A COMPARATIVE ANALYSIS OF VARIOUS ASPECTS OF DIFFERENT COLLABORATIVE VIRTUAL LEARNING ENVIRONMENTS

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ABSTRACT

Tremendous growth of information and communication technology brought crucial changes in the every part of society including education. It has also raised the interest of researchers & educational practitioners who wants to combine its capabilities with the World Wide Web to facilitate the creation of online collaborative virtual environments over last decade. However, these CVEs have been focusing on sharing of events; giving very less attention to the specific services and functionalities it could provide to the traditional e-learning systems. This paper describes the review and analysis of the current efforts that are developing, evaluating or using collaborative virtual environments in education

Keywords: Virtual Environment, Avatar, VRML, Collaborative Learning, E-Learning

I INTRODUCTION

As the nature of the working environment is shifting from a product-based economy to a knowledge-based economy, Online learning technologies and particularly virtual learning environments are gaining an educational foothold among the people who wants to acquire degree or education to cope up with the ever changing demand of knowledge and skills in an increasingly globalised economy without disturbing their regular duties. . It has also raised the interest of researchers & educational practitioners to carry out research in the field of Collaborative Virtual Environment (CVE) over last decade. As stated by G. McArdle, these Collaborative Virtual Environments (CVEs), are computer-enabled, distributed virtual space or a place, that enables multiple users, located at different physical locations to meet and interact with each other, with agents or with virtual objects and study the educational material which can be either in the form of 3D model, image, audio, video or simple text [1]. For getting increased effectiveness with the CVES, the design of these CVEs should be based on certain design principles that are extracted from a generalization of the design elements gathered after the analysis of Dillenbourg's interpretation of collaborative learning [2], Moshman's interpretation of dialectical constructivism [3] & Current learning theories. According to it CVEs

- Have common features with a physical space and should be shared among the users to provide the sense of place
- Support number of persons having different roles and rights.

- User within the environment should be represented realistically to enhance their virtual and social presence
- Users within the environment should not be passive, but should be able to interact with the environment and other inhabitants within the environment.
- Support a natural way of interaction, which is as close as possible to the real world, contributing the easy and fast familiarization and adaptation of users to the virtual environment.
- Integrate various technologies to mimic the real learning situation and to support various e-learning scenarios that cater the need of student with different learning style.
- Support various functions related with learner support and management.
- Provide flexibility in terms of time and space

Currently, some systems exist like VRLEARNERS [4], C-VISion [5], & VES [6] that makes the use of CVEs features for supporting the teaching & learning of various subjects related with history, physics, chemistry, biology, engineering and design. The next section will discuss about it.

II RELATED WORK

Taking into consideration the capabilities of CVEs, much research has been done on the exploration of its unique features and their interaction in the distance education, learning and collaboration. In this section, characteristics and usage of different CVEs are summarized.

A. C-VISion: C-VISion Project was developed by National University of Singapore (NUS) for supporting science education to School students. C-VISion uses desktop variant of virtual reality to create an online multi-user collaborative virtual environment that encourages students to run science experiments related with physics, chemistry, and biology in the virtual world and view the outcomes as they change simulation parameters. Users represented as avatars in the space can navigate within the 3D worlds and interact with other users as well as virtual objects in the worlds albeit in fairly limited ways [5].

B. VEC3D: VEC3D (virtual English classroom) is 3D immersive and interactive campus-like learning environment developed by National Science Council, Taiwan to enhance Taiwanese learner's English communicative competence. It integrates various goal-based activities and vivid 3D graphics in which learner can take part in order to expand their knowledge, construct meaningful personal understanding, and gain communicative competence. It also provides a novel platform for students to conduct synchronous communication and real-time interactions in written and spoken format [7].

C. AppEdTech: AppEdTech, developed by Appalachian State University; assist college students in web design course. Using three dimensional virtual environments, AppEdTech provides a sense of presence and develop learning communities often lacking in current distance learning environments. The system is equipped with number of different 3D scenes, such as a frontier town, a park, or Roman palace in which participants represented by avatar, can move using keyboard commands and can interact with each other and with objects within the world in order to complete the task. Moreover, active web links and other resources are also available to help or guide the learner during their session. In addition to these, several forms of individual

and group communication tools are provided within the environment to encourage small group discussions concerning collaborative assignments and tasks to be completed [8].

D. RiverCity: River City is a multi-user virtual environment designed by Harvard University for teaching scientific inquiry and 21st century skills to the student of middle school science class. In this world, students conduct their scientific investigations in a virtual historical town—populated by themselves, digitized historical artifacts, and computer agents—in order to detect and decipher a pattern of illness that is sweeping through the virtual community. Students manipulate a digital character, called an avatar, in order to explore the town; and they conduct virtual experiments to test their scientific hypotheses about the causes of the River City epidemic [9].

E. VRLEARNERS: VRLEARNERS project, developed by European Commission, assist the school students in understating Europe's cultural heritage. It enable groups of geographically disperse educators and students to access digital archives of European museums and work together by inhabiting common three-dimensional information spaces. It offers numerous services including; navigation within digital museum archives, linkage to other sources of on-line information, guided tours by experts and collaboration between students and teachers to achieve their goals [4].

F. VES: VES Project is designed by Educational Multimedia Task Force Initiative of the European Union to assist secondary school education. It is 3D, multi-user, distributed Virtual Environment that provides educational material and communication facilities to students and teachers through a user-friendly 3D interface to supplement traditional teaching techniques. Interactive activities are also provided for students to reinforce learned theories in a practical manner [6].

G. Virtual Campus: Virtual Campus is a shared virtual world of the real campus of Nanyang Technological University in Singapore; used for teaching the concepts of virtual reality, real time rendering and shape modeling to the computer graphics students. It includes VRML models of the land, buildings, interiors, avatars, and texture images that can be accessed from any internet connected personal computer. In this world student represented as avatar can easily navigate the familiar 3D environment, can go to their favorite places, can attend electronic lectures or can meet with friends and chat with them. In addition to this virtual campus is populated with the number functions that guide or provide work-related assistance and quick answering questions on computer graphics and virtual reality to the students. Moreover, one of the places of the virtual campus includes Collaborative shape modeling hands-on experience, which teaches students how 3D shapes and their colors can be easily defined with parametric and implicit functions and thus add more immersion and fun to education [10][11] .

H. AWEDU-Chemeet World: Using three-dimensional models of molecules, AWEDU, developed by University of Milan; allows undergraduate college students to explore together the spatial configuration of a molecule, its shape and orientation and acquire deep understanding about molecules' complex structures. As avatars students can interact with molecular objects and simulate chemical experiments in the 3D world. In

addition to these white board is provided within the world to improve in-world communication between teachers and students [12].

III EVALUATION OF DIFFERENT CVES

As discussed in above section the design of effective CVEs should be based on certain design principals which suggest that collaborative virtual learning environment should encompass media over which educational procedures and interpersonal communication could be performed in a manner closer to the real classroom. To achieve this, it needs to incorporate a synchronous system using which the teacher can interact with real-time in class (online lectures from a trainer on a specific theme), an asynchronous system that can let the learner to study in their free time with educational material and notes from previous lectures or minutes from collaboration, and a system that can serve as a meeting point among the members of learning communities for exchanging ideas, accessing the information and collaborating on learning activities. Besides these, it also needs to incorporate 3D virtual environment which can increase learner's interest and attention and sophisticated services that provides the leaner support. The below table shows the comparison of different CVEs based on these design elements.

Table 1: Comparison of different collaborative virtual learning environment based on the functionalities it supports and components it includes to support that functionalities

Tool/ Functionality	***Name of the CVEs***							
	C-Vision	***VEC3D***	***AppEdTech***	***RiverCity***	***VRLEARNERS***	***VES***	***Virtual Campus***	***AWEDU***
Representational fidelity, learner interaction & workspace awareness								
Realistic display of environment and its objects using 3D space	1	1	1	1	1	1	1	1
Smooth display of view changes and object motion	1	N/A	1	1	1	1	1	1
Immersive audio with distance attenuation	3	3	3	N/A	1	N/A	3	3
Kinaesthetic and tactile force feedback	3	3	3	3	N/A	3	3	3
User representation as realistic avatar	2	2	1	1	1	1	1	1
Avatar configuration or customization	N/A	3	1	1	N/A	N/A	N/A	1
Avatar's interaction with environment and its objects including view control, navigation & object selection and manipulation of its attributes	1	2	1	1	2	1	1	1
Reflection and propagation of user-interaction events within shared environment	1	N/A	1	2	1	1	1	1
Support for situated remote communication								
Text chat	1	1	1	1	1	1	1	1

Voice (VoIP) chat	2	1	1	1	1	N/A	1	N/A
Avatar gestures	3	1	1	1	3	N/A	N/A	1
E-mail	3	3	3	N/A	1	1	3	3
Forum/Bulletin board /Discussion board	3	1	1	3	3	3	3	3
Remote task support and collaboration								
Application sharing	3	3	3	3	3	3	3	3
Shared whiteboard	1	3	3	3	3	3	3	1
Shared slide presenter	3	2	3	3	3	1	3	3
Real-time audio/video streaming	1	1	3	3	3	N/A	1	1
Brainstorming tool	1	3	3	3	3	3	3	3
Co-browsing	3	3	3	3	3	3	3	3
Student's support and management								
Student's self-regulation / Active learning								
Inclusion of multimedia /hypermedia knowledge base or curriculum that cater different learning styles & need	3	2	2	2	3	1	3	3
Inclusion of simulations or interactive demonstration or story-based scenario	1	1	1	1	1	3	1	1
Inclusion of course management and administration for providing versatile course content to the learner	3	1	1	N/A	N/A	1	3	3
Support for learner scaffolding and guidance								
System help, tips or annotation	1	1	1	1	1	1	2	1
Teacher's assistance	3	1	N/A	N/A	3	1	3	3
Intelligent agent	2	3	3	1	3	N/A	1	3
Support for learner knowledge assessment								
Through assessment of one to one tutorials	3	3	3	3	3	3	3	3
Using self assessment quizzes or practice modules with feedback	3	3	3	3	3	3	3	3
Learner progress & performance monitoring								
Maintenance of student's learning history	3	N/A	3	1	N/A	3	3	3
Maintenance of evaluation history	3	3	3	3	3	3	3	3
Functionality fully supported	***10***	***10***	***13***	***12***	***10***	***12***	***10***	***12***
Functionality partial supported	***3***	***4***	***1***	***2***	***1***	***0***	***1***	***0***
Lack of functionality	***16***	***15***	***15***	***15***	***18***	***17***	***18***	***17***

In this table 1,2 and 3 respectively indicates Full, Limited or No support of particular feature in application

IV RESULTS AND DISCUSSION

The applications presented in the section 2 are much more mature and are more suitable for wide-spread use regarding the hardware and software requirements. All these eight applications are based on desktop virtual reality technology that makes the use of standard desktop computers and conventional interaction devices (e.g. mouse and keyboard) for the creation of learning space which mimics the real learning situation so they are much more cost effective and easy to use. Secondly, the simulator sicknesses, the physical and psychological stress factors, associated with immersive environments were rarely found with these applications. In addition to the cost and usability, for enhancing the virtual and social presence, these CVEs had represented the virtual environment very realistically using 3D graphics and had represented the users within the environment as avatars that can actively involved within the environment and can interact with each other and with the objects of the environment. However, as depicted in Table 1; some of these CVEs had limited support for realistic avatar representation, avatar customization and body language and that's why the feeling of real presence and the sense of being there physically, was still limited with them. It was also strongly suggested that multi-user collaborative VEs should include multiple communication options (i.e. text, voice, gestures) to support the social need of the member of learning communities. But most of these applications rely primarily on the text based communication and have a very little or poor support of audio discussion and user gestures which was not sufficient when the discussion on the complex concepts is required. Besides the communication features which aim on supporting collaborative work or real time information sharing among the members are either not integrated or partially included with these applications and thus the increase of social presence is not accomplished. However, majority of these applications support learner centered environment where learner get active role in the learning process, they offer little room for learners' knowledge assessment, learners' support and monitoring of the learners' progress and participation during the learning process; which is the key requirement to support exogenous view of constructivism.

V CONCLUSION AND FUTURE WORK

Results of the review and existing data suggest that this technology offers significant and positive support for education. On the basis of this review, it is also important to note that still much work need to be done in this direction to support several learning objectives which are more or less missing in the above discussed applications. This study indicates the right direction on the basis of which a further larger scale study can be planned in this area.

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