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Reflection on Practical Implementation of Virtual Reality in Interior Design Teaching Studio

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ABSTRACT

The advancements in Information and communication technology are reshaping the architectural design studio teaching and design practices. The digital-imperative to switch from analogue to digital mode has already begun to manifest itself at the schools of design. This paper introduces the foresighted step in revitalizing architectural interior design studio teaching by the application of collaborative Virtual Reality in the design studio. The paper reflects on the practical implementations approaches including design process, communication and presentation, studio pedagogy, and students' learning. The next step ahead for architectural interior design studio teaching in which virtual reality acting as a partner is introduced. In this paper a co-design process and implementation requirements of an interactive interior design service system is demonstrated. The study depends on the integrated research methodology through descriptive analytical method as well as the experimental method through the description and analysis of the use of virtual reality applications in architecture education, and experimentation through the use of the cave to simulate students work to investigate the impact of technology on creativity in the design studio. This paper reports the design process and results of the co-design sessions; and evaluation of the Virtual reality functionalities in design studio and architecture education.

Keywords: interior design, virtual reality, 3D model, cave, architecture education.

Acknowledgment: We would like to thank Eng. Mohamed Farargy at Virtual Immersive Science and Technology Applications (VISTA) at Bibliotheca Alexandrina for his collaborative input and technical assistance in training all lecturers and students involved in interior design project, and his contribution to the simulation of the work reported within this paper.

Introduction

Virtual Engineering is a simulation of real reality and working to help engineers in decision-making, and evaluation of engineering designs. And through the use of three-dimensional models (3D Models) interacts with the designer through immersion in the virtual environment and live with it, as if realistic environment.[1]

There are many uses of virtual reality applications in engineering, especially in recent years. The most important feature of the default of reality is no need to use physical models (Physical Models) during the design process, which is reflected positively on the custom engineering projects and reduce costs to the maximum because of the formulation of all the adjustments and modifications in the virtual environment in order to apply them in the final design.

As a result of the growing spread of this technology in several areas (engineering, medicine, game), it has become necessary to introduce it to college students and engineering institutes through teaching. Virtual reality (VR) principles must be presented, especially in the construction of three-dimensional modeling with all the details.

Virtual reality software varies from just a sense of three-dimensional model, but beyond that to simulate the interaction with the three-dimensional objects in a realistic manner.

Virtual reality technique combine human senses to be able to experience like a realistic illusion with the aid of some accessories connected to a computerized device which enable the individual not only to see in a stereoscopic three-dimensional, but to touch and feel every detail.

This work on virtual reality focus on its applications in the field of architecture education, and a special focus on the subject of design and manufacturing computer assisted (CAD/CAM) and the details of modeling three-dimensional for students of architecture engineering because of their close association of virtual reality technology. Interior design, in particular, is an application field where the combination of real and virtual benefits the user.

Based on measured drawings produced, the final output and report provides the basis of a ‘storyboard’ of a walkthrough the project using VR technology and animation to present the interior space simulation. This study demonstrates how design and learning can be enhanced through the use of computerized techniques to visualize information collected and the drawings produced. The development of virtual reality will bring about its increasing relevance in the educational experience as it contributes to architecture education of the younger generation and efficient understanding of spaces.

[1] Brey, P. (2008). Virtual Reality and Computer Simulation, Ed. Himma, K. and Tavani, H., Handbook of Information and Computer Ethics.

Virtual Reality Components and Phases

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.

Virtual reality is a type of simulation in which a computer graphics are used to create a virtual world [1].[2] It enables users to deal with a virtual (realistic looking) world through the use of computer simulation and special devices. The virtual world is a real-time and interactive system that responds to the user's physical inputs and modifies the virtual world according to the user's inputs. Virtual reality has the potential to change and improve the ways in which students are educated [2].[3] In fact, future trends in learning and training will use virtual reality based education laboratories to support every type of education program.

A special hardware and software requirements are necessary to construct a virtual reality system, these includes;

(a) Hardware requirements;

- Sensors and actuators,
- Head-coupled displays, and
- A personal computer with full multimedia facilities.

(b) Software requirements:

- Modeling virtual worlds using AutoCAD, 3Dstudio,
- Physical simulation: computer animation systems,
- Virtual reality toolkits: software environment to support a wide range of applications.

A typical virtual reality system consists of four basic components, as illustrated in Figure 1, these components are:

(1) Virtual Environment: A user can view and interact with entities through a stereo display monitor and stereo glasses.

(2) Virtual Reality Devices: These include;

- Stereo Glasses; which allows the user to view computer generated images in true 3-D stereo depth.
- Gloves; which allow the user to communicate with virtual environment through finger control.
- Position Sensors; which are used for tracking the position and orientation of the user's head and hands in 3-D space.

[2] Vince, J. (1995). *Virtual reality systems*. Pearson Education India

[3] Pantelidis, V. S. (1997). Virtual reality and engineering education. *Computer Applications in Engineering Education*,*5* (1), 3-12.

- Data Acquisition and Distribution unit (card) for computer interfacing with virtual devices.

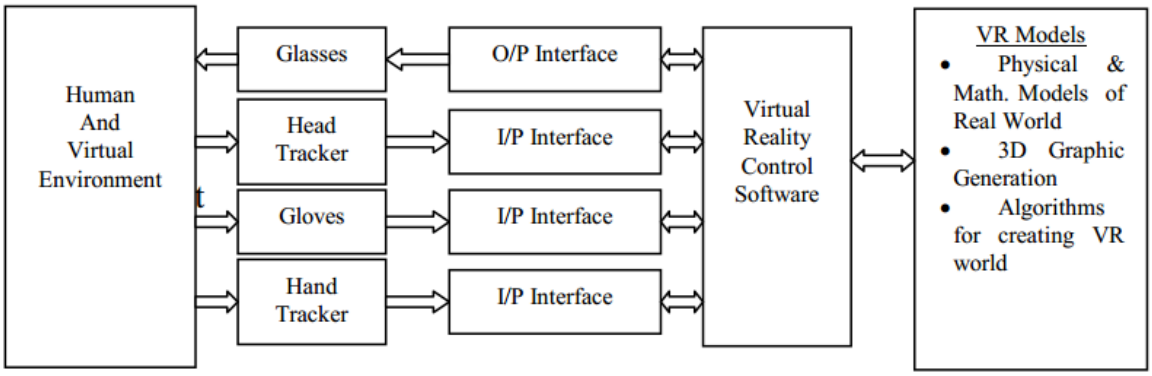
(3) Virtual Reality Modeling: real-time modeling, which includes;

- Mathematical models of real (actual) world environments.
- Algorithms for on-line 3-D graphic generation.
- Algorithms for creating virtual environments.

(4) Virtual Reality Control Software; which represents the main part of the virtual reality system. The functions of this software include;

- Signal processing on the real-time information from the virtual world.
- Real-time control of the changing virtual reality.
- Real-time communication between different virtual reality components.

Figure 1. *A Typical Virtual Reality System*[4]



A virtual reality system is a computer application capable of generating a 3D environment in which the user is an active participant and interacts with the artificial world using a range of multisensory interfaces. According to Bricken (1991),[5] Byrne (1996),[6] Zeltzer (1992)[7] and Winn (1997),[8] the main features offered by virtual worlds are as follows:

- Presence: users immersed in a virtual reality system get the feeling that they are actually there in the real place. Students are carried off to an environment of pure information that they can see, listen to and touch. In artificial worlds where presence is high, the sensation of immersion

[4] Al-Aubidy, K. M. A VIRTUAL REALITY BASED EDUCATIONAL MODULE FOR KNOWLEDGE LEARNING & SKILLS TRAINING, https://goo.gl/6oqWoS.
[5] Bricken, M. (1991). Virtual worlds: No interface to design. In Cyberspace: First steps, M. Benedikt (ed), MIT Press, Cambridge, MA.
[6] Yrne, C.M. (1996). Water on tap: The Use of Virtu al Reality as an Educational Tool. Ph. D. Dissertation, Depar tment of Industrial Engineering, University of Washington, Seattle, WA.
[7] Zeltzer, D. (1992). Autonomy, interaction and presence. Presence, 1, 127±132.
[8] Winn, W. (1997). The impact of three-dimensional immersive virtual environments on modern pedagogy. HITL Technical Report R-97±15. Human Interface Technology Laboratory, University of Washington, Seattle, WA.

is so strong that the interface disappears and users lose all notion of interacting with a machine.

- Navigation: students can be either immobile observers or travelers in the virtual environment, moving around in different ways, e.g., walking, flying, speaking (giving verbal order), using a vehicle, touching an object or pointing in any direction within the environment, etc.
- Scale: the scale of the virtual environments can be altered, changing the relative size of users in respect of the virtual world and allowing students to become the same size as the biggest thing (a star) or the smallest object (an atom).
- Viewpoint: this is the possibility of users changing perspective at will. For example, students could pass on their viewpoint to a given artificial world object or process, or even to the viewpoint of another participant. Students can also be a floating viewpoint, flying or moving at any speed in any direction.
- User-environment interaction: users can make use of a range of ways of manipulating and modifying virtual worlds. Student s could move the virtual objects by hand, eye movement or voice. Also, they have the ability to create and alter the environment.

Interaction in virtual reality can be divided into two levels:

  - *Low level of interaction*: The participant is limited to navigate within the virtual environment.
  - *High level of interaction:* a more complex level, in which the participant is capable to rebuild and create new virtual environments.

- Autonomy: a virtual environment is autonomous and dynamic when it is capable of pursuing its own goals, executing actions and evolving, irrespective of user interactions.
- Co-operative learning: distributed and networked environments provide for collective participation, offering several users the possibility of sharing virtual spaces at the same time. Accordingly, the real- time interaction between different students leads to genuine co-operative learning.[9]

Research Methodology

The study depends on the integrated research methodology through descriptive analytical method as well as the experimental method through the description and analysis of the use of virtual reality applications in architecture

[9] Sánchez, Á., Barreiro, J. M., & Maojo, V. (2000). Design of virtual reality systems for education: a cognitive approach. *Education and information technologies*, *5*(4), 345-362.

education, and experimentation through the use of the cave and impact of technology on creativity in the design studio, Figure 2.

The co-design process falls under the methodological frame of participatory design, which generally aims at democratizing design so that the people to be affected by the systems should also be able to participate in and influence the design process.[10]

An interior project was presented to students in spring semester to be delivered in certain date. The preliminary design was accomplished using AutoCAD, 3Dstudio drawing and sketches.

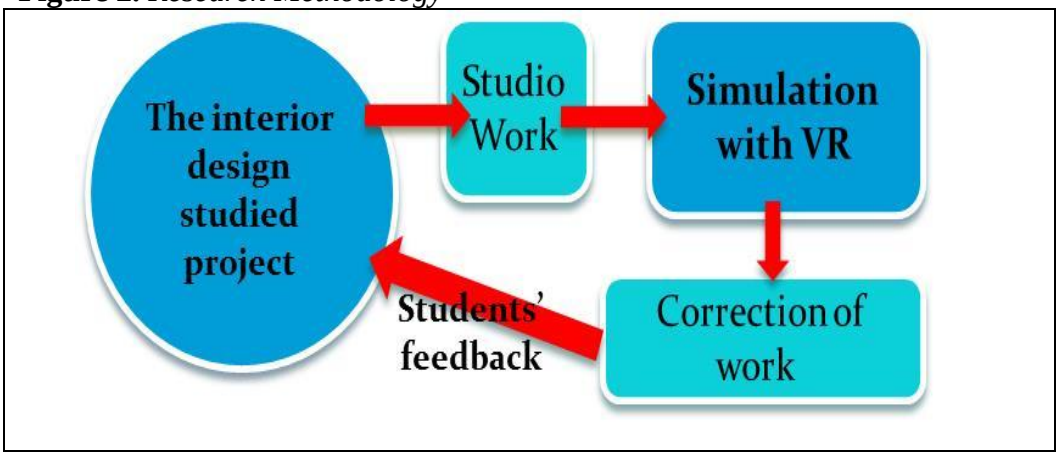
The co-design process was pragmatically conducted by utilizing sketching and CAD drawings as a co-design method, to provide means for users to produce design outcomes. This method appeared to be a flexible way of prioritizing design issues, and considered suitable for these particular focus group participants.

Students' projects were then played in virtual reality cave at (VISTA) at bibliotheca Alexandrina in order to develop and adjust the design.

A survey was then collected from ordinary students of Interior Design at Architecture Department (80 respondents) to assess students' feedback.

In this study, the respondents were the participants students in interior design studied course. Because of their being architecture students, the participants were seen as critical users of the future service as graduates competing in the professional market.

Figure 2. *Research Methodology*



[10] Zara, J. (2006, March). Virtual Reality course—A natural enrichment of Computer Graphics classes. In *Computer Graphics Forum* (Vol. 25, No. 1, pp. 105-112). Black well Publishing Ltd..

Discussion and Findings

Interior Project Requirements

The project was entitled "Residential House interior design of a celebrity". In this project, student had to choose a famous person in any work branch to design his/her house compatible with his/her needs, Figure 3.

There were four deliverables in the project:

- Plans 'drawings of the residential house and looking up plan (scale 1:50).
- Elevations and sections sufficient to explain solution and design concept (scale 1:50).
- Photographs sufficient to show principal design of the spatial sequence or visualized 3d images. (Rendered elevations or perspectives may be substituted for photographs).
- Details, lighting fixtures and diagrammatic sketches for concept and movement.

Students were asked to design efficient space planning with suitable flow, correct placement of partitions and furniture, shape of rooms, etc. This work required trial and error and many refinements.

Project Presentation

During the phases of problem definition and conceptual designing, the students selected any design medium in designing. At this stage, students/ subjects created initial designs with tentative forms. The students presented varieties of projects either house of musician or psychiatrist or astronaut or Arabic designer or actor ...etc.

Students' projects were presented on two card board 50* 70 cm, as shown in Figure 4. Having initial forms and designs, students made digital models in order to be used in the Virtual Reality program. Digital models were built by different modeling programs, for example 3ds max, Sketch Up, AutoCAD. Then, students' interior projects were selected as to be studied in the cave at the Virtual Immersive Science and Technological Applications (VISTA) at bibliotheca Alexandrina. Students made presentations to evaluate their work and present inside explanations of the design process. This exposure to different ways of VR applications was an objective by itself of the design studio.

Figure 3. *Presented Interior Design Sheet Showing Project Requirements*

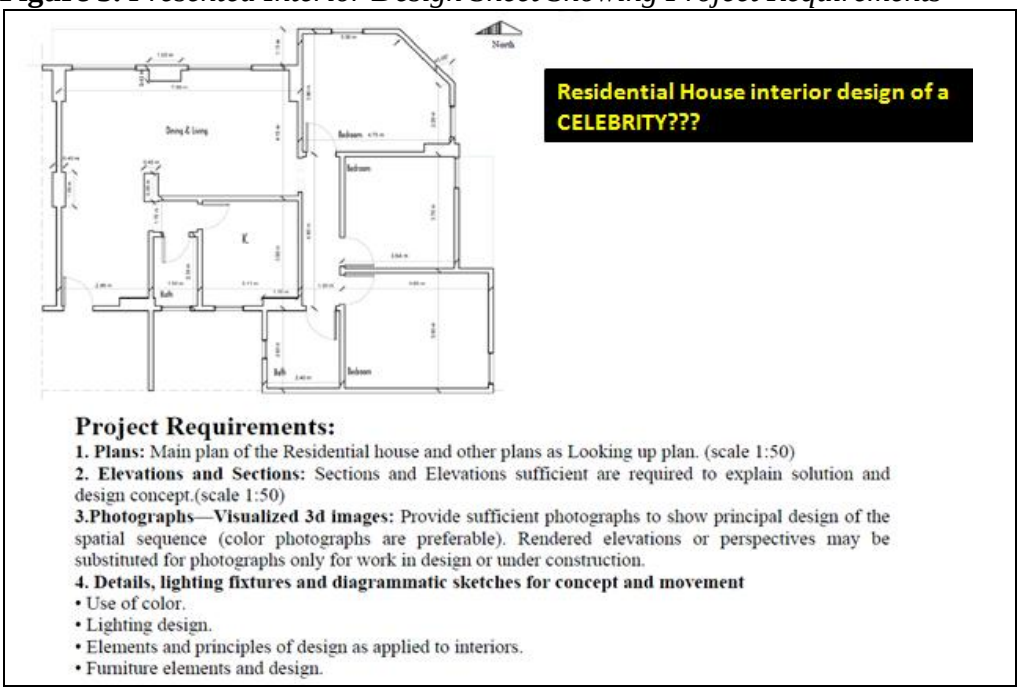
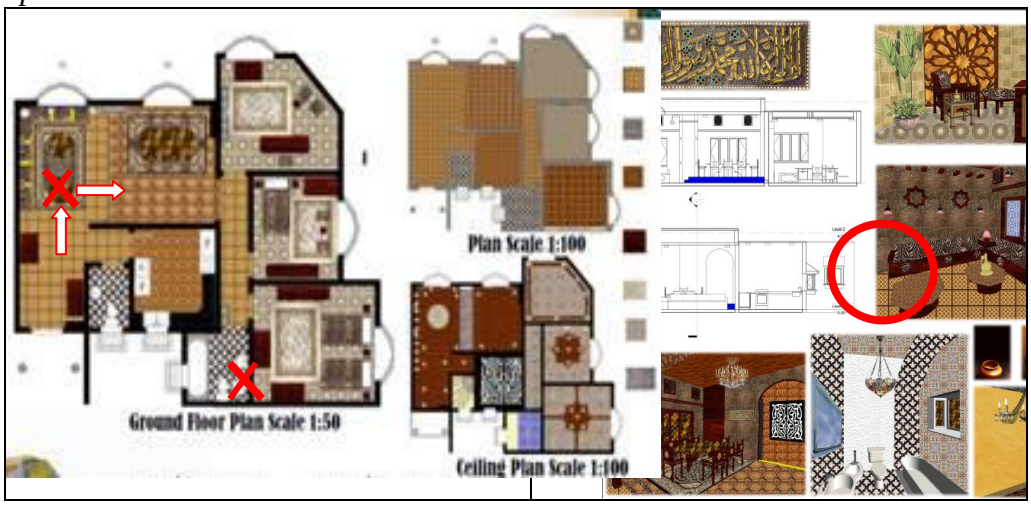


Figure 4. *Example of the Presented Project; Residential House for an Arabic Artist Exposed by Drawings on Two Card Board 50*70 cm Showing Mistakes in Furniture Arrangement and Space Planning after Walking through the Interior Space with VR*



Studio Experience in the Collaborative Virtual Design Studio

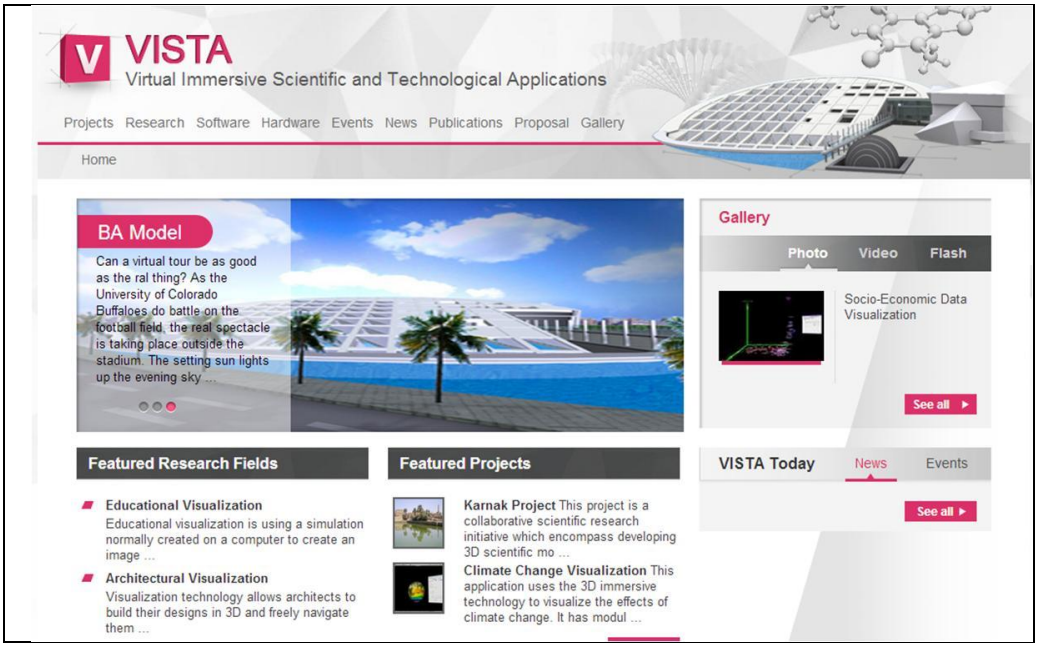
The central component of the model is the metaphorical projection, which provides the guidelines for the entire virtual world design. The goal of metaphorical design is to create a semantic space. All its elements are configured symbolically to make sense of an artificial environment that students can visualize and experience with their senses. The virtual environment thus

becomes the physical representation of the knowledge to be taught.[11] Students must perceive, assimilate and make sense of the stimuli from this environment.

The VR program is used in student projects in the next stage after almost completing conceptual designing. There were lectures and presentations in the design studio to explain for students how to import and export the digital models, and how to use the main functions of the VR program. The basis upon which the technology (VR) is three-dimensional models, so it was essential to teach students the knowledge of three-dimensional modeling (3D Modeling), as the techniques (CAD) do not have the foundations of modeling adopted in designs like (Assembly) for example.

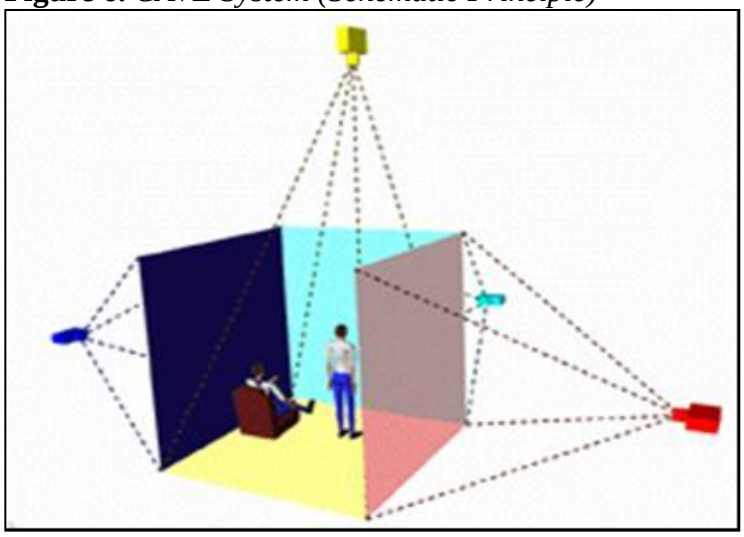
Students' projects were then played in the cave of the Virtual Immersive Science and Technology Applications (VISTA) at Bibliotheca Alexandrina,[12] Figure 5, in order to develop and adjust the design drawings.

Figure 5. *Virtual Immersive Science and Technology Applications (VISTA) at Bibliotheca Alexandrina*[13]



[11] Poupyrev, I. and Ichikawa, T. (1999). Manipulating objects in virtual worlds: Categorization and empirical evaluation of interaction techniques. Journal of Visual Languages and Computing, 10, 19±35.
[12] http://www.bibalex.eg/en/project/details?documentid=284.
[13] http://www.bibalex.eg/en/project/details?documentid=284.

Figure 6. *CAVE System (Schematic Principle)*[14]



The CAVE is a multi-person, room-sized, high-resolution, 3D video and audio environment, Figure 6.[12] The use of the virtual reality cave enabled students to analyze their projects and find their mistakes either in the dimensions of the furniture elements or the organization of the interior space and its planning.

Figure 6 is an example of the effect of visualizing furniture within the space to perceive the spatial dimensions of the interior space and inefficient furniture arrangement and space planning as shown in the figure. The influence of the presentation medium revealed to student his error in arranging furniture in the apartment.

Another example of the effect of visualizing furniture in the space was the error in the size of corner lamp in the project discovered while previewing the VR model of the apartment and using furniture; as shown in Figure 7 and Figure 8.

Virtual reality is an effective design medium. Perhaps more than any design medium, virtual reality facilitates selective reinterpretation and immediate evaluation. Virtual reality also allowed designers to oscillate easily between design elements, abstract representation, and component assembly of the interior space in a single design activity.

On the other hand, Virtual Reality eases imagination and therefore highlights the relationship between architectural design and space furniture. The advantages of employing Virtual Reality as a design medium have been appeared in students' textual explanations. Students highlighted few areas in using Virtual Reality in their discussions and presentations throughout the studio. There were more and high awareness of the Perceived Spatial Dimensions and Spaciousness of Interior Space during design activities.

The Virtual Reality use is interrelated with individual ways of visual design thinking used by students in designing. Indeed, each designer uses the virtual reality environment in a way that fits his/her visual design thinking. In

[14] http://www.slideshare.net/AmitSinha59/virtual-reality-59630153.

other words, the individual subjective way of visual design thinking and perception that varies from one designer to another has a recorded effect on the result and output of the VR use. Students who have more experience in modeling computer programs, become easier and faster more familiar with the VR environment, which leads to effective and more modifications in both structural and architectural levels.

Figure 7. *Residential House for a Musician with Error in Dimensions of the Furniture Elements (the Corner Lamp) Revealed after the VR Performance*

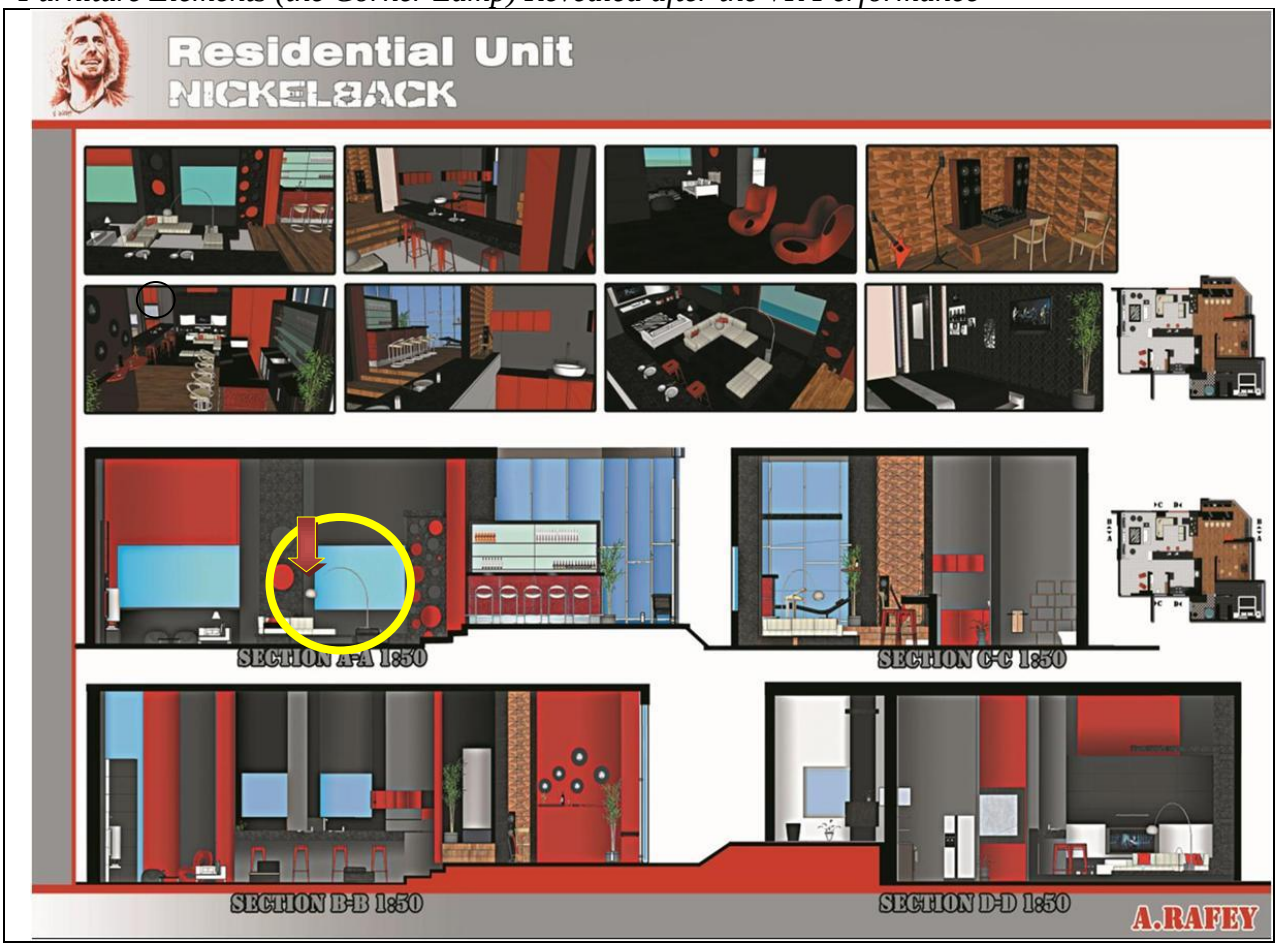
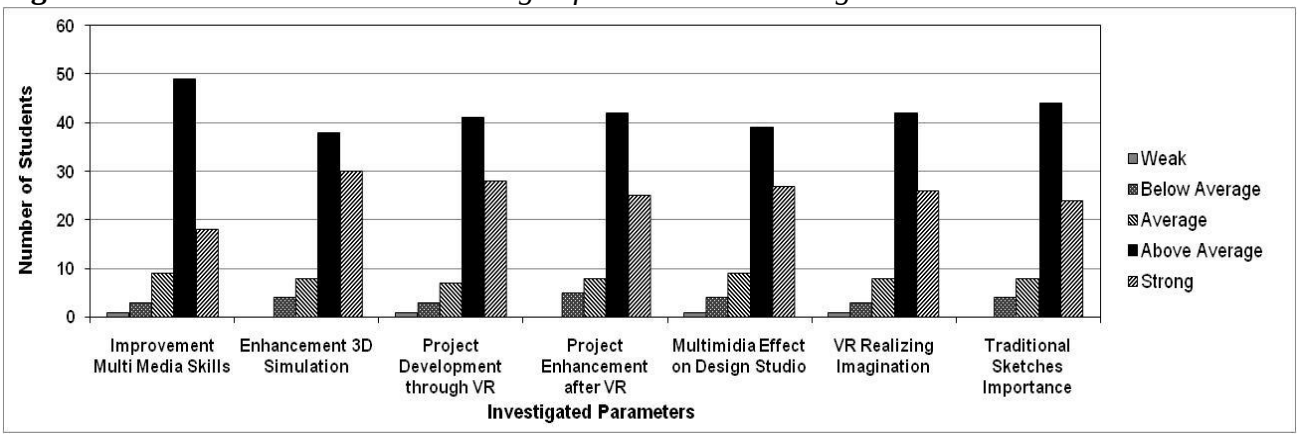


Figure 8. *Within the Interior Design Course, the Previous Student Having a Walk in Virtual Reality System Interactive Work within Three Dimensional Computer Models of his Project at Virtual Immersive Science and Technology Applications (VISTA) at Bibliotheca Alexandrina and Discussions with his Tutor*

Students' Feedback

A questionnaire-based survey was conducted after the VR project to represent a simple feedback mechanism to gauge the students' opinion based on the outcome of this project which combines learning of interior design with Virtual Reality (VR) technologies. The questions were given based on the parameters affecting the virtual reconstructions of the interior project. Hence students were asked basic questions on whether the Multimedia and modeling tools combined with sketches and architectural data offered an opportunity them to improve their skills while at the same time, to deepen their understanding of interior design techniques. About 80 students, from 3rd year of architecture, participated in the survey, which included questions on their skills before and after the project, their opinions on the understanding the subject matter such as after the completion of the project.

Figure 9. *Students Feedback on the Usage of VR in Interior Design Studio*



Results of the questionnaire shown in Figure 9 revealed that most of the students were with the opinion that their 3rd modeling skills being of 'average level' before the project. Then the VR enabled them to improve their skills, particularly in their opinion - in multimedia presentation and compositing - which improved their project. The level of improvement was assessed as higher than 3D modeling skills, learnt to the students have in their earlier years of study. Hence the interior project on the VR provided a jump start in their multimedia skills learning and presented an opportunity to deepen and increase understanding of the perceiving space and furniture arrangement and suitable scale.

The students' response was extremely positive. The overall results demonstrate evidence of their agreement that their better understanding of the 3D model better through VR interaction.

Figure 9 gives an overview of the student's opinions on the benefits of VR and an outline of the achievements in terms of both skills development and subject matter education. Multi-user 3D virtual learning environments provide the capacity to merge the institutional infrastructure for academic subjects with the educational principles of interior architecture pedagogy.

From a studio instructor's perspective, it has been witnessed that students have been fascinated by the opportunities provided by the activities of inhabiting, designing 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 VR as teaching model is a very successful tool. Previewing design allow students to look around space before the design has been finalized. The result is confidence in design and successful decisions and a lot of saved time.

Conclusions

The research aims at investigating the use of the Virtual Reality environment in visualization the interior space during designing in architectural design studios. This study has confirmed that the VR use is beneficial in the designing phase. The VR use increases the awareness of designer during designing in many terms.

Virtual reality represents a high-end technology that has an exciting and explorative quality to complement more traditional methods of architectural learning. Increasingly it is developing into a necessary component in the educator's arsenal of tools to educate and afford opportunities to learn and even experience space environments, which for reasons cannot be experienced or learnt in a such engaging and meaningful way.

Through implementation of virtual reality technology in the interior design studio, it offered the following advantages:

1. Support imagination and visualization operations.
2. Reduction of required time to design processes and production time.
3. Replace physical models by virtual models.
4. Reduction of defects that may occur during implementation processes.
5. Participating views through VR simulation and joint cooperation to make decisions in the final design hence creating team work spirit.

International universities using VR technique display among students the background of modeling and presentations with computer (Computer Graphics), and so it is possible to easily export these models to virtual reality programs. The VDS enriches the architectural experience by exposing studios to different design cultures and to a larger context of design feedback.

In the Arab universities especially, virtual reality is a new technique that is rarely available in universities for many reasons such as;

- Lack of educational materials.
- Lack of special hardware and components of the VR as they are expensive.
- Lack of experienced teacher in this branch.
- Lack of technical foundations and supports for VR.
- And the lack of references translated interested in this subject.

This work aims to clarify a very small part of the technique of (VR) and its applications much related fields and its close association with the Architecture education and this is no doubt, and also is a call to the attention of this technology in the Architecture education; to attach a lot of areas: education, and training, and research. More investigations and researches should be also directed to this area.

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[1] Brey, P. (2008). Virtual Reality and Computer Simulation, Ed. Himma, K. and Tavani, H., Handbook of Information and Computer Ethics.
[2] Vince, J. (1995). *Virtual reality systems*. Pearson Education India.
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[12] http://www.bibalex.eg/en/project/details?documentid=284.
[13] http://www.bibalex.eg/en/project/details?documentid=284.
[14] http://www.slideshare.net/AmitSinha59/virtual-reality-59630153.