dice in turn. All participants must answer a question in every round. Every player is provided with coins and points. Coins are deducted only when, in order to buy land or build a house, the player chooses to answer the questions. The amount of the payment depends on the deduction resulting from performance at the Q&A session. Parameters can be set by the system administrator through a database. When walking into the premise of a competitor, the player must first answer questions as well. The payment of tolls also requires parameter setting by the system administrator through a database. When answering the questions, users can use points to call the tips in order to obtain the prompts for the item, as shown in Figure 2.

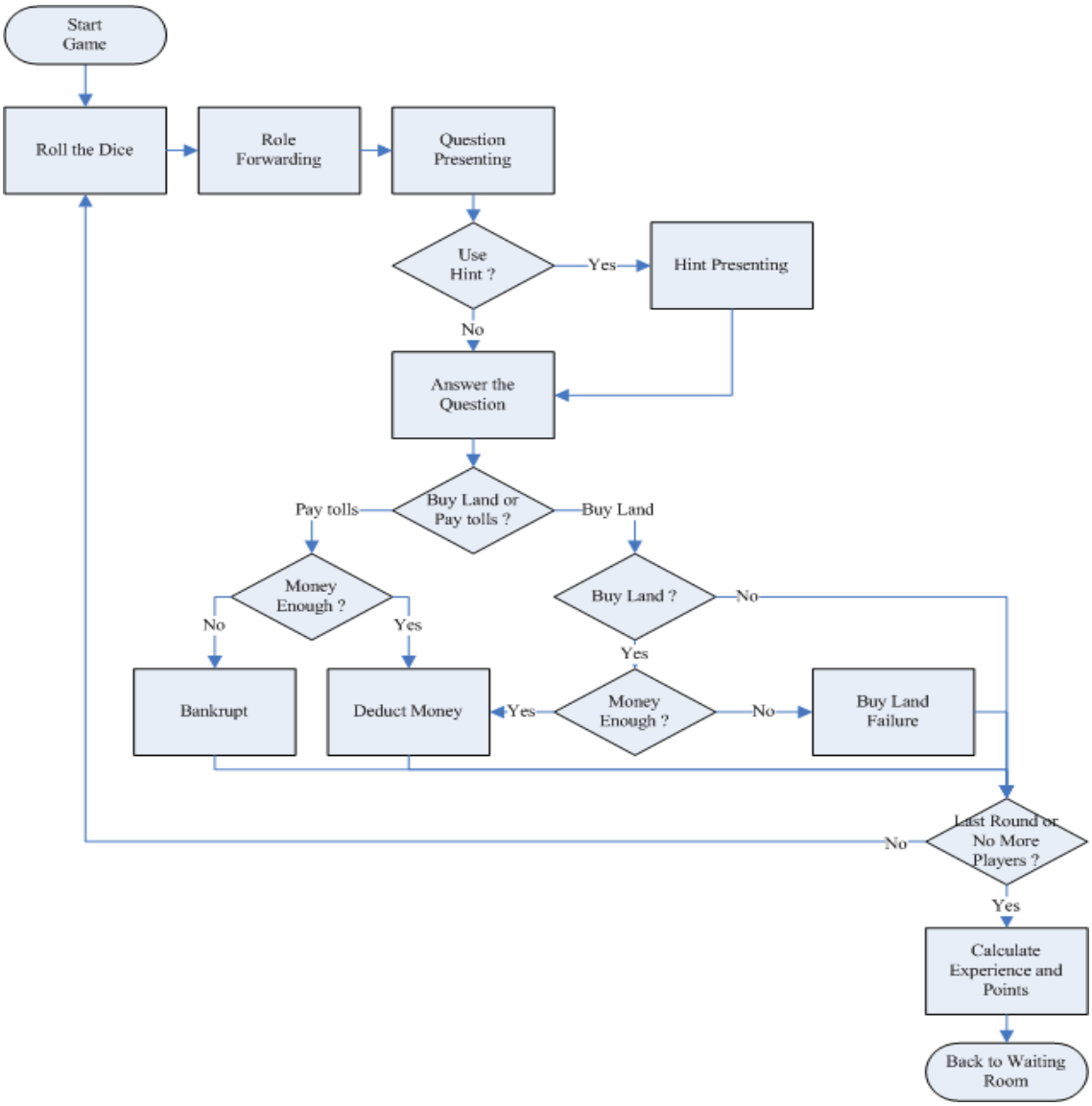

Figure 2: Flow Diagram of Games

Finally, when the preset rounds are reached, or only a single person survives as the others are bankrupt (this round is terminated forcibly), the system will calculate the number of coins or the bankruptcy sequence, and then assign the final points. This game is characterized by (1) research on learning materials: the teaching staff design and analyze the teaching items and tips to establish a large question bank, and assist the arts and program designers in planning suitable learning materials; (2) increased player interaction: the players could use points to call the tips, thus increasing the interaction of players for the fun of "learning through play"; and (3) personal training: the players may enter the personal study room if they fail to correctly answer the questions in the games. The items in the personal study room are designed by the teaching experts to ensure the credibility and effectiveness.

System framework

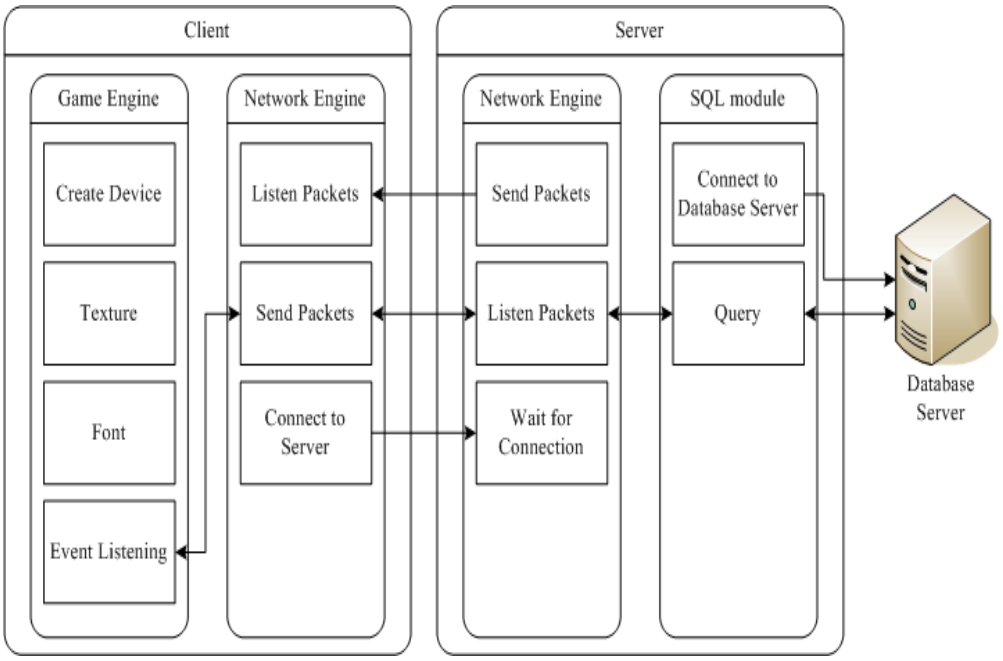

Figure 3: System Framework

The system framework is shown in Figure 3, wherein the game engine of freeware Irrlicht and the network engine of another freeware Raknet are combined integrally to build the entire system. At the user end, the game engine is responsible for creating the system window, font, texture and listening events at the user interface, while the network engine connects the user to the server and sends the packets. At the server, the network engine is responsible for transferring messages among users. In addition, the SQL module is employed to connect to the database server and query.

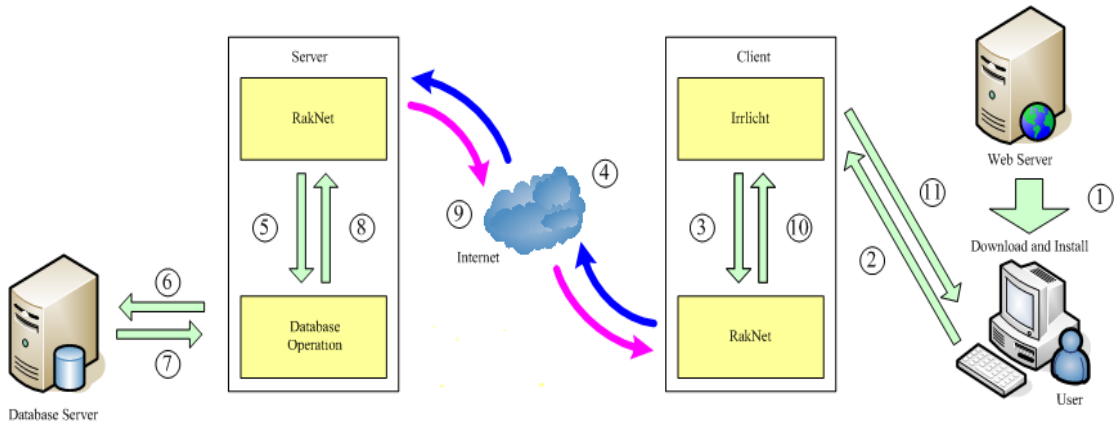

Figure 4: Flow Diagram of System Operation

Figure 4 shows the flow diagram of the game engine and the network engine in the system. Firstly, the player downloads the user system (item 1) from the website delivered by the web server, then installs it and triggers various actions (item 2) through the graphical interface presented by the Irrlicht game engine. If login verification is required, for instance, Irrlicht game engine will transfer the account and password entered by the players to the RakNet network engine for packeting (item 3), and then send the data via Internet to the server (item 4).

The packets of the server are transferred by the RakNet network engine which converts them into the corresponding format and calls the respective services. After the RakNet network engine calls the log-in verification program, the program will call the SQL module, and send a request for the player's account and password (item 5), while the SQL module is linked to the back-end database to fetch the player's account and

password (items 6, 7). After verifying and comparing the player's account and password obtained from the database with those entered by the player, the results are transferred to the RakNet network engine for packeting (item 8), when the RakNet network engine also sends the packets to the user (item 9) via the Internet. After receiving the packets, the RakNet network engine of the user converts the packets into a corresponding format, and transfers the verification results to the Irrlicht game engine (item 10), which will display the results at the graphical interface accessible to the players (item 11), thus finishing an entire verification process.

Game mechanism

(1) Learning points

In the games, every player has exclusive learning points, which can be used to call the tips during multiplayer competition. Every player can have 10 points when the account is set up for the first time. The points are obtained only through multiplayer competition, where the more competitors, the more points after the competition. The number of points obtained from competition and offered initially when setting up a new account is determined by the system administrators or the teachers through modification of parameters in the database.

(2) Competition mechanism

A multiplayer competition mechanism is added to address the dilemma created by the novel effects and raise the motivation and performance of students. After login, the players can create a gaming room for the competition among 2 to 4 persons, or join a gaming room already created by other players. In the gaming room, different representative roles can be selected and the competition is conducted by means of Monopoly. During the gaming process, every player has his/her own coins and points, of which the coins are only used to buy land, build houses and pay tolls in the games. The objects specific to every player are marked by flags of different colors. The points can be used to call the tips. The deducted number of coins and points is determined by the system administrators or the teachers through changing the variables in the database.

(3) Training room mechanism

The training room is designed for the players who are not familiar with the game interface, operating modes and gaming mechanism. A single-player gaming mode allows the player to simulate the real competition. In addition, the training room, as the name implies, highlights the exercise of individual items and acquaints the users with the learning contents. Prior to the competition, the players could do some exercises to become familiar with the contents, by means of which they will have advantage over others in the competition for the final rewards.

(4) Questioning & questioning & answering mechanism

When a player rolls dice in the game process, the system will present simultaneously the points and the animated cartoons to every player in the game room. After the cartoons come to an end, the players in this round must answer the questions extracted randomly from the database in a real-time manner. When the questions are presented, all players in the gaming room can see the contents as well as the answer given by a certain player, but cannot help him/her with it. However, the players can discuss the questions through a session system due to lack of time limitation.

(5) Tips mechanism

According to the scaffolding theory, a hint system is included to provide tips or strategies to the players when they are not familiar with the questions or need further assistance. To give the students timely assistance and fun in the games, they can call the tips if they meet difficult questions either in the training room or in multiplayer competition. Every question comes with 1 to 3 tips; the harder the question, the more tips are provided in a progressive way. In the same game room, non-players can be allowed to see the contents of and answers to the questions, but not the tips. In multiplayer competition, points of the players shall be deducted to prevent players from abusing the system to win rewards. The system is preset to deduct one point when a tip is used in a multiplayer competition. Point deduction can be determined by the system administrators or the teachers by adjusting the variables in the database, but points will not be deducted if the tips are used in the training room.

(6) Feedback mechanism

A feedback mechanism is added to this GBL system in accordance with the design framework introduced in Section 2. A round refers to a process in which every player attends the game in turn. 30 rounds are preset for every game, and the number of rounds can be altered by changing the parameters in the database. In the end of a round, a scoreboard will be presented showing the final ranking order, which is decided by the coins held by every player in the gaming room. The ranking order is also determined by the player's points and experience, which are calculated by the following formula:

Points = (total number of persons–ranking of its own) × multiplying factor of points

EXP = (total number of persons–ranking of its own) × multiplying factor of experience.

The multiplying factors of points and experience can be adjusted by the system administrators or the teachers through changing the variables in the database.

Figure 5: Screen of Game Lobby

After successful verification by the server, the player can enter the screen of the game lobby, and then select a new game (i.e., create a new multiplayer competition waiting room), or join the waiting room already established by other players (Figure 5). The newcomers may also select the training room for personal training. If the player wants to inquire about his/her accumulative online hours, number of points and experience, he/she may select personal learning information. The list of players at upper right corner of the screen shows the names and positions of all online players, of which red names represent female students whereas blue names represent male students.

Figure 6: Screen of the waiting room

In the waiting room, the upper left corner of the screen shows the current chief of the room, the lower part is a session system enabling conversation with other players in the waiting room, and the right-hand field shows the

map preview, role selection, map selection, persons selection, the “ready” button and the “back to lobby” button from top to down (Figure 6):

- Map preview: the upper right corner shows a preview of the map selected by the chief.
- Role selection: several roles are available for the players.
- Person selection: in a multiplayer game, the chief may select 2 to 4 persons for the games, but the personal training room is limited to individuals.
- “Ready” button: the players must press this button after getting ready. The game will begin after all players press this button.
- “Back to lobby” button: the players can exit the waiting room and enter the game lobby by pressing this button.
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Figure 7: Single-/Multi-player Game Screen

Figure 7 shows a game screen in operation, wherein the upper right corner displays the color of flags, nicknames, coins and points of all players; the lower right corner displays the dice rolls and rolling button, of which the rolling button can be clicked only by the player in turn.

Figure 8: Questioning & answering Screen

When the player rolls the dice and then specifies the steps, the game screen will immediately display the questions and options. The questions and options are selected randomly from the database of the server by the

teachers or administrators from the specified subjects and chapters, and then transferred to the players. At the same time, other players in the same game room can see these questions and options, though without the right to answer the questions. The questions are generally categorized into textual and multi-media ones. Figure 8 is a multimedia screen. The players can answer questions by clicking the options below. After verification by the server, the circles and cross dots below the options will show whether the answers are correct.

Figure 9: Calculation Screen

As shown in Figure 9, when the number of rounds displayed on the rounds billboard is reset to zero, the system will decide the ranking and points based on the remaining coins of every player. After confirming the result, the player presses the OK button and returns to the waiting room.

2. The Implementation of Teaching Experiment

Participants & research instruments

The participants of this study were 35 junior high school freshman students (17 males and 18 females). The online competitive game-based learning system was employed for 10 week teaching experiment. The pretest and posttest were conducted in the beginning and the end of the teaching experiment in order to assess students' learning performance. Descriptive analysis, independent t-test, and paired t-test were performed to analyze the collected data.

Development of the Game-based learning Survey Questionnaire

The initial questionnaire contains 21 questions and the content of the questionnaire was constructed and revised based on the literature review and Csikszentmihalyi's Flow theory (1975). Five-point Likert scale was used in the questionnaire (5=strongly agree, 4=agree, 3=neutral, 2=disagree, and 1=strongly disagree). The content validity of the survey questionnaire was established by five scholars and experts in the game-based learning related fields. After the content validity was established, the questionnaire was sent to 30 students for pilot study. The responses to the questionnaire were analyzed by item analysis and factor analysis. As a result, the formal questionnaire contains 19 questions with 4 categories of "System operation," "Learning interest and performance," "Competition and incentive," and "Training Room." The questionnaire obtained .925 of Cronbach alpha value, indicating a high reliability of the questionnaire.

RESULTS AND DISCUSSIONS

Results of descriptive statistics of the questionnaire

Table 2 shows the statistical results of descriptive analysis of the survey questionnaire. A total of 35 students with 17 males and 18 females responded to the survey questionnaire. The results also show that 23 students (65.7%) had prior online game playing experience.

Table 2: Results of descriptive analysis of the questionnaire

Variable	Category	Number	Percentage
Sex	Male	17	48.6%
	Female	18	51.4%
Prior online game playing experience	Yes	23	65.7%
	No	12	34.3%

Statistical results of independent t-test of the survey questionnaire

The statistical results of independent t-test show that there are no significant differences between the gender and the effectiveness of game-based learning on the whole questionnaire and the four categories of the questionnaire (t=1.586, p=.122> .05; t=1.556, p=.129>.05; t=1.434 p=.161>.05; t=1.461, p=.154>.05 respectively).

Table 3: Results of independent t-test of the survey questionnaire

Variable	Male (*n*=17)		Female (*n*=18)		*t*	*p*	95% *CI*	
	M	*SD*	*M*	*SD*			*LL*	*UL*
The whole	79.12	6.14	75.78	6.30	1.586	.122	-.944	7.623
I. System operation	20.41	1.58	19.61	1.46	1.556	.129	-.246	1.848
II. Learning interest and performance	25.88	3.04	24.50	2.66	1.434	.161	-.579	3.344
III. Competition and incentive	17.76	1.56	17.00	1.53	1.461	.154	-.300	1.830
IV. Training room learning	15.06	1.89	14.67	1.97	.601	.552	-.936	1.720

Table 4 shows that results of t-test on the prior online game playing experience, indicating the effect of game-based learning would not be affected by the factor of prior online game playing experience.

Table 4: Results of t-test on the prior online game playing experience on the survey questionnaire

Variable	YES (*n*=23)		NO (*n*=12)		*t*	*p*	95% *CI*	
	M	*SD*	*M*	*SD*			*LL*	*UL*
The whole	77.83	6.79	76.58	5.63	.991	.329	-1.076	3.120
I. System operation	20.04	1.82	19.92	0.90	.991	.329	-1.076	3.120
II. Learning interest and performance	25.52	3.15	24.50	2.32	.778	.442	-.708	1.585
III. Competition and incentive	17.52	1.56	17.08	1.62	-.500	.620	-1.745	1.057
IV. Training room learning	14.74	1.89	15.08	2.02	.543	.591	-3.416	5.901

Statistical results of paired t-test of the survey questionnaire

Table 5 shows the statistical results of paired t-test of the survey questionnaire, indicating the scores of the posttest were significantly higher than the pretest on the four categories of the survey questionnaire. In other words, the students made significant progress after the 10-week teaching with using the online competitive game-based learning system.

Table 5: Results of paired t-test of the online competitive game-based learning survey questionnaire

Statement	Pre Test (*n*=35)		Post Test (*n*=35)		Sig. (2-tailed)
	M	*SD*	*M*	*SD*	*t*-test
The whole questionnaire	59.77	3.62	77.40	6.36	-15.99***
I. System Operation	16.03	1.36	20.00	1.55	-13.37***
1. I know how to play this game very quickly.	3.37	0.60	4.17	0.51	-8.10***
2. I find this game software very interesting.	3.06	0.34	4.03	0.30	-15.03***

3. I find it is easy to operate this game.	3.09	0.45	4.06	0.42	-12.69***
4. The game displays and steps are clear and easy to understand.	3.34	0.54	3.91	0.37	-6.06***
5. The tips are helpful.	3.17	0.62	3.83	0.45	-6.58***
II. Learning Interest and Performance	19.29	1.98	25.17	2.90	-11.36***
6. I find I like "Comprehensive Subjects" better when learning through online games.	3.14	0.49	4.17	0.51	-10.71 ***
7. I'm expecting such online competitive game-based materials in the next unit of "Comprehensive Subjects."	3.40	0.55	4.20	0.47	-7.48***
8. I'm eager to attend this online competitive game-based course after class or school.	3.17	0.45	4.11	0.72	-8.16***
9. I hope to learn other subjects through the same kind of online games.	3.17	0.45	4.29	0.46	-11.31***
10. I will recommend such online competitive game-based courses to my friends.	3.14	0.43	4.17	0.71	-8.61***
11. I think online competitive game-based learning can improve my performance.	3.26	0.51	4.23	0.49	-8.66***
III. Competition and Incentive	12.00	1.21	17.37	1.57	-15.88***
12. I find it more interesting to learn the subjects through online competitive games	3.09	0.37	4.29	0.46	-13.36 ***
13. I feel stressful because I'm afraid that I might have poor performance in the games.	2.66	0.54	4.31	0.47	-12.82***
14. Online competitive games enable continuous learning.	3.11	0.53	4.43	0.56	-11.50***
15. The points-based incentive system is also a contributing factor to continuous learning.	3.14	0.43	4.34	0.48	-10.48***
IV. Training Room	12.46	1.40	14.86	1.91	-8.52***
16. The training room provides me with diversified learning methods.	3.09	0.51	3.71	0.52	-6.80 ***
17. The training room is helpful to my learning.	3.09	0.45	3.74	0.56	-8.07 ***
18. I will often use the training room to win the games.	3.17	0.51	3.69	0.53	-5.41***
19. The training room is a contributing factor to my success in learning.	3.11	0.47	3.71	0.57	-5.88***

Note: df=34. ***p<.001.

According to the statistical results in Table 5, the 5 items in the category of System operation obtained mean scores ranging from 3.83 to 4.17, indicating the students are satisfied with the system operation of the online competitive game-based learning system and are interested in the interface of the system. In the category of Learning interest and performance, the 6 items obtained mean scores ranging from 4.11 to 4.29, indicating the students expect that other subjects can be learned through the online competitive game-based learning system and agree that their learning interest and performance are enhanced and improved by using the online competitive game-based learning system. In the category of Competition and incentive, the four items obtained mean scores ranging from 4.29 to 4.34, indicating the competition mechanism in the online competitive game-based learning system can effectively motivate the students' continuing learning willingness. Finally, the four items in the category of Training room learning obtained mean scores ranging from 3.69 to 3.71, indicating the training room mechanism can effectively assist the students in learning through online competitive game-based learning system and is helpful for learning other subjects.

In summary, easy-operating interface of the online competitive game-based learning system can influence the students' motivation of use. Additionally, a game with competition and incentives can increase the students' learning interests and effect. In particular, the Training room is helpful for the students in subject learning. As a result, an online competitive game-based learning system can effectively enhance the students' learning motivation and effectiveness.

CONCLUSION AND SUGGESTIONS

CONCLUSION

This study primarily aimed to establish an online competitive game-based learning (GBL) system for junior high school students as well as to verify its effectiveness. The online competitive game-based learning system was constructed through a series of sound technical process, including game engine, internet engine, and SQL module. The features of the game mechanism of this online system contain learning points, competition mechanism, training room mechanism, questioning & answering mechanism, tips mechanism, and feedback mechanism. Particularly, the competition mechanism can effectively enhance the students' learning interests, performance, and willingness to learn continuously as supported by Tsai et al, 2010). Additionally, according to the students' responses to the survey, the questioning & answering, tips, training room, and feedback mechanisms also important and effective for students to practice, gain problem-solving skills and improve their knowledge and skills (Kim, Park, & Baek, 2009). Regarding the operation of the online game-based learning system, an easy-operating and user-friendly interface influences the users' learning motivation and willingness. As a result, a sound and effective online competitive game-based learning system should contain functions or mechanisms of training room, tips, questioning and answering, and feedback in order to improve the user's learning interests and performance.

SUGGESTIONS

A qualitative approach with in-depth interviews should be employed to the online competitive game-based learning system in order to understand the user's opinions and suggestions in details and for further improvement of the online learning system. Additionally, the results of the survey cannot be generalized because there were only 35 junior high school students participated in this study, which is also the limitation for the study. Thus, more students may be invited to participate in future studies or teaching experiments may be conducted in order to validate and confirm the findings of this study.

ACKNOWLEDGEMENT

The authors wish to thank the project was supported by a grant from National Science Council, Executive Yuan ROC (98-2511-S-366-002).

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