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A Collaborative Virtual Environment for Situated Language Learning Using VEC3D

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ABSTRACT

A 3D virtually synchronous communication architecture for situated language learning has been designed to foster communicative competence among undergraduate students who have studied English as a foreign language (EFL). We present an innovative approach that offers better e-learning than the previous virtual reality educational applications. The proposed method supplies learners with autonomy in virtual communications, allowing learners to achieve a variety of shared goals. The traditional text-based or web-based virtual reality systems are generally less attractive to students because of their lack of 3D immersion and real-time voice interaction. Three-D virtual reality technology can be exploited to compensate these weaknesses. We propose an immersive and interactive virtual English classroom, entitled VEC3D, that integrates a goal-based instructional design, vivid 3D graphics, and real-time voice communication. The ultimate goal of the VEC3D project is to enhance learners' English communicative competence. This research determines how learners perceive their experiences in the virtual space and use communication strategies (CSs) in the process of advancing communicative competence. The recent ethnographic study results revealed that the proposed application promoted positive student attitude and interactive learning experiences.

Keywords

3D virtual reality, Situated language learning, Goal-based scenario, Strategic interaction, VEC3D

Introduction

The most effective way to learn a language is to participate in a community in which the target language is used to communicate in a real context. In such an environment, the language learners are left with no place to hide. They are forced and encouraged to think, speak, and write in the target language. In other words, they become immersed in an input-rich, natural, and meaningful context in which the target language can be acquired spontaneously.

Toward this goal, we proposed and designed a contextualized and playful 3D Virtual English Classroom, called VEC3D, in which learners are encouraged to possess communicative competence. The 3D virtual reality technology offers an appropriate and appealing context for foreign language learning. Undergraduate students in Taiwan are allowed to communicate with different people over the Internet, construct their knowledge, and develop their communicative competence through an interactive online virtual environment. VEC3D is a 3D campus-like interactive learning environment designed to help learners develop English communicative competence. Students conduct synchronous communication and real-time interactions in written and spoken format. Moreover, learners are given opportunities for engaging in various goal-based activities and teleporting to other virtual worlds in the target culture. VEC3D is significant in that the immersion and interaction inspire students to take part in a virtually situated 3D learning environment. VEC3D is a novel platform with real-time voice as another option for online chatting.

According to Canale (1983) and Canale and Swain (1980), communicative competence consists of four components: grammatical competence, discourse competence, sociolinguistic competence and strategic competence. Strategic competence is the ability to employ communication strategies (CSs) using both verbal approaches, such as native language switch, and nonverbal approaches, such as mime, to keep communication going. Strategic competence plays a crucial role in advancing interlanguage development and achieving communicative competence (Faerch & Kasper, 1983). Communication strategies help language learners take part in a conversation and ensure effective ongoing communication. Based on the preliminary qualitative and quantitative data, this paper discovers how learners perceive their experiences in the virtual space and use communication strategies (CSs) in the process of advancing communicative competence.

VEC3D is also an ideal solution for integrating English composition and conversation into a class in which extensive immersion experience is required. One option, avatar-masking, allows the learners to remain anonymous to reduce the inhibition that impedes language learning. This inhibition occurs frequently in traditional composition and conversation courses.

Growing research shows the educational effectiveness of constructivist and collaborative learning in virtual learning environments. The virtual learning environment features are considered a support for knowledge construction, self-direction, immersion, interactivity, and education. VEC3D is designed to facilitate English learning by integrating virtual reality into the curriculum. Through experiencing a virtual world, interacting with others, and confronting the virtual reality collaboratively, English learners expand their knowledge, construct meaningful personal understanding, and gain communicative competence.

To the authors' knowledge, there is no published research that systematically and formally investigates the use of 3D virtual reality technology for the development of communicative competence. VEC3D is based on related research concerning network-based communication (NBC) and the development of communicative competence to deal with this new issue in foreign-language education. Currently, the educational virtual world is rapidly expanding. The integration of 3D interactive technology into English as a Second Language (ESL) or English as a Foreign Language (EFL) learning and teaching is relatively new in the world. We expect to integrate 3D interactive technology into future Taiwanese English classrooms to make language learning both enjoyable and fruitful.

This paper is organized as follows: Section 2 compares related works. Section 3 introduces the instructional design of VEC3D. Section 4 describes the systematic design of VEC3D. Section 5 demonstrates the operation of VEC3D. Section 6 evaluates the effectiveness of VEC3D. Section 7 concludes this paper. Section 8 discusses the paper's limitation and future works.

Related Works

A MOO (MUD Object-Oriented) (Tomek, 2000) is a text-based online system designed for communication via the Internet. MOOs in educational settings have been applied to language learning and different subject areas. Students are allowed to become fully involved in MOO to create or decorate their personal spaces using their imagination, and exchange ideas through writing. A WOO (Web-MOO) is expanded from MOO and has significantly more options available. For example, graphics and sound are incorporated into WOO. SchMOOze University (SchMOOze, 2006) and ForMOOsa (ForMOOsa, 2006) create online environments in which ESL/EFL students are encouraged to share their ideas, enhance their writing abilities and conduct cross-cultural communication. Generally, WOO is based on 2D graphics, which do not provide students with sufficiently realistic and immersive feelings and experiences in situated learning.

Internet-based collaborated virtual environments (CVEs) and distributed virtual environments (DVEs) (Bouras, Philopoulos, & Tsiatsos, 2001) have promising potential for e-learning because they provide an online environment in which learners can participate and communicate according to their needs. CVEs have been widely used in educational settings for many different purposes. INVITE (Bouras, Hornig, Triantafillou, & Tsiatsos, 2001) is a synchronous e-learning platform that can be interfaced with instructional management systems or standardized content. SAIL (Bares, Zettlemoyer, & Lester, 1998) is an inhabitable 3D learning environment in which learners can control avatars to manipulate objects in the virtual world in the course of problem solving. BVW (Lin & Kuo, 2005) is a collaborative learning environment that integrates learner profiles, objects, and the learning world based on constructivism. Octopus (Hartling, Just, & Cruz-Neira, 2001) is a cross-platform, object-oriented software library for constructing shared virtual worlds. NECTAR (Law & Chan, 2002) is a 3D collaborative environment for simulation and visualization, with an emphasis on cost-effectiveness and interoperability. These academic systems are either still in the prototype status or lack sufficient support in communication and interaction functions required in language learning.

The most compelling commercial virtual-learning environment systems today are Community Place, OnLive! Traveler, Blaxxun, and Active Worlds. Community Place (Lea, Honda, Matsuda, & Matsuda, 1997), developed by Sony Corporation, is another virtual environment designed to be scalable and support many users interconnected through low-bandwidth and high-latency communication links. However, the chat and whiteboard windows are

separated from the navigation window. Users are forced to continually shift attention between different windows. OnLive! Traveler (Digital Space Commons, 2006) is the first VRML browser that supports voice communication between multiple users in a 3D virtual environment. The avatars actually mimic or lip-sync facial gestures when users speak into their microphones. Blaxxun (Blaxxun, 2006) is a 3D virtual world in which multiple users can interact with one another. Blaxxun has the advantage of using humanoid animation compliant avatars. However, these commercial systems offer relatively limited opportunities to construct a custom-made world in educational settings.

Active Worlds (AW) (Activeworlds, 2006) is a multiple-user virtual world that provides a game-like 3D-rendering world. Users are given the freedom to import images and animation, as well as add sounds and create web pages to enhance their virtual spaces. AW also comes with a chat window that supports text-based communication among users. Viras (Prasolova-Forland & Divitini, 2002) is a collaborative virtual environment for social awareness support and has been realized through AW. SciCentr (Corbit, 2002) also uses AW to incorporate interactive simulation-based exhibits. These commercial solutions either lack the support of real-time voice communication or do not provide learners with sufficient immersion and interaction. Learners can only passively read and listen to acquire information and sometimes write text-based communication, but can seldom actively speak to communicate in an online discussion. An integrated solution is definitely required to provide flexibility, portability, scalability, and usability in an educational setting for language learning.

Three-D interactive technology integration into ESL or EFL teaching and learning is still in its infancy. This spectacular way of constructing knowledge is spreading quickly and connecting learners around the world to learn for fun. In this paper, we propose a VEC3D system that combines the beneficial functions of the virtual learning environments and live voice communication to provide an immersive environment for undergraduate students learning English. VEC3D contains a 3D virtual campus-like space with objects and avatars that are controlled by numerous learners spread within the Internet. Moreover, VEC3D is flexible and scalable in that the virtual world layout and the supporting functions can be customized according to various learning needs and research goals.

Instructional design

The VEC3D instructional design principles and theories are based on constructivist learning design (CLD), collaborative learning (CL), communicative language teaching (CLT), goal-based scenarios (GBS) (Schank, 1992), story-centered curriculum (SCC) (Schank, 2003) and strategic interaction (SI) (Di Pietro, 1987).

Pellettieri (2000) discusses the importance of goal-based activity design, including synchronous network-based communication (NBC) and the development of grammatical competence. His study incorporates tasks for learners' negotiation in virtual classrooms. He indicates that "Synchronous NBC language tasks should be goal-oriented…all participants are required to request and obtain information from one another for successful task completion" (p. 83). According to our pioneer study (Shih, 2003), one of the reasons participant interest decreases while exploring virtual places is the lack of tasks and fun. Participants prefer learning by playing and engaging in multi-player gaming since it offers a context, the chance to role-play, gratification, and competitive interactive tasks. Pellettieri concludes that the 3D virtual environment is tied to engaging activities. The 3D environment will fail without proper activities and tasks designed to meet learners' needs. The great challenges to instructional designers of virtual environments are how to create motivating (even addictive) goals and tasks for students to perform.

The learners tend to be highly motivated to learn when they acquire the desired information to accomplish goals within authentic contexts. Schank and Kass (1996) summarize the following three elements related to an effective learning environment: first, create motivating goals for students to get information; second, situate students within an authentic learning context; third, give students tasks that must be completed by analyzing the information they get and devising a course of action. Schank proposes goal-based scenarios (GBS) (1992) and story-centered curriculum (SCC) (2003) approaches as a solution to designing successful e-learning curricula. He insists that a series of goal-based scenarios and stories inspire learners to role-play, engage, and learn in the context.

It is important in a collaborative learning environment that learners be allowed and encouraged to interact and give one another support with their language learning. Relying on the constructivist paradigm, VEC3D provides a novel language-learning experience with prolonged immersion in a natural and authentic context. Virtual reality is regarded

as a constructivist and collaborative learning tool. We firmly believe that successful learning is anchored in collaboration, cognitive apprenticeship and situated cognition. VEC3D is a virtual collaborative learning environmental alternative to the traditional English classroom. The instructional strategy is based on constructivist learning design and collaborative learning, which are considered to enhance language learning in a contextualized virtual reality. Learners are allowed to engage in personal, meaningful learning through collaboration and interaction.

An authentic and communicative context rich in linguistic and socio-cultural materials plays a critical role in the language learning process. In general, English learning environments in Taiwan are constructed artificially and independently of context. Decontextualized learning, meaningless mechanical practice, and drills have permeated Taiwan's traditional English classrooms. Consequently, students use English in an unnatural or improper way that impedes communication with other speakers of English.

The solution to improve Taiwanese students' "unnatural or improper way" of using English is to help them develop communicative competence through providing learning contexts and a natural way of receiving understandable messages (Krashen, 1981, 1985). The "communicative competence" concept was suggested by Hymes (1972). He regarded communicative competence as an ability to use language appropriately in different socio-cultural contexts. Savignon (1983) clarified the notion of "communicative competence" with these key points: communicative competence related to the ability to conduct interpersonal negotiations, dealing with written and spoken language, using suitable ways of communicating depending on various conversational situations.

This novel solution to the problem, the lack of real contact with English speakers, inspires ESL/EFL teachers and researchers to meet learners' needs and provide fun, authentic communication, gratification, a sense of community and competitive tasks. Since 3D rendering and real-time voice communication technologies are integrated in VEC3D, it becomes possible to design more interactive, immersive, and communicative language-learning activities. Successful e-learning outcomes and experiences are tied to participants' sense of community and engagement. We applied the group formation strategies, such as story-based task sharing, to break the ice and create a feeling of being a group. Consequently, we gained and retained participants' interest in staying in VEC3D. Moreover, to meet the challenges of learner diversity and individual needs by applying instructional strategies and materials according to entry skills and characteristics of the learners, user-interaction techniques of VR, such as 3D navigation, were integrated into curriculum.

We followed Dick and Carey's (1990) instructional development model to conduct systematic VEC3D curriculum design for users. The analysis phase begins with goal analysis followed by subordinate skills analysis, based on the needs assessment results conducted previously (Shih, 2003). Feedback is gathered from ongoing group meetings, participant observation, chat log and survey. The main instructional goal for this project is to improve learners' English communicative competence. The sub-goal is to help students develop communication and technical skills required for dealing with situations and problems that may arise in using VEC3D. The goals are classified into four domains: verbal information, intellectual skills, psychomotor skills and attitudes, rendered by Gagne and Briggs (1974). The learning outcomes are categorized and exemplified in Table 1.

Table 1. *Learning outcomes*

Domains	Examples
Verbal Information	1. Name the objects in VEC3D in English 2. Know the layout of the VEC3D system
Intellectual Skills	1. Generate ideas using communication strategies 2. Write sentences to ask courteously for something to be given/done
Psychomotor Skills	1. Save and send chat log 2. Install the related software 3. Control the avatar to move in virtual spaces
Attitudes	1. Decide to follow the English-only rule in VEC3D 2. Cooperate with all group members to accomplish missions

To identify entry skills and characteristics, the information related to learners' abilities such as language proficiency, communicative competence and technical capabilities, learning styles, motivation, and preference was gathered to ensure further effectiveness of VEC3D application.

The authentic VEC3D tasks are not predefined to be accomplished by an individual. Instead, work is completed by pair or group of learners to facilitate natural communication and foster interaction in the target language. Krashen (1981, 1985) clarified how the learner acquires a second language and suggested the concept "natural communicative input" to design a syllabus. "Acquisition requires meaningful interaction in the target language — natural communication — when speakers are concerned not with the form of their utterances but with the messages they are conveying and understanding" (Krashen, 1981, p. 1). Following his suggestion, we supplied a scaffolding curriculum and understandable and communicative input, corresponding to the learner's linguistic competence, for language acquisition. A potential list of topics and communicative situations, generated by the natural approach (Krashen & Terrell, 1983) and the previous results of a needs assessment (Shih, 2003), were names, self description, greeting messages, classroom messages, requesting directions, physical appearance, and virtual objects in the 3D virtual environment.

The instructors identified target skills such as communication strategies to develop learners' communicative competence via goal-based scenarios. The missions and their cover stories were created to establish conversational context and stimulate learners' interest. Learners applied communication and technical skills, as well as knowledge, to achieve predefined goals.

The scenario content was designed based on real-life situations, with a "twist," to place the learners in conflicting situations by offering each group different goals, roles, and perspectives. Four types of goal-based scenarios: two-role, multiple-role, group and open-ended, based on strategic interaction (SI) (Di Pietro, 1987), are planned in VEC3D. Every group member behaves and reacts to a conflict situation based upon the previous group discussion in two- or multiple-role scenarios or in his or her own way in group or open-ended scenarios. During the scenario, the learners are encouraged to acquire communication and discourse skills to avoid communication breakdowns.

We planned special events preferred by the majority of target learners. The opening event, "Who Am I?" and a goal-based activity, "Virtual Scavenger Hunt," were highly valued. In the "Who Am I?" event, students were allowed to login to VEC3D anonymously, role-play, and state their character, habits, interests, etc. The anonymous person would make a comment such as, "I often eat my sandwich during the lesson." The participants then raised questions regarding the anonymous person's characteristics or habits and relied upon this information to guess who he or she was. The goal-based scenarios, "Virtual Scavenger Hunt" and "Complain about Food," are detailed in Table 2. The interactive exploration of 3D virtual worlds and hunting for virtual objects caused learners to feel anticipation and excitement, and satisfied their curiosity about virtual worlds. VEC3D learners looked forward to treasure hunting in 3D VR.

Systematic design

The learning design architecture of VEC3D is described in Figure 1. The architecture of VEC3D includes a web-based content learning environment (VEC3D website) and 3D virtual reality learning environments (VEC3D). We hosted a 3D virtual world named Old VEC3D, in the AWEDU of Activeworlds Inc., and constructed a new 3D world called New VEC3D concurrently. Simultaneously, Old VEC3D allows a large group (of around twenty learners) to explore vast 3D virtual worlds and chat with other (native) English speakers over the Internet. Typically, the smaller group size (in the range of two to five) is perfect for the interactive nature of the events. As shown in Figure 2(a), the VEC3D website contains a user-friendly interface including a discussion forum for Q&A and announcements, a preview tour for demonstration purposes, setup instructions for new participants, a VEC3D gateway for quick launch, and a mission page, where learners can browse scenarios and reference materials. VEC3D provides multiple users with four different privilege levels for constructing VEC3D. First, learners are allowed to access multiple scenarios and virtual scenes. They can also provide suggestions on content knowledge authoring of VEC3D. Second, instructors are allowed to upload scenarios and reference materials to the project website and/or virtual environment. They can also arrange the virtual items they need from the pre-built object library to construct a

virtual scene. Third, designers can conduct the high-level instructional design and administration. Finally, programmers take care of the low-level implementation and coding to extend the object library and add more virtual scene templates. The goal-based scenarios in VEC3D take the form of 3D virtual learning environments in which the learners, instructors, designers, and programmers share the opportunities to manage the virtual spaces and author tasks/goals/missions.

Table 2. Detailed information about two goal-based scenarios

Mission	Virtual Scavenger Hunt	Complain about Food
Story	Participants are scavengers going on a hunt for virtual objects in VEC3D. They act, name, move, and hunt for virtual objects.	Students complain about food provided by a café while café staff members defend food quality and customer service.
Roles	Role: Scavengers must name the objects and exchange ideas with their partners.	Role A: Students register their complaint about the unsatisfactory food that they have purchased in the café. Role B: Café staff members try to convince students of the quality of their food and service.
Expectations	Participants' ability to locate and name virtual objects and discuss the answers with their partner or group in target language will help their personal progression in communication skills.	All participants are expected to learn about communicative skills and conduct negotiation from different roles involved in this situation. Students' ability to progress through these crises will not only keep them away from unsatisfactory food but will also help their personal progress in communication skills.
Plans	Countdown timer is set in VEC3D. All participants must accomplish the task as soon as possible.	Two roles are performed by participants in VEC3D. The context is anchored in the unsatisfied situation and settlement of the minor complaints about food service.
Expectation Failures	The mission fails if the scavengers do not name the virtual objects in time.	If the participants do not succeed in identifying the crisis, developing strategies, negotiating with café staff or customers, and saving themselves from the crisis within a specific period of time, they will approach the final failure state in the mission.
Explanations	Participants confront challenges designed to elicit answers within a specific period of time.	Participants confront challenges designed to elicit failure, and gain detailed feedback (comment, argument, or agreement) from other characters so that they might modify their proposal to adjust to a new condition.
Goals	Participants need to: 1. Name the objects in VEC3D in the target language 2. Know the layout of VEC3D	Participants need to learn: 1. Process knowledge — how to practice effective interpersonal communication skills 2. Content knowledge — food and background information; terms and expressions related to the events
Overall Goals	1. Build virtual community 2. Enhance communication strategies 3. Improve overall communicative competence	

Operation

Before joining VEC3D, it is necessary to download and install a Java runtime package by following the step-by-step setup instructions on the VEC3D website (VEC3D, 2006). At the beginning, each participant (either a teacher or student) inputs his or her user ID and password into the VEC3D login dialog to enter a gateway connecting to different places in the virtual campus.

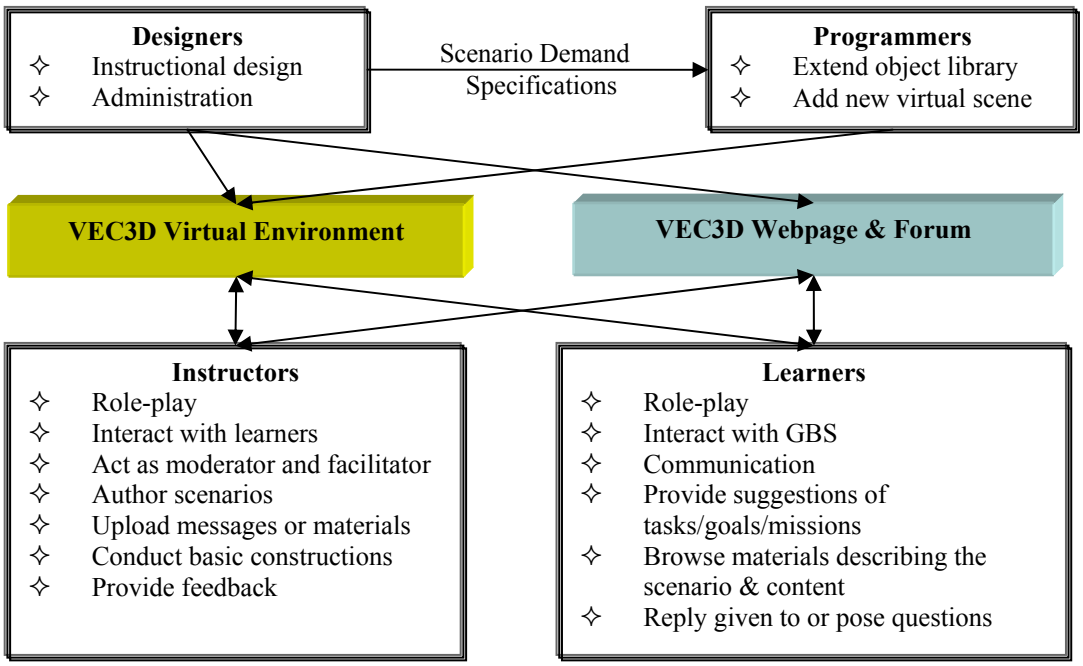
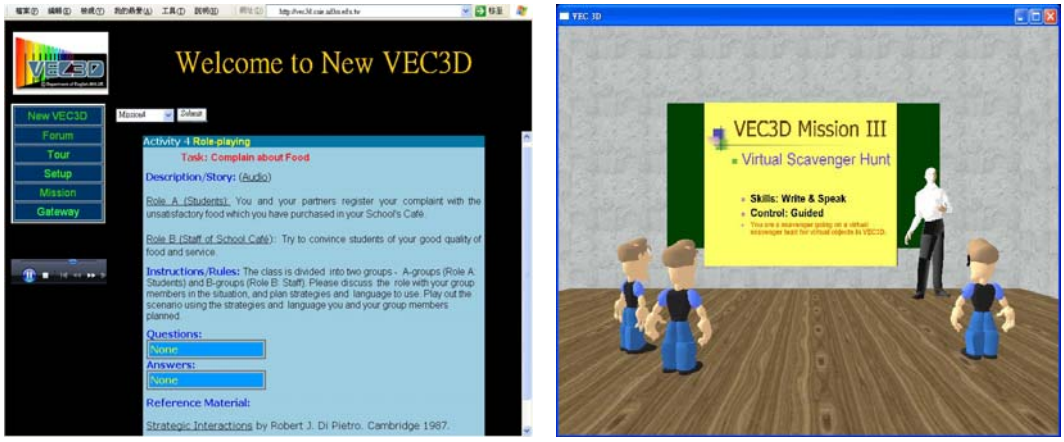


Figure 1. Architecture of VEC3D



(a) (b)

Figure 2. Screen shot of VEC3D. (a) Webpage showing the user-friendly interface and scenario description. (b) Virtual classroom where an instructor and students communicate and interact with each other through live voice.

The curriculum begins by requesting students to receive information and instruction for a specified virtual event with a corresponding goal-based scenario via the mission page of the VEC3D website. The learners view the scenario descriptions and prepare for their roles via online text/voice chat. When they feel ready, multiple groups of participants log onto VEC3D to act out their roles by typing (text chat) or speaking (voice chat) via microphone and earphone. Simultaneously, they are allowed to control the movement and action of their avatars using either keyboard or mouse.

To ensure that the scenario is played successfully and that the interaction continues, VEC3D provides several assistant functions, such as the slide-show control, real-time voice chat, virtual-object handling, and group

management. The teacher can use these functions to carry out the instructional activities. Figure 2(b) shows a client-side screenshot of a virtual classroom in VEC3D, in which an instructor and three students communicate and interact with each other through live voice. Moreover, the teachers act as moderators, facilitators, and participants to provide the learners with just-in-time assistance via text and/or voice chat during the scenario in VEC3D.

In the "Virtual Scavenger Hunt" scenario, detailed in Table 2, the instructor splits the learners into two or more groups. Each learner takes the role of scavenger to exchange ideas regarding the names of virtual objects with other group members via text or voice chat in VEC3D. A countdown timer is set to place the group in a pressure and competitive situation. A character played by the instructor provides assistance. In addition, reference materials linked to the website enable the learners to interact with the scenario and others. VEC3D forum enables instructors and learners to pose questions and provide answers and feedback.

In the "Complain about Food" scenario, detailed in Table 2, two roles are played (students and café staff). This activity is open-ended and close to a real-life situation. Learners are organized into two teams to play out the roles within the conflicting situation anchored in the students' complaints about food and the possible settlement. Each group prepares for its role and appropriate communication strategies via text/voice chat. Based on the strategies and language preplanned during the previous stage, group members take turns to serve as a spokesperson on behalf of the whole group to react to the situation. Specific information and scaffolds are provided via instructors' in-time assistance and reference materials on VEC3D website to support students' interaction. The teacher and students will logout from the system after accomplishing the task. The chat log and event history can be recorded automatically for analysis/evaluation.

Evaluation

The study is primarily a qualitative investigation. We considered foreign language acquisition in the broad sense of a whole socio-cultural system. The linguistic issue, the development of communicative competence, and individual factors that interact with language-learning experiences were qualitatively investigated in a bigger socio-cultural picture. Powell (1877) indicated that, "language is best understood when the habits, customs, institutions, philosophy — the subject-matter of thought embodied in the language — are best known" (vi). Based on the theoretical framework, ethnography of communication (Saville-Troike, 1982; Hymes 1972, 1992; Schiffrin, 1994), we made sense of the findings and explored the human interaction with technology and virtual context. The virtual community was regarded as an ethnographic reality. The researcher as ethnographer and participant-observer took part in the virtual community to make sense of participating students' communicative behavior and its relation to the conduct of social life in the virtual speech community.

The quantitative data were also obtained from the learner attitudes questionnaire and chat sessions to develop analysis and complement qualitative findings. The data were collected and analyzed using quantitative methods including questionnaire and frequency counts of communication strategies (CSs) used. Figure 3 illustrates the design linking qualitative and quantitative data.

The ethnographic approach is suitable for investigating communicative events and how and why they occur within a virtual cultural context. The ethnography of communication puts emphasis on the speech community; "the way communication within it is patterned and organized as systems of communicative event, and the ways in which these interact with all other systems of culture" (Saville-Troike, 1982, p. 2). This methodology is excellent for interdisciplinary research into 3D interactive technology in an online virtual community, as it is in traditional communities in which ethnographers engage. The virtual community is seen as a speech community in this study.

We attempted to explore how the students perceived their experiences in VEC3D. During consecutive months, students participated in a prolonged immersion in VEC3D. Learners participated in the study, joined various goal-based activities and real-time communication. In the field trials, we evaluated the application by observing the activities held in VEC3D and interviewing with the typical learners from the target audience. We observed and routinely administered open-ended questionnaires and conducted in-depth interviews with typical students through raising additional questions related to language capabilities, communicative and technical problems arising from real-time communication, activity preference, confidence levels, and experiences in using VEC3D. Chat logs were also collected for further discourse analysis. Most of these students had access to computers and the Internet either at

home or in their classrooms. They became quite excited about using this new technology in class. Participants had not expected to combine language learning and 3D VR, but all of them felt excited by the innovative application.

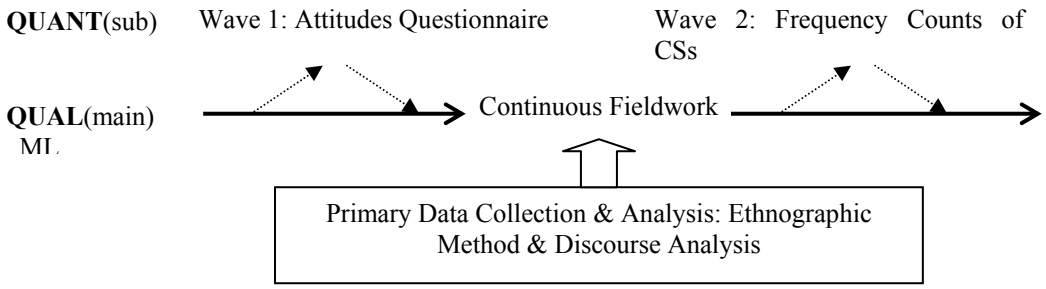


Figure 3. Illustration for the research design linking qualitative and quantitative methods. Partly adapted from Figure 3.1 (Miles & Huberman, 1994, p. 41)

This paper reports on a one-year ethnographic study of foreign-language acquisition in an interactive 3D VR environment. Undergraduate EFL students, ages 20–23, ranging from intermediate to high-intermediate level on the general English proficiency test (GEPT), taking distance education and English teaching classes were chosen for this study. The participating students were majoring in English language teaching at a teachers' college located in Hualien City, Taiwan. The primary mission of the Department is to help prepare future elementary teachers of English at the undergraduate level. At the site we researched, students were native speakers of Mandarin Chinese who were learning English as a foreign language. They were taking courses related to language and literacy education to fulfill the requirement for professional elementary teachers of English, and also English language training courses to improve their communicative competence.

Grammar-translation and audio-lingual approaches dominate traditional English classrooms in Taiwan. Discrete grammatical patterns, vocabulary teaching and high accuracy are emphasized, even at the sacrifice of fluency. Decontextualized language learning, mechanical practice, and drills have occupied many English classrooms, even today's elementary classrooms. The participating students' English-language learning experiences prior to the college level were artificial. In other words, English teaching was exam-oriented and independent of context. Thus, many of the participating students we observed and interviewed were unable to use English in a natural way, to communicate confidently and effectively, and express themselves clearly even though they had had eight years or more of English language education. The signs of nervousness and the lack of confidence, competence, or both in communicating with other speakers of English were commonly found in the students.

In addition, the observation and interview results showed that students enjoyed the opening stories and role plays. The goal-based scenarios motivated learners to use communication strategies. They felt comfortable in VEC3D as a gathering place, using virtual objects, posing questions in VEC3D forum, and receiving instant assistance over the Internet, such as help from the instructor who acted as an avatar during the scenario, to avoid communication breakdowns. The students were asked to evaluate their improvement in terms of attitudes and respond on a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). The result suggests that VEC3D has significant impact on the students overall educational experience. The overall impact on the students was rated in average 4.12 out of 5 (with 47% rating it 5, 31% rating 4, 7% rating 3, 13% rating 2, and only 2% rating it 1). With regard to attitudes toward VEC3D, a motivation, students rated it in average 4.41 (with 65% rating it 5, 23% rating 4, 3% rating 3, 7% rating 2, and only 2% rating it 1). Eighty percent of the students strongly agreed that they were relaxed when communicating through their avatars in VEC3D. Students indicated that the anonymity ensured through avatar-masking in the virtual environment resulted in decreased communication inhibition.

VEC3D provided opportunities for the learners to learn language in context and develop communicative competence. A variety of communication strategies were acquired when communication broke down. The scenarios also enabled the learners to practice discourse skills. The findings were mainly derived from the discourse analysis of chat transcripts of six synchronous online events showed the students' increased acquisition of communication skills or strategies. The quantitative data of frequencies of several types of communicative strategies were investigated. In our sample of six events held in VEC3D, a total number of 252 instances of communicative strategies were recorded.

The communication strategies (CSs) used, in order of frequency, were: non-linguistic means (32%), paraphrase (23%), fillers and gambits (23%), borrowing (7%), appeal for assistance (5%), avoidance (4%), and prefabricated patterns (2%) (Table 3). VEC3D provided a 3D virtual learning environment for learners to repair communication breakdowns by using communication strategies. Table 3 shows the types, number, and frequency of communication strategies employed by the students in the events. The number of CSs used by the students in sequential events (E1 to E6) increased from around 30 to 60.

Table 3. Types, number and frequency of communication strategies

Strategy Type		**Number of Strategies Used (E stands for online event)**							**Total**	**Frequency (%)**
		E1	E2	E3	E4	E5	E6	Sub-total		
Paraphrase	Approximation	10	5	3	10	3	8	39	58	23%
	Circumlocution	4	4	2	3	3	3	19		
Borrowing	Literal translation	0	1	1	0	13	2	17	19	7%
	Language switch	1	0	0	1	0	0	2		
Appeal for Assistance		6	1	1	1	4	0	13	13	5%
Non-linguistic Means		16	5	10	6	20	24	81	81	32%
Avoidance	Topic avoidance	0	1	2	0	0	1	4	9	4%
	Message avoidance	0	1	3	0	0	1	5		
Prefabricated Patterns		1	1	0	0	0	2	4	4	2%
Fillers & Gambits		1	8	8	7	16	19	59	59	23%
Others		0	1	2	2	1	3	9	9	4%
Total Number for Each Event		39	28	32	30	60	63	252	252	100%

The application and integration of GBS, SCC, and SI instructional designs in VEC3D brought language acquisition to a potential of fostering students' communicative competence through role-play and the construction and development of open-ended scenarios. As learners engaged in dramatic scenarios, as exemplified and detailed in Table 2, they perceived a sense of community, support, and experiences undertaking roles in an authentic context in which the target language was used to negotiate in pressure situations. The synchronous dialogue between the students and the instructors provided "comprehensible input" (Krashen, 1985) during the scenario.

Moreover, qualitative analysis of the data revealed themes about social boundaries and the fear of entering into the virtual community. Community formation and user motivation benefited from the avatar-masking, partner support, collaboration, and instant mentoring. Several advanced student participants were able to provide detailed and instant feedback or responses to peers' questions. Tan, for example, owing to her rich experiences of communicating with native English speakers, had the ability to communicate effectively and the high self-confidence to express herself clearly and immediately. She was quite excited about joining synchronous computer-assisted discussion and supporting her partners. The positive experiences gained by Tan and other participants in VEC3D motivated them to communicate and acquire more communication strategies.

Although the field trial results showed that many of the participants were motivated to join activities and perceive the virtual experiences and engagement, scaffolding system was insufficient in this stage to satisfy those students belonging to the lower level of English language proficiency, confidence, or both. Ching, for instance, had a good time communicating with peers; nevertheless, he felt frustrated and considered himself a slow reader.

Ling: do you want to talk to them?
Ching: yes, we haven't had a talk like this for a long time …humm…
Ling: yes…it is a long time
Ching: too many words made me a kind of uncomfortable…I prefer speaking (Mandarin) Chinese to English because my English is not good enough.

We also found that student performance and motivation were negatively influenced by time pressure. Synchronous discussions require not only language skills, but also the ability to react immediately to changes and events. The reaction time was slowed by limited typing skills and/or poor reading and listening abilities. Under time pressure, several participants with limited typing and/or reading and listening skills were poorly motivated and frustrated. The great challenge we confronted was that the motivation to actively use English to communicate with others is still low among students with relatively limited language and/or related capabilities.

Conclusion

Research teams around the world are still tasked with designing effective 3D VR applications for language learning and the systematic evaluation of these language programs. Today 3D VR technologies are progressing faster than VR curriculum development. Participants feel excited about the innovation the technology brings. However, participants are still often disappointed by poor or unsuitable instructional design. To meet learners' needs such as fun, realistic situation, challenge, and a sense of community, goal-based scenarios, story-centered curriculum, and strategic interaction were applied to the instructional design of VEC3D.

Authentic communicative situations are critical to successful language learning. VEC3D aims to elicit authentic communication by offering a realistic context in a virtual environment. We combined 3D rendering graphics and live voice communication technologies to enhance learners' immersion and interaction. Students are expected to achieve communicative competence.

VEC3D is a novel language-learning platform merging the principle elements in instructional designs and current technologies. Maximum flexibility and responsiveness are guaranteed by VEC3D systematic implementation. The layout of the virtual world and supporting functions in VEC3D can be customized according to various teaching circumstances, learning needs, paces, styles, and research goals.

A one-year ethnographic study was conducted to evaluate learner experiences in communication in VEC3D. The field trial results showed the effectiveness of motivating advanced EFL undergraduate students, triangulated with the attitudes questionnaire, acquiring communication strategies, and further extending autonomy in virtual communication through integrating goal-based design, role-play, and 3D VR. We also discovered which interlocking aspects, such as the sense of belonging within the virtual community, interaction/collaboration, and typing, reading, and listening skills are relevant for success of communication in virtual spaces.

Limitation and future work

The latest results addressed the potential of this application. Field trials were administered to collect information to revise VEC3D and ensure effectiveness of the further application. The overall communicative competence is expected to get promoted through the long-term goal-based exercises in VEC3D in the future. However, the scaffolding system was insufficient currently to satisfy those students belonging to the lower level of English language proficiency, confidence, or both. Research can be done to investigate possible improvement in the learner's overall communicative competence through transcribing spoken discourse and conducting a discourse analysis of chat data. Future research will include analysis of the communicative competence components such as phonology, grammar, lexicon, nonverbal, and paralinguistic incidents. The communicative interaction consists of textual

analysis with spatial reference and discourse analysis to unveil the social meaning of the interaction between informants.

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