Framework of Learning by Virtual Reality in Architectural Design Studio, india

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Abstract

The advancements in Information and Communication Technology (ICT) are reshaping the architectural design studio teaching and designpractices. The digital-imperative to switch from analog to digital mode has already begun tomanifest itself at the schools of design. This paper introduces the application of two approachesrepresenting various dimensions of revitalizing architectural design studio teaching using ICT:a paperless design studio and collaborative virtual design studio. The paper reflects on the practicalimplementations of these two approaches including the design process, communication andpresentation, studio pedagogy, and students' learning. The next step ahead for architecturaldesign studio teaching in which ICT acts as a partner is introduced.

Architectural design studio environment has been propagated as an effective tool for courses at the undergraduate level, a study has been conducted, with even fewer giving emphasis to the teachers and students and how they feel about changing their environment. Virtual reality is a technological breakthrough that stimulates reality perception. Virtual reality is a new technology that merges the virtual and real worlds and offers support for the architectural design process. Technologies are important tool to conceptualize and implement by making a concrete contribution. Several digital interfaces had been developed over the years that utilize the Virtual reality technologies for visualizing the architectural project digitally in an interactive manner. This paper presents the actual simulation possibilities and challenges of Virtual reality in the field of experiencing the design process. It also describes a study of user perception in a customized environment by proposing with the aim of promoting innovativeness and real time simulation.The research focuses on how Virtual reality can be effective for the architecture students in improving their designs. An experiment was done with the students to see how they respond to Virtual Reality in perceiving 2 dimensional to 3 dimensional. The virtual design studio established the fact of skill development among students for better perception.

This paper will examine the experience of VDS and pose some questions which we, as teachers, should address if we are to use the experience of a VDS to the students' advantage.

Keywords- Virtual Reality, Virtual Design Studio, customized environment, Information and Communication Technology

1.0 INTRODUCTION

Traditionally, architectural design begins with an idea. The two-dimensional concept is then sketched on paper and a three-dimensional model is constructed to evaluate the designed product. This convention is very much culture-bound and it limits stimulation and inspiration for idea generation.

Multi-user 3D virtual learning environments provide the capacity to merge the institutional infrastructure for academic subjects with the educational principles of constructivist pedagogy. It may be divided into the categories of:

(a) Knowledge and skills acquisition, including competence with tools and techniques;

(b) Socialization, particularly induction into the canons of particular communities, disciplines or professions; and

(c) Development of intentional learning is the goal and the individual becomes a self-organized learner, capable of critical thinking, reflective practice and active open-ended inquiry.

Anecdotal evidence and limited research studies exploring the design educators' view lament the potential loss of direct interactions between educator and design students in an online learning environment making it impossible to offer design education online.

Given that today's design students are considered tech-savvy, and there is a growing student demand for flexible study options, it would seem that design students would embrace online delivery options. The aim of this study is to explore the perception of undergraduate design students towards the idea of studying design online and whether or not blended learning could provide a transitional middle ground to a fully online design course. This study also touches on any student reservations about online delivery and identifies the barriers to study design online.The studio environment has been intended for project work schedules in the disciplines associate with art and design, necessarily involving the teacher and student as major stakeholders to change their environment. The phenomenon of providing diversity will broaden personal vision, enrich the memory of mental images, and stimulate multidirectional thinking.

Electronic Pin up
Drawings in AutoCAD Sketch up
Models in Revit, Sketch up
Walkthrough in Rhino
Handouts in Photoshop
Text in form of digital report
Digital presentations on Google meet
Pictorial reference through images
Brochure/panels

Source: Author

Although architects have used a pencil-and-paper medium to translate ideas into physical products for generations, computer technology has revolutionized architectural representation during the past decade. A design product can be displayed on a computer from various angles with amazing visual effects. Changes are easy to make and results can be shown instantly. The interactive nature of the computer technology is an excellent teaching tool.Design studios are abode to the application and integration of different mode of learning. The activities that characterize university learning such as critical thinking, research, and professional education are evident in the design studio (Hashimshony & Haina, 2006) making it of relevance to higher education in general (Bose, 2007; Boyer & Mitgang, 1996; Hashimshony & Haina, 2006; Schon, 1987).

Architectural design opportunities presented by ICT in practice, two distinct types of applications can be identified. The first relates to the improved performance of existing tools in commercial applications where collaboration focuses on sharing building information models placed in cloud-based storage (Singh & Wang, 2011). The second centers on developing new communication platforms that allow instant model updates or use virtual reality (Ong et al., 2013). A casting studio would force changes in one's process, forms, and experience (Norman, 2001).

A virtual reality system has three primary requirements: immersion, interaction, and visual realism.The most important requirement is an unlimited possibility of the object exploration in real time with high levels of details. The list of requirements can be divided into different areas and includes, but is not limited, to:

- Real-time manipulation with an object and its exploration from all viewpoints.
- Geometrical precision and credibility.
- High level of detail.
- Exactness of appearance - physical, or physically based model of illumination, shadows, diffuse-diffuse inter reflections, mirroring, general BRDFs.
- 3D displaying.
- Fast and immediate interaction and modeling (dynamic design).
- Interoperability and compatibility among a great variety of CAD systems.
- Atelier presentation - possibility to walk through the 3D model together with collaborators, discuss the product, highlight problems, etc.

Developments in the field of Virtual reality technology, low-cost VR headsets and increasing sophistication of the mobile handsets, has made access to VR much easier and cheaper as well.According to experience, knowledge retention in learners is highest when they 'Do' as opposed to what they hear, read, or observe. The educational experience delivered through virtual reality can be entertaining, delightful, and practical all at the same time.

Digital models and web-based project sites are becoming normal practices within the real world of building construction.

In the VDS students bringmultiple perspectives, diverse backgrounds, learning styles, experiences, and aspirations. To foster collaborative learning there should be a structure that encourages student conversationand communication (Kvan & Yunyan, 2005).

2.0 HISTORY OF VIRTUAL REALITY

Virtual reality has a beginning that has precedence the time that the concept was coined and formalized. In this detailed history of virtual reality we look at how technology has evolved and how key pioneers have paved the path for virtual reality as we know it today:

1838 – STEREOSCOPIC PHOTOS & VIEWERS

In 1838 Charles Wheatstone's research demonstrated that the brain processes the different two-dimensional images from each eye into a single object of three dimensions. Viewing two side by side stereoscopic images or photos through a stereoscope gave the user a sense of depth and immersion.



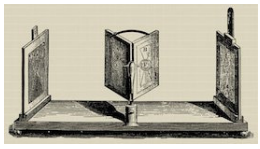



Figure 1: 1838: The stereoscope (Charles Wheatstone)
Figure 2: 1849: The lenticular stereoscope (David Brewster)
Figure 3: 1939: The View-Master (William Gruber)

In the 1930s a story by science fiction writer Stanley G. Weinbaum (Pygmalion's Spectacles) contains the idea of a pair of goggles that let the wearer experience a fictional world through holographic, smell, taste, and touch.

In the mid-1950s cinematographer, Morton Heilig developed the Sensorama (patented 1962) which was an arcade-style theatre cabinet that would stimulate all the senses, not just sight and sound. It featured stereo speakers, a stereoscopic 3D display, fans, smell generators, and a vibrating chair.Morton Heilig's next invention was the Telesphere Mask (patented 1960) and was the first example of a head-mounted display (HMD), albeit for the non-interactive film medium without any motion tracking. The headset provided stereoscopic 3D and wide vision with stereo sound.In 1968 Ivan Sutherland and his student Bob Sproull created the first VR / AR head-mounted display (Sword of Damocles) that was connected to a computer and not a camera. It was a large and scary-looking contraption that was too heavy for any user to comfortably wear and was suspended from the ceiling (hence its name). The user would also need to be strapped into the device. The computer-generated graphics were very primitive wireframe rooms and objects.



Fig. 5 Sword of Damocles

In 1987 Jaron Lanier, founder of the visual programming lab (VPL), coined (or according to some popularized) the term "virtual reality".

The research area now had a name. Through his company, VPL research Jaron developed a range of virtual reality gear including the Data glove (along with Tom Zimmerman) and the iPhone head mounted display. They were the first company to sell Virtual Reality goggles (Eye Phone 1 $9400; Eye Phone HRX $49,000) and gloves ($9000). A major development in the area of virtual reality HAPTICS.



Fig. 6. Visual Programming Gear

The first fifteen years of the 21st century has seen major, rapid advancement in the development of virtual reality. Recently companies like Google have released interim virtual reality products such as the Google Cardboard, a DIY headset that uses a smartphone to drive it. Companies like Samsung have taken this concept further with products such as the Galaxy Gear, which is mass produced and contains "smart" features such as gesture control.

Learning environments, in general, have been faced with challenges about how to contemporize themselves and respond to the needs of "digital natives" (Prensky, 2001,Bennett et al. 2008) describe "digital natives" as active experimental students who have the ability of multi-tasking and who rely on digital tools for gaining information and for communicating with each other. This new generation of learners has changed dramatically. They are no longer compatible with our physical educational system, or with our educators who are unfamiliar with their students' language (Prensky, 2001). Information technology is now seen as a way of providing students with more flexibility and enabling

universities to position them more competitively. Today, learning settings are decreasingly formal timetabled classroom-based and increasingly collaborative and socially peer to peer oriented (Fisher, 2004). Participants share their knowledge and experiences and develop them through discussion and collaboration (Garrison & Vaughan, 2008, p. 17). Problem-based learning, being closely aligned to constructivist theory, is very suitable for; team working, process focused learning, flexible programs, practice based learning, and interdisciplinary courses.

Byrne (1996) suggests that immersion in 3D environments is highly motivating, inducing users to spend more time on a given activity. Pedagogically, Wickens (1992) argued that virtual environments encourage people to be more active in the way they interact with external representations, through having to continuously choose their position and viewing perspective when moving through the virtual environment. It has been suggested that learning and retention of information can be increased. Kvan (2001) asserts that the advent of virtual design studio appears to raise promising opportunities for reconsidering the way we teach design. Utilizing virtual environments in architectural design teaching advances the concept of designing with computers (e.g. in a paperless design studio), to a multi user real-time 3D virtual environment for achieving collaborative designing and learning (Reffat 2003, and 2005).

3.0 VIRTUAL REALITY IN ARCHITECTURE

The architectural studio model has its own culture and values that are as influential in a student's education as the actual projects they complete. In many cases, the habits and patterns exhibited in this culture are not the intentional product, but a byproduct. These byproducts can be very positive, but they can also produce harmful results. Many scholars, like Thomas Dutton and Kathryn Anthony, have called the consequences of this culture the "hidden curriculum" of studio learning. In simple terms, the hidden curriculum refers to those unstated values, attitudes, and norms that stem from the social relations of the school and classroom as well as the content of the course (Dutton, 1991).

3.1 VIRTUAL DESIGN STUDIO

The "Virtual Design Studio (VDS)" integrates building simulation models, a "virtual building" database of building related information, and a knowledge base of architectural design principles to help achieve a coordinated, integrated and optimized design of sustainable buildings.

A functioning protocol have established for exporting architects digital models from standard platforms like 3D Studio Max, Rhino or Revit, through the Kubity App to be installed on iOS devices and experienced in Virtual Reality headsets. This experiment was done on 3rd year students of Faculty of Architecture and Planning
Integral University, New Delhi, India.

Project Integration Studio students tested out their designs by "walking through" the compositions with the VR tool. *It was a charged morning class, even without coffee. It warms a professor's heart to see students so excited. It was even more gratifying to hear them react to their design decisions — from inside their models.*

Qualitative research methods were seen as the most suitable way of collecting, analysing and reporting data for this study in order to understand the attitudes perceptions, opinions and concerns of students in regards to use of VR technologies in their learning.

Students were shown their own 3D model in VR Headgear. Students who have not made 3D model were shown a virtual reality walkthrough where they can feel the space and the building as they felt that they are the part of that building and they are themselves walking with the walkthrough. Students will employ a variety of media both as resources and media for exploration. Books, videos, photographs, models, sketches and even real life typically contribute to any design evolution.

Virtual studios occur in a number of formats, with the only common feature being that some of the participants are remotely located from others.

In another permutation, the teacher is remote from the students, perhaps because the students are working from home and traveling to the campus infrequently. This permutation finds its ultimate expression in the setting of distance learning where the students are unable to attend classes at the campus without great difficulty in traveling.

In all of these permutations, the basic communications are still required. A program has to be issued, a design problem stated. Students are then to explore and evolve ideas and propose solutions. Reviews are needed along the way, with tutor reviewing student submissions.

28 structured interviews were conducted with key participants involved in the integration of 3D technologies.

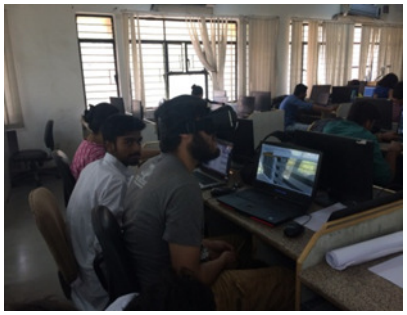

Fig. 7 students are experimenting in computer lab

4.0 ANALYSIS OF SURVEY CONDUCTED

Pedagogically, Wickens (1992) argued that virtual environments encourage people to be more active in the way they interact with external representations, through having to continuously choose their position and viewing perspective when moving through the virtual environment. It has been suggested that learning and retention of information can be increased. Utilizing virtual environments in architectural design teaching advances the concept of designing with computers (e.g. in a paperless design studio), to a multi user real-time 3D virtual environment for achieving collaborative designing and learning (Reffat 2003, and 2005).

The experiment was done on total 28 numbers of students. The whole process is appraised against some parameters as

1. Students' motivation
2. Learning new tools and techniques of electronic communication and etiquette
3. Attractive design process though interaction and socialization
4. Developing library of projects
5. Synchronous communication between student and teachers
6. Flexibility of time devoted to design project
7. Possibilities of intercultural and interdisciplinary learning
8. Collaborative learning
9. Real life experience on Location
10. Lack of face to face interaction
11. Technological problems
12. Cultural and religious barrier
13. Learning by doing
14. One on one dialogue
15. Process orientation

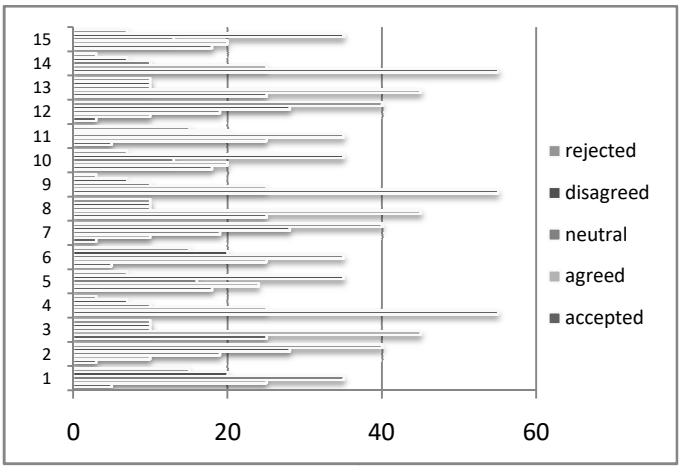

Fig. 8. Student's feedback using simulative environments

27 students out of 28 have overall rated VR to be helpful in experiencing design. They strongly recommend the use for VR to make learning interesting. Students enjoyed the expressions of VR. Students learned more and enjoyed theproject more used 3D models to visualize their world before they built objects in the computer.

Architectural design opportunities presented by ICT relates to the improved performance of collaboration focuses on sharing building information models placed in cloud based storage (Singh & Wang, 2011) and developing new communication platforms that allow instant model updates or use virtual reality (Ong et al., 2013).

Reflections on Studio Experience in the Collaborative Virtual Design Studio

The multi-user 3D virtual collaborative learning environments provide immersive, learner centered educational environments that are based on the constructivist pedagogy (Lombardi & McCahill, 2004). In the VDS students bring multiple perspectives, diverse backgrounds, learning styles, experiences and aspirations. In order to foster collaborative learning there should be a structure that encourages student conversation and communication (Kvan & Yunyan, 2005). The utilization of the IDCE teaching model in the VDS has permitted a range of communication media and engaged students, studio instructor, and teaching assistants over a relatively long duration allowing more freedom in learning approaches.

From a studio instructor's perspective, it has been witnessed that students have been captivated by the opportunities provided by the activities of inhabiting, designing, constructing and evaluating their design ideas in the VDS in which they have been fully

immersed, engaged and enjoyed the experience of design process within a more social sitting. Furthermore, from students' perspective, the advantages of applying the IDCE teaching model in a VDS compared to using a single user CAD software in a traditional face-to-face studio include:

• Improving students' motivation for active, creative and explorative learning.

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• Fostering learning electronic communication, collaboration techniques and etiquette in addition to design technology.

• Online archiving of design information and keeping track of previous design actions, approaches and critique helped students to improve design reflection and moving into new directions.

• Synchronous communication within the current design as it is developed at the VDS across all stages of the IDCE model has stimulated the sense of presence and collaboration between students themselves and between students and studio instructor and teaching assistants.

• The process of designing has become more exciting and natural in a social sitting for learning and design development.

• Extending collaboration time due to the availability of access to the VDS at all times and from anywhere.

• Enriching collaborative learning experience wherein students realized exploring and learning together without ego, embarrassment or domination.

• Strengthening the social bonds between studio participants since they occasionally had chance to talk about other issues during their collaboration or just surfing or walking through the VDS to observe what others are doing in their designs.

On the other hand, there are some drawbacks that have been realized and faced during the processes of applying the IDCE teaching studio in VDS. The capacity of bandwidth (via networking, DSL, or dialup) and firewalls are limiting factors governing the speed of mobility, access, resolution of visual and sonic objects, and quantity of data transferred in (near-) real-time in a multi-user online environment. Modeling objects and modifying their geometries are other important limitations that should be taken into account while adopting Virtual Environments (basically Activeworlds), in virtual architectural design studios. The above limitations were the most important constraints that interrupted all participants during this experiment. However, these are technological limitations that are expected to be overcome in the near future with the fast and advanced rate of development in IT and communications.

The ICT is expected in the near future to play a more important role than being a medium; it will potentially play the role of a reliable partner in the design process. How can they become a partner and what will be the role of this partner in the design process? ICT will be used as partner when its advancements and supportive tools successfully function as: knowledge integration tools, decision support tools, and design assistant tools (Sariyilidz & Van der Veer, 1998). Therefore, viewing information and communication technology as a partner in architectural education requires developing new methodologies and techniques to realize the goal that computers can be put into the education process and act as a reliable partner. The need for such methods and techniques presents challenging tasks to architectural educators with expertise in information and communication technology to carry out and provide creative directions. An approach that envisages the new generations of supportive collaborative medium architectural designing and studio teaching has been developed which carried out synchronously within smart and real-time 3D virtual environments within which architects are designing with intelligent agents based on the view of situated digital architectural design (Reffat, 2006b).

This paper is a comparative study exploring the limitations and benefits of physical and virtual design studios. It employs grounded theory to identify and describe teachers' and students' perceptions of their learning environments. It is expected that this study could explain the basic factors of studio learning environments to respond to the needs of comparing, analysing, and planning of new settings.

Learning environments in general have been faced with challenges about how to contemporise themselves and respond to the needs of "digital natives" (Prensky, 2001). Bennett et al. (2008) describe "digital natives" as active experimental students who have the ability of multi-tasking and who rely on digital tools for gaining information and for communicating with each other. This new generation of learners has changed dramatically.

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• Strengthening the social bonds between studio participants since they occasionally had chance to talk about other issues during their collaboration or just surfing or walking through the VDS to observe what others are doing in their designs.

3.1.2. Changes the setting

In establishing this new setting, a number of problems present themselves. Issues of place, time and channels need to be addressed.

Is the relationship of teacher to students going to be limited to one-to-many or is the setting going to allow many-to-many communication? How are communications going to be facilitated by the technology?

Using e-mail, the communications are private between the participants addressed.

Is the communication going to synchronous or asynchronous? How does this affect the level of communication? What changes when you teach using a network as your means of communicating?

Most obviously, communication channels change.

Sitting adjacent to a tutor, listening to their comments as they work, the students observe the acts of knowing-in-action and reflection-in-action which Scho¨n identifies. How can this be achieved when the bandwidth is substantially less than that available when teacher and student are co-located?

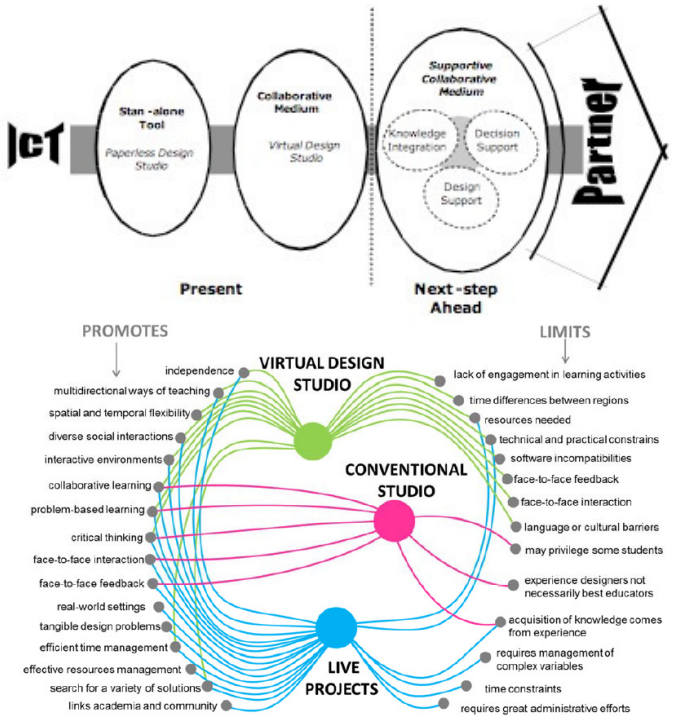
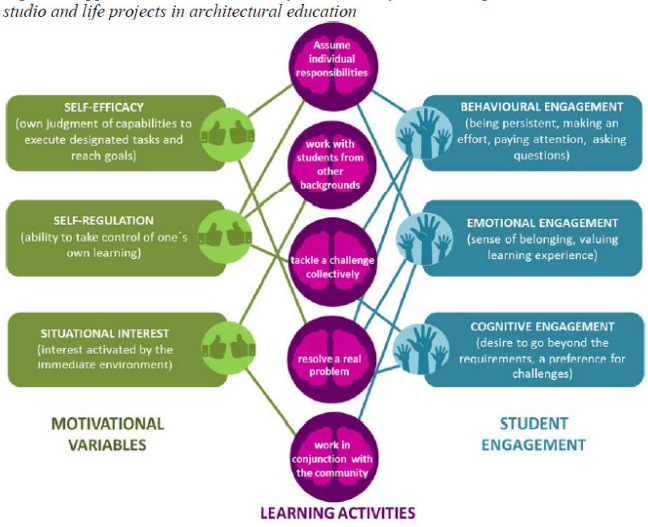


Figure 1: Opportunities and limitations from the use of virtual design studio, conventional studio and life projects in architectural education



Virtual places, which include virtual worlds and virtual reality applications, can be defined as computer-mediated dynamic world models that create a sense of place.

The Internet has been accommodating more than a dozen different technologies supporting multi-user text-based, and two- and three-dimensional graphical virtual worlds. When adopting the place metaphor, preparing a virtual design studio is much like designing a physical studio. The studio is set up to facilitate and support collaborative design activities. A virtual design studio differs from the physical design studio in a significant way: the virtual studio can react to the people's use and presence, and it changes and responds automatically; a physical studio is passive and is changed only when people physically change it.

Using the place metaphor, it is possible to design and develop tools which have counterparts in a physical studio such as slide projectors and telephones. However, the virtual place is not limited to activities possible in the physical world. For example, to move from one area to another in a virtual place a person can "teleport," that is, specify the area he wants to go by a command (eg. 'teleport office') and then be relocated to the area. A person in a physical building is not able to "jump" from one area to another without passing through contiguous rooms.

There are several approaches to developing a virtual design studio based on the place metaphor. A critical characteristic is to create a studio as a place that people go to when working on the design project. Here, designers may have a personal space as well as a public space for meetings and presentations. The place metaphor can be implemented as a text-based virtual world or a graphical virtual world (Cicognani and Maher, 1998). The distinction between text-based and graphical virtual worlds lies in the underlying representation of the place:

- A text-based virtual world that uses an object-oriented representation has properties and verbs to define the world where one of the properties could be a 3D model, and
- Graphical virtual worlds are represented as a 3D model with the possibility of actions and other non-geometric properties.

Studio MOO is an example of a virtual design studio that is part of our multipurpose education virtual world, The Virtual Campus. Studio MOO is based on the Lambda MOO software, an object-oriented MUD (Multi User Dungeon or Dimension). MOO environments started as role playing games environments, and have become one of the preferred software packages for the development of virtual worlds. Virtual communities (eg. LambdaMOO8) and virtual campuses (PennMOO,9 Diversity University10) have been implemented starting from the basic Lambda MOO software.

Studio MOO, shown in Figure 5, illustrates the interface to a room. The metaphor of the physical studio is very strong, providing an intuitive use of the various objects in the studio. Studio MOO is text-based with a Web aware interface. The Web aware interface, continuously updated, that can include images, text, and 3D models, these being in VRML (Virtual Reality Markup Language).

The Web part of the studio, written in HTML, is automatically generated by the underlying software that supports the central studio, and it is updated each time a change occurs in the environment. The Web interface, on the top of the screen, is integrated with a text-based window, on the bottom of the screen, and a series of icons on the left and right sides. Links on the Web part present more information about an object, or lead to other areas of the virtual world.

The nature of design with its uncertainty and irregularities are congruent with the epistemology and ontology of the constructivist pedagogy. The inclusion of constructivist ideology within the paperless design studio helps to increase learning and advance constructions of knowledge (Powers, 2001). Similar to a traditional design studio the responsibility in the learning process is shared and negotiated amongst teachers and learners. Utilizing digital media in a paperless design studio enriches the design studio environment with a multiplicity of informational sources and representations that help students and teachers to reflect upon design ideas at different time intervals at the early conceptual stage of the design process. The paperless design studio is an excellent place for the outgrowth of exploring, investigating and constructing design ideas.

Communication and Representations in a Paperless Design Studio

The newcomer to a paperless design studio might expect instant efficiency as a result of the move to digital design studio. Yet, even after developing a basic fluency with a given program, this efficiency is not likely to be immediate. Initially, a significant amount of time must be devoted to mastering computing in the design context. It is important to anticipate a “time sink” at the early stages of the digital engagement and to allow for it (Lewis & Wojtowicz, 2001). The forms of representation in the traditional design studio include the use of physical models, manual drawings, and even to some extent two and three-dimensional CAD drawings. In a paperless design, design tools are used as tools for inquiry. Furthermore, various types of representation forms are produced by students including, real-time modeling, web-based presentation, dynamic presentation incorporated with sound, QTVR animations and walk-through. A promising aspect of the digital model lies in its inherent ability to be used as data for the production of design and to serve as data in CAD-CAM (computer aided manufacturing), or the quick prototyping process using rapid prototype machine that was made available to students to produce physical models of their designs from their digital 3D models. This has created a new relationship between designers, project and design objects; perhaps turning the designer into the digital artisan-craftsman. The nature of the digital design medium has permitted designers to think more naturally in three dimensions and to a greater degree than previously imagined.

Teaching Architectural Design in Virtual Environments

The concept of virtual environments has emerged from advances in computer networking, image processing, modeling, simulation, and multimedia representation (Simoff & Maher, 1997). Virtual environments that mimic the spatial arrangements of the physical world have changed the role of 3D CAD systems from drafting to producing blocks of the new 3D virtual environments. Virtual Environments (VEs) are attractive platforms for learning in which they provide opportunities for new kinds of experience that enable users to interact with objects and navigate in 3D space in ways not possible in the physical world. The benefits of easier learning, better understanding and training, more engagement, and pleasure (Psotka, 1995) are manifested on the key properties of VEs in their ability to captivate. For instance, Byrne (1996) suggests that immersion in 3D environments is highly motivating, inducing users to spend more time on a given activity. Virtual Environments present an essential learning for practice of the future, exploiting technology in design teaching, researching the nature of design communication and processes, and searching for ways to improve the educational experience of a student (Kvan, 2000).

A typical cycle of design teaching takes the studentthrough a number of settings. First, the designproblem is introduced. Students and teacher gather todiscuss the specifics of the problem set size, site,building type. and the intentions for the studio itself. After the brief is introduced, further interactions occur in both formal and informal settings. First is formulation of the problem, an approach to solvingthe problem and a solution itself. These presentationstypically consist not only of the final presentation and final jury but also interim juries from which thestudent will be able to receive formal criticism oftheir project.

Informal settings will consist of desk criticism —reviews held at the desk or the student or at anotherdesk to which the students bring their work. Thematerial brought to these desk critics is typically rough,often multiple in intent and unresolved in outcome.

Students participate in these desk critics in two ways—by bringing their own material to be reviewedand by observing the review of others, for oftenthese desk critics are held in open areas which permitobservers to participate. Indeed, I always encouragesuch participation, as there is much to learn fromobserving another's review.

At all of these reviews, the students are free touse a range of materials. Some studio problems maybe formulated to require or predispose the student toinvestigate particular media; for example, a studiomay be based on the notion that sculpture can beused as a medium for design investigation. Othersmay allow the student to use whatever media theywish. Regardless of the media suggested, studentswill employ a variety of media both as resources andmedia for exploration. Books, video, photographs,models, sketches and even real life typically contributeto any design evolution.

In establishing this new setting, a number ofproblems present themselves. Issues of place, timeand channels need to be addressed.Is the relationship of teacher to students going tobe limited to one-to-many or is the setting going toallow many-to-many communication? How are communicationsgoing to be facilitated by the technology?

Using e-mail, the communications are privatebetween the participants addressed.Is the communication going to synchronous orasynchronous? How does this affect the level ofcommunication? What changes when you teach usinga network as your means of communicating? Most obviously, communication channels change. Sitting adjacent to a tutor, listening to their comments as they work, the students observe the acts of knowing-in-action and reflection-in-action which Scho¨n identifies. How can this be achieved when the bandwidth is substantially less than that available when teacher and student are co-located?

Informal settings will consist of desk criticism - reviews held at the desk or the student or at anotherdesk to which the students bring their work. Thematerial brought to these desk critics is typically rough,often multiple in intent and unresolved in outcome.Virtual studios occur in a number of formats, with the only common feature being that some of the participants are remotely located from others. Thus, in one permutation, we link up students in one university with those in another, each location having a complete complement of participants teachers and students. However the problem posed requires the participation of both sites to satisfy the studio objective.

In another permutation, the teacher is remote from the students, perhaps because the students are working from home and traveling to the campus infrequently. This permutation finds its ultimate expression in the setting of distance learning where the students are unable to attend classes at the campus without great difficulty in traveling.

In all of these permutations, the basic communications are still required. A program has to be issued, a design problem stated. Students are then to explore and evolve ideas and propose solutions. Reviews are needed along the way, with tutor reviewing student submissions.

Learning in a Virtual Architectural Design Studio

In collaborative learning, students work together as members of a learning community by questioning each others, discussing, and sharing information. Flexibility and interactive communication are key features in collaborative learning. In order to achieve collaborative learning, the author has developed an alternative teaching model that includes four major phases as shown in Figure 3: Inhabiting, Designing, Constructing and Evaluating (IDCE). These phases are carried out in a multi-user real-time 3D virtual environment platform (Activeworlds), wherein activities do not occur sequentially but rather in a constructive loop that maps in part to the activities in the conventional face-to-face design process. The new activities in this model are inhabiting and constructing. Inhabiting requires users to virtually familiarize themselves with:

a) Nature of the design problem to be solved,
b) Electronic interaction with their colleagues and studio instructor, and
c) Design environment within which they will design, construct and evaluate their ideas.

At the moment however, this learning environment is not compatible with changes in society, higher education, and professional practice (Crowther, 2010). Reviewing the literature shows that the design studio faces similar challenges to higher education as a whole. Therefore, if a model is able to respond to the problems in design studio education, it will be applicable in many other fields of higher education.

All of these are happening virtually (students and studio instructor do not have to be physically collocated), within one sitting, that is the multi-user real-time 3D virtual environment.

This is an alternative to the various settings of the traditional face-to-face, paperless design studio, and previous VDS that included disjunction among lecture sessions, discussion groups, studio sessions, individual drawing boards or individual and a single user CAD platform. The real difference here is that all previous activities are now taking place within one sitting in a multi-user real-time 3D virtual environment wherein students' actions, communications, and designs are viewable to all participants from a single computer interface. Within this interface each user selects his/her view point and location in the 3D virtual environment, interacts with objects and navigates in 3D space. Students build their designs in the VDS in a similar fashion to the construction process in real world. Therefore, they evaluate their designs and modify them as they build or construct them. This is an unparalleled experience for each student to realize the design as it evolves without mental transformation efforts and shift of focus between various design representations. It also allows studio instructor, teaching assistants and each student to view each design from his/her computer interface (as s/he moves "teleports" to its virtual location), interacts and communicates with the designer and provides alternative solutions in one to one or one to many collaboration settings since many users can be at the same virtual location simultaneously.

A unique characteristic of the conventional design studio is that sketching, tracing and recording ideas are left visible. This provides richness to the exploration through revisiting and revising previous ideas. The ability to see where a design idea is at present and where it came from seems to be of benefit while working in a physical or tangible medium. All of this and more can be offered using digital media in the paperless design studio (Norman, 2001). The history of a project and process of design must be evident in the educational techniques employed in the paperless design studio. Editing a digital file might cause the history or part of the design process to be lost. This was simply resolved by using the design tool to benefit the design process in the paperless design studio. Whenever a design idea was revised then a new file was saved providing a record of the past. This strategy was not applied by our students at every change in the design process but rather at times of conceptual changes.

Another alternative to document the design process is with taking frequent captures and snapshots of the computer's screen state, well prior to final presentation. This allowed the students to see the evolution of their designs from various concepts to design developments. The documentation of the design process in the form of a digital sketchbook "digital portfolio" has broaden the students' design universe to utilize the design tool to digitally merge design ideas created at different time intervals of the design process. Changing medium of instruction from one based on face-to-face meetings to another which allows us to interact at great distances. Of course, we should not assume these arise only when oceans and time zones separate us; the same issues arise if we teach from just the other side of town.

In establishing this new setting, a number of problems present themselves. Issues of place, time and channels need to be addressed.

Is the relationship of teacher to students going to be limited to one-to-many or is the setting going to allow many-to-many communication? How are communications going to be facilitated by technology? Using e-mail, the communications are private between the participants addressed.

Is communication going to synchronous or asynchronous? How does this affect the level of communication? What changes when you teach using a network as your means of communicating?

Sitting adjacent to a tutor, listening to their comments as they work, the students observe the acts of knowing-in-action and reflection-in-action. How can this be achieved when the bandwidth is substantially less than that available when the teacher and student are co-located?

A comparison could be made between a paperless design studio and another traditional studio that has cast as the only medium for exploration. A casting studio would force changes in ones process, forms and experience (Norman, 2001). To draw a parallel to the paperless design studio, one needs to become aware of the unique capabilities of what digital media offers and how it can be used to explore the design process. Digital models and web-based project sites are becoming normal practices within the real world of building construction. As the world becomes a more global society, the ability and means to transfer, communicate, and collaborate design ideas in more efficient ways and timely manner is ever increasing.

Paperless design studio lies in the notion that digital media can change the process of design, the forms of design, and how design ideas are communicated. A comparison could be made between a paperless design

studio and another traditional studio that has casting as the only medium for exploration. A casting studio would force changes in one's process, forms and experience (Norman, 2001). To draw a parallel to the paperless design studio, one needs to become aware of the unique capabilities of what digital media offers and how it can be used to explore the design process. Digital models and web-based project sites are becoming normal practices within the real world of building construction. As the world becomes a more global society, the ability and means to transfer, communicate, and collaborate design ideas in more efficient ways and timely manner is ever increasing. The Virtual Design Studios (VDS) explores the asynchronous and synchronous techniques in remote design collaboration. By using technologies, such as video conferencing, Internet publishing, e-mail, Web3D, and digital modeling, students gain an increasing understanding of the new modes of collaboration and media integration in design practices. The VDS also enriches the architectural experience by exposing studios to different design cultures and to a larger context of design feedback. The first Virtual Design Studio was attempted at the University British

These early experiences relied heavily on asynchronous communication technologies that supported e-mail, bulletin boards, FTP, and Internet publishing. As collaboration technologies evolved and became available to the masses, virtual studios began to foster more international experiences that lasted a complete semester. Most studies report that cross-cultural and global nature of the VDS experience usually motivates students. Also several interdisciplinary experiences emerged in the mid-1990 as students from architecture, engineering, and building construction from institutions such as U.C. Berkeley and CIFE at Stanford University, have collaborated in virtual studio experiments (Kalay, 1995).

RECOMMENDATION

My recommendation for architectural education is for add & stir approach in which first of all we need to add the element of virtual reality such as hardware related knowledge to be induced in first phase then the second phase will be comprises of software knowledge and implementation through some small exercise and lastly for design implementation we have to take virtual reality as an integrated design studio in curriculum.

The ICT is expected in the near future to play a more important role than being a medium; it will potentially play the role of a reliable partner in the design process. How can they become a partner and what will be the role of this partner in the design process? ICT will be used as partner when its advancements and supportive tools successfully function as: knowledge integration tools, decision support tools, and design assistant tools (Sariyilidz & Van der Veer, 1998). Therefore, viewing information and communication technology as a partner in architectural education requires developing new methodologies and techniques to realize the goal that computers can be put into the education process and act as a reliable partner. The need for such methods and techniques presents challenging tasks to architectural educators with expertise in information and communication technology to carry out and provide creative directions. An approach that envisages the new generations of supportive collaborative medium architectural designing and studio teaching has been developed which carried out synchronously within smart and real-time 3D virtual environments within which architects are designing with intelligent agents based on the view of situated digital architectural design (Reffat, 2006b).

The advantages of applying the IDCE teaching model in a VDS compared to using a single user CAD software in a traditional face-to-face studio include:

• Improving students' motivation for active, creative and explorative learning. Revitalizing architectural design studio teaching using ICT

• Fostering learning electronic communication, collaboration techniques and etiquette in addition to design technology.

• Online archiving of design information and keeping track of previous design actions, approaches and critique helped students to improve design reflection and moving into new directions.

• Synchronous communication within the current design as it is developed at the VDS across all stages of the IDCE model has stimulated the sense of presence and collaboration between students themselves and between students and studio instructor and teaching assistants.

• The process of designing has become more exciting and natural in a social sitting for learning and design development.

• Extending collaboration time due to the availability of access to the VDS at all times and from anywhere.

• Enriching collaborative learning experience wherein students realized exploring and learning together without ego, embarrassment or domination.

• Strengthening the social bonds between studio participants since they occasionally had chance to talk about other issues during their collaboration or just

surfing or walking through the VDS to observe what others are doing in their designs.

The digital technology to be imbibed to the curriculum in the following manner

1st year

- Digital referencing
- Digital case studies
- Digital documentation

2nd year

Computer Application

Virtual reality projects BMP for History

Online medium of teaching and creating digital resources

Modern technology to conceptualize design project

3rd Year

1. Collaborative design studio
2. Access and creating online library
3. Techniques for Online communication
4. Career counseling for alternative projects requires architects intervention online

5.0 CONCLUSION

We have found what benefits and characteristics Virtual Reality offers. Furthermore, more comprehensive studies regarding the actual learning benefits should be deeply explored and Recorded over a longer period of time in order to see what kind of effects Virtual Reality has on education compared to traditional teachingmethods. By doing so we can prove the effectiveness Virtual Reality has as an educational tool.

According to an educator; an appropriate learning environment should offer a diverse range of spaces associating with diverse personalities and needs. She continues; saying that a range of lightness and darkness, private and public attitudes, and indoor to outdoor places are examples of this diversity. Flexibility is another advantage to deal with different arrangements and furniture to associate with different activities like temporary exhibitions. Learning spaces have an important role in design studios since students build up relationship with their environment all the time. A box as a studio cannot inspire in comparison to the place that contains cultural identity, attractive physical attributes, and exhibited works which are publically displayed. Spatial aspects of design studios are also very important functionally and symbolically. Functionally, these spaces need to accommodate various modes of learning and needs of students to invite and support sustained use. Symbolically they need to read as places of exploration and creativity. These characteristics, whether existing in physical or virtual environments, can deal with different students' personalities to inform their ideas. 4) Technology The technology of education can be divided into hardware and software, such as online platforms, which facilitate the delivery of knowledge. Technology can provide noticeable benefits like access to information from different places and time. If considering design studio without using digital tools, there are many benefits that will be left, including saving time for working with resources, saving costs for publishing information, and presenting resources with more multimedia facilities and higher quality. This research reinforces the view that the effective communication in design studio depends on simultaneous interaction to be able to respond students' needs and expectations. This process is also achievable through audio and/or video communication platforms (such as Elluminate Live) in synchronous mode

Studio culture can also be characterized by certain myths. These myths influence the mentality of students andpromote certain behaviours and patterns. There's this romantic notion that staying up all night needs to be part of an architecture student's life; a 100 percent dedication and sacrifice to design. Or the best students are those who spendthe most number of hours at studio. This is a serious flaw of a studio system; flaws that are actually consideredsound teaching practice and the right attitude. How can we expect future architects to design our built environmentwhen they themselves are train to live a dysfunctional life. More worrying, it is the actions of the students topromote such culture.

Academically, architecture is in fact itself pedagogy and each building have their own embedded hiddencurriculum that can greatly influence and affect learning process. However, the problem is teaching has beenwrongly assumed to take place in buildings and neglected the other experience in which architecture learning can beexperienced. The built environment and the landscape can be a powerful tool of learning, in this regard the campusas a whole should be regarded as a place where learning occurs. "Architecture lab is out there among the nature andthe built environment," this was quoted from one of the author during a debate among faculty's member, why doarchitecture students need to travel and spend so much.

In recognizing the architecture as pedagogy, we must first recognize that learning process occur beyondclassroom through everyday experience.

According to experiential learning theory, learning is a process wherebyknowledge is created through the transformation of experience and knowledge results from the combination ofgrasping and transforming experience. (Kolb, 1999).

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