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The Design and Analysis of Learning Effects for a Game-based Learning System

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***Abstract*—**The major purpose of this study is to use network and multimedia technologies to build a game-based learning system for junior high school students to apply in learning "World Geography" through the "role-playing" game approaches. This study first investigated the motivation and habits of junior high school students to use the Internet and online games, and then designed a game-based learning system according to situated and game-based learning theories. A teaching experiment was conducted to analyze the learning effectiveness of students on the game-based learning system and the major factors affecting their learning. A questionnaire survey was used to understand the students' attitudes towards game-based learning. The results showed that the game-based learning system can enhance students' learning, but the gender of students and their habits in using the Internet have no significant impact on learning. Game experience has a significant impact on students' learning, and the higher the experience value the better the effectiveness of their learning. The results of questionnaire survey also revealed that the system can increase students' motivation and interest in learning "World Geography".

***Keywords*—**Game-based learning, situated learning, role playing, learning effectiveness, learning motivation.

I. Introduction

THE guidelines of information education in "Grade 1-9 Curriculum" [1] proposed by the Ministry of Education in Taiwan pointed out that modern people have the ability to apply information technology to the development of knowledge, so many countries actively promote information education to set up the foundation for their development in the twenty-first century. The goal of information education is to help students on information acquisition, application and analysis as well as the development of creative thinking, problem solving, active learning, cooperation, communication, and lifelong learning abilities. The major purpose is to establish correct concepts in campus information ethics and intellectual property rights, and to introduce information technology and the related issues in human society in order to cultivate right attitudes and habits in using information technology.

Chang and Lin [2] considered the essence of information education should gradually switch from learning computer skills to integrating technology into teaching subjects, and finally to combining information technology with our daily life. That is, information technology and education in schools must reflect the reality, not only focus on the applications to teaching various subjects but also the applications in social life, for example, the concepts and laws for proper use of computer, information, and the Internet. Teachers can also apply the results of their studies to some game-based learning activities requiring teamwork for young students to participate in. It is better if the activity design can reflect the real world such that students will realize the difference between the virtual and real situations.

The development of the Internet has changed the human's learning styles and activities. Since online learning is not limited by time or space, it has become a trend for the human to obtain knowledge. Game-based learning is a new idea evolved from the development of e-Learning, and it is aimed at enhancing learners' motivation and interest for achieving better learning effects. With the popularization of the Internet, online games have become a prevalent entertainment in today's society. Online games can motivate people to actively participate, as compared with traditional stand-alone computer games. The players of online games come from different areas with different ages, which enhance the game competitiveness and challenging nature. Also, people are brought together through the Internet to form a global village due to the experience sharing.

Chen described in her study [3] that the role-playing games (RPG games) allow players to control an avatar through which they can explore or go on an adventure, and have dialogues to exchange ideas with other players. The frequent interaction can result in community connection and lead to the development of a new hierarchical social structure. For example, the virtual farm on Facebook [4] enables the players to grow vegetables, raise chickens, or buy a dog to watch their farms. They can even sneak into a friend's farm to steal vegetables and eggs. After harvest, the players can see the results of their hardworking and feel a sense of accomplishment.

Most online games begin with a fictional story to develop the contents, though not too much help for learning, but they can promote active participation in learning activities. Liang et al. [5] considered that game-based learning has an important feature of providing simulated situations and roles for the users to search for interesting or meaningful goals, e.g., completing a mission, accumulating scores, defeating enemies, treasure hunting, etc. Users obtain knowledge through the potential learning process, which can also help assimilate the obtained

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knowledge and convert it into useful concepts. Sun [6] stressed that the goal of game-based learning is not to replace traditional teaching methods but to be used as an assistant tool since it can increase the effectiveness of traditional teaching method. Therefore, the relation between game-based learning and traditional teaching methods are complementary.

To understand the motivation and habits for young students to play online games and their willingness to participate in game-based learning, this study has conducted some literature surveys. According to Xue's questionnaire results [7], more than half of the junior high school students play online games, among them, 75% are boys and 25% are girls. Liao's results [8] also showed that the ratio of boys playing online games is significantly higher than that of girls. He inferred that the cause might be due to interest. In general, the boys are more interested in exciting activities, so online games can satisfy their needs. On the other hand, girls like to perform music or artistic information search. Lu and Xue [9] pointed out in their study that playing online games could affect the relationship of junior high school students, and the longer they play online games the better their relationship in the Internet world.

Lin and Su [10] proposed a model to explain for online game players' behavior, and their research results indicated that the self-respect developed in online games is an important factor affecting players' participation, while another important factor is the immersive experience. Since the online game can engage the player's attention, it can also increase his or her willingness of participation. In addition, the research results also showed a significant correlation between players' intention to participate and their influence on the game world, sense of belonging, and acknowledgement regarding entertainment and. Yang [11] also found that online games have a positive impact on the junior high school students, but it is necessary to counsel students to clarify the correct social values.

The above literature surveys can be summarized as follows. The percentage of playing online games for junior high school students has gradually increased, and the ratio of boys playing online games was significantly higher than that of girls. Most students play online games at home, and cybercafé is another popular place. Playing online games could affect the academic achievement of junior high school students, and the longer they play online games the lower their academic achievement is. However, the majority of junior high school students think that online games can help with common topics among classmates and friends, and enable them to develop a good relationship through the same hobby. The researchers in this study believe that the attractive features of online games can help induce active participation if they are applied to learning, and therefore enhance students' learning motivation and interest.

Garris, Ahlers, and Diskell [12] proposed a set of learning model combining learning contents and game characteristics. This model makes learners feel happy and become willing to participate and stay in the game cycle to achieve certain training goals or learning outcomes. In this study, Garris' game-based learning model was used as the theoretical basis for developing a game-based learning system where junior high school students can travel around the world and learn about the knowledge of world geography. In the mean time, they can create a knowledge transformation process and gradually enhance their learning interest and problem-solving ability.

The situated learning theory proposed by Brown, Collins, and Duguid [13] considers that the learners' knowledge and skills are developed in certain situations by the interaction between learners and the situations, so the nature of a learning process is affected by activities, thoughts, and social culture. This study adopted the situated learning strategy proposed by Collins [14] for the design of the game-based learning system. To enhance students' learning motivation and interest, this study simulated the situation of traveling in foreign countries based on the experience of a self-help traveler, and the objective was to complete the mission of traveling around the world and obtain sufficient knowledge in "World Geography".

The major purpose of this study was to use network and multimedia technologies to build a game-based learning system according to Garris' game-based learning model and Collins' situated learning strategies. The goal was to help increase the motivation and willingness of junior high school students in learning "World Geography" to enhance their learning. This study first examined the motivation for students to participate in online games and their habits in using the Internet, and the results could be used as a guideline for designing the functional modules and user interface of the game-based learning system. A teaching experiment was conducted to analyze the learning effectiveness of junior high school students on the game-based learning system and the major factors affecting their learning. A questionnaire survey was used to investigate students' attitudes towards game-based learning.

The design of the game-based learning system was based on the real situations of self-help travel and several renowned attractions in the world, so students could enjoy the beautiful scenery and carry out adventure and treasure-hunting activities in the game world. The idea of the game-based learning system is drawn from real life, allowing young students to learn the right attitudes when dealing with people and situations, such as "Always make a plan and be prepared to be easy for the success. Master one's time, money, and health to reach the goal in life journey." Therefore, it has a positive effect on inspiring young students' outlooks on life and its management.

II. Learning Theory and Strategy

The game-based learning system developed in this study can be accessed on the Internet and its programs are executable by browser's Flash Player. The users play the role of a self-help traveler in the game world to travel around the world for learning geographical knowledge, while the status of the role, e.g., experience, food, sleep, physical strength, will change during the trip according to the game rules. Users have to complete their missions and collect the specified souvenirs to be qualified for the final contest. The rank in the contest represents a milestone of learning "World Geography" knowledge on the game-based learning system.

In the travel game, the user must manage the time, money and health properly for the role that he or she plays in order to achieve the goal of traveling around the world and accumulate sufficient geographical knowledge and experience to become a winner in the contest. This study has designed a billboard which enables users to know the status of other competitors and it can also be used as an indicator to encourage learning. Users must accept the challenge of tour guides and answer questions about "World Geography" to enhance the role's knowledge, money, experience and ranking position. Therefore, the design of game rules conforms to Garris' game-based learning model by using the game cycle to stimulate participating motivation.Please submit your manuscript electronically for review as e-mail attachments. When you submit your initial full paper version, prepare it in two-column format, including figures and tables.

A. Game-based Learning Model

This study used Garris' input-process-outcome game-based learning model as a theoretical basis for the system design. By accepting the challenges in the game, users continue to behave, accept system feedback, and make a judgment to achieve the goal of learning (Fig. 1). The game-based learning model used in this study is described in the following.

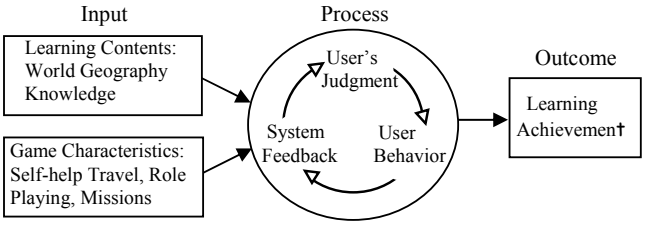

Fig. 1 The game-based learning model used in this study

1. Input

(1) Instructional Contents

The learning contents in this study include the important knowledge and concepts in "World Geography" learning unit, for example: the world's major lands and seas, the regional differences of climate and natural landscape, the world's natural resources, the world's residents. This study provided users with these learning contents by game scenes, missions and contests in an immersive way such that they can gradually construct the knowledge of world geography.

(2) Game Characteristics

The game-based learning system adopted the role-playing approach to carry out the mission of traveling around the world, and the basic game characteristics are:

- *Fantasy:* Users in this game play the role of a self-help traveler and the goal is to travel around the world and learn the related geographical knowledge in different countries and tourist attractions.
- *Rules/Goals:* In a journey, the role's physical strength is reduced due to long traveling, so the user can not continue to learn or carry out a mission. Therefore, the user must plan his or her trip properly such that the role can remain in the best physical condition to complete the mission.
- *Sensory stimuli*: In this study, computer animation is used to enrich the visual effects and learning contents.
- *Challenge*: Users in the travel game can apply the geographic knowledge to challenge the local tour guides. The success in the challenge can increase experience values and money, which can help raise their ranking positions.
- *Mystery*: Users in the game can visit several countries and renowned attractions in the world. They must carry out the missions and treasure-hunting activities in the game world and may experience some adventures.
- *Control*: Users can control a variety of role's states, including: planning the schedule and learning progress as well as the management of food, sleep, money, and time.

2. Process

(1) User Behavior

Users must schedule the trip properly to maintain the best health condition for the role to enhance the learning efficiency, and they must complete the missions to raise their ranking positions on the billboard.

(2) System Feedback

- *Game rules and interaction*: The role's physical strength is reduced due to traveling a long distance, so he or she must eat and sleep for recovery. In addition, air tickets, public transportation, accommodation, and meals all cost money, so the role must earn some money by complete a mission.
- *Challenge and learning knowledge*: Accepting challenges can enhance the user's geographical knowledge. A successful challenge can also increase the role's experience values, money and souvenir as a reward.
- *Guidelines for learning*: After answering all the questions in a challenge, the system will provide the source of the test questions so that users can easily find the correct answers and the relevant information on the subject.

(3) User's Judgment

The user's judgment includes their interest, enjoyment, task involvement, and confidence, which can be reflected in the achievement of the role that he or she plays. The role's status in the game will appear on the billboard so that the user can know the learning progress of other users and use it as a reference of competition. Besides, the message board provides a network space for the users to discuss and share their learning and gaming experiences and it can also be used to support the user's judgment.

3. Output

The users can obtain the knowledge in "World Geography" by completing the missions of traveling around the world. A teaching experiment was conducted to analyze the learning effectiveness of the users on the game-based learning system and the major factors affecting their learning. All tables and figures you insert in your document are only to help you gauge the size of your paper, for the convenience of the referees, and to make it easy for you to distribute preprints.

B. *Situated Learning Strategies*

In order to simulate the situations of traveling abroad, this study designed the game rules based on the real circumstances of a self-help travel. The user must maintain the role's best health condition, and properly manage his or her time and money in order to achieve the goal of traveling around the world while accumulate sufficient geographical knowledge and experience values to become the winner.

- In this study, the situated learning theory was applied in the game-based learning system. For example: the physical strength of the role is decreased due to long-distance travel, and it can be recovered by adequate diet and sleep. In addition, the travel game is designed with intertwined links to enhance the users' interest and learning motivation, e.g., the beautiful scenery in different countries and the missions for completion. This allows users to learn foreign customs, culture and landscape features to increase their travel experiences and geographical knowledge.

III. System Design

The format of Flash animation adopts vector graphics technology, so its file size is smaller than those developed by other animation design tools. Currently, a variety of browsers have built-in Flash player, so this study used Adobe Flash CS3 to design the game rules, characters, user interface, learning modules and challenge tasks. This study used client/server system architecture to integrate Flash multimedia applications and MySQL database by Action Script programs. The sending and receiving of user data is done by PHP programs, and the application programs of online game are executed by the built-in Flash player in the browser.

The system architecture can be divided into official website and travel game. The official website provides the functions of account application, novice guide, game rules, message boards, etc. for the users to understand its contents and the method of operation. Users must apply an account and use this account to login the travel game system. The travel game provides a menu screen, including the functions of tour maps, game announcement and background music, allowing users to control the role's states. In addition, the travel game provides four types of game scenes, namely, cities, tourist attractions, hotels and international airports. The design of user interface, game rules and learning modules for the game-based learning system are described in the following.

A. *User Interface*

The user interface (Fig. 2) of the travel game contains the main menu (lower left), the tour maps (upper right), the game announcement (above), and background music control (upper left), allowing users to control the role's states in the travel game.

- The main menu provides six functions, i.e., tourist status, baggage, missions, message board, billboard and help. The main menu is designed using icons and texts to facilitate the users to inquire about the functions. The functions of the main menu are described in the following.

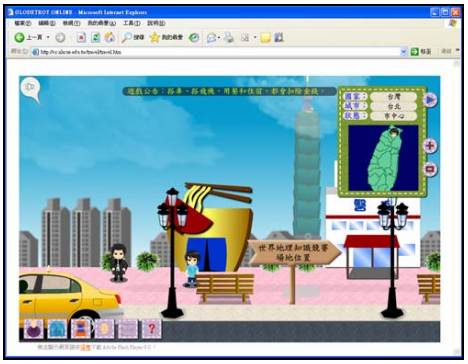

Fig. 2 The user interface in the travel game

  - ✓ Tourist status: This function can check the role's states and basic information, including: character name, level, money, experience, food, sleep, physical strength, etc. Thus, the users can control and be aware of the role's states in the travel game.
  - ✓ Luggage: This function can indicate all the items in the tourist's luggage, such as: money, souvenirs, and flags, etc., which are required for the users to be qualified for the world contest.
  - ✓ Mission: This function can remind the users about the achieved percentage of progress in the mission, and it also lists the requirements of the mission and the reward obtained after completing the mission.
  - ✓ Message board: This function provides the users with a network space to discuss and share their experiences and encountered problems in the travel game in order to enhance the interaction between the users.
  - ✓ Billboard: This function can check the experience values of the users and their ranking positions, which can be used as a reference of competition.
  - ✓ Help: This function provides the users with immediate assistance when they forget the operational method.
- The tourist map shows the role's current position on the map of a country or a city. Users can use the buttons on the tourist map to open a city map or a country map.
  - ✓ City map: It shows the role's current position in a city. The map also indicates the positions of international airport, hotels, and tourist attractions.
  - ✓ Country map: It shows the role's current position in a country and the continental map containing this country. For example, if the role is in Italy, the country map will show the Europe map and mark the role's position in Italy.
- The game announcement provides a continuous display of some statements to remind the users about the operational methods and game rules.
- The travel game will play the local music when the user is traveling to a country to increase the immersive effect. The button of background music enables the user to turn on or turn off the music.

B. *Scene Design*

The travel game provides four types of game scenes, i.e., cities, tourist attractions, hotels and international airports. The design of game scenes and their user interface is based on the

real situations of a self-help travel. The user can take a taxi to different game scenes, and use the mouse to click at the location in the game scene to control the user's movement.

- *Tourist City*: When the user first logins to the system, the default location is in Taipei. The other tourist cities include: Tokyo, Hiroshima, and Kumamoto in Japan, Paris in France, Cairo and Aswan in Egypt, Rome and Pisa in Italy. The user can obtain the geographical knowledge by traveling around the world. When the user has completed all missions and collected the specified souvenirs, he is eligible to participate in the world contest held in Taipei.
- *Tourist Attraction*: The travel game offers ten famous attractions in five countries for the users to visit, and the game scene for each attraction is designed according to the landscape in that attraction, for example: Fort San Domingo at Tamsui, Japan's Fujiyam, Miyajima's Torii, Kumamoto Castle, Eiffel Tower and Arc de Triomphe in Paris, the Egyptian pyramids and Abu Simbel Temple, the Leaning Tower of Pisa, and the Colosseum in Rome (Fig. 4). In the game scene, the user can use the mouse to click on the tour guide and choose "Learning Knowledge" in the dialog box to start learning. There are four learning topics for selection, i.e., country, attraction, worldview, and continent.
- *Hotel*: The role can stay in the hotel to rest or have a meal to recover the values of food and sleep, which are important factors affecting the role's physical strength. If the role's physical strength is too low, he or she can not continue the trip or any learning activities.
- *International Airport*: The role must go to the airport and take a flight to visit another country. Before that, he or she must buy a ticket first. After reaching the destination, the screen is switched to the game scene of local international airport. The role must take a taxi or bus to the hotel for a rest or to some tourist attractions for visiting.

C. Learning Modules

The game-based learning system provides three kinds of learning modules: learning knowledge, challenge and world contest, and each module is described as follows.

- *Learning Knowledge*: The user can use the mouse to click on the tour guide in the game scene and select "Learning Knowledge" in dialog box to start learning. The learning contents are based on the materials of "World Geography" learning unit in junior high schools. The user can go to some other countries, cities or tourist attractions to learn more geographical knowledge under the guidance of local tour guides. For example, the tour guide provides 4 learning topics at Fort San Domingo, Tamsui for the user to choose, i.e., Taiwan (country), Fort San Domingo (tourist attraction), worldview, and Asia (continent).
- *Challenge*: The travel game provides the primary tasks and secondary tasks. The primary tasks have to pass a test with questions requiring the geographical knowledge in four different areas, that is, World, Europe, Asia, and Africa. The system will display the results after the test, and direct the users to find the right answers if some answers are wrong. The secondary tasks are more entertaining, for example, solving the puzzle of a continent map, digging diamonds in South Africa, and helping other tourists to find their lost items. When carrying out a task, the user must comply with the game rules and complete the task within the time limit. The user can increase his or her experience and money, and receive a souvenir after accomplish the task.
- *World Contest*: When the role collects a complete set of specified items (including flags and souvenirs), he or she is qualified to participate in the world contest. The role must return to Taiwan to join the contest. There are 20 questions about world geography in the contest. The user must answer all questions within the time limit and have at least 15 correct answers to pass the test. However, the user can call for help three times during the test.

IV. Teaching Experiment

In this study, a teaching experiment was conducted to analyze the students' learning effectiveness on the game-based learning system and the major factors affecting their learning. A questionnaire survey was used to investigate the attitudes of students towards the game-based learning. The experimental results can also be used as a reference to improve the system design in the future.

This study first performed a preliminary user testing with twenty 9th grade students (non-experimental samples), and their suggestions were adopted for the modification of system functions. These students were then asked to fill out the questionnaire and the results were used to modify the survey questions to become the formal questionnaire for use in the teaching experiment. After the development of test items for "World Geography", forty-four 10th grade students were asked to take the test and the results were used for modification to become the formal achievement test items.

In this study, a quasi-experiment was conducted using the counter-group pretest-posttest design. Sixty 9th grade students were randomly selected from a junior high school in Miaoli County as the experimental samples, among them, 30 students as the experimental group and 30 students as the control group. Both groups were taught by the same teacher for the same time using the same teaching materials in "World Geography" learning unit. The experimental group students used the game-based learning system at home as an assistant tool for reviewing geographical knowledge, while the control group students studied the lessons after school using their own methods. After the experiment, the experimental group students had to fill out the questionnaire to investigate their motivation and habits in using the Internet and online games, as well as the attitudes towards the system design and game-based learning.

This study used the achievement test (including pretest and posttest) to analyze whether there was a significant difference in learning effectiveness between the experimental group and control group. To find out the major factors affecting students' learning effectiveness on the game-based learning system, a one-way ANCOVA was performed in this study using student gender, the Internet and online game usage, and the experience values as the independent variables, the posttest scores as the dependent variable, and the pretest scores as covariates.

A. Research Tools

In this study, a game-based learning system was designed and used as the experimental platform, where students can play the role of a self-help traveler to travel around the world and collect the specified items by accomplishing the tasks. Once the collection is complete, the students are eligible to join the world contest. The system integrated the teaching materials of "World Geography" in junior high schools, including geographical location, topography, climate, hydrology, economics, and the features of natural and cultural landscape. This study consulted some geography teachers to make sure that the learning contents of the game-based learning system are consistent with the teaching materials of "World Geography".

This study used the self-designed achievement test to analyze the students' learning effectiveness. A number of 25 multiple-choice questions were created and three geography teachers were consulted to ensure the validity of the questions. To analyze the reliability of the test questions, forty-four 10th grade students were asked to take the test and the results were analyzed using the coefficient of internal consistency. After removing the unsuitable questions, a total of 20 questions were left for use as the formal test questions, and the value of Cronbach α=0.77 for the entire questions.

In this study, a questionnaire survey was used to investigate the students' attitudes towards the game-based learning system. A number of 30 questions were created, which were categorized into four areas, i.e., basic information, user interface design, functions & feedback, and motivation. The questionnaire used a five-point Likert scale to measure the students' attitudes. The scoring range is divided as "strongly agree: 5 points", "agree: 4 points", "no opinion: 3 points", "disagree: 2 points", "strongly disagree: 1 point". When designing the questions, the researchers discussed with some geography teachers to ensure the validity of the questionnaire. Twenty 9th grade students were asked to fill out the questionnaire and the results were analyzed using the coefficient of internal consistency. The value of Cronbach α=0.91 for the entire questions.

B. Experimental Procedure

In this study, the students in both groups took the achievement test (pretest) before the teaching experiment. At the beginning of the experiment, the researchers showed the experimental group how to use the game-based learning system. During the experiment, the geography teacher taught both groups in their classrooms as usual using the same teaching materials in "World Geography". The experiment continued for 5 weeks in which the experimental group used the game-based learning system as an assistant tool after school while the control group used some other methods to review the geographical knowledge. At the end of experiment, both groups took the achievement test (posttest), and the experimental group was asked to fill out the user questionnaires.

After the experiment, the pretest and posttest scores of the experimental group and control group students were analyzed using a paired t test, and the results could be used to investigate if the students in each group made a significant improvement. To discover the major factors affecting the experimental group students' learning effectiveness on the game-based learning system, a one-way ANCOVA was performed using student gender, the Internet and online game usage, and the experience value obtained in the travel game as the independent variables, the posttest scores as the dependent variable, and the pretest scores as covariates to analyze the impact of each factor individually. Finally, the results of questionnaire survey were analyzed by calculating the average score for each scale in the questions to understand the attitudes of experimental group students towards the game-based learning system.

V. Results and Analysis

The experimental results in this study include the pretest and posttest scores in both groups and the questionnaire results of the experimental group. The results were processed using SPSS, the software for statistical analysis, to investigate the learning effectiveness of students on the game-based learning system, the major factors affecting their learning, and their learning attitudes towards the game-based learning system.

A. Learning Effectiveness

To understand the impact of the game-based learning system on students' learning geographical knowledge, this study used a paired t test to analyze whether a significant difference occurred between the pretest scores and posttest scores in the experimental group and the control group. The achievement test consists of 20 multiple-choice questions, and the students could receive 5 points for each correct answer. The results in Table 1 show that both groups have made progress, but the experimental group performed much better than the control group. Table 2 shows the experimental group's learning achievement before and after the experiment has achieved a significant difference ($p<.001$), while the control group's has not ($p=.198$). Therefore, this study infers that the game-based learning system can enhance the students' learning in geographical knowledge.

Table I Descriptive data of achievement test in both groups

Score / Group	Pretest			Posttest		
	Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
Experimental	54.00	18.21	3.33	68.17	18.91	3.45
Control	47.83	18.32	3.35	51.50	18.48	3.38

Table II Paired t test results of achievement test in both groups

Progress	Avg.	S. D.	S. E.	T	P
Experimental	14.17	6.44	1.18	12.04	p<.001
Control	3.67	15.25	2.79	1.32	p=.198

B. Factors affecting learning effectiveness

According to the literature review, the possible factors affecting students' learning effectiveness on the game-based learning system include student gender, the habits of using the Internet and online games, and the experience values obtained in the travel game. This study used a one-way ANCOVA to analyze these factors to see if they cause a significant impact on

the experimental group students' learning. The results of statistical analysis are described in the following.

1. Student Gender

It was found in the literature review that there exists a significant difference between junior high school boys and girls in their preference for the online games. Therefore, this study would like to investigate whether student gender is an important factor affecting students' learning on the game-learning system. According to the data in Table 3, there are 13 male students in the experimental group, with an improvement in the average score equal to 12.7, and 17 female students, with an improvement in the average score equal to 15.3. Since the difference of improvement between boys and girls is not obvious, this study used a one-way ANCOVA to examine if a significant difference exists between the boys' and the girls' learning effectiveness on the game-learning system.

TABLE III DESCRIPTIVE DATA OF STUDENT GENDER VS. TEST SCORES

Score / Gender	No.	Pretest			Posttest		
		Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
Boy	13	50.38	18.31	5.08	63.08	16.65	4.62
Girl	17	56.76	18.80	4.41	72.06	20.08	4.87

The one-way ANCOVA used the pretest scores as the covariates, student gender as the independent variable, and the posttest scores as the dependent variable to perform the statistical analysis. The test for homogeneity of regression coefficients (f=2.923, p=.099) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores (p<.001). After removing the influence of covariates, the student gender has no significant impact on the posttest scores (p .254), indicating the students' learning on the game-based learning system was not affected by student gender. In addition to the previous results, this study infers that the game-based learning system is suitable for boys and girls since they both made a significant improvement in their learning.

2. Habits of using the Internet

The literature review in this study showed that daily use of the Internet could affect the academic performance of junior high school students. Therefore, this study intends to explore if the habits of using the Internet will affect the learning effectiveness of junior high school students on the game-based learning system. The habits include the time spent on Internet, the type of Internet recreation, using the Internet for learning geography, and playing online games.

(1) Time spent on Internet

Based on the daily time spent on the Internet, this study divided the experimental group students into 3 categories: "less than 1 hour", "between 1 and 3 hours", and "more than 3 hours", to examine if this factor has a significant impact on the students' learning on the game-based learning system. According to the data in Table 4, there are 11 students in the experimental group spending less than 1 hour per day on the Internet with an improvement in the average score equal to 14.55, 13 students spending 1-3 hours per day on the Internet with an improvement in the average score equal to 14.61, and 6 students spending more than 3 hours per day on the Internet with an improvement in the average score equal to 12.5. The results show that the differences of academic improvement in these three categories are not obvious, so this study used a one-way ANCOVA to further examine if this factor will affect students' learning on the game-based learning system.

TABLE IV DESCRIPTIVE DATA OF TIME SPENT ON INTERNET VS. TEST SCORES

Score / Time	No.	Pretest			Posttest		
		Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
< 1 hour	11	52.27	15.55	4.69	66.82	18.48	5.57
1-3 hours	13	58.85	16.48	4.57	73.46	17.61	4.88
> 3 hours	6	46.67	25.63	10.46	59.17	21.78	8.89

The one-way ANCOVA used the pretest scores as the covariates, the time spent on the Internet as the independent variable, and the posttest scores as the dependent variable to perform the statistical analysis. The test for homogeneity of regression coefficients (f=1.932, p=.167) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores (p<.001). After removing the influence of covariates, the time spent on the Internet has no significant impact on the posttest scores (p .774), indicating the students' learning on the game-based learning system was not affected by the time spent on the Internet.

(2) Type of Internet recreations

This study classified the Internet recreational activities that junior high school students often engage in as three types, i.e., "online casual games", "chat with friends" and "others", to explore if they will affect the students' learning effectiveness on the game-based learning system. According to the data in Table 5, there are 7 students in the experimental group playing the online games, with an improvement in the average score equal to 12.86; 17 students chat with friends, with an improvement in the average score equal to 14.71; 6 students engage in some other Internet recreations, with an improvement in the average score equal to 14.17. The results reveal that the differences of academic improvement by these three types of students are not obvious, so this study used a one-way ANCOVA to further examine if this factor will affect students' learning on the game-based learning system.

TABLE V DESCRIPTIVE DATA OF INTERNET RECREATIONS VS. TEST SCORES

Score / Time	No.	Pretest			Posttest		
		Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
Games	7	53.57	21.35	8.07	66.43	17.49	6.61
Chat	17	53.82	20.12	4.88	68.53	21.78	5.28
Others	6	55.00	8.94	3.65	69.17	13.57	5.54

The one-way ANCOVA used the pretest scores as the covariates, the type of Internet recreations as the independent variable, and the posttest scores as the dependent variable to

perform the statistical analysis. The test for homogeneity of regression coefficients (f=2.1, p=.144) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores (p<.001). After removing the influence of covariates, the time spent on the Internet has no significant impact on the posttest scores (p .830), indicating the students' learning on the game-based learning system was not affected by the type of Internet recreations that students often engage in.

(3) Using the Internet for learning geography

Since web-based learning is an efficient approach to for modern people to acquire knowledge, this study would like to explore if the use of Internet for learning geography will affect the learning effectiveness of junior high school students on the game-based learning system. According to the data in Table 6, there are 16 students in the experimental group using the Internet to study geography, with an improvement in the average score equal to 12.18; 14 students didn't use the Internet to study geography, with an improvement in the average score equal to 16.43; The average pretest score of the former is much higher than that of the later, meaning that using the Internet for learning geography is an efficient approach. However, the differences of progress between these two types of students are not obvious, so this study used a one-way ANCOVA to further examine if this factor will affect students' learning on the game-based learning system.

TABLE VI DESCRIPTIVE DATA OF USING INTERNET LEARNING VS. TEST SCORES

Score / Use	No.	Pretest			Posttest		
		Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
Yes	16	59.38	18.61	4.65	71.56	19.47	4.87
No	14	47.86	16.26	4.35	64.29	18.17	4.86

The one-way ANCOVA used the pretest scores as the covariates, using the Internet for learning geography as the independent variable, and the posttest scores as the dependent variable to perform the analysis. The test for homogeneity of regression coefficients (f=.314, p=.580) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores (p<.001). After removing the influence of covariates, the use of Internet for learning geography has no significant impact on the posttest scores (p .080), indicating students' learning on the game-based learning system was not affected by the ordinary use of Internet for learning geography. Even the students without using the Internet for learning geography can achieve a significant progress when using the game-based learning system for learning geographical knowledge.

(4) Playing online games

The literature review in this study showed that playing online games could affect the academic performance of junior high school students. The longer they play the online games the lower their academic achievement. Therefore, the researchers wanted to know if playing the online games will affect the students' learning on the game-based learning system. This study divided the experimental group students into 2 categories: "often playing", and "seldom playing", to examine if this factor has a significant impact on the students' learning on the game-based learning system. According to the data in Table 7, there are 18 students in the experimental group often playing the online games, with an improvement in the average score equal to 14.16; 12 students seldom playing the online games, with an improvement in the average score equal to 14.17; It can be seen that the differences of average pretest and posttest scores by these two types of students are small, so this study used a one-way ANCOVA to ensure this factor will not affect students' learning on the game-based learning system.

TABLE VII DESCRIPTIVE DATA OF PLAYING ONLINE GAMES VS. TEST SCORES

Score / Use	No.	Pretest			Posttest		
		Avg.	S. D.	S.E.	Avg.	S. D.	S. E.
Often	18	54.17	20.24	4.77	68.33	19.33	4.56
Seldom	12	53.75	15.54	4.49	67.92	19.12	5.52

The one-way ANCOVA used the pretest scores as the covariates, playing online games as the independent variable, and the posttest scores as the dependent variable to perform the analysis. The test for homogeneity of regression coefficients (f=3.525, p=.072) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores (p<.001). After removing the influence of covariates, whether playing online games has no significant impact on the posttest scores (p .997), indicating students' learning on the game-based learning system was not affected by the frequency of playing online game. Besides, the students often and seldom playing online games can both achieve a significant progress on the game-based learning system.

3. Experience value

The experience value represents the degree of engagement and achievement by a player in the travel game. This study would like to know if the experience value in the travel game is an important index reflecting the learning effectiveness of junior high school students on the game-based learning system. According to the data in Table 8, there are 11 students in the experimental group with low experience values and the average score of their progress equal to 9.09; 19 students with high experience values and the average score of their progress equal to 17.1. It can be seen that the students' experience values are closely related to their learning achievement, so this study used a one-way ANCOVA to further examine if this factor will affect students' learning on the game-based learning system.

TABLE VIII DESCRIPTIVE DATA OF EXPERIENCE VALUE VS. TEST SCORES

Score / Exp.	No.	Pretest			Posttest		
		Avg.	S. D.	S. E.	Avg.	S. D.	S. E.
Low	11	49.55	24.13	7.28	58.64	20.99	6.33
High	19	56.58	13.85	3.18	73.68	15.62	3.58

The one-way ANCOVA used the pretest scores as the covariates, the experience value as the independent variable, and the posttest scores as the dependent variable to perform the analysis. The test for homogeneity of regression coefficients ($f=3.743$, $p=.064$) revealed that the assumption of homogeneity was met and thus it can be further analyzed by the ANCOVE. The statistical results show that the pretest scores have a significant impact on the posttest scores ($p<.001$). After removing the influence of covariates, the experience value has a significant impact on the posttest scores ($p<.001$), indicating students' experience values in the travel game is an important factor affecting their learning on the game-based learning system.

C. Questionnaire Results

In this study, a user questionnaire survey was used to investigate the experimental group students' attitudes towards the game-based learning system after the teaching experiment. The questionnaire was designed using a five-point Likert scale and its scoring range was divided as "strongly agree: 5 points", "agree: 4 points", "no opinion: 3 points", "disagree: 2 points", "strongly disagree: 1 point". A number of 30 questions were created and divided into four categories, i.e., basic information, user interface design, functions & feedback, and motivation. The questionnaire results are described in the following.

1. Basic Information

The questions in this category were used to evaluate if the game-based learning system provides complete information about the main theme, learning contents, features, operational methods and functions of the website, and the objective was to understand the acceptance of the basic information by students. The average score for all the questions is 3.65, and more than half of the students chose "agree" or "strongly agree" in most of the questions, meaning the students are basically satisfied with the provision of basic information on the website.

Among all the questions, the one with the highest score is "*The website clearly states the main theme in the travel game and its learning contents*", and its average score equals 4.03, meaning the students understood the main theme and learning contents of the website very well. The question with the second- highest score is "*The website clearly states the game features*", and its average score equals 3.70. The other two questions are "*The website clearly states the operational methods*", with an average score equal to 3.53, and "*The website clearly states the game functions*", with an average score equal to 3.33. The lower scores in theses two questions may be due to the reason that the students just play with the game for a few weeks and may need some more time to adjust themselves to become familiar with the functions and operational methods of this game.

2. User Interface Design

The questions in this category were used to evaluate the user interface design on the game-based system, including: buttons, text and icons, display, fluency, fonts, color, and sound, etc. The objective was to understand the degree of acceptance by the students in user interface design. The average score for all the questions is 3.57, and more than half of the students chose "agree" or "strongly agree" in most of the questions, meaning that the students are basically satisfied with the design of user interface on the website.

Among all the questions, the one with the highest score is "*The website design can enhance my interest in the travel game*", and its average score equals 4.30, showing most of the students are very interested in the travel game. Some other questions with higher average scores are "*The instruction of text and icons on the website can help me to browse clearly*", with an average score equal to 3.80, and "*The website design lets me operate easily and smoothly*", with an average score equal to 3.63. The questions with lower average scores are "*The design of the buttons on the website enables me to click on easily*" with an average score equal to 3.37, and "*The arrangement of colors, sound effects, and fonts on the website is appropriate*", with an average score equal to 3.33, indicating a small part of the user interface still need to be improved.

3. Functions and Feedback

The questions in this category were used to evaluate the functions and feedback on the game-based learning system, including account application, message board, problem report, login and logout, challenge tasks, knowledge learning, game announcement, user information, mission lists, message board, billboard, etc. The objective was to understand the reaction of the students about the system functions and its feedback. The average score for all the questions is 3.86, and more than half of the students chose "agree" or "strongly agree" in most of the questions, meaning that many students are satisfied with the system functions and feedback.

Among all the questions, the one with the highest score is "*The knowledge learning function in this game can help me to learn world geography knowledge"*, and its average score equals 4.27, showing most of the students were satisfied with the knowledge learning function on the website. Some other questions with higher average scores are "*The function of problem report let me receive help easily as needed*", with an average score of 4.03, "*The billboard can enhance the motivation of competition in the travel game*", with an average score of 4.03, and "*The challenge tasks in the travel game can help me to learn world geographical knowledge*", with an average score of 4.00. The question "*I can communicate with my classmates easily through the message board on the website*" has a lower average score of 3.57. The possible reason is that some students preferred to use the chat function to receive immediate response.

4. Learning Motivation

The questions in this category were used to investigate the students' attitudes towards this game-based learning, including learning motivation, interest, and reduction of learning pleasure. The average score for all the questions is 3.91, showing that most students are satisfied with the game-based learning in the teaching experiment. The questions with higher average scores are "This game can reduce my pressure in learning geography", with an average score of 4.03, "This game can increase my learning interest and motivation", with an

average score of 4.00, and "I think this game is a suitable assistant tool for learning geography", with an average score of 4.00. Therefore, most students believed that the game-based learning system is suitable for the application in geography learning because it can reduce the pressure of learning and enhance their interest and motivation in learning geography.

VI. Conclusion

In this study, a game-based learning system was developed using network and multimedia technologies, in combination with the learning contents of "World Geography" in junior high schools and "role-playing" game approach, to provide students with a network environment for learning geography. The system is designed on the basis of Garris' game-based learning model. By accepting the challenges in the travel game, students continue to learn, accept system feedback, and make a judgment to enhance their learning. This study adopted Collins' situated learning theory for the design of game rules and learning strategies to enhance students' learning motivation and interest. To simulate the situation of traveling in foreign counties, this study designed the game scenes and travel situations based on the experience of a self-help traveler, and the objective was to complete the mission of traveling around the world and obtain sufficient knowledge in "World Geography".

A teaching experiment was conducted to analyze the learning effectiveness of students on the game-based learning system and the major factors affecting their learning. The experimental group used the game-based learning system as an assistant tool for learning geographical knowledge, while the control group students used their own methods for studying. The results showed that the experimental group's learning achievement has achieved a significant improvement while the control group's has not. Therefore, this study infers that the game-based learning system can enhance the students' learning in "World Geography" knowledge.

According to the literature review, student gender and the habits in using the Internet may affect students' learning on the game-based learning system. The habits include the time spent on Internet, the type of Internet recreation, using the Internet for learning geography, and playing online games. Also, this study would like to know if the experience value in the travel game can be used as an index reflecting the learning effectiveness on the game-based learning system. The experimental results showed that students' learning on the game-based learning system was not affected by their gender or habits in using the Internet, while the experience value in the travel game is an important factor affecting their learning and the higher the experience value the better the learning effectiveness.

In this study, a questionnaire survey was used to investigate the students' attitudes towards the game-learning system. The questionnaire results showed that over half of the students are satisfied with the design of basic information, user interface, functions and feedback on the website. Many students agreed that the website clearly states the main theme in the travel game and its learning contents; the website design could enhance their interest in the travel game; the knowledge learning function in this game can help them to learn world geography knowledge; the function of problem report let them receive help easily as needed; the billboard increases their motivation of competition in the travel game; the challenge tasks in the travel game can help them to learn world geographical knowledge. Therefore, most students believed that the game-based learning system is suitable for the application in geography learning because it can reduce the pressure of learning and enhance their interest and motivation in learning geography.

In addition to geographical knowledge, students can learn the right attitudes to deal with people and various situations in the travel game, such as "Always make a plan and be prepared to be easy for the success. Master one's time, money, and health to reach the goal in life journey." Therefore, it has a positive effect on inspiring young students' outlooks on life and its management.

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