Virtual Reality Software Usage in an EFL Scenario: An Empirical Study

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***Abstract*—Current software development and advancement have created many possibilities in both industry and education. Within the educational realm, software advancement in terms of virtual reality simulation has introduced an entire new arena in learning scenarios. In Taiwan, numerous scholars have ventured into this endeavor. However, empirical findings are quite limited. In light of this issue, this case study focuses on evaluating the effectiveness of virtual reality courseware in learning occupational English. A total of 120 freshmen and sophomore English as Foreign Language students participated in the study. Pre/post-tests were gathered and analyzed. Results show that students gradually increased their vocabulary competence. Insights are also provided on how the courseware was created.**

***Index Terms*—virtual reality, learning scenario, virtual worlds, English language learning, statistical analysis**

I. Introduction

Currently there are numerous commercial services and websites for digital learning. The most commonly seen are Second Life (SL), Active Worlds, Kaneva, Smallworlds, Entropia Universe, IMVU, and Twinity. Since 2003, more virtual classrooms were built with the same concept as of Second Life. Inman [1] analyzed 27 articles on the application of SL in instruction from K-12 to higher education and suggested that more empirical research should be done to establish standards and best practices for virtual worlds as it is likely that virtual worlds in any form will continue to play a role in education and research. However, Dreher, Reiners, Dreher, and Dreher [2] pointed out that the capacity of Virtual Worlds are underused in educational contexts. Hew and Cheung [3] reviewed research on the use of 3-D immersive virtual worlds in K-12 and higher education settings and found out that 455 out of 480 were opinion and conceptual papers, non-empirical studies, and non K-12/higher education related and only 7% is empirical studies on language learning.

As English is viewed as a language of international communication, a lingua franca, or global English [4]. Global English is an important element for the information, knowledge and cultural flows in the contemporary world [5]. In Taiwan, university student linguistic competence, particularly in English, has long been emphasized [6, 7]. English Language professionals have endeavored to enhance students' English language proficiency level by incessantly trying innovation including technology use, such as computer-mediated communication [8, 9] and blog writing [10, 11]. As some of the features in virtual learning environments such as role playing fit with the instructional strategies of language learning [12], virtual learning environments can be created and built to provide an alternative approach to language learning and to meet the needs and characteristics of contemporary students [13-15].

With the importance placed on the potentials of a virtual learning environment, the current study shall try to evaluate the actual contributions within a language learning scenario.

II. Literature Review

A. Virtual Worlds and Language Learning

Virtual worlds (VW) are computer-based simulated environments where users can use and create objects and can interact with one another. In the interactive environments, users take the form of avatars and appear as textual, two-dimensional (2D), or three-dimensional (3D) representations [16]. VW provide an online immersive learning environment where students can participate, explore, interact and have fun and hence construct their own knowledge [2]. Savin-Baden [17] defines it as "a social medium where informality, ingenuity and wit are valued" (p.10). As more empirical research studies on the impact of virtual environment on learning are suggested to be done in higher education [1, 18, 19], the value and meaning of virtual world learning environments should be considered.

Since the early 1990s, virtual reality such as text-based MUDs (Multi-User Dungeons) and MOOs (MUD Object Oriented) has been applied in educational contexts [20]. The features of these virtual reality environments are: 1) they open up the classroom to a larger world; 2) spaces are shared and user changeable; and 3) communication is text-based. The text-based worlds have a potent immersive power. Recent technological advancements have developed from Web 2.0 to Web 3.0 [21] and virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, 3D environments [22]. People use two way social networking Web 2.0 such as blogs, wikis, video,

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and podcasts to share information and exchange ideas via either text or voice whereas people live in Web 3.0 for a myriad of purposes including business and education. Moreover, all media can flow in and out of these 3D-portals virtual worlds [23].

B. Scenario-based Language Learning

Herrington, Oliver and Reeves [24] defines scenario-based learning environments "where conditions, characters, circumstances and parameters are drawn to simulate a real life context for learning" and requires learners to suspend their disbelief in a virtual environment. Learning a language effectively entails the learners to be immersed in a community in which only the target language is used [25] and since many learners may not have the means to travel abroad, creating a virtual learning environment focused on language learning becomes an important method to create an "authentic" environment. In other words, a virtual learning environment "brings language learners closer to the target language community and its speakers while also providing an array of tools for awareness-raising activities and critical reflection" [26]. Moreover, virtual environments facilitate learning through communication and exploration, and the skills that they acquire through the process are likely to be applied to similar situations in the real world [27]. Learners are able to make mistakes without real-world repercussions [28]. In addition, the characteristics of tasks set for students in these VLEs have to be contextualized, authentic, and meaningful [29].

In contrast to traditional classroom learning methods, virtual learning environments allow a new method to facilitate student motivation. In a study on situated language learning in a virtual learning environment, students were asked to evaluate their attitudes and responses on a five-point Likert scale. 65% of the students reported that after using 3D Virtual English Classroom (VEC3D), they became strongly motivated to learn [25]. Virvou and Katsionis [30] found that usability and likability play important parts in motivating learners. Usability is analyzed through the amount of time wasted by gaming competency of the students which are divided into novice, intermediate and expert levels. The results show that the novices wasted the largest amount of time mainly due to navigational problems and gaming user interface problems (p. 168). In terms of likability, students reported higher motivation when playing an educational game in virtual reality while in class than playing an educational game in class (p. 176).

As technology continues to advance, more educators turn to combining lessons with technology. Many schools are turning toward researching the effectiveness of situated language learning in a virtual learning environment. Since these research studies are still in their infancy, there is more room for further improvement.

In the present study, the Science and Technology University in Taiwan (the venue of the study) has been working on 2D virtual language learning environment and is starting to work towards producing a game-based 3D version. In the future, along with expanding the game to become multiplayer, animated agents may be incorporated to enhance the learning environment for the students [31]. These agents can engage students and help them accomplish certain tasks, act as guides in various environments, direct students towards places with additional information, provide non-verbal or verbal feedback to students, contribute to human interaction and communication, convey emotions to the students that may increase their motivation, and act as a virtual teammate [31].

C. English for Occupational Purposes

Hutchinson and Waters [32] divided ESP into two main types: English for academic study and English for work/training. The latter one is labeled English for Occupational Purposes (EOP), English for Vocational Purposes (EVP), or Vocational English as a Second language (VESL), as opposed to English for Academic Purposes (EAP). Other terms such as corporate English, business English and workplace English are frequently seen. EOP combines general English and workplace English [33-35]. Dudley-Evans and St John [36] defined EOP as English which is not for academic purposes. Both professional purposes in administration, medicine, law or business and vocational purposes for nonprofessionals in work or pre-work situations are included (p.7). The purpose of EOP is to improve learners' communicative competence in job-related contexts to enhance workplace performance [37]. Learners learn English for the purpose of better communication in corporate contexts.

Kim [38] used multiple methods of inquiry to survey participants' perception of EOP in Korea and summarized some essential characteristics of EOP as follows: a) EOP is content-based – its instruction is based on content knowledge of a certain field; b) EOP is focused on the purposes and needs for learning; c) EOP aims for efficiency and is constrained by time – its purpose is to improve performance and efficiency without wasting the work time of the trainees; d) EOP is specific – it is different from other types of English teaching and deals with specific language; and e) EOP is context-specific – it focuses on learning specific language in a particular workplace context.

Kim [38] described that the instructional design processes of prevailing EOP models are almost identical with Training and Development (T&D) in the field of human resource development with an emphasis on needs analysis in developing programs. Swanson and Holton [39] defined T&D as "*a process of systematically developing work-related knowledge and expertise in people for the purpose of improving performance*" (p. 204). However, Kim also pointed out that there are lacks in literature sharing knowledge and practice between EOP and T&D as well as in viewing EOP as an interdisciplinary field between language learning and T&D.

Dudley-Evans and St. John [40] provided some guidelines of needs analysis in the workplace: namely, a) knowledge, on the part of employees, of the communicative function of EOP; b) understanding, on behalf on employers, of the expectations of those who need English in order to do a job; c) knowledge, on the

part of the employees, of the theory and practice of EOP. Furthermore, cross-cultural sensitivity and openness is another key element to success and effectiveness of an EOP program (p. 60).

III. Courseware Production

Before beginning the process of producing digital teaching materials for English learning, there are seven main steps that need to be taken into account: Idea, Storyboard, Necessity, Content, Technicality, Testing, and Prototype.

In brainstorming for an idea behind the digital teaching materials, a project plan is established. It includes a written proposal, the goal, the target group as well as other special requirements. After the project plan is finalized, the process moves on to animation production. For this study, both 2D and 3D animations are used. Typically, animation production is divided into three general stages: pre-production, production, and post-production. For 2D animation production, the pre-production stage begins with story development, screenplay, dialogue recording, character designing, story boarding, color styling, track reading, character animation, and background layout. Next, the production stage involves key animation (posing) that includes animation and background painting, and in-between & clean-up. The post-production stage includes the digital department, ink and paint, compositing (rendering), aftereffects, additional sound effects, final editing followed by final export output (see figure 1).

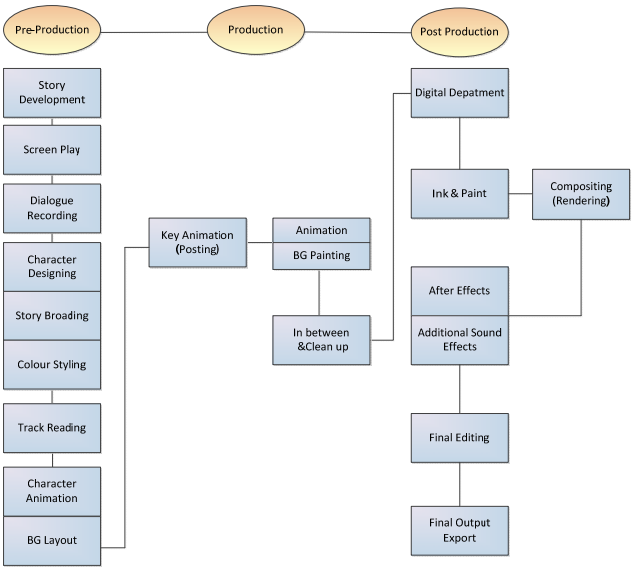

Figure 1. 2D animation production stages

In the research venue's own 2D animation production for digital English teaching materials, there are 4 main stages: pre-production, production, filming and post-production. In the pre-production stage, the content, script, storyboard, and visual design are established. Next, the focus turns to the layout, animation, sketching and coloring in the production stage. During the filming stage, the process moves to inspection and animation recording. Finally, editing and sound effects are added in the post-production stage, completing the entire animation production process (see figure 2).

Figure 2. 2D animation production

For 3D animation production, the process is more complicated and production can be categorized by the story, the technical, creative, and auditory aspects. Similar to 2D, all the processes are generally divided into three stages: pre-production, production and post-production. The first step of the process is to create the story line. Once the story board and/or story reel is established in the pre-production stage, the process moves onto the layout/pose reel in the production stage. The focus then moves on to the animation reel, which moves the process to the post-production stage in which the focus turns to compositing and final rendering. The entire process is completed in the final cut (see figure 3).

Figure 3. 3D animation prototype (MAYA)

In the pre-production stage for the technical portion, research is done first, followed by technical development, rigging, lighting and establishing character dynamics, which closely follows the story board. In the production stage, the technical process moves onto advanced rigging, lighting, and character development, coinciding with layout/pose real in story development. The next step moves onto refining technical direction to aid in the

compositing and final rendering of the story line (see figure 4).

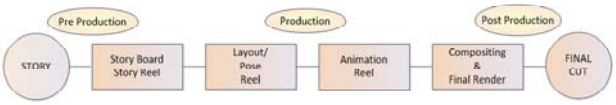

Figure 4. 3D animation production stages

The creative aspect begins with research in the pre-production stage, followed by designing the character set, the background and the props according to the story board. In the production stage, the process turns to the final design package and modeling, following the layout/pose real. Next is the establishment of light, texture and color to complete the composite and final render of the story development.

For the auditory aspect, the pre-production stage includes sound design followed by the Foley score mix in the production stage, all contributing to the final cut. Using Pixar as an example, first a story idea is pitched, and if accepted, the text treatment is written, detailing what the story is. Next, a storyboard is drawn and voice recording begins. The editorial begins making reels, and the art department creates the look and feel. Models of the characters and props are sculpted and articulated. The set is created as a 3D image in the computer, and the shots are laid out. This is followed by the animation of the shot and then the sets and characters are shaded as the lighting is established. The next step is rendering the computer data into film and final touches are added.

In the process of creating a 3D interactive game that includes digital English teaching materials, the storyboard is set up, which includes the story idea, the written script, the flow process, the characters and sets drawings, as well as the storyboard frames. The storyline is continuously revised until a final version is reached. Before the actual production process, the feasibility of the project has to be confirmed, followed by the establishment of a schedule and desired functions or purpose. The content of the project plays a vital role. The function of the project is designed to include interactive and animated teaching. In addition, the user interface and operating process designs take user platform and viewing angle into account. Furthermore, content materials include a narrative script, the schematic sketch, and auditory recordings.

The production schedule is arranged based on three parts: art design, program development and music/sound effect production. Art design includes character design, setting design, character animation and user interface design. Program development includes system structure, component integration and component control. Music/sound effect production includes background music and animation (game) sound effects.

In the production of the situational digital teaching materials, the software used is MAYA, Unity, and Photoshop. The content materials include designing and creating teaching materials for 6 different units, each with its own storyline, script, and storyboard. The artistic design included the establishment of the settings and characters. In the interactive production, the interactive sequence, the tasks, the controls/movements and the interface are created.

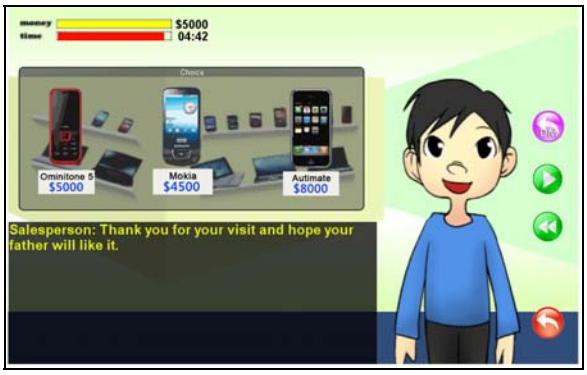

Figure 5-6. Courseware screenshots

IV. Research Methodology

This study is quasi-experimental, therefore the methodology employed shall follow a quasi-experimental design [41]. The single group pre-test/post-test design is used to determine the effectiveness of the virtual reality courseware. This quasi-experimental design is referred to as a compromise design, because the random selection or assignment of schools and classrooms is impracticable [42]. Mostly, the researchers attempt to employ something approaching a true experimental design in which the control over what Campbell and Stanley [43] refer to as to the who and whom of measurement is important.

Moreover, this study is also designed as a case study, wherein the primary objective is to investigate the phenomenon within its real-life context, in this case the actual application of a virtual reality courseware [44]. Furthermore, Merriam [45] views a case as an individual, a program, a class or students, a school, or a community. She fashions the distinctiveness of case studies as particularistic due to the focus on one social unit; descriptive because they result in a rich thick portrait; and heuristic because case studies sharpen readers' understanding while leading to new meanings.

A. Participants of the Study

Table 1 shows the participants of the study. A total of 120 freshmen and sophomores from the Department of Applied Foreign Languages at a Science and Technology University in Taiwan participated. Both levels had 60 participants with a total mean age of approximately 19 years old. In addition, students' initial English language competencies were tested prior to enrollment; hence, participants of the study were almost the same level.

TABLE I.
PARTICIPANTS' DEMOGRAPHY (N=120)

Age / Year level	Mean	*N*	*SD*
1	18.57	60	0.75
2	20.10	60	0.73
Total	19.33	120	1.06

B. Research Process

The study was accomplished during the 1st semester of the 2012 and 2013 school year. In the beginning, the students were first given an orientation regarding the project. The courseware was shown and navigations were explained and simulated. The courseware mainly focused on developing English competencies of English as Foreign Language (EFL) students. The courseware was designed with 3 main themes involving shopping, such as: 1) Buying a gift for one's mother; 2) Looking for a cellphone for one's dad; and 3) Buying business attire for oneself.

The quasi-experimental study was accomplished as follows: Students of different year levels underwent the courseware in different computer labs. Each of the thematic lessons was completed in two sittings. Therefore in order to finish the three themes, students had to use the courseware 6 times. Before each of the sittings, a 100 point pre-test of the lesson was given consisting of listening; orthographical knowledge through auditory stimulus and phonology, fill in the blanks; wherein students accomplished sentential contexts to promote syntactic learning, sentence completion or chunking, definition matching; vocabulary knowledge through recognizing affixes, and multiple choice; knowledge of affixes. After finishing the courseware, a post-test was then given with a similar scope as of the pre-test, but randomly numbered. Scores were tabulated and analyzed with the use of the Statistical Software Package for Social Scientists (SPSS) version 20.

C. Research Objectives

The main objective of this study is to determine the effectiveness of the courseware. More detailed questions are as such:

1. Is there a significant improvement between the students' pre-and post-test scores?
2. What is the overall effect of the courseware?
3. What are the other factors involved in the improvement of the students?

V. RESULTS AND DISCUSSION

To meet the various objectives of this study, the results are further separated into sections: Pre-and post-test scores analysis, overall effect of the courseware, and factors involved in the students' improvement.

A. Pre-and Post- test Scores Analysis

A total of 6 pre/post-test scores were collected, tabulated, and analyzed using SPSS. In order to determine if the scores were of concern, paired-sample T-tests were completed. Paired sample T-tests are used in instances wherein there is only one group of participants (students) and data is collected from them on two different occasions or under two different conditions. Pre-test/post-test quasi-experimental design is a great example of such type of situations. Students first take a pre-test to measure their initial knowledge of subjects; then exposing them to some intervention (in this case, going through the courseware), and finally the students were tested again using the post-test.

TABLE II.
PAIRED-SAMPLE T-TESTS FOR PRE/POST-TEST SCORES (N=120)

Sessions / Pre/Post-test Scores		Mean	*Standard Deviation*	*t value*
1	Pre	44.70	27.37	0.205
	Post	45.13	30.89	
2	Pre	41.93	32.37	0.979
	Post	43.87	29.25	
3	Pre	59.74	24.03	1.509
	Post	62.60	29.19	
4	Pre	58.78	18.10	**4.379****
	Post	63.18	22.43	
5	Pre	69.08	27.41	**3.361****
	Post	76.55	28.86	
6	Pre	66.73	18.48	**8.880****
	Post	78.57	21.82	

Note. **p<0.001

Table 2 shows the result of the paired sample T-tests of the various pre/post-test scores. Results show that there are significant differences among the pre/post-test scores of sessions 4 to 6. Denoted by the bold values in Table 2, which also shows that the significant value is less than or equal to 0.001. Furthermore, Table 2 also shows that the scores of the students increase such as (computed by taking the difference between pre- and post-test scores): Session 1=0.43; Session 2=1.93; Session 3=2.86; Session 4=**4.39**; Session 5=**7.48**; and Session 6=**11.84,** only Sessions 4 to 6 are significant (or meaningful). Such results indicate that the English score improvements in

Sessions 4 to 6 can be attributed to the use of the courseware.

B. Overall Effect of the Courseware

Besides determining which courseware sessions have a significant impact on the students' scores, determining the overall effect of the courseware is also quite important. In order to identify such effects, a multivariate repeated measure was accomplished to understand the overall effectiveness of the courseware. In addition, the pre-test score of session 1 was used as a covariate. A covariate is defined as a continuous control variable that is observed rather than manipulated, but can affect the outcome of an experiment or study. Hence, in this study, in order to overcome the effect of individual differences, students' initial English language competencies (even though they are almost the same, as shown by the test they took during enrollment) were taken into account [37]. The session 1 pre-test scores shall be used as the covariate.

Multivariate repeated measure results show that the **Wilks' Lambda** is computed at 12.27 with a probability of 0.000. Since the probability (or more commonly known as *p* value) is less than 0.05, therefore the results conclude that there is a statistically significant effect for the different sessions; suggesting that there is a change in English competency scores across the 6 different sessions. Moreover, effect size or **Eta squares** is also obtained with a value of 0.35; which is considered to a large effect [37]. In sum, the statistical results show that the courseware accounts for an overall significant improvement of the participants' English competencies.

Besides the reported score improvements, the students were also asked about their usage satisfaction. In regard to the courseware use satisfaction, the students were asked to fill out a ten item questionnaire adapted from a study by Tsai [46] with an overall mean of **3.60**, denoting moderately satisfied. Such results are consistent with other studies involving the use of courseware materials for training [47] and learning [48].

TABLE III.
COURSEWARE USAGE SATISFACTION (N=120)

Factors	Mean	SD	Min	Max
It improves my cognition in Shopping English	3.58	1.27	1	5
It is sufficiently helpful to improve terminology for Shopping English.	3.58	1.29	1	5
It is sufficiently helpful to improve listening skills for Shopping English.	3.76	1.28	1	5
It is sufficiently helpful to improve speaking skill for Shopping English.	3.50	1.08	1	5
It is sufficiently helpful to improve reading skills for Shopping English.	3.55	1.37	1	5
It is sufficiently helpful to improve writing skills for Shopping English.	3.63	1.20	1	5
It is sufficiently helpful to improve translation skills for Shopping English.	3.55	1.22	1	5
The sentence patterns for a variety of situational contexts in Shopping English are applicable.	3.74	1.22	1	5
The English content of the courseware is relevant.	3.42	1.22	1	5
The layout for a variety of situational context in Shopping English is relevant.	3.68	1.21	1	5

The highest item is the survey "*The courseware is sufficiently helpful to improve listening skills for Shopping English*" with a mean of **3.76**, denoting that students acknowledge the perceived advantages of using this type of courseware in learning. Table III also shows that the item "*The courseware layout for a variety of situational context in Shopping English is relevant*" with a mean of **3.68**, denoting that courseware and software design are quite conducive to learning.

C. Factors Involved in Student Improvement

The study also tries to determine whether the students' year level is a significant factor in the students' improvement. To accomplish this, independent sample T-tests are used to compute for the perceived effect of students' year level. Interestingly, T-test results seem to be no significant difference among the freshmen and sophomore students' English scores whether in the pre- or post-test scores. Such result is actually encouraging, since it denotes that student year level is not affected by the courseware. More importantly, courseware usage is not limited to the age or prior English language competency of the participants.

VI. CONCLUSION

This paper analyzes and studies the possibilities of a virtual reality courseware designed towards improving EFL students' English language competency. Although still in its initial testing phase, results show that within the various courseware sessions, students gradually improved their scores. In addition, the overall analyses prove the significant effect of the courseware towards the students' scores. As with the technological advancement in computer software is at an arm's reach, new pedagogical tools are being created day by day. Hence, studies that look into the various pedagogical implications and the various factors that contribute to learning effectiveness are a must.

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