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A case study on building web3D virtual reality and GPS applications to ubiquitous network and joyful learning environment

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ABSTRACT

The study constructs joyful Web 3D virtual situational learning materials with the perspectives of learners, and takes Tainan Confucian Temple as an example to allow the learners to learn and experience freely in virtual reality. The joyful learning environment is presented in the virtual situation through vivid text, sound, a guided picture tour, and a game-like learning mechanism.

Different from the passive "knowledge giving model" in the past virtual situational learning system, the "joyful learning component" is integrated into the virtual situation to change knowledge imparting from "passive" to "active" to effectively enhance the learning motivation of learners and improve their learning effectiveness. Finally, grade 5 students are applied as the experimental subjects in the study analysis focusing on the satisfaction of learning system application and the significance difference of the learning result before and after the system is applied. The study result shows that the application of a joyful virtual situation can indeed achieve the same effectiveness of on-site experimental learning.

KEYWORDS

Web3D;
Virtual reality;
GPS;
Mobile device;
Ubiquitous learning.

INTRODUCTION

Constructivism thinks knowledge construction occurs during the meaningful learning of learners. The learning of virtual reality is based on the theory of constructivism to create a virtually real world to allow users to learn freely. Some scholars have recommended applying virtual reality as an educational tool[1-4]. A virtual environment can create a real world or a new world, which can be regarded as special learning platform to provide a safe learning environment[5]. However, a traditional virtual reality system is very expensive and requires special hardware, such as a facemask, multiple projectors and a 3D input device. In addition, the program development is more difficult, and less effective. In recent years, due to the improving network performance and technology development, virtual reality has become an emerging trend on websites.

The educational sector is also committed to the development of "joyful e-learning" in recent years. "Joyful e-learning" refers to providing a learning method that is interactive, diverse, and not limited to classroom space, and applying computer resources and processing various teaching activities or making up the insufficiency of

class learning through the use of the internet. The students can also learn through the internet in class or after class. Therefore, to effectively lower learners' equipment barriers and increase students' learning motivation, the study hopes to construct a Web learning platform that applies the "joyful system design" concept as the infrastructure, design a virtual reality learning situation with the learners' perspective, and input the learning elements such as Confucian Temple related knowledge, and guiding mode, in the virtual learning situation, which can break the time and space limit to allow the learners to teach themselves in the virtual situation, and achieve the joyful learning effect through event triggering and vivid reality.

Through the implementation of the study, the following objectives are expected to be achieved:

1) The construction of a Web 3D virtual situational learning environment (arts course)
2) Joyful learning experience analysis
3) The realization of ubiquitous learning

LITERATURE REVIEW

Situated instruction theory

The concept of situational teaching is first proposed in a thesis "Situated Cognition and the Culture of Learning" by Brown, Collins, and Duguid[6]. It is developed with the theory base of constructivism knowledge, and also advocates that knowledge is the interactive production of learners and situations, and its nature is deeply impacted by activity, social context and culture; knowledge will only create meaning when it is being explained in the activities and situations it created and applied. Its major points are as follows:

1) Diverse comprehensive intelligence: The meaning of knowledge is dispersed in the environment around us; it is the creation of the interaction between people and the environment, which cannot be isolated from the environment.
2) Authentic tasks: Learning requires a real environment to obtain meaningful knowledge; knowledge has the characteristic of developing gradually through real activities.
3) Professional cognitive apprenticeship: The learners must be like art apprentices to observe, imitate and learn in professional culture environments to construct solid knowledge.
4) Technological anchored instruction: To have the anchor, knowledge must have a complete teaching environment to provide sufficient opportunities for students to explore and experience.
5) Seamless assessment: Evaluate students' activities and completed work during the learning process, and combine with real activities.
6) Collaborative social interaction: Learning is gradually achieved through collaborative social interaction and group constructive knowledge.
7) Assistant role of teachers: Teachers are the subsidiaries; they help students to learn through the scaffolding construction method.

The study of scholar Liao Yu-Ling also pointed out that the application of computer technology can effectively assist the curriculum designers to complete the construction of learning situations to allow the learners to be able to self challenge, and promote knowledge obtaining and sharing[7]. Therefore, the study used the situational learning theory to construct a virtual situational learning environment to allow the learners to teach themselves knowledge in a situational virtual environment.

Joyful e-learning meaning and operational mode

The terminology of joyful learning mainly originated from the concept of "Game Based Learning". It arranges the teaching content and concept with the game-design mode, applies fun, challenges, competition, cooperation, self-satisfaction and a sense of achievement of games to provide the learners with motivation, promote continuous learning willingness, effectively retain and organize skills or knowledge, and further improve learning effectiveness[8]. The important spirit of joyful e-learning is "joyful learning". It focuses on "method" and "process", not "purpose" and "result". The game method changes along with the situation and learners' choices; it has an autonomous learning process, and is flexible. It goes through interface interaction to process target learning, and designs content according to teaching materials and learning strategies to form valuable educational software [9,10].

In joyful e-learning, learners actively construct knowledge, and teachers provide side guidance to allow the learners to learn in mutual cooperation. Use the

feedback mechanism and reflection to effectively revise learning strategies and pace to inspire the joy of learning and extend learning time. Properly explore various academic fields and abilities, self construct and integrate knowledge concept without rough browsing[11]. At the same time, create a more vivid teaching, and hospitality learning atmosphere to make up for the insufficient joy of traditional teaching.

The inner process of learners' joyful learning can be divided into digital game learning mode[12] and experience game mode[13]. The basic concept of the two both corresponds with flow theory; they both think that with the guidance of game characteristics, the learners will be able to enter the learning cycle, repeat the same learning experience, and achieve the expected target in a joyful situation.

The study applied "experience game mode", and maintained the learners' participation motivation and high degree of learning enthusiasm and developed students' autonomous learning ability through the challenges provided by different games. It is presented according to the learners solution strategy, teachers can observe learners' behavior, and guide learners to construct knowledge through appropriate message feedback, and promote the learners to present more innovative and specific solutions to lower students' learning frustration.

Web 3d virtual reality

In brief, Web 3D virtual reality uses a website to present 3D virtual reality. It is a 3D virtual world created by computer simulation. It provides users with visual, auditory, and tactile simulation to allow them to have vivid and live experiences and to observe the objects in the 3D space timely and unlimitedly. This concept was first proposed by Mark Pesce and Tony Parisi in 1994, who constructed the first 3D website browser prototype "Labyrinth". In addition to widening the standards, there are some website 3D technology, such as java 3D0Shockwave 3D, and some software manufacturers that develop 3D programs. They've developed programs that can present 3D objects on a website, and only installing a small browsing program on the browser, watching 3D web pages will be easy; it has lowered the 3D web page technical boundary, such as Virtools, 3D Max, EON Studio.etc.

According to the different Web constructions, it can mainly be divided into the three following categories:

1) Geometry-Based Virtual Reality or Graphic-Based Virtual Reality: Users can surf freely in the designed space, and interact by touching the objects in the scene. As every object in the scene of virtual reality must be constructed with a 3D model.
2) Image-Based Virtual Reality: It mainly applies a "panorama" skill to take a 360-degree image using the camera as the rotation axis, then circle the images taken into a circular cylinder.
3) Hybrid Virtual Reality or Augmented Reality: It is mainly based on image-based virtual reality to set object characteristics and give behavior orders through a simple program design (such as java, javascript, vrml script.etc), to improve the interaction of image-based virtual reality. Therefore, the hybrid virtual reality is also called Augmented Reality.

The related advantages and disadvantages are summarized as follows (shown in TABLE 1.)

TABLE 1 : Advantages and disadvantages of the three virtual reality comparison

	Image-Based Virtual Reality	Geometry-Based Virtual Reality	Hybrid Virtual Reality
Interactive	Bad	Merit	Good
Manufacturing Technology	Easy	Difficulty	Moderately
Hardware Requirements	Low	High	Medium
File size	Small	Large	Medium
Realistic feel	Excellent	Bad	Good
3D stereoscopic	Bad	Excellent	Good
manipulative system	Bad	Excellent	Good

In applying virtual reality in the education related studies, many scholars think virtual reality has considerable potential in improving students learning ability[14-17]. Sykes pointed out that the technology of virtual reality is applicable to all courses[18]. McLellan thinks virtual reality can be used as a learning tool to improve students' spatial ability, and therefore recommended using virtual reality in teaching to allow students to explore spatial concepts[19]. Also, Biocca thinks the application of virtual reality can help to develop spatial cognitive abilities[20,21]. Hartman used virtual reality environments to test students' spatial ability[22]. Park found that using a virtual reality map can improve students' spatial ability[4].

Therefore, the study mainly applies Virtools as the tool to lower the design boundary of situational courses,

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and accomplish the construction of 3D virtual situations.

Tainan confucian temple website exploration

Tainan Confucian Temple is the oldest Confucian Temple in Taiwan. It was built in 1665, and is the oldest Confucian Temple, with the most spectacular building structure, and has historic significance. The researcher analyzed the introduction related to current Confucian Temple websites, which are mostly traditional websites, and have pictures and text descriptions. Currently, the virtual reality designed especially for Tainan Confucian Temple has three types:

Hybrid Virtual Reality: It is described in 3D flash animation and 2D pictures. The description method is text with sound, and the control range is limited. The representing website is – Taiwan Confucian Temple, Council of Cultural Affairs.

Image-Based Virtual Reality: The production method applied 360-degree panorama shooting. Users can move the mouse to select the places they want to see, and there are text descriptions under the pictures; the interaction is still limited. The representing website is – Win Times Information Technology LTD.CO.

Video-Based Virtual Reality: The production method applies Quick Time virtual reality, and each building is saved as an MOV file for downloading; users must install Quick Time Plug-in to watch it. The virtual reality of Quick Time does not have text descriptions; users can only watch and cannot obtain any interactive learning information. The representing website is – the virtual reality downloads created by the Tainan City government.

The abovementioned three types all have good presentation for the construction of virtual reality, but the learning interaction is significantly insufficient, and also cannot effectively improve the learners' learning motivation. Due to this, the study hopes to combine the abovementioned related literature characteristics to solve the barrier of current websites' insufficient interaction, and design the virtual learning courses with educational meaning to allow learners to teach themselves in the situational virtual environment.

RESEARCH PROCESS

To conclude the abovementioned literature exploration result, the study applies Virtools to design the interactive function of virtual reality; cope with the construction model of "Hybrid Virtual Reality" and integrate the guiding advantages of "Geometry-Based Vir-

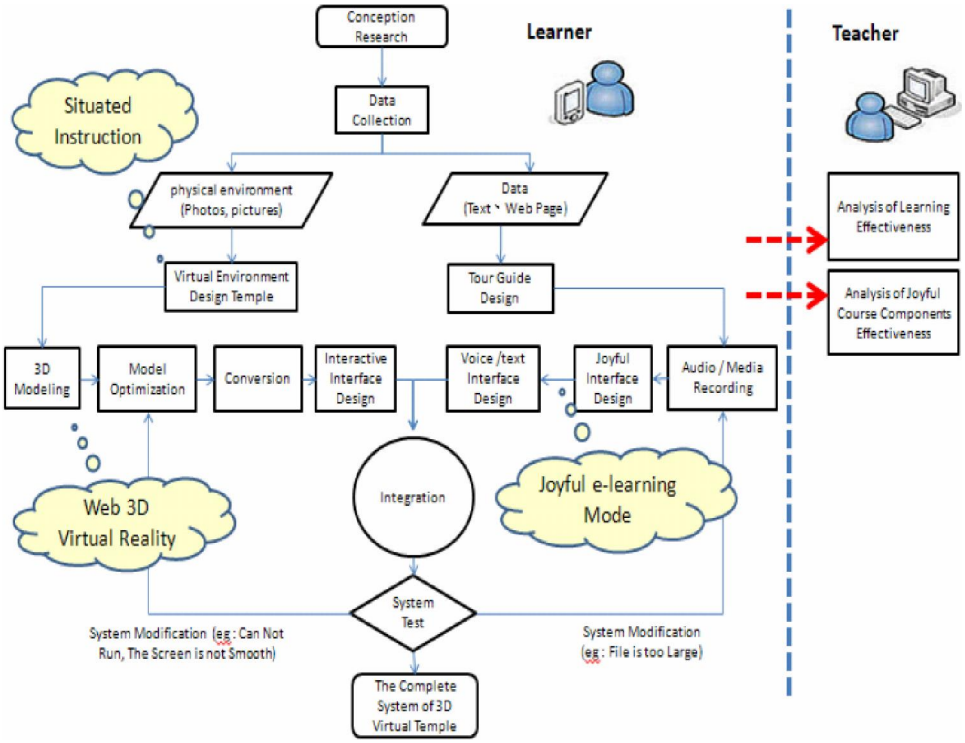

Figure 1 : Research flow chart

tual Reality" to strengthen the realistic level and interaction of virtual reality; the explanation and game function is designed with Flash to allow it to be joyful, and finally obtain feedback through a questionnaire method to understand whether the knowledge obtained by the learner has a significant difference. The study process is described as follows. (shown in Figure 1.)

SYSTEM IMPLEMENTATION

System planning

Computer processing ability, network bandwidth and the difficulty of producing joyful courses must be considered when planning a 3D virtual reality learning platform. Therefore, in the platform planning, the study applies the mixed model of Flash and virtual reality for construction; shown as Figure 2.

Virtual reality design

Many procedures must be processed before presenting 3D virtual reality on a computer. The setting of 3D graphics technologies is required in modeling, texturing, lighting, and shooting to simulate the message obtained by eyes in the real 3D space, and allow people to live the experience; the design flowchart is shown as Figure 3.

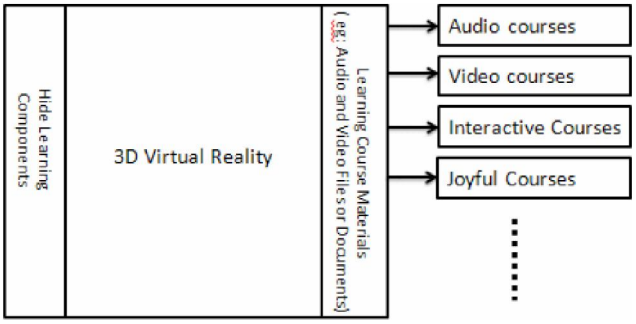

Figure 2 : Virtual reality learning platform interface plan

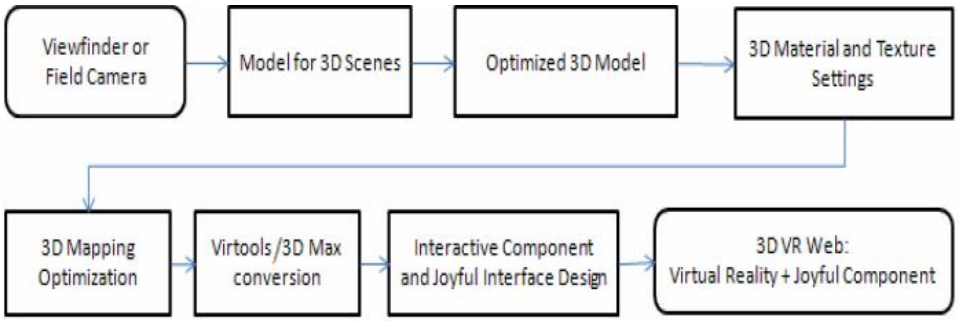

Figure 3 : 3D Virtual Reality Production Flowchart

The system construction is completed after the abovementioned designs, shown as Figure 4. and 5.

Joyful learning component design

To effectively increase the learning motivation of students, and solve the problems through game-based methods, the study applied Flash to design joyful learning components and cope with virtual scenes. The system allows students to learn independently in the virtual situation through the interactive game design and achieve the purpose of entertaining and educational learning; the joyful learning components are shown as Figure 6.

Technology design and application of gps - nmea sentence

In this research, carrying a mobile device windows system mainly through access to GPS - NMEA sentence system can indirectly obtain a GPS satellite-related information, such as the latitude and longitude coordinates level, high-level altitude, speed, positioning satellite information, actuarial value, and so do. The key to this is for GPRMC sentence codes for the positioning information, front-end for the AP updated automatically every 15 seconds learners of the addresses and through the Ajax framework will address information updated in the system, such as the note referred to Figure 7.

EXPERIMENTAL DESIGN

Experimental objects

The study applied convenience sampling method, and used 166 grade-5 students as the study objects. After removing the invalid samples, there are 163 effective samples. They are divided into two groups according to the pretest result. The control group is the students who have been to Tainan Confucian Temple

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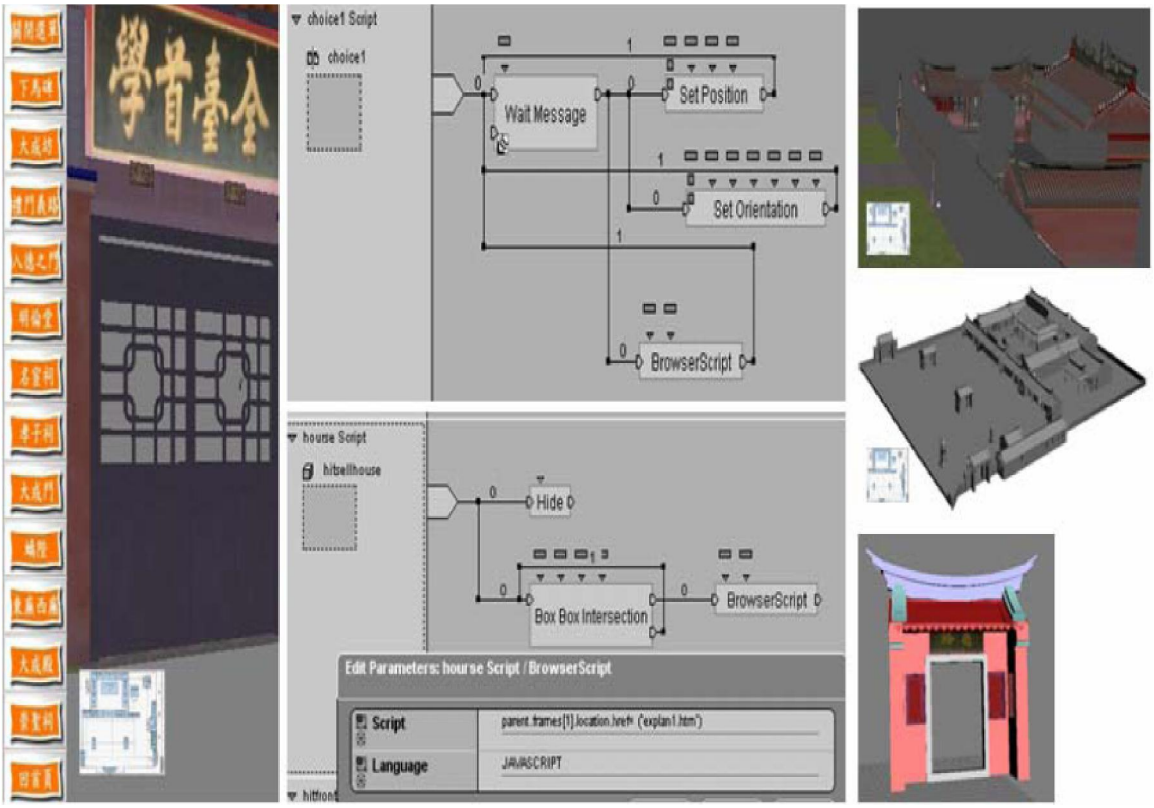

Figure 4 : Menu Function Setting Connection Graph

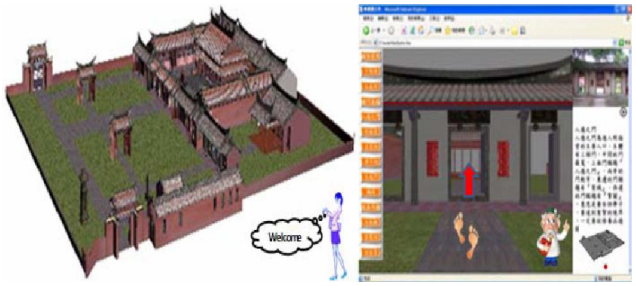

Figure 5 : Web 3D Virtual Situational Teaching Interface

Figure 6 : Joyful Learning Component Design

(62 students). The experimental group is the students who haven't been to Tainan Confucian Temple (101 students).

Experimental procedure

The experimental procedure divided the students into 2 groups according to the options chosen by the students in the first test. One group had been to Confucian Temple, and the other one had not. On the second day after the first test (pretest), all students operated the virtual reality system, and then filled in the second test (posttest) and questionnaire. The second test result is used to verify whether there is a significant difference between the two groups regarding the knowledge learned of Confucian Temple, and a satisfaction questionnaire analysis is processed. The experimental flowchart is shown as Figure 8.

EXPERIMENTAL RESULT ANALYSIS

Learning effectiveness result analysis

The experiment applied ANCOVA for analysis. The study based on whether the learner has been to Tainan Confucian Temple in the first test to divide the group into a control group (has been to Confucian Temple) and an experiment group (has not been to Confucian Temple). The first test score is the covariate; the sec-

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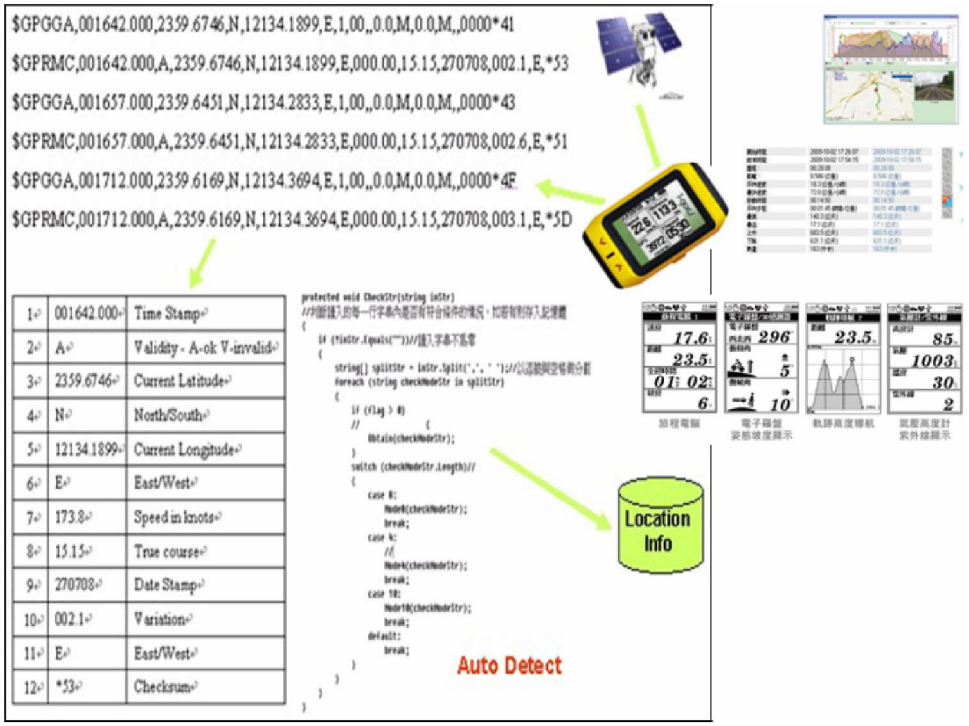

Figure 7 : Gps sentence codes calculus flow chart

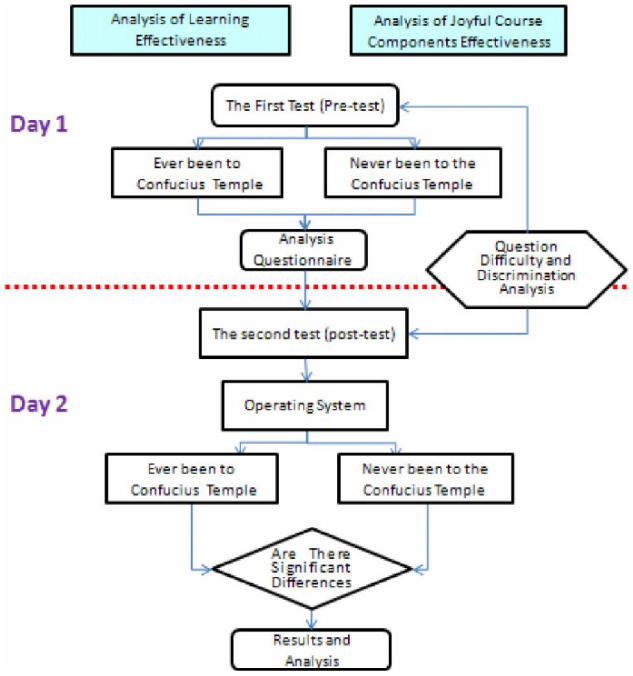

Figure 8 : Experiment Flowchart

ond test score is the dependent variable. The sample amount, mean, standard deviation, and variance of the groups in the two tests are listed as TABLE 2.

To satisfy the assumption of "homogeneity of within-class regression coefficient", the study applied the SPSS' general linear model to test whether there is a significant difference in the regression coefficients of the two groups; the result is shown as TABLE 3. The F value is 2.233, and has not reached the significance level of.05. The assumption that satisfies "homogeneity of within-class regression coefficient" can continue to process the analysis of covariate and further test whether there is a significant difference between the two groups; the result is shown as TABLE 4.

TABLE 2 : 2 Test Score Statistical Table

Item / Group	Samples	Mean of the first Test	Standard deviation of the first Test	Mean of the second Test	Standard deviation of the second Test
Control group	62	5.77	2.028	9.21	3.265
Experimental group	101	5.65	1.735	8.54	2.496
All students	163	5.70	1.846	8.80	2.822

TABLE 3 : Homogeneity Test Summary Table for The Regression Coefficient Within A Group

Source of Variation	Sum of Square	Degrees of Freedom	Mean Square	Value	Significance
Between Groups	17.304	1	17.304	2.233	.137
Residual	1232.051	159	7.749		

TABLE 4 : Covariate Analysis Summary Table

Source of Variation	Sum of Square	Degrees of Freedom	Mean Square	Value	Significance
Between Groups	15.718	1	15.718	2.013	.158
Residual	1249.355	160	7.808		

The result shows that the F value of the independent variable (experimental group and control group) is 2.013, and the significance does not reach.05, which indicates that the second test score will not differ due to

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a different experimental process (independent variable), which is that there is no significant difference between the experimental group and control group.

Finally, the revised mean of the second test scores is used to process the test and see whether there is a significant difference under the impact of the two groups eliminating the covariate (first test score); the statistical result is shown as TABLE 5.

TABLE 5 : The Confidence Interval Table of The Mean Difference

Mean difference (Control group - experimental group)	Standard Error	Significance	95% Confidence Interval	
			Confidence limit (lower)	Confidence limit (upper)
.640	.451	.158	-.251	1.531

It can be seen from Table 4 that the mean difference of the two groups is 0.64, which represents that there is no difference between the mean of the two groups, and landing in the 95% confidence interval represents that there is no significant difference under the impact of the two groups eliminating the covariate.

System application result analysis

The questionnaire is mainly divided into realistic level, system operation, course (Joyful) providing and thoughts for after use, and learning effectiveness to explore the system application satisfaction. The questionnaire reliability and mean is shown as TABLE 6.

TABLE 6 : Questionnaire Reliability and Mean Table

	Reliability	Mean
Realistic level	0.916	3.83
System operation	0.737	3.80
(Joyful) courses satisfaction	0.938	3.84
Learning Satisfaction	0.831	3.77
Learning Effectiveness	0.855	3.81

This research result shows that most learners agree that the system is very interesting, and they can learn much knowledge regarding Tainan Confucian Temple. Learners who have been to Confucian Temple also agree that they can learn more from the system than from visiting the place themselves. After completing the system operation, students have very high learning motivation to visit Tainan Confucian Temple in person, and the student test result shows that the learning effectiveness for students who used the virtual learning system is indeed better than the ones who haven't used the system.

CONCLUSION

E-learning is an inevitable trend; the major purpose of the study is to use "situational teaching theory" and "joyful e-learning theory", and apply Web 3D virtual reality teaching, computer network and virtual reality characteristics. In the operation of "joyful teaching strategy", knowledge is fully transformed to allow the learners to achieve effective learning goals.

In the study process, the teaching method may change, but the nature of teaching never changed. Therefore, in the e-teaching environment, teaching design shall still use learning theory and focus on the learning goal to achieve the teaching goal.

After concluding the learning effectiveness result analysis and system application result analysis, even for the learners who haven't been to Confucian Temple, their learning effectiveness does not have a significant difference when compared with the ones who have visited Confucian Temple after using the "Web 3D virtual situational learning platform" developed by the study, which means that even for students who haven't been to Confucian Temple, after using the platform to learn, their knowledge can be as good as the ones who have visited Confucian Temple. The learning situation and joyful contents provided by the system both obtain high satisfaction.

The following conclusions can be proposed after summarizing the study purpose and study analysis result:

The construction of a Web 3D virtual situational learning environment (arts course): Harper pointed out that virtual reality cannot replace a real environment, however when we are limited to time, space and money, and cannot learn in a real place, using virtual reality to obtain learning content is the most appropriate learning method; it can be verified from the study result.

Joyful learning experience analysis: Different from the traditional websites, it uses Web 3D to present digital learning materials to allow every user to surf freely on the website, feel fresh and curious, and further improve their learning motivation and interests, and promote the learners to continue learning to accomplish the teaching ideal of "Edutainment".

The realization of ubiquitous learning: Break the disadvantage of traditional expensive virtual reality equip-

ment, and use internet and software characteristics to allow learners to use the internet and a browser to learn at any time to achieve the effectiveness of ubiquitous learning.

It is worth mentioning that the learners agree that the system can assist learners to learn the related knowledge of Confucian Temple, and agree that what they've learnt from the system is actually more than visiting the place themselves. However, when they are noted with the idea of "after having this system, they do not need to visit Confucian Temple in person", they have an average response, which shows that even adding joyful learning elements and a virtual reality learning platform can effectively improve the learning motivation and effectiveness, it still cannot replace the thrill and experience brought by a real situation.

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