Arab American University

Faculty of Graduate Studies

Investigating the Possible Adaptation Techniques for Audio and Video in the Context of Adaptive 3D Virtual Learning Environments

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This thesis was submitted in partial fulfillment of the requirements for the Master's degree in

Computer Science

February / 2018

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Declaration

This is to declare that the thesis entitled "Investigating the Possible Adaptation Techniques for Audio and Video in the Context of Adaptive 3D Virtual Learning Environment" under the supervision of Dr. Ahmad Ewais and Dr. Mohammed Maree is my work and does not contain any unacknowledged work or material previously published or written by another person, except where due reference is made in the text of the document.

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Dedication

I humbly dedicate this work to my dear mother.

To my best friend, dear dad.

To my support in life, my happiness in this life, my husband: Dr. Esam Nazal.

To my lovely sons and daughters: Abdel Baset, Tala, Raed and Jana.

To my extended family.

To all those who have been supportive, caring and patient, sometimes beyond their strength .

I dedicate this work.

Acknowledgments

In the Name of Allah, the Most Beneficent, the Most Merciful.

Peace and blessings be upon the best messengers Prophet Muhammad, the Prophet, the best prayer, and delivery.

Firstly; thank God that he achieved what I aspire to and enabled me to complete the master's degree, praise be to God before and after.

Then, I would like to offer my sincerest respect to many individuals who have contributed their expertise, time, and resources to various areas of this Thesis, and to them, I am most grateful.

I would first like to thank my thesis advisers. Dr .Ahmad Ewais & Dr. Mohammed Maree Who have taught me exceptional knowledge.

Additionally, the acknowledgements are due, to Arab American University which gave me the chance to follow a graduate degree, and also for all the support I received in carrying out this research.

To all those who have been supportive, caring, and patient, sometimes beyond their strength.

Thank you very much..!!

Abstract

The use of Three dimensional (3D) Virtual Environments is gaining interest in the context of academic discussions on e-learning technologies, as it provides several advantages over classical learning material. However, the use of multimedia resources such as videos and audio inside 3D Virtual Learning Environments (3D VLE) also has drawbacks, especially usability and effectiveness issues. One way to overcome such drawbacks is by providing an adaptive 3D VLE, i.e., an environment that dynamically adapts to the learner's characteristics and activities inside the environment. In general, providing different adaptation techniques inside 3D VLE is a straightforward task. Accordingly, this research is conducted to investigate the different adaptation techniques that can be applied to the audio and video learning resources which are considered as one of the essential components of 3D VLE. The proposed adaptation techniques can be used to improve the learning outcomes from a 3D VLE. This research describes an approach to support adaptation not only for 3D conventional models inside the 3D VLE but also multimedia resources such as video and audio. Our proposed approach differs from existing approaches from several aspects. First, it is learner-oriented approach so that the learner will be led to view specified part of video and audio files. Second, the learner will be able to view corresponding 3D models visualizing the content of the running part of the video or audio. Third, some possible adaptation techniques for multimedia resources have been used by the proposed research approach.

A prototype has been built, and an example of adaptive course has been elaborated. We have evaluated the proposed approach using qualitative and quantitative evaluating methods. To evaluate the proposed approach, we have considered aspects such as easy to use, usefulness, leaner's attitudes and easy to learn about adaptation techniques, synchronization between 3D models and multimedia resources. The produced promising results demonstrate the effectiveness of the proposed approach.

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LIST OF ABBREVIATIONS

3D : Three Dimensions

2D : Two Dimensions

3D VLE : 3D Virtual Learning Environments

VR : Virtual Reality

AR : Augmented Reality

DSRM : Design Science Research Methodology

AH : Adaptive Hypermedia

PIR : Personalized Information Retrieval

PHD : Portable Handheld Devices

UI : User Interface

SUS : System Usability Scale

SIQ : Subjective Impression Questionnaire

WPQ : Workload Perception Questionnaire

UFQQ : User Feedback Questionnaire – Qualitative Feedback

DQL : Demographic Questionnaire for Learners

ICT : Information and Communication Technology

Chapter One - Introduction

1.1 Background

The current information technology revolution has brought various approaches and solutions for using Virtual Reality (VR) and Augmented Reality (AR) in different domains. For instance, one of the AR applications used in education is the application for teaching the basic concepts of electromagnetism (Ibáñez, et al. 2014). In this application, students can explore the effects of a magnetic field. Another example is the exploitation of VR in ecommerce (Zeng & Richardson, 2016). In this application,the authors investigate whether consumers prefer an immersive virtual reality format for information search rather than static picture format in an e-commerce context. This application has been adopted by researchers in simulation and training. Another domain which uses the advantages of VR is e-learning. For instance, researchers in (Merchant,et al., 2014)have examined the overall effect, as well as, the impact of selected instructional design principles in the context of virtual reality technology-based instruction (i.e., games, simulation, virtual worlds) in K-12 or higher educational settings.

In recent years, the emergence of 3D techniques in educational institutions has brought new successful applications in this domain. For instance, different courses use VR in education such as (Hartley, et al., 2015). In this example, the authors describe promising practices for creating and implementing learning activities in Second Life[1]®, a virtual world, in a teacher education program that serves prospective and practicing teachers in many rural communities. Many colleges and universities rely upon online programs to

[1]http://www.mediafire.com/file/uag72qus37jl3t3/anatomy-vr-video-player-demo2.apk

support distance delivery of personnel preparation programs in special education and related services. In (Laver, et al., 2017), the authors explore the immense potential for virtual reality to be applied in educational settings. They discuss recent technological developments against a backdrop of several decades of research. Another example is the work carried out by (Martín-Gutiérrez, et al., 2015)to achieve a connection between the theoretical explanations and the laboratory practices using augmented reality tools.

1.2 Motivation

Modern methods of learning have emerged in the last few years by using the computer in education (Scott, Soria, & Campo, 2016). For instance, many Virtual Learning Environments (VLE)s have been widely adopted by educators to fulfill likely learning outcomes (Pattanasith, et al., 2015). Recently, these environments have evolved into more advanced ones using 3D technologies and taking into account improving the individual learner's needs and preferences (Hartley et al., 2015). Then many adaptive 3D VLEs have explored adaptive features to enhance learning experiences in different contexts(del Blanco, Torrente, Moreno-Ger, & Fernández-Manjón, 2008). Additionally, the development of 3D Virtual Worlds plays a central role in distance learning. The focus in this context is on three main features: i) it helps learners to visualize some learning concepts such as the Solar System, Anatomy of the Human Body, etc. ii) it offers real-time communication tools, interaction capabilities, and collaboration empowerment. Thus, students can gain experiences and skills. iii) it supports the usage of avatars as virtual representations of human users, so that he/she will be able to interact with different 3D objects and navigates through a virtual scene (Goyal, Yadav, &Choubey, 2012).

E-learning introduces a flexible learning process for the learner and enables this directly to decide about various factors directly linked with their study program. Through e-learning, learners become able to decide where what and how to learn or study. E-learning helps various higher education institutes to apply and implement various flexible pedagogies. As though such flexible pedagogies, such higher education institutes become able to gain various benefits. Firstly, the quality of their education improved. Secondly, they become able to use improved IT techniques and advanced technologies in the learning process to reduce boredom resulted from teaching. Thirdly, the education institutes have plenty of time to arrange various research work to meet the quality standard of advanced international education institutes and to increase the credibility of the institute as well. E-learning mainly focuses on three aspects of learning which are pace, place, and mode. For pace, it refers to various delivery schedules which are used by an educational institute. The pace of learning can be full time or part time, or it may be in the form of a complete program (full degree program, e.g. bachelor's degrees or master's degrees) or even a part of a program. Place refers to the physical location of learning. It can be learners' home, workplace, during travel or any other location preferred by learners. This is the most important feature of the e-learning which has made the learning process ubiquitous. It also has increased learners' ability to learn and increase their knowledge whenever or wherever they want. For more, it refers to the use of various advanced and modern technologies of learning and the use of some techniques to facilitate the learning process of the learner. The use of 3D techniques plays a direct, decisive role in this. Currently, most of the e-learning modes are based on different principles and aspects of 3D learning technique (Gordon, 2014).

Although adaptive 3D VLE represents a promising area with high potential for improving (VR) educational applications, some studies have been done in this area outlining disadvantages and limitations. As stated in (Vera et al.2007), adaptive 3D VLE is still under development. As a result, there are still open issues related to exploring different adaptation techniques that are related to multimedia resources like audio and video inside a 3D VLE. As a starting point to explore adaptation techniques for sound/video, it is important to understand the 3D VLE anatomy and the sound/video anatomy too. For instance, videos are considered a standard learning material which will be displayed, enabled, disabled, paused, or resumed depending on defined characteristics of the user model like knowledge level, background, preferences, etc. This will lead us to provide a systematic overview of adaptation techniques by investigating what can potentially be adapted in a 3D VLE.However, the use of 3D for learning environments also has drawbacks, especially usability and effectiveness may cause problems. There is one way to overcome these draw-backs which is by providing an adaptive 3D VLE, i.e., an environment that dynamically adapts to learner and the activities that he/she performs in the environment.

Considering the significance of virtual learning environment and its increasing adaptation all around the globe, this research emphasizes the use of audio-visual aid in the learning process. The research is conducted to investigate the different adaptation techniques that can be applied to the audio, video learning resources which are considered one of the components of the 3D VLE. As a result, such adaptation techniques could be used to improve learning outcomes from 3DVLE. Furthermore, applying adaptation techniques is another direction that still needs a further investigation that is considered in this research.

For instance, (Merchant et al. 2014) identifies some adaptation techniques that can be used to deliver suitable audio and video resources and adapt text chatting, voice conference, etc..However, some other adaptive techniques must be applied carefully, as different adaptations for different users may be confusing when users are collaborating on a common task. Swiss Higher Education uses various e-learning projects, and 3D means to increase the education level among various advanced student. E-learning projects play a significant role in increasing knowledge related to multimedia and internet cartography among students of various fields. The three famous universities of Switzerland named (ETH Zurich, University of Zurich and University of Applied Sciences Northwestern Switzerland) took various initiatives to increase e-learning techniques among their teaching means. Different modules or courses which are offered by universities are redesigned to meet the new challenges of learning since it improves the quality of distance education. Through the use of 3D techniques, these universities become able to include new teaching techniques in their e-learning process like users own manageable or controllable animation streams or direct interactive teaching tutorials (Schnabel et al. 2014).

1.3 Research Problem

As mentioned earlier, the primary objective of this research work is to investigate the possible adaptations that could be applied to audio, video learning resources and different techniques inside the 3D Virtual Learning Environments, to adapt 3D VLE to learners' knowledge, skills, and behavior. Overall, the research aims to identify the possible adaptations that can be implemented to the audio-visual resources in the 3D virtual learning environments.

As a starting point to explore adaptation techniques for sound/video, it is essential to understand both the 3D VLE and the sound/video components . For instance, the video is considered as a learning material which can be displayed, enabled, disabled, paused and resumed depending on defined characteristics of the user's model like knowledge level, background, preferences, etc. (Konrad et al.2013). This leads us to provide a systematic overview of adaptation techniques by investigating how can multimedia resources potentially be adapted inside a 3D VLE.

The research attempts to identify the significance of 3D VLE in all fields and not just one which makes the results of the study generalizable. Several factors improve the learning environment out of which the 3D audiovisual resources are considered. These resources are not specific to one dimension of learning but all of them. As a result, the findings of this project can be applied by 3D VLE engineers and developers to construct and adapt3D VLEs. It is important to mention that most of the adaptive 3D VLEs are developed by well skilled programmers or researchers, and most of the adaptation mechanisms are realized by an ad-hoc implementation. Besides, nearly every adaptive 3D VLE has its unique way to deliver 3D contents and materials adaptively. This study investigates the possible adaptation techniques that can be applied to audio, video learning resources and different communication techniques inside the 3D Virtual Learning Environments which can be used in different domains such as medical, computer science, dental surgery, etc.

1.4 Research Questions

As mentioned before, the main objective of this research is to investigate the possible adaptations that can be applied to multimedia resources inside the 3D VLE, to adapt 3D

VLE to the learners' knowledge and skills. Therefore, the research questions addressed by this study are the following:

a) What are the possible adaptations techniques that can be applied to audio and video resources inside 3D VLE?

b) To what extent can we support learners by applying adaptation techniques to audio and video inside 3D VLE?

1.5 Research Methodology

The research emphasizes the improvement in the 3D virtual learning environment. The purpose of picking up virtual worlds for the study purpose is the increase in their prevalence and adaptation to the changing technological trends. Several instances depict that use of audio and visual aids in the 3D VLE which is a crucial element to enhance understanding of learners. However, it is observed that supporting or involving educators in the development of adaptive 3D VLE is at the beginning stages. The difficulty of engaging instructors in designing adaptive 3D VLE can be considered as one of the significant barriers to adopt adaptive 3D VLE widespread (Molka et al.2016). Therefore, one way to allow authors (educators) to create educational and adaptive 3D VLEs is by supporting them with high abstract adaptation techniques where they can use and apply adaptation techniques without being expert in 3D modeling or programming (Chau et al., 2013).Considering such challenges, it is determined that the current state of audio and video resources in 3D VLE is serving the purpose, but not sufficiently. Thus, the study focuses on improving the state of the virtual learning environment by exploring the areas

of improvement, advancement, and development in the adaptation of audiovisual resources used in 3D VLE.

The research project approach is based on the Design Science Research Methodology (DSRM) (Peffers et al., 2007). Following DSRM, the research approach includes five steps:

1) problem identification and motivation
2) delineate the objectives of a solution
3) design and development of the solution
4) demonstration
5) evaluation

Furthermore, an iterative method to satisfy the ultimate objectives and goals is used. The problem identification and motivation are realized after an explorative study. In other words, after reviewing related literature work, some essential aspects in the context of adaptive 3D VLEs that still need more investigation were revealed. One of the discovered issues is the need for more investigation in the context of adaptation techniques related to multimedia resources like audio and video inside adaptive 3D VLEs. After that, the objectives of a solution are established by first understanding the current attempts to provide adaptation for 3D VLEs and determining how adaptation mechanisms are incorporated in such environments. This step was taken to identify the current limitations that exist in the proposed approaches and frameworks to identify the possible improvements and objectives for a solution. This step involved a recent literature review.

For the research design and development of a solution, they have been conducted to re-examine and compare the different adaptation techniques that were proposed in different contexts such as e-learning, e-commerce, etc. Our objective is to explore a wide range of adaptation mechanisms that are applicable not only for 3D but also proposed adaptation techniques for audio and video without being limited to the educational domain. This provided us with insight knowledge about 3D VLE and multimedia resources anatomies. Also, this will contribute to insight knowledge about sound and video components and types.

As far as a demonstration step is concerned, we used the proposed adaptation techniques to author a simple adaptive 3D course. This course will be used to demonstrate the proposed adaptation techniques by both students and educators in the Faculty of Medicine at the An-Najah National University ,because there is no human medicine faculty at the Arab American University so far.

As for the evaluation step, a quantitative, as well as a qualitative evaluation method, were adopted. This step focuses on the evaluation of the proposed adaptation techniques and the effectiveness of using such adaptation techniques in the developed adaptive 3D course. Aspects such as usability and acceptability aspects were evaluated thoroughly in the quantitative user evaluation. A qualitative evaluation was also conducted to seek for explanations about the less positive aspects as well as more favourable aspects. In every field of work, there is a need to understand the core concepts and then to move to the advanced level of learning. In both cases, the need is to ensure that the virtual learning environments provide the utmost level of understanding by conveying information in the most efficient manner (Braun, & Slater, 2014). Considering the fact of learning on virtual

platforms, the significance of 3D VLEs is enhanced in this study. By identifying the challenges of adaptive 3D VLEs, this study reports emphasizes on how the performance of the virtual environments can be improved by improving audiovisual aids. The possible adaptations of the audio and video resources are enhanced in the 3D VLE. Also, the extent, to which learners are supported for the application of audio and video techniques – 3D, is implemented.

1.6 Thesis Outline

The study is organized as the following:

Chapter 1: introduces an overview of the general context of the work. It also presents the research problem and the approach adopted.

Chapter 2: presents background and related literature to this study. It discusses integrating multimedia contents in Virtual World in a different application and uses adaptation technique in multimedia inside the virtual world resources.

Chapter 3: Introduces the conceptual framework which was developed and presented in 3D virtual learning environment adaptation. Basic design principles are mentioned and illustrated that are important to design the context of 3D.

Chapter 4: introduces design and development for multimedia resources adaptation in 3D.The chapter explores the research methodology providing the current use of technological utilities based on that a scenario in the process of technology-enhanced learning. It also presents the demonstrations of evolved 3D VLE system which is capable of providing e-learning by using the facilities, especially for portable handheld devices (PHD) like mobiles or tablet PCs equipped with Android OS particularly.

Chapter 5: introduces the analysis of all relevant research approach, methodologies and techniques to be employed in this study. The chapter began with an introduction and proceeded with an explanation of the type of research, research approach, and goal of data evaluation, questionnaire design, methods of data collections, explaining and analyzing the questionnaire and establishing the statistical approaches to be used for data testing and analysis. It also includes the interpretation of results.

Chapter 6: presents the conclusion and the final result of the study, and the limitations were encountered. It also offers future studies related to this work.

Chapter Two - Related Work

A reviewed related work will enable the interested reader to understand the knowledge of different aspects related to applying adaptation to 3D VLE and integrated multimedia contents. This review will also help to identify the technology gaps in the adaptive 3D VLE. Literature related to the e-learning technologies is reviewed in this work since the present work focuses on the development of e-learning systems to fulfill the sophisticated learner's requirements with the help of evolving multimedia and learning (educational) technologies. Moreover, the present research deals with the following two aspects:

a) Creating 3D VLE using multimedia tools and applications.

b) Facilitating adaptive user behavior for the system.

These two issues are reviewed and analyzed based on the existing literature. However, when considering various multimedia components for review, audio and video integration inside the 3D VLE should be considered thoroughly. The study of related work in this chapter is classified into two categories. The first category is relevant to the development of multimedia resources for developing the 3D VE in general. The second category is related to research work that represents principles of adaptation techniques in the context of adaptive hypertext and hypermedia. That will give insight into possible adaptation techniques for video and audio inside 3D VLE. It may also be noted that including adaptive behavior of an e-learning system could also be treated as part of intelligence system development (Nye, 2015).

The following section discusses the different approaches and proposed techniques to integrate multimedia resources in the context of classical hypermedia e-learning

applications. This section also presents how multimedia contents are incorporated in the classical 3D VLE (non-adaptive).Section 2.2 presents the different adaptation techniques used in the context of adaptive hypermedia. This section also introduces the related work to this study along with a summary of the adaptive methods included.

2.1 Multimedia Resources

2.1.1 The Use of Multimedia Contents in e-learning Applications

Many educational institutes mostly use the concept of e-learning. The trend of adopting e-learning means during teaching and learning process is not limited to developed countries only, as many developing and less developed countries are also taking initiatives to implement e-learning techniques and application in their teaching process. Multimedia is considered as one of the important medium through which the quality and efficiency of e-learning process improved up to a great extent. Multimedia helps to interact with numerous numbers of listeners or audience or learners at the same time with a visual presentation as well. Multimedia helps the tutor or teacher to use various infographics, animations, pictures, videos and different sounds to keep the interest of learners to the learning process. Multimedia provide a complete change and unique mode of learning in contrast to classic or traditional learning techniques where the individuals have to rely only on textbook and oral presentation of teachers only (Gossavi et al.2014).

Multimedia usually has two different approaches known as (i) linear and (ii) non-linear. In linear multimedia approach, the user has no control over the flow of video or content in multimedia, and there is no interaction element in this technique. While in non-linear multimedia technique, the user can interact with the learner and control the content, e.g.,

pause and play of the video. Both methods are used in e-learning process. In distance e-learning, the linear multimedia approach is frequently used, while at in classrooms, mostly non-linear multimedia techniques are used (Langa, 2014).

The presence of multimedia e-learning visuals technique brings positive impact towards the memory of learners. While the ability to use subtitles during a video, also bring significant benefits towards learning process. It increases the element of entertainment and helps learners to keep the focus on video or visuals only in contrast to old learning techniques where learners have to focus on the textbook, notebook and the words delivered by the teacher during the lecture. Multimedia helps to simplify the various complex ideas and concepts with help of the various images, videos and live tutorial through which the learning and understating of the learner improved. Alongside, multimedia can range and increase understanding of learners through various techniques as it can use written description, use video, image and tutorial as well as enhance the understanding level of the learner. Through this, learners' engagement to learning process remains positive. The use of multimedia mix enables teachers or instructors to use a combination of multimedia techniques as required and based on the needs of learners and the subject as well. As per various scientific research, the individual can remember the material they see, hear and communicate (at the same time) for a longer time. There is no standard method of learning and teaching as everyone has its subjective approach in this regard. Through multimedia, the user became able to approach and grab the control of the mind of various learners or audience and keep them interact and engaged until the end (Leow & NEO, 2014).

2.1.2 Integrating Multimedia Content in Virtual World

From 2000 to until now, the trend of using and exploring the virtual world is increasing rapidly. Advancement in communication and Information Technology sector brought significant positive effects towards computer and internet sector and increased the use of internet everywhere. Not only developed and developing countries, but also the less developed countries have access to internet means. Internet has become ubiquitous nowadays and can connect people from a region to another within seconds. Hence, the level of interaction and awareness increased among individuals from all over the world. Technology has changed the meaning of education entirely due to such increased awareness. Now, people are more interested in learning various courses and programs offered by various universities internationally. Thus, the education sector has expanded its operations up to virtual world and internet computer (Mateu et al. 2015).

Two approaches are commonly used while taking care of integrating multimedia elements within a single learning application or the environment. The First is the age of old computer programming approach that started in the first generation of instructional technologies. The method includes massive use of engineering skills by the developers along with the incorporation of visual design and human-computer interactions issues. High level of programming languages usually takes the entire responsibilities in this approach, and hence, machine response time is found more useful in this case. This approach is observed to be efficient, even today where hardware interactions are more important part than the visual design along with shorter span and budget of development. With the evolution of sophisticated high-end software, multimedia integration became easier compared to the approach described above. In this approach, integration issues are

undertaken by educators (course authors) by providing them authoring tools (Ewais & Troyer, 2013; Ewais & Troyer, 2014). Authoring tools perform the tasks by less use of programming skills and more use of icon based drag and drop operations. The first generation of multimedia authoring was dominated by various authoring paradigms like time line metaphor, icon metaphor, book metaphor, slideshow metaphors, etc. These metaphors were primarily evolved for 2D interfaces, but they were enhanced to facilitate 3D visual designs. Slideshow metaphor is found to be easiest, while time-line metaphor is more useful for movie development among the stated authoring paradigm. Moreover, network metaphor of authoring has taken central stage, while web-based authoring started to dominate the market. It might be noted that scripting languages was included as a build in additional facilities within most of the high-end authoring software (Sauer et al.2006).

To integrate multimedia components for 3D VLE, the authoring tools should have the capability to fulfill in the virtual worlds, i.e., facilitate improved hardware interactions and extremely sophisticated visual with users' interactions facilities. It should also have the potential to facilitate or implement pedagogical aspect during the authoring process. While considering previously defined pedagogical issues, low end authoring tools may fulfill the purpose. But high end scripting based authoring tools will be expected while developers will focus on implementing adaptive pedagogical requirements by using (i) 3D Engines (like Unity3D. Unreal Engine and Cry engine) added script on the 3D objects modeled in the 3D editing applications. (ii) 3D editing applications (like Autodesk Maya, 3DS Max, Cinema 4D, Blender) 3D Studio Max (Murdock,2003)], and CINEMA 4D is a 3D modeling, animation and rendering application, capable of procedural and polygonal/sub modeling, animating, lighting, texturing, rendering, and common features

found in 3D modeling applications. It has reliablemodeling tools; Blender is examples of such tools where developers can quickly implement adaptive pedagogical design issues (Sousa, 2017).

Multimedia use a series of different csubstances like sounds, visuals, videos, infographics and various other tables, graphs as well. All such contents are used only with an intention to increase understanding level among learners and open new ways of knowledge and awareness. Such multimedia contents have high interaction and collaboration with the virtual world. As in visual world, the instructor or teacher is not present physically, but the contents of multimedia play an important role to simplify the concept or idea with help of pictures, background sound, etc. Besides, the multimedia ability of repetition, pause and play also help learners during the learning process (Hussein & Natterdal, 2015). Multimedia contents and its techniques increased the popularity of the virtual world up to a great extent. As in virtual world, one can access to the information level and courses offered anywhere. The multimedia content makes this learning process easy with no ambiguities and more economical and time-saving as well. The virtual world is directly based on the use of computer and internet facility available. The use of multimedia content increases the efficiency and popularity of virtual world everywhere. The number of distance e-learners is overgrowing and many universities have introduced their distant e-learning programs to facilitate learning process to learners. Besides, universities initiated programs, through the virtual world that anyone can have access to multiple sources of information. Such contents simplify the concept in which most understandable modes keep viewing different understanding approaches of various individuals (Minocha, 2015).

2.2 Adaptation Techniques

2.2.1 Adaptive Hypermedia

Adaptive Hypermedia (AH) is the area of study to deal with the growing challenges by PIR(Personalized Information Retrieval) extensively to incorporate adaptation and personalization issues. Adaptive information presented in this area is to satisfy varying learners' need, different background and context to give a personalized answer to their requirements.

Numerous assumptions are integrated and termed as personalized dimensions in this hypermedia system. Learner's model presents a goal, learning context and preferences which are accorded to generate system response with a non-linear composition of these attributes. AH, systems need to be developed to include external multimedia contents by enhancing its capabilities, and PIR systems have to add individual preferences (by scaling down).

(Brusilovsky&Millán, 2007) have also presented a careful survey of all technical aspects related to adaptive hypermedia applicable to create a virtual world. The years to come will bring exciting examples of new hypermedia resources that have been started to be used in the field of e-commerce and e-learning. Though the present work is trying to bring forward most of the resources, there are still many yet to be included in this work in the coming chapters and when required to be applicable in particular.

2.2.2 Adaptive Virtual World

Odninarily, virtual world (known as virtual environment) is developed using traditional 3D modeling and animation software. The capabilities and effectiveness of the 3D virtual

worlds could be enhanced with the incorporation of adaptive attributes considerably in the usability sense. A variety of typically difficult adaptive tasks could be considered such as finding targets, orienting characters, acquiring specialized knowledge of the environment. It has been observed that developing adaptive virtual world is difficult because most of the functions of the adaptive system on 2D interfaces commonly in the form of pages of texts and other hypermedia. Thus, usual adaptive activities that take place within these systems are navigation from one interface to another through hyperlinks(Kotsilieris&Dimopoulou, 2013)

Contents are organized in the form of 3D models within the 3D space of the virtual world. Here, is the navigation activities take place, not by browsing hyperlinks, but by complex interactions with 3D objects to build seamless movements in 3D space. Hence well-known adaptive techniques like the presentation of page fragment manipulation, navigation through link annotation, cannot be applied merely. Web3D sites based research works have evolved some adaptive hypermedia-based techniques for virtual world (Chittaro & Ranon, 2007a&b). Also demonstrated dynamic construction architecture of the software for 3D web content development applied to virtual museums and e-commerce applications. These systems offer an adaptive multimedia content presentation and personalized navigation support. The following are some issues to deal with the development of adaptive virtual world:

(1) Building and updating users' model

The main concern here is how user actions resolve the update of user models. The usual assumption is that user model will be updated after going through every requested page

with all the hypermedia content included. A similar assumption is employed in the 3D virtual world development.

(2) Adaptive navigation support

There are techniques which guide user navigation towards the most suitable object or places in the virtual world provided that a list of suitable objects is given. One interesting solution is using the virtual character to act as a guide in the virtual world, and the other solution is to use constraints navigation techniques through annotations to guide users in the said world.

(3) Adaptive presentation of content

Adaptively modifying, inserting or deleting code snippet make the adaptive presentation of the content that draw, position, move and other interactive behavior of 3D objects in the virtual world. However, the application of adaptive fragments techniques is more complicated than the techniques based on adaptive hypermedia. Moreover, extra attention is required to deal with 3D content, preserve a meaningful, and understanding 3D space. Unfortunately, it is observed that development of a general algorithm for this purpose is challenging and rarely available in the literature.

2.3 Adaptive Multimedia Resources in Virtual World

Persuasive technologies motivate the study of computers escapology. This incorporates the analysis, research design, and interactive computing products such as (mobile phones, computers, websites, video games, mobile applications, wireless technologies, etc.,) that are created to change people's behaviors and attitudes (Yusoff et al. 2011). Furthermore, demonstrating most of the resources that take part in creating an adaptive virtual world

such as the authors mentioned in (Piovesan et al.2012) by the development of applications of U-SEA. It is a system of Teaching Adapted Ubiquitous, which has a primary purpose of adapting the educational needs of students by the computational context, (Lepouras et al. 2005) by creating adaptive virtual reality museums on the web quantitatively measure the "learning skill" of a student in 3D-VLEs. Analysis (Ompok, & Mountain, 2016).

Different aspects need to be considered in the development of adaptive 3D VLE. For instance, (Lepouras&Vassilakis,2006) highlighted some important aspects such as IT infrastructure, pedagogical planning, teaching plans, etc., Moreover. The production practice is often considered as a change process at the strategy level. Resource allocation and efficient utilization tasks are taken care by the efficient hypermedia authoring tools (Tese & Digitais, 2014).

2.4 The Effectiveness of 3D VLE in Learning for Medical Students

The use of (3D VLE) in medical classrooms has offered engaging and authentic learning experiences to students (Richards and Taylor, 2015). However, there is still the need for a lot of research to be done regarding what facets of the technology isuseful and the purpose it wasintended for. There is also the need to measure the learning gains. There has been an increase in3D VLEs in health science in increase learning and assimilation of knowledge. A 3D VLE is web-based and allows multiple users to interact and communicate. VLEs often use avatars or 3D characters controlled by computers that simulate individuals or patients.

Virtual reality-based instructions for learning purposes can take different forms including simulations, games and Virtual Worlds (Merchant et al., 2014). 3D virtual worlds provide an intrinsic experience similar to what is found in the fields because it allows the students to move around within a confined space and interact with objects. The focus of 3D VLE is usually on promoting interprofessional learning among health students. Researchers are looking for ways to use VLEs to improve communication among different disciplines in a bid to improve the experience of the patient.

- **The concept of interprofessionality and the impact of 3D VLE**

Interprofessionality has been defined differently by different researchers. (Reis, Faser, and Davis,2015), defined it as a process whereby professionals from related disciplines put their clients at the center of their practice while working as a team. The practice and body of knowledge is still relatively new in the United States.

3D VLE uses a problem-based learning approach to foster interprofessionalism. In this technology, a group of students are brought together to address real-life problems as a way of stimulating them to acquire knowledge and the skill for critical reasoning in clinical sciences. With each new activity encountered, the learners advance their critical reasoning skills.

- **Recent studies on the effect of 3D VLE among medical students**

Organizing team-based activities among science students of different professions who are scattered in different geographical location has always presented a serious challenge especially when educators have to rely on classroom-based learning. 3-dimentional VLE and web-based technologies are relatively new but present a lot of promise in terms of

bringing together science students from different disciplines when face-to-face meeting is not present (Reis, Faser, and Davis, 2015) – and encourage the spirit of teamwork.

(Reis, Faser, and Davis,2015) explored the impact of web-based framework on the education of health professional from different fields particularly midwifery and medical students. The researchers studied the experience of third-year medical students and midwifery when education was delivered using web-based Virtual Community Clinic Learning Environment (VCCLE) which is a 3-dimentsion asynchronous environment. Students are able to log into the environment and interact with virtual patients controlled by instructors. The students then follow a diagnostic sequence to reach a plan to take care of the women throughout their entire life. Through the 3D VLE problem-based management students learn capabilities for interprofessional cooperative practice.

The VCCLE was designed to be interactive and includes a text-to-speech engine which converts typed text into the case-building site into sound files. This makes it possible for the virtual patients to be able to speak their responses. The text-to-speech engine makes it easy for the instructors to create a scenario that requires interprofessional patient management. Each case challenges not only the learner's critical thinking power but also their ethics and values as well as their ability to work as a team and interprofessional communication skills.

3D VLE has a number of benefits including flexibility, accessibility, and also exposes students to Web 2.0 technologies. It is paramount that education leaders should employ pedagogic strategies and tools of contemporary and evidence-based clinical practices to support the acquisition of knowledge (Wilson and Hungerford, 2015).

In furtherance of the knowledge on the use of TeamSTEPPS for interprofessional education among medical students, (Umorenet al,2018) used virtual TeamSTEPPS to compare the teamwork attitudinal changes among health professional students.At the end of the study which involved 319 learners, the researchers discovered that the use of TeamSTEPPS enhanced mutual support among the learners. The findings will be undoubtedly useful for the evaluation and development of a curriculum targeted at interprofessional learning.

(Pickering,2014) also examined the effect of anatomy drawing screencast on the learning of medical students. In this study, five anatomy drawing screencasts which were an imitation of the anatomy illustration constituent of traditional lecture were put up on the University's VLEand made accessible to all the students. Thequestionnaire at the end of the module and usage data was used to dictate the influence of the screencast on the education level of the students. The student groups indicated that the extraresources that were provided were useful in revision and enhancing their understanding of the topic. The data collected showed the students indicated preference for screencasts to traditional approach of learning. The screencast has also shown to enhance flexible learning.

In dental curriculum, for example, there is usually a training that provides the students the opportunity to learn how to use both hands as well as be highly versatile indiversemedicalprocessesin advanceof treating clinical patients (de Boer et al, 2017).

(de Boeret al,2017) are among the researchers that have tried to show the effectiveness of force feedback (FFB) in a 3D VLEon performance of studentsusing the Simodont dental trainer. The researchers assignedSimodont dental trainer to one hundred and one dental students in their first year with no prior knowledge of working in VLE or cutting a tooth

with forced feedback (FFB). The students were divided into two. One half practiced with FFB while the other half practiced without FFB. The two groups practice for four sessions lasting 45 minutes each.

At the end of test 2, the students were given questionnaire to fill. The result showed that every other student failed except the ones that used FFB. The students also preferred working with FFB. In summary, the result of the experiment showed that FFB enhanced student performance in a VLE.

Inasmuch as there are lots of literatures supporting the use of 3D VLE to enhance the effectiveness of learning among medical students, (Janßenet al,2016) used a pretest to show that the student's behavioral trait and characteristics can influence that experience in a VLE. This means that learning in a 3D VLE will have a greater benefit on some students more than the others. More studies are needed to further determine which student traits can significantly affect their user experience in a 3D VLE, and to what extent.

In a bid to solve this problem, (Richards and Taylor,2015), carried out a research making use of one hundred and twenty-nine students of biology over 2-year duration. The aim was to determine the part of the technology that was useful for education. They compared the knowledge acquired by the students after a regular classroom session with the knowledge gained through 2-dimensional simulationsestablished in NetLogo and 3-dimensional simulationsestablished in Unity3D. The result showed that the students had a better learning outcome with the two-dimensional NetLogo model compared to the three-dimensional model. The researchers attributed this to the distractions often encountered in the virtual world as well as cognitive overload.

Other factors that need to be considered include gender, age, and self-confidence. To effectively integrate VLE and virtual reality (VR) technologies into formal and higher education's, stakeholders like teachers, parents, and the educational institution need to be considered.

Nurses are not exempted from the benefits offered by 3D VLEs. (Wilson and Hungerford,2015) demonstrated this in a review showing how nurses can conduct assessment of the mental health of their patients using an e-portfolio. According to the authors, the use of VLE provides the nurses with practice-based learning experiences that are safe as well as enhance their capacity for critical thinking about a variety of situations even before real-life exposure. The use of wikis and simulation activities will also help the nurses to acquire clinical skills that are necessary to support the recovery process of patients suffering from one mental health challenge or the other. This will ultimately lead to a better health outcome among the patients.

Table1:Comparing the results of previous studies and their results

Researchers	**Media used**	**How the media was used**	**Result**
(de Boer *et al*,2017)	Simodont dental trainer	Randomly assigned to participants. One half practiced with FFB while the other half practiced without FFB. The students were giver two tests and then asked to fill a questionnaire afterwards.	Only students that practiced with FFB were able to pass the two tests
(Janßen*et al*,2016)	Game (Minecraft)	The experimental design made use of an immersive and non-immersive hardware. Immersive hardware used was Oculus Rift DK 2. While the non-immersive was a computer.	Individual characters and traits affect user experience in a VLE.

(Merchant *et al*,2014).	Game, simulations, and virtual worlds	The authors carried out a meta-analysis of 7078 articles. Materials were selected based on the impact of the design on virtual reality technology instruction.	Games, simulations and virtual worlds improved learning outcome gains.
(Pickering,2014)	Anatomy drawing screencast	The screencast with associated resources was uploaded to the University VLE and made accessible to students.	Screencast promote flexible learning and was preferred by students to traditional lecture.
(Richards and Taylor,2015)	NetLogo (2D program) and Unity3D (3D program)	Participants watched six simulations in the two programs followed by a posttest with the same set of questions.	2D-NetLogo model delivered a better learning outcome.
(Reis, Faser, and Davis,2015).	VCCLE	The participants enter and interact with virtual patients controlled by instructor. They then diagnose and plan for the care of each patient.	Development of critical reasoning through problem-based learning.
(Hook, Bodell and Griffith,2015)	Second Life	Participants were first-year students of occupational therapy with no prior experience on supporting someone on a wheel chair. Participants were asked to try to remedy the barriers to occupational performance experienced by a wheelchair user.	Participants developed new knowledge and understanding of barriers to occupational performance.
(Wang *et al*,2018)	Glaucoma Diagnosis & e-Learning System	The participants made use of visualization –based learning environment with expert support while the control group were not provided expert support.	The inclusion of expert support made the system more effective in improving the ability of the learners to solve problems.

Challenges of 3D VLE in interprofessional learning

Inasmuch as there have been notable advantages in the use of 3D VLEs, operating a web-based learning also has its difficulties. One of such challenges is building a concept into a curriculum that was already saturated with unprofessional content (Reis, Faser, and Davis, 2015). In terms of interprofessional education, it is also difficult to control the duration of interaction among the students due to the flexibility of VLE and the different schedules of the different professionals.

Another major challenge that can deter the wide use of 3D VLE for interprofessional education in health and medical sciences is the fact that they are very expensive and time consuming to develop. Without grants, this feat may be difficult to achieve or replicate in different education settings.

Making the right diagnosis can be a serious challenge in a 3D VLE especially for medical students who have no prior knowledge of how the system works. (Wang et al,2015) proposed an expert support as a way of dealing with this problem. Their experiment showed that the provision of expert support improved the performance of the participants and made the learning process more effective.

2.5 Summary

The thoughtful elaborate literature review covered both; the problem domain and solution domain. The prime emphasis of this research is to focus on the field of adaptive 3D VLE as a problem domain. However, the related literature of particular development techniques are also touched as require, but other more exceptional details will be

discussed in the relevant chapters, chapter number four and chapter number five that deals with the focused development issues.

All the reference listed in section 2.1.1 and 2.1.2 support videos, texts, and images. But, just a few of them support collaborative learning. Also, most of them are 2D learning VLEs, while only the VLE presented in (Hariharan et al. 2013)supports 3D technology. Although, the 2D VLE is good for learning purposes, it is better to provide the 3D learning in order to provide students with more modern and more interesting way of learning (Scheucher et al. 2009).

The VLE adaptive techniques presented in 2.2.show that most of the adaptive techniques refer to the content adaptation, but there are also adaptive techniques that are related to users' performances adaptation, energy consumption adaptation and the VLE development adaptation. Most of the researches have chosen content based adaptation because the VLE primarily based on the content, so its quality has the crucial importance.

The summary of the difference among the VLEs presented in this work and in(Yin et al. 2013) .The work presented in(Yin et al. 2013) is devoted to the similar subject as the work presented in this study as it proposes new interactive-video e-learning system. The participants are medical students. The system provides case-based multimedia teaching materials. The instructor can online edit static text- and graphics-based teaching materials, as well as interactive multimedia video. Students can learn basic information and case histories from different cases. They are required to answer questions when watching documentary films. Simulated animation enables users to conduct operations in the virtual environment. Steps of operations can be recorded as personal portfolio of

learning effect. However, some improvements comparing to the work in (Spink& Jansen .2004), such as additional access control and 3D environment, are adopted,.

This review shows a good number of literature in the field of e-learning and virtual reality with some cross-sectional areas where adaptive hypermedia technologies have taken the center stage. The literature survey, in its early phase, had helped the present worker to appreciate the concerned areas and to find out the technology gaps for the problem under consideration in the area of e-learning where original contributions can be made.

Traditional learning has always been the means of delivering knowledge to medical students. However, with the growing need for a better health experience as well as the expansion of the medical curriculum, it has become imperative to find a better means of passing knowledge especially as it regards to the use of modern digital facilities. Pretest and posttest in different studies have shown that medical students who are exposed to 3D VLE eventually perform better. The use of questionnaires in some of those studies has also further highlighted the students' preference to VLE than traditional learning. However, more research is needed to further determine how the students' personal traits can affect their experiences in a 3D VLE. Also, efforts on integration of these technologies as part of school curriculum should be expedited.

Chapter III

Framework for Multimedia Resources Adaptation in 3D VLE

3.1 Introduction

The primary goal of this chapter is to present a conceptual framework to support adaptation technique in video and audio in 3D VLE, and this conceptual framework is helping in defining what should be adapted inside the 3D VLE and when or how the components of the 3D VLE should be adopted.

3.2 Principles for designing 3D VLE with Multimedia Resources

3D VLEs designs have enabled learners to avoid and minimize the problem that they face while learning through UN scaffold learning approach which refers to a variety of instructional techniques used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process. The term itself offers the relevant descriptive metaphor: teachers provide successive levels of temporary support that help students reach higher levels of comprehension And skill acquisition that they would not be able to achieve without assistance. and allow them to have tasks that are authentic and open-ended. 3D VLEs and virtual learning environments can pave the way for learners in developing motivation and engagement towards effective learning(Wilson & Devereux, 2014). But all this cannot be a cause to minimize the problems and issues related to the pedagogy, and linked with the scaffolding. When learners' perform learning activities and tasks, they are provided with the support through the scaffolding system to uphold the motivational and engaging process in learning and to minimize the problems. To support in elaborating the idea of scaffolding and 3D VLEs

design according to (Ewais & De Troyer, 2013) and (Kelvin et al. 2012) the following components and associations functionality in a 3D VLE (see Fig. (1) which can be defined as follows:

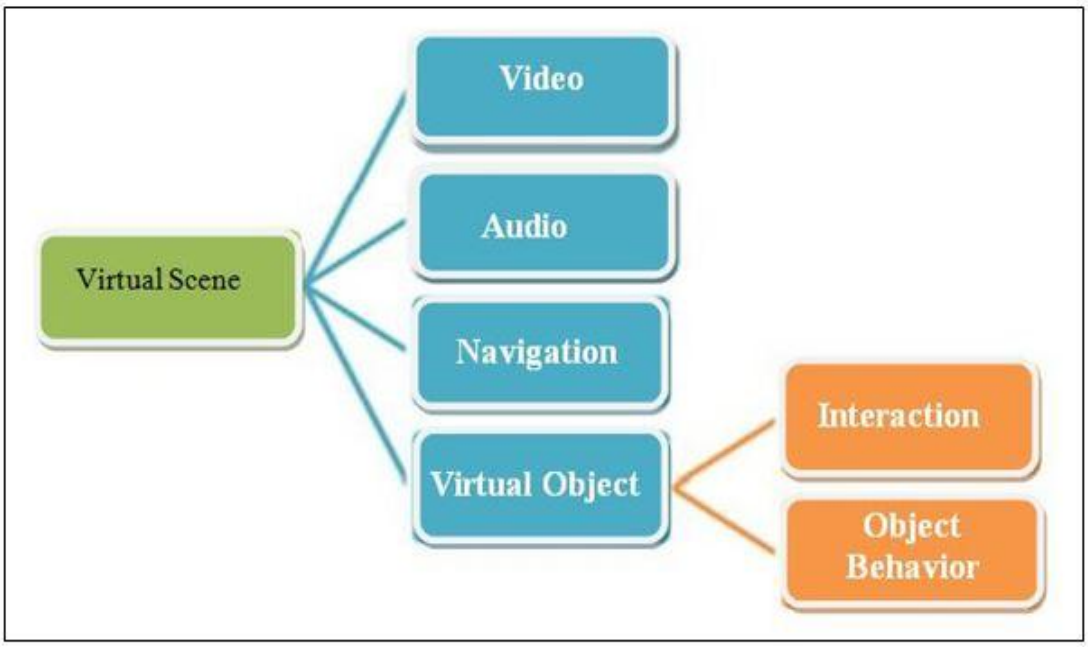

Figure 1 Developed of 3D components of virtual Environment from (Ewais& De Troyer, (2014)

We can distinguish the following components and associated functionality in 3D VE acceding to(Ewais & De Troyer, 2014)

1. The virtual scene: the scene corresponds to the 3D space in which the virtual object is located.

2. The virtual objects: the virtual object are usually 3d object, but there can also be 2D objects in the 3D space. They have a visual representation of color and material properties,a size, apposition, etc..

3. Object behaviors: the virtual objects may have behaviors, and these behaviors may reflect real-life action and activities. For instance, the object may be able to move, rotate , change size, etc..

4. User interaction: the user can interact with the virtual object, for instance, a user may clicking on an object may start its behavior.

5. User navigation: the user can navigate in the 3D VLE by walking, the user can navigate through the 3Dspace by following a particular path.

6. Sound: A 3D VE usually involves sound. Sound can be important in simulation to enhance the feeling of reality.

7. Video: A 3D VE usually involves video ,video can be important to explain how to interact with the object behavior, a component in 3D VLE.

The system of 3D VLE is designed upon the principle of the sound and video instructional system to help in achieving specific objectives of learning based on these specifications. 3D VLEs can be identified in a different manner than all other environments. .

3.3 Adaptation Techniques for Audio and Video in 3D VLE

In this section, we present the Adaptation Techniques that can be adapted to the video and audio in 3DVLE. In this section, the aim is to provide adaptive and personalized interaction in virtual environments, which has the ability to adapt to users intelligently, and eventually may increase user performance and enhance user interaction.

According to (Chorianopoulos & Giannakos, 2013) there some adaptation techniques that could be applied to the video and audio in Video-Based Learning in e-learning systemsuch

as Add-Video, Add-Audio,. Such adaptation techniques for instance, skip frame, play frame are inspired by reviewing related work (Chorianopoulos & Giannakos, 2013; Zhang, 2017).

The mentioned adaptation techniques, can be applied to video or audio learning resources inside the 3D VLE. It is important to say that proposed adaptation techniques for 3D models and learning resources can be implemented synchronously manner. It is essential to understand the different adaptation techniques that have been proposed for multimedia learning resources in the context of classical e-learning applications.

The nature of multimodal virtual environments utilizes a wide range of 3D interaction techniques from simple to very complex (Renny & Chris, n.d.). When users need to carry out a particular task in such environments, they are confronted with much freedom in deciding which to choose from the various interaction techniques. This situation may possibly introduce additional complexity and cognitive load for users, which in the end might hinder their interaction. We envisage providing adaptive personalized 3D user interfaces as a potential solution to enhance user interaction in virtual environments. There is no plenty of studies focused on investigating adaptation and customization in virtual environments, and in particular, little attention has been spent on adaptation and personalization of 3D interaction techniques in virtual environments. The design of adaptive user interfaces is considered a key figure to improve users' interaction with systems by facilitating user performance and helping users deal with complex systems(Lavie & Meyer, 2010).

For all the individual components of 3D VLE, adaptation principle can be applied. It may have some types of limitation for individual and single components and particularly

for 3D VLE. Besides, there may be different kinds of components involved in 3D VLE. The first and important application of adaptation technique is for single components. In case of the single component, there is a possibility for objects, navigation, interaction, and behaviors. These are all different types of adaptation. In the present analysis, only video and audio components are involved. There must be some essential care about properties of the system under consideration and the impact of these components. The adaptively can be applied for standard hypermedia and standard hypertext (Ewais , 2013).

For adaptive e-Learning , the new innovative and trending feature is 3D VLE. The components of adaptive 3D VE include audio, video, text components, 3D models and 2D images. Some ways are there to have an interaction of content with the user. For instance, the interaction can be through navigation with 3D spaces, interaction with 3D objects, keyboard, mouse, and actions taken by special kind of task-specific type of pointing devices. In this study, the concerns are related to applications of 3D VEs in e-learning . The adaptation techniques are often dynamic adaptation technique for 3D VLE. The prime focus of these techniques is linked to applications of desktop 3D/VR and web browser applications of 3D VLE (Pirker et al. 2013).

The proposed adaptation techniques are the following:

1. **AddVideo**: Through this techniques , the system add new videos to the list of videos seen by the student according to the user level.

    -Usage: the system use this technique when a student fails in any exam so the system uses this technique to add new videos that explain the courses that was deposited in a new way

- **Example**: When a student fails to in the exam due to a wrong answer about the anatomy of the chest cavity questions, the system replaces the old video by adding new videos that explain the anatomy of the chest cavity in another way to help the student to have a deep understanding .

2. **HideVideo** : Through this techniques the system hideVideos from the list of videos seen by the student according to the user level.

   - **Usage**: the system uses this technique When the student moves to a new level, the system hides some videos that are higher than the level of the student until he is watching the videos that make him eligible to watch

   -**Example**:When the student moves to abdomen courses, the system hides the stomach and esophagus videos that are higher than the level of the student until watching the inguinal region videos that make it eligible to watch the other video .

3. **ShowCaption** :This technique is used to display a written explanation of what is displayed in the video.

   - **Usage**: the system using this technique under some video if that's video needs clarification to give the user clear idea about the content of the same video.
   - **Example**: During the presentation of the video about the anatomy of the nerves.

     The system offers comments explaining the various nerve names to help the student during the study .

4. **Add Audio**: The system uses this technique to add audio files to alert the student to be attention.

    -**Usage:** The system use this technique to add audio files to alert the student or when opening a new level or when entering the application.

    - **Example**: when the student level is thorax but the student chose the pelvis part and Students must not enter this level before completing thorax and abdomen level the system will play the alert sound file to alert the student and to be attention .

5. **Skip Frame**: In this technique, the system skips some frame according to the student level or according to the instructor plain.

    - **Usage**: When the student is deposed in the exam the system skip some frames and replace with other frame more suitable to him

    - **Example**: if a student fails in an exam because he answered wrong about heart and great vessels question. The system forces the student to re-watch the videos again. The system, however, skips all the frames about the parts he succeeded in answering its questions.

6. **Stop Video**: The system turns off the video depending on the user's behavior.

    - **Usage**: This technique is used by the system when the student moves from one room to another, so that the video sounds do not interfere with each other during playback.

    - **Example**: When a student is playing a video about the rectum in a pelvis room, and the student is coming out of a room without stopping the video, The system immediately turns off the video playing.

3.4 Conceptual Framework and Adaptation Approach

The different topics which must be taught under a specific course by the provided domain model are known as course models (Yi & Mogilski, 2015). According to our proposed approach in figure 2, the user model has two sub-models. One of them is the 3D activity model, and the other one is the user profile. Demographic data related to the age, name, and gender information, is stored in the user's profile. In contrast, the use of 3D activity model is to collect and re-arrange information, and data of the user related to his/her activities in the 3D virtual learning environment. To drive the adoption of users, their interaction with different objects of 3D and their position should be evaluated and monitored (Schmidt et al. 2010).

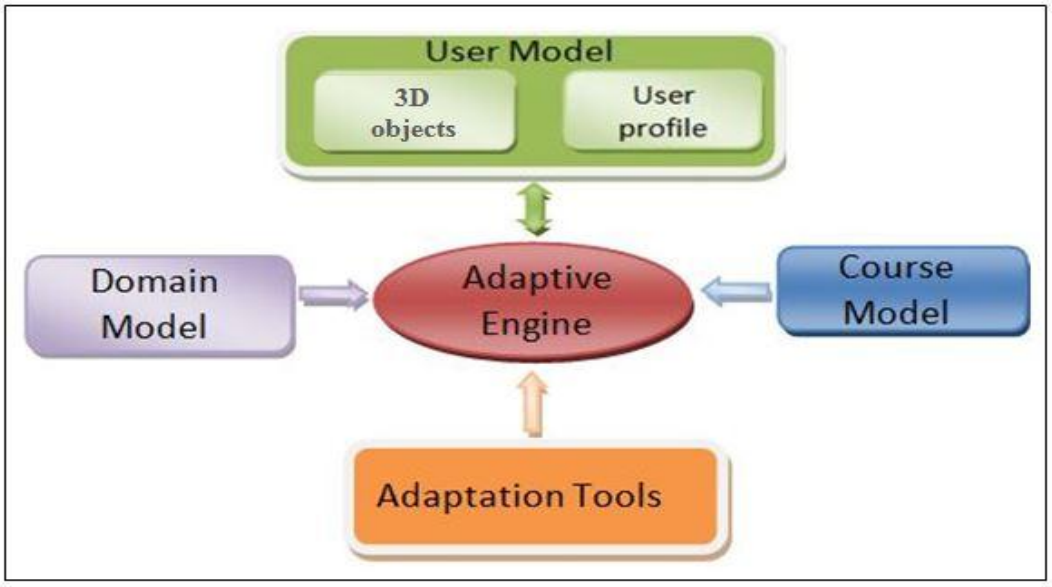

Figure 2Types of Adaptation Models

A conceptual modeling approach can be applied to different aspects of 3D VLE adaptive in order to achieve the objective of the 3D virtual environment and for adaptive e-learning. The model-based is for proposed approach and different specified models are applied for individual and separate models. The conceptual modeling is applied for

specific 3D VLE that can be applied particularly for four types of models such as adaptation model, domain model, user model, and course models. The prime important model is the adaptation model. All these models can be applied for 3D VLE and provide significant purposes and properties. For instance, the user model is a type of model that gets information and stores all information for the user. Through user model, the user can get any information on the basis of preferences, interests, knowledge, skills, and goals.

The different topics of a specific course material, which must be taught under a provided domain model, are called Course Model. According to ourapproach (Figure 3) , the user model has been divided into two more sub-models; one of them is the 3D Activity model and the other is known as User Profile. Demographic data related to the information of age, name, and gender of a learner user are stored in User Profile under his/her name. While the use of 3D activity model is to collect and manage information and data of the user that relate to his/her all activities performed in the 3D virtual learning environment. To drive the Adoption of the user, his position should be monitored by someone, and his interaction with different objects of 3D should be evaluated. Adaptation rules, adaptation types, The adaptation models are contained of outlines and 3D Virtual learning environment contents. On the basis of specific adaptation rules, the outline provides specific topics presented in the model.

Domain models have prime importance for learning concepts in courses and resources of these learning concepts. The adaptation models have the widest range of applications, while the main concerns in adaptation model are reasoning analysis of3DVLE. It can be

used to have instructions in 3D VLE for what, how and when analysis..

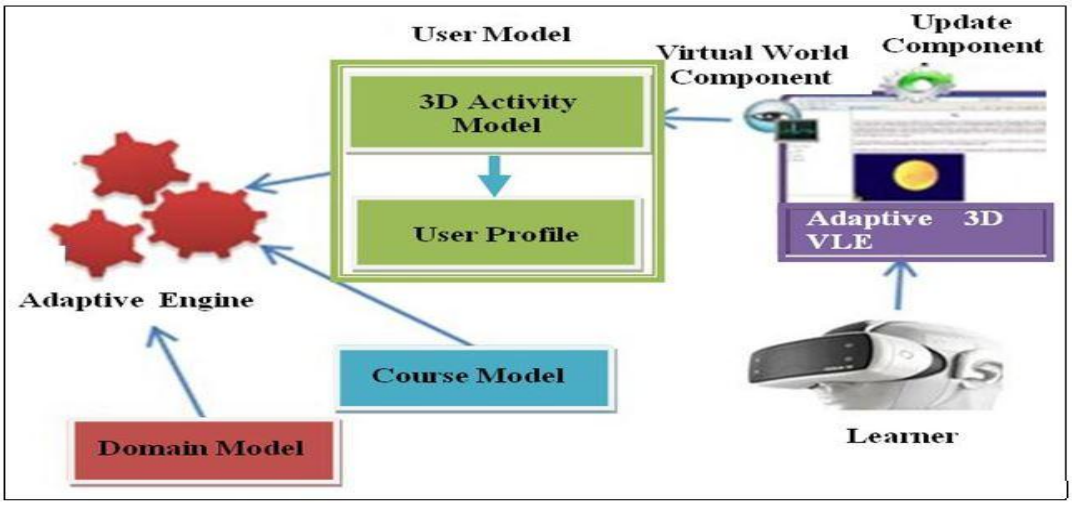

Figure 3:shows conceptual framework for 3D VLE adaptation

The adaptation models work along with adaptation rules, adaptation types..The adaptation models include outlines and 3D VLE contents. The outlines provide sequences of topics provided in the model on the basis of specific adaptation rules.

The adaptation models have applications in 3D educational systems that include gaming, videos, and audios. The adaptation models provide adaptive behaviors of different 3D virtual environments. It can be used to define storylines. In case of 3D gaming, the adaptation model provides the micro and macro level of adaptation. The first level in the model is related to concepts of storylines. The sequences of sub-topics that can be used for structural processes. Sequences of topics provide guidelines about the course materials. The learner learns about the path of study by having the glimpse of storyline content (Schmidt et al. 2008).

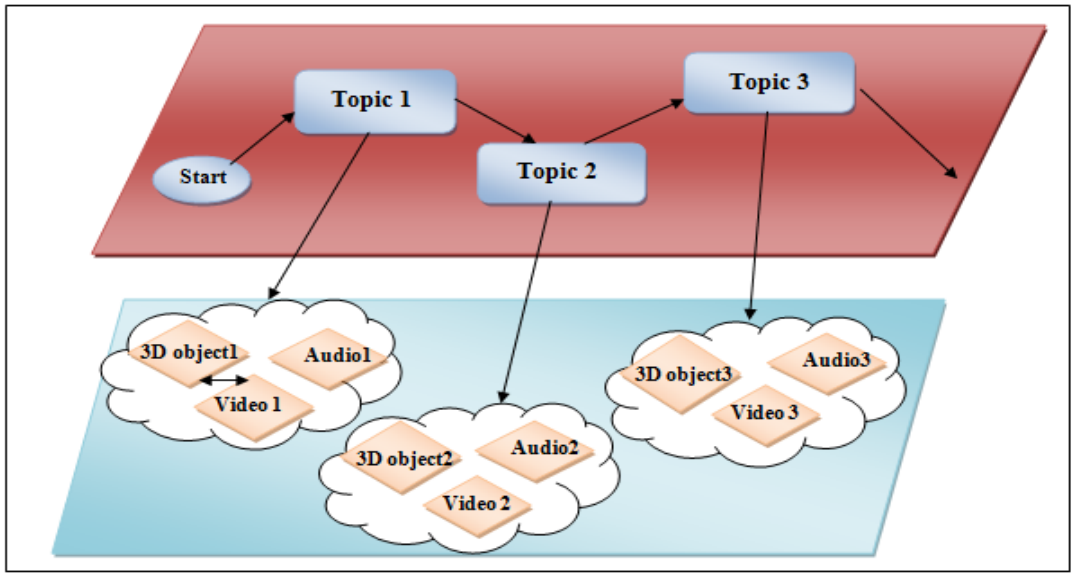

Figure 4:shows two- level specific type of adaptation model

As seen in figure 4, there are two specific types of levels in adaptation model. It should be adaptive to all the target learners. The learner needs to have knowledge about concepts and process of learning. The learning process needs experiencing and examination of 3D VLE and video and audio . The process also includes direct interaction with 3 D content. This level of adaptation is directly linked to users and provides guides for the mor learners (Ewais & Troyer, 2014, Schmidt et al. 2008).

In the second level of adaptation model, the main components are adaptation topic model. Adaptation topic model provides information about the behavior of the whole topic at individual levels. This part of the model contains specified content of what, how and when for completed content in the model. The combined details of adaptive models and adaptive topic models provide the complete adaptive model.

3.5 Summary

A conceptual framework was developed and presented in favor of 3D virtual learning environment adaptation. Basic design principles are mentioned and illustrated are important to design a framework of 3D virtual learning environment.3D virtual learning environment and the other similar functional technologies like virtual reality have a great influence by adopting these technologies: e-Learning process within educational institutes and academics can be enhanced. Through the use of 3D virtual learning environment, authentic and open-ended tasks are assessable for learners through which they can eliminate problems in learning. The 3D virtual learning environment support students in developing motivational attitude and engagement in learning. Regardless of its effectiveness, it is unable to minimize all pedagogy problems with the association of scaffolding. The low considerations for the use of adoption approach are for the education of the learner that is possible to bring out by adopting behavior and attitude. The factor that is really important but sometimes gets negligence in single user 3D VLE can be titled as communication. A Higher level of adoption requires more component numbers of components that should be more than one. This strategy is known as the adoption strategy.

Chapter IV

Prototype of the Proposed Adaptation Approach

"For the things we have to learn before we can do them, we learn by doing them."

Aristotle (384 – 322 BC)

4.1 Introduction

This chapter explores the research methodology providing the current use of technological utilities based on that scenario in the process of technology enhanced learning. It also presents the demonstrations of evolved 3D VLE system capable of providing e-learning using the facilities, especially for portable handheld devices (PHD) like mobiles or tablet PCs equipped with Android OS particularly. As a proof of concept, this chapter presents the potential implementation issues of an adaptive 3D VLE equipped with audio and video resources about Anatomy Course for second-year students studying medicine.

4.2 Approach and Method

This section presents the research methodology providing the principles for designing and implementation methods of a typical VLE. The said design method consists of users' interfaces design, user interactivities design, and database design issues. On the other hand, implementation method is explained by presenting the VR software, programming abstraction, and web implementation issues. Learning involves environmental, emotional, and cognitive information processing by a human being (Izard,2013). It also facilitates acquiring, experiencing, enhancing, and making changes of personal knowledge, skills behavior, and attitudes.

The current study work is conducted by developing a 3D VLE for PHD devices and using the utilities therein for learning .The main idea of this research is to investigate the theory about the possibilities and benefit of employing adaptation techniques for audio, video in the Adaptive 3D VLE. To prove this theory,,the researcher developed an application to measure the result and impact that the study will do when using the adaptation techniques. The ultimate objective of the application is to test the issues that are faced during implementation-of the adaptive techniques for audio, video and communications with a 3D VLE. For primary issues that need attention in this regard are presented below one by one towards developing the said VLE accessible through PHD.

4.2.1 Exploring Visual (Image, Video, and Animation) Elements

3D VLE is usually created with the multimedia elements as pointed in chapter 2. Based on that perception, It could be noted that two categories of the environment were discussed among which 3D environment takes the more crucial roles than 2D. To create such 3D environment, most important media elements are image, videos and animations. All of which are visual elements. Beside normal presentation of those visual elements, they are attached and integrated within the 3D models created in the 3D modeling software tools like 3DS-Max and Maya.

4.2.2 Exploring Audio Elements

Beside visual elements, other media element that makes virtual environment entertaining is -the audio. Users' actions and system responses must be demonstrated with the help of auditory elements alongside with demonstrations of contents which may be available in 2D e-learning applications. Almost, all 3D VR software provides facilities for integrating audio with the other elements available in the environment.

4.2.3 Exploring Interactions Elements

Users' interactivity is the main component of the VLE that makes it different from a movie or film, often used in the educational environment, especially in distance learning (Rennie & Morrison, 2013). At first, it should be differentiated between 3D editing applications (like: Autodesk Maya[2], 3DS Max[3], Cinema 4D, Blender) and 3D Engines (like: Unity3D[4]. Unreal Engine[5], CryEngine[6]) (Wang et al., 2010). The 3D editing applications are used to create 3D objects using creators and modifiers on objects and apply textures on objects to make it meaningful. For example: if we want to make Wooden Box, we must create 3D cube then apply the wood image on it to get Wooden Box demonstrated with help of the following Fig. 5 below.

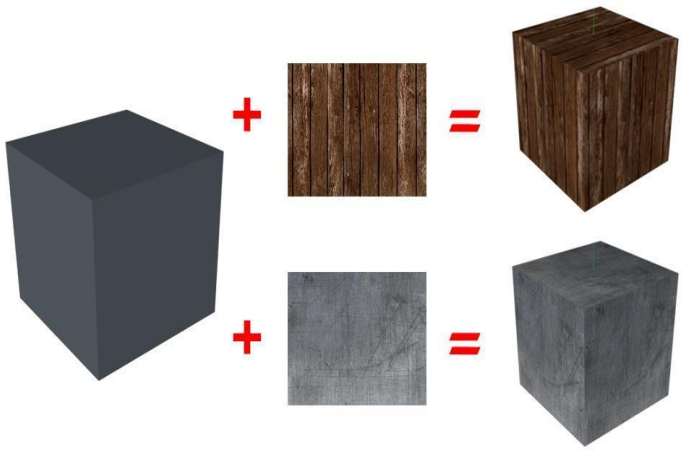

Figure 5Example of how to create 3D wooden cube

3D engines, on the other hand, add script on the 3D objects modeled in the 3D editing applications. For example, if we want to change the wood texture to metal texture by

[2]https://www.autodesk.com/products/maya/overview
[3]https://www.autodesk.com/products/3ds-max/overview
[4]https://unity3d.com/
[5]https://www.unrealengine.com/en-US/what-is-unreal-engine-4
[6]https://www.cryengine.com/

triggering by mouse in 3D engine, we must prepare the two textures (wood & metal), and check if the user click by mouse on the box to swap between the two textures.

4.2.4 Exploring VLE through Mobiles and other PHD

The developed VLE application demonstrated above, must be distributed in the APK format for installation in PHD like mobiles or tablet PCs. APK development software plays a crucial role for this purpose. Eclipse is one of the most used integrated development environment commonly used for this purpose of APK development.

4.3 Design and Implementation Methods

This section presents the research methodology providing the design and implementation methods of a typical VLE. The said design method consists of user interfaces design, user interactivities design and database design issues. On the other hand, implementation method is explained by presenting the VR software, programming abstraction and web implementation issues.

4.3.1 3D VLE Design Methods

- **User Interface Design**

User interface design consists of the following two steps:

1) Preparing the graphics files (2D and 3D both).
2) Arranging the backgrounds and icons in the interface.

It may be noted that the 2D graphics are the images, while the 3D graphics are the 3D model of human anatomy. We have searched free resources of 3D human anatomy, but they were not found sufficiently with details features. Even the interior parts of human anatomy were not detected as free resources. The application the study made covered all human parts according to stages the study has explained, so it needs interior parts of the human to describe the components of videos which are talking about. It may be noted that

significant efforts have been invested in building 3D anatomical elements using extended skills of realistic modeling, texture mapping, etc. from basic 3D graphics skills.

- **The complete model of human anatomy including:**
  - Cardiovascular System
  - Circulatory System
  - Digestive System
  - Endocrine System
  - Integumentary System
  - Lymphatic System
  - Muscular System (including both deep and external)
  - Nervous System
  - Reproductive System
  - Respiratory System
  - Skeletal System
  - Urinary System

And some of the 3D human anatomy models such as of male and female both were bought from Turbos quid website.[7]

- **Video production**

The user interface also contains many video elements. All the video lessons in the project have been edited using Adobe Premier. As the source of videos is original 6- DVD's we have bought, the videos were needed for editing and converting to another format to be compatible for mobile phones, the study has used Adobe Premier for that, then export it in separate stages. The study is editing, rendering and naming in custom syntax for parsing in C# because as it was mentioned, the study has used unity 3d to develop our application, which is multi-platform targeting application that can publish the same project for Android, IOS, WP8, and many other platforms. While unity 3d uses c# as

[7] https://www.turbosquid.com/

main programming language, the study mobile application was based on c#. Unity3d publishing the project for android platform directly without eclipse or net beans. Note that the videos are composed of Acland anatomy's DVD's encyclopedia[8]

While the study usually refers to "Metadata" concerning video, it talks about structured data that represents the characteristics of the entities described for the purposes of identifying, searching, evaluating and managing. For example, in YouTube world, it means that during the publishing of your video, you should take advantage of the appropriate areas for keywords tags, titles, descriptions, and even annotations and captions. When video files are placed in the appropriate video folders, video Metadata and posters are automatically downloaded from the Internet. The exception is home videos, whose Metadata needs to be edited from the very beginning. All of that "Metadata" assists search engines in serving your video as a relevant result when a user types in specific words. In addition to that, Metadata is used in searching the content of the video by two ways:

1. Segmenting the video along the duration into intervals for each subject in the video,
2. Tagging topics in the suitable time along the timeline.

However, in real sense of the word, Metadata goes far beyond on-page textual information when it comes to video. Metadata is particularly useful in video, where information about its contents (such as transcripts of conversations and text descriptions of its scenes) is not directly understandable by a computer, but where the efficient search is desirable.

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[8] https://www.amazon.com/Aclands-Atlas-Human-Anatomy-DVD/dp/B000K28XA2/

While Metadata is often associated with on-page textual information (titles, descriptions, etc.), it can be leveraged to provide more indepth information. Throughout the process of creating and publishing a video, there are many opportunities to provide video Metadata. For example, Direct Temporal Metadata, or time-based Metadata is information that is tied to the timeline within a video. A good example of one form of temporal Metadata is closed captions. However, timed-text can also include information regarding the time and the quality of music that is being played, where the scene is, when there is laughter, speaking, different subjects in the scene, etc… There is a ton of information or Metadata that can be helpful in relating to the content of a video.

The study has used Metadata retrieving video information when requesting a video for the requested lesson in specific stage, the system is integrated with "JW Player" SDK, where the study has hosted externally, videos by the same website JW-Player[9], after creating a free account and putting the study API ID for our account in Unity3D.

The study has segmented the intervals of videos into specific subjects, so when requesting a video lesson in VR System, the system requests the same subject in JW-Player website, that is searching for the requested subject by the hosted videos, then it retrieves specified interval of requests, those intervals are needed to play specific duration along the video timeline from start to end. The following fig. 6 presents the interface of JW-Player of video annotations.

[9]www.jwplayer.com

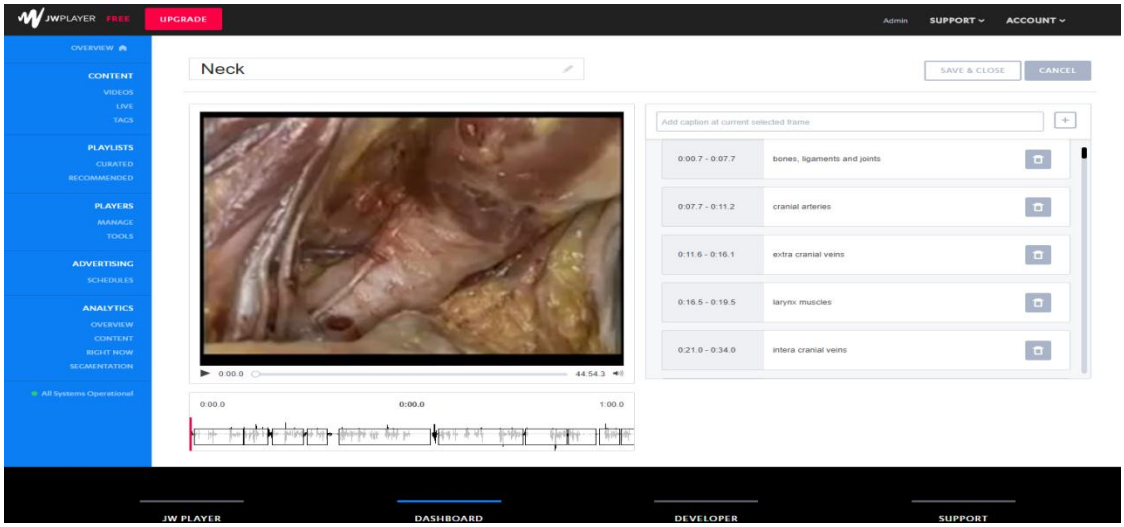


Figure 6JW-Player interface of video annotation

- **Interactivity Design**

There are many choices of software tools like Unity3D, Unreal Engine, Cry Engine for this purpose. But as the requirements of the project are to make it for the mobile, the study used Unity3D. Following, are the salient reasons for choosing Unity 3D listed below:

- Unity3D has thousands of resources (code, plug-ins, UI Elements and 3d models) .
- Unity3D is using different programming languages: C# and JavaScript, that we are familiar with it.
- Interacting with different Media Files: 3D models (fbx, ma, 3ds, obj.), Images (JPEG, PNG, TIF), Audio Files (wav, mp3).
- The good process of interacting with servers and online databases.
- Publishing to different platforms, WebGL, Android, iOS, Windows, Linux, MacOS etc..
- Best VR Application Editor, as big companies says (UBISOFT)

It may be noted that the developer should take proper care while transforming our thought from real to virtual world, because of difficulties and complexities that arise in the case of considering human length, walking speed, view, obstacles in VR world and many other issues. The 3D model of the human needs some editing, from the separation of interior parts to regenerate materials and textures, as well as, modifying the normal (reflecting) of the models because 3D engines cameras can see the model only from one direction. To do all that, we need to use 3D editing program where we can be assisted by different tools to accomplish this process, like, Autodesk 3DS Max, Cinema 4D, Blender.

Unity3D has simple user interface which is easy to understand. It is widely used.That means there are many developers around the world publishing VR applications & video games using Unity3D. Another point is that there are thousands of resources like: tutorials, plug-ins and pre-made assets in Asset Store that are for free to use or for sale. In addition, it is easy to import 3D objects from 3D editing applications just by copying and pasting it in Unity project directory. Following is fig. 7 that presents the easiness to use interface of the said software for understanding.

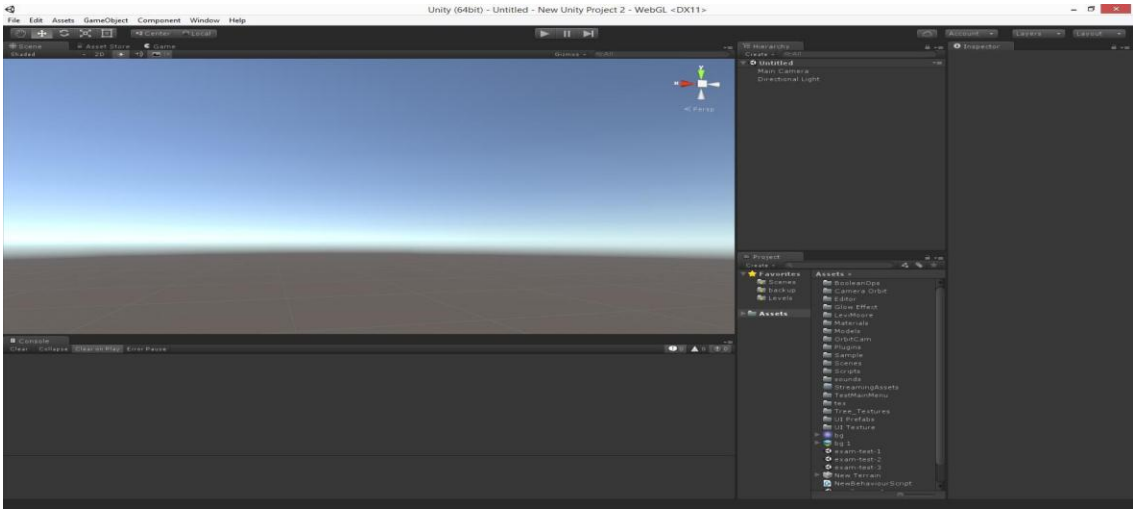
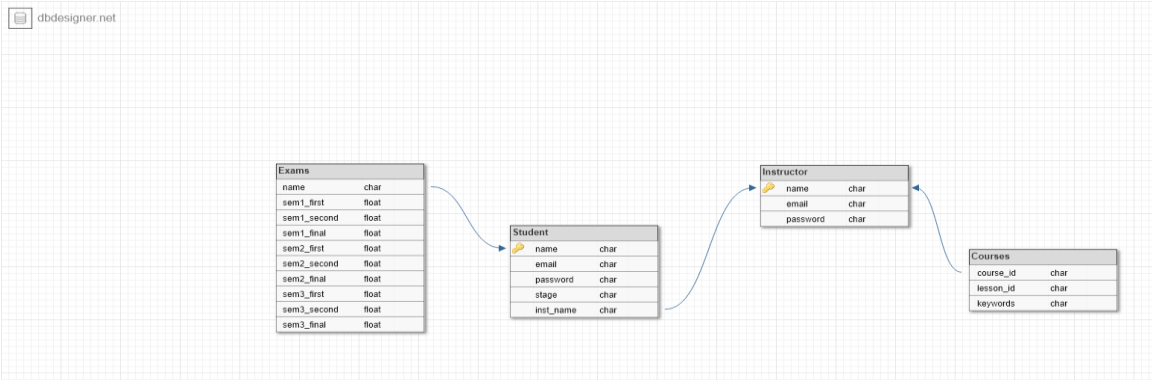


Figure 7 Interface of Unity 3D interactivity development platform

- **Database Design**

Databases are an integral part of any software project. The relational model of database design is often used in the projects in variety of domains. The database in this development consists of four main components shown below in fig 8:

1) Instructor.
2) Student.
3) Course.
4) Exams.



main component of database

Appendix I presents the above mentioned four components in the form of a component diagram. This figure also demonstrates the interactions among the different components of the database. These four components are normally represented with the help of four tables with different attributes given below.

The Instructor table contains the following attributes: name, email, pass, and forgot. The Student table contains the following attributes: name, email, pass, forgot, stage, inst_name, knowing that inst_name is the teacher associated to the student. The Course table contains the following attributes: course_id, lesson_id, andlesson_link. Course_id is the teacher's responsible for the lesson,lesson_id is the name of the lesson and lesson_link is the video lesson link.

Appendix 2 presents the class diagram for all the classed that were used for the database.

When the student login successfully, the application retrieves his stage from the database on the server based on his username, by sending his name to a specific web page has written with PHP programming language, that use GET method the retrieve it, and it make connection with the database, after that it retrieve the stage based on the username from the database and post it the the same page, the application read the result from the page and parse it as integer number, and based on it the application can specify in which part of the human anatomy the player belong. So this is how we get the stage from database

4.3.2 3D VLE Implementation Methods

- **Virtual Reality Software**

There are two main purposes for creating VR content with virtual reality apps. Some apps are for developing VR application for mobile and PC, and other apps are for creating VR videos,360 images(Wang et al., 2010). The development of software is already divided in two subcategories as described above: modeling software and interactivity development software. However, playback takes place in two ways: in stand-

alone application and through web browsers. The development approach for these two distribution types is expected to be different with respect to media design and interactivity design considerations. The current work will use the interactivity development software approach.

- **Programming Abstraction**

To make something interactive, it needs to be programmed. Every image, 3D model, sound, icon, etc. will become a written code to interact with it. The scripts we have written are for the following purposes:

Moving main VR character and make it target a specific area of human anatomy, program the triggering function by mouse using Ray casting Camera Technique. In order to check out the object ,we click on and give the feedback to the user about it.

Register & login the students and instructors, using GET, POST methods in PHP, by sending values to custom web page that sends the values to the database, and make some operations to get the result.

- **Navigating between different scenes.**

  - Giving feedback in the main menu by playing sounds, coloring specific areas and displaying text messages on the screen.
  - Loading the video links and lesson names from database and insert it as buttons in a scroll list, and make it intractable to play the video inside specific area.
  - Updating the video links and the stage of the student when he watches half duration of the video of the lesson.
  - Playing the videos using WebGL Library, and navigate the video (play, pause, stop, display the video duration and timeline).

- Checking the time to exanimate the student and specify the correct exam according to the student's level and marks .In addition to that, displaying the questions and checking the correct answers.
- Loading teachers names in the student's registration scene, loading students names in the instructor main menu scene, and load student marks from database when clicking on student name and load the marks in the diagram.
- Labeling the 3D parts of the human anatomy, and display the label when the camera is near of the part we looking for, by calculating the distance between the 3D part and the position of the camera and make it oriented to the camera.

Animation for Doors and Anatomy Parts.

- Web Implementation

One of the important sides in the project is preparing Web Server to handle registration and users data operations. There are lots of operations done using web server like: user registration and login, retrieve user stage, retrieve list of instructors, retrieve exam & its marks, updating user stage, updating the instructor of the student, and much more.

The above processes are designed with the help of thegiven in appendix II. The whole design is divided in to eight classes in the object oriented design approach. The classes are Exam Manager, Exam, SelectVideoSystem, LevelSlider, LevelLoader, MainMenuSelection, GetInstructorData, and Instructor Data. The inside data types and methods are given inside the class presentation block in each classes. The names of individual classes demonstrate the assigned tasks to itself. However, some of the classes redivided into two sub sections.

All of those operations done between Unity3D and web server using "www" class in Unity3D, by posting values to web page using its URL, or downloading text data from web page by downloading its content after posting values to it.

```
using UnityEngine;
using System.Collections;

public class UpdateInstructor : MonoBehaviour {
    string stname;
    public string instname;
    GameObject stData;

    void Start () {
        stData = GameObject.Find ("StudentData");
        stname = stData.GetComponent<StudentData> ().stName;
    }

    public IEnumerator makeUpdate(){
        WWWForm form = new WWWForm();
        form.AddField("name", stname);
        form.AddField("inst_name", instname);
        WWW www = new WWW("http://localhost/anatomy/UpdateInstructor.php", form);
        yield return 0;
    }
}
```

Figure 8Code snippet example written in Unity 3D for the purpose mentioned above

Following fig. presents an example of code snippet visible through web browser after getting it developed through Unity 3D

Figure 9 Example of code snippet visible through web browser

4.4 User Perspectives on 3D VLE Utilities

1. Learners Utilities in the 3D VLE

The project designed for PHDs that support VR, and it can be used through setting up of the VR Glasses on the mobile after installing the APK file of the project on the device. The environment looks like rooms and halls in hospital, which has doors to go from stage to stage, and scene to another. The interaction by learners is done through two steps:

- Moving the head after setting the VR headset comfortably on our head, then looking around ourselves.
- Aiming the middle point and click enter on the wireless remote control or on the VR headset.

The first scene is setting our character in a room. The room has two doors (Student and Instructor) in front of us, and exit door in behind. If we want to enter the student's door, just we have to aim on the label above the door and click in venters.

We will enter into the student portal room. We can enter into instructor portal by clicking on the label above instructor door on the other hand. Clicking on the Exit label above the door, we will exit from the application. It may be noted that, the player character is looking from first person camera where the camera is looking like human eyes with suitable distance over the ground (160 cm), to make the user feel comfortable.

- **User Registration and Login**

If we enter into student portal door or instructor portal door, we will go to different scenes for each one. In each portal, we will see login panel over the wall, and between the panels and us. There is virtual curved keyboard. If you want to login, just click on the username label then we need to aim to characters on the keyboard to start entering our username. While entering password, the same process is followed by clicking on login to check our input data on the server and continue the process. The appendix III presents the login, registration and other activities in the application with the help of an activity diagram. Moreover, the following figure 10 annd 11 demonstrate these activities. Whereas, figures 12,13 and 14 present some views with zoom of these interfaces for detaining.

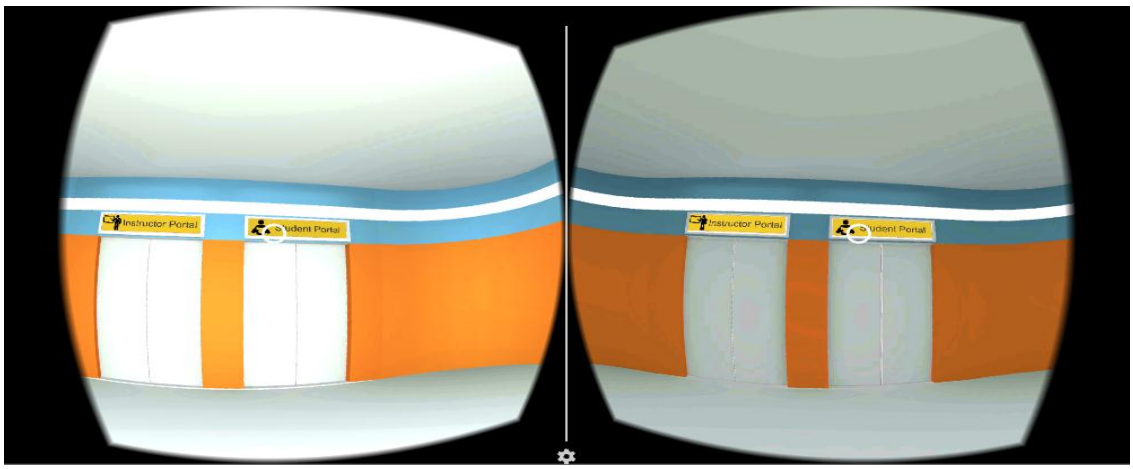


Figure 10 Sequence diagram User interface before user registration and login

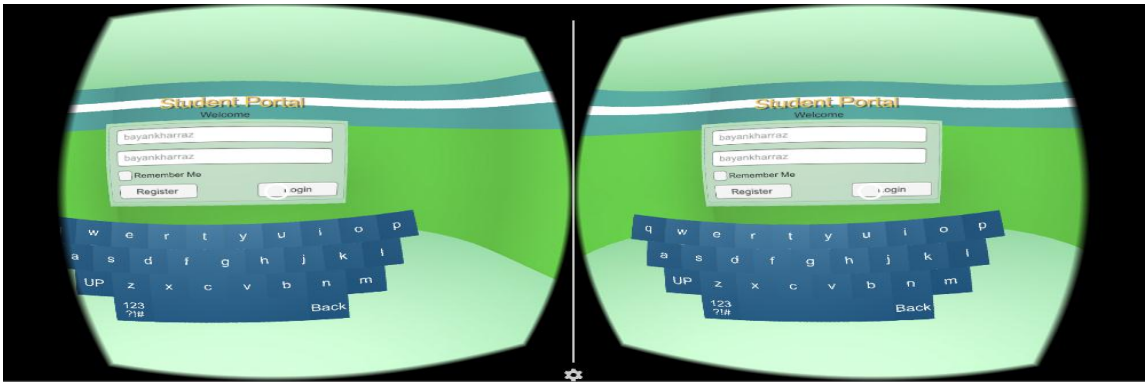


Figure 11 Sequence diagram User interface for registration and login

Figure 12 Sequence diagram Zoom view of the interface before user registration and login

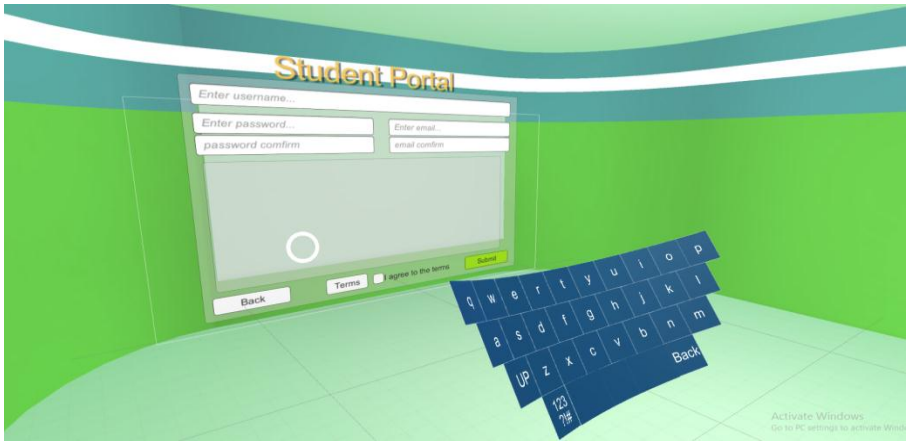


Figure 13 Sequence diagram: Zoomed view of the interface during user registration

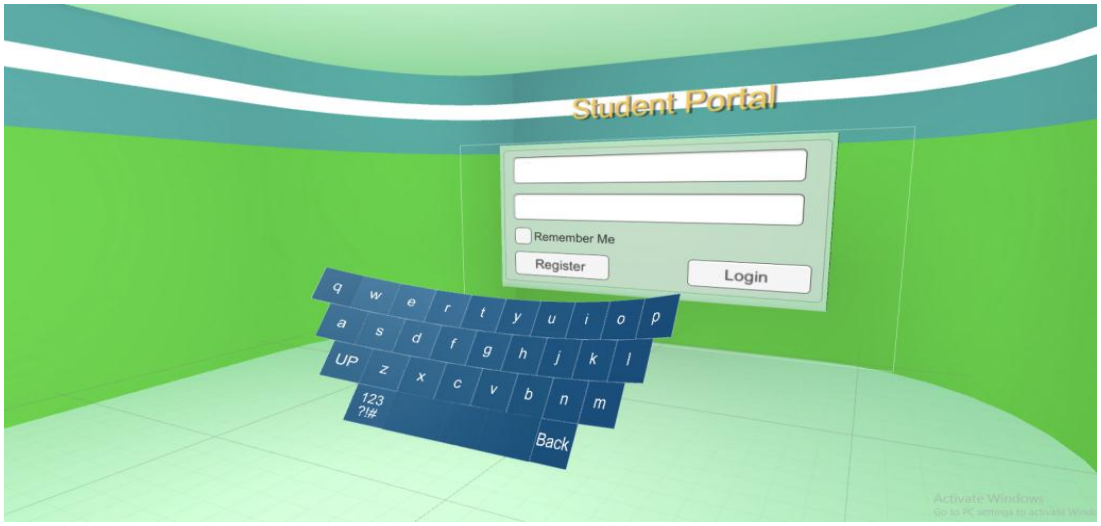


Figure 14 Sequence diagram Zoomed view of the interface during user registration and login.

The window of sign-in and sign-up for a new account appears first, while the application gets started. If we do not have an account, we can register as a new account by pressing on Register, and then fill in our information (name, e-mail, and password). Here, we have to choose the name of the instructor we want to interact with or join, taking into consideration that the list of names of instructors is invoked from the database. later, the system processes the parsing to identify the names of each instructor individually, and put each name within a Button that will be listed in a special window in a form of scroll window to assimilate many names as possible. After the successful registration of a new account, the student starts from the first section of the first semester of the lesson and a message of success in the registration process appears. If you already have an account, you can enter your login name and password and then click the login button. Upon successful login, all student's data will be invoked from the database (such as the level and name of the associated instructor).The system will run accordingly.

- **Virtual Tour Example of Learning**

This section presents the research methodology with the help of demonstrating a typically developed virtual learning environment with the help of the schemes described in section 3.3. It may be noted that the user interface design for mobile application is different from that for PC applications. In the mobile and PC applications, the user uses his/her mouse or finger to move the pointer on the screen (i.e. on the touch screen) to interact with the application, and the UI elements (images, text and input windows) are flattened on the screen. The following fig. 18 to 23 presents the learning user interfaces of the developed application.

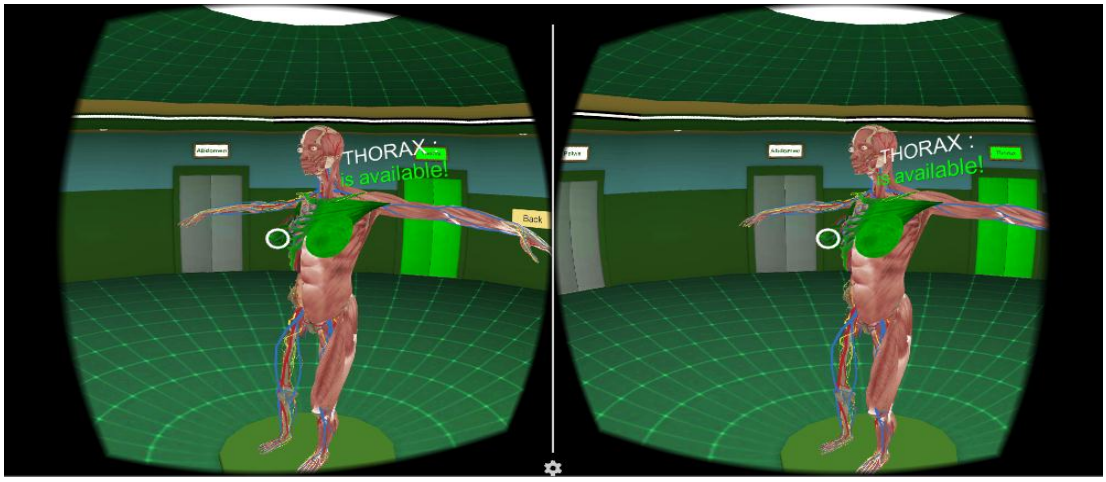


Figure 15 Sequence diagram Mobile view of thorax section of the VLE

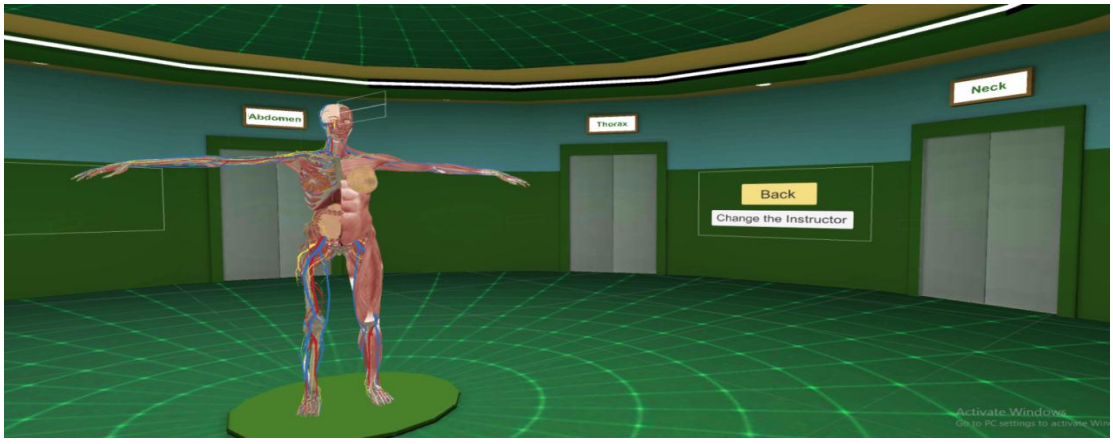


Figure 16Sequence diagram Main student window of the VLE

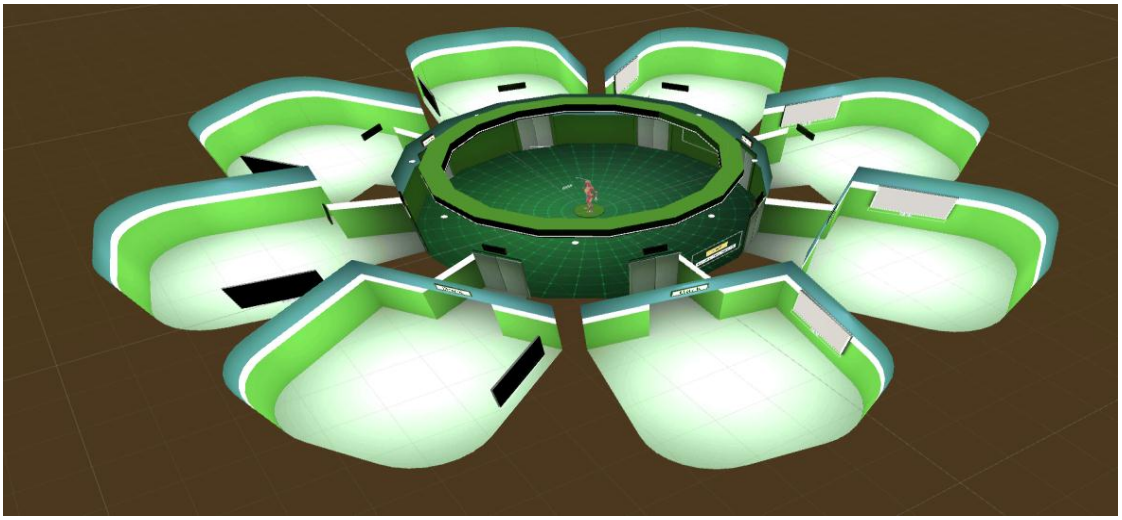


Figure 17 Sequence diagram Eight evenly distributed doors of the VLE

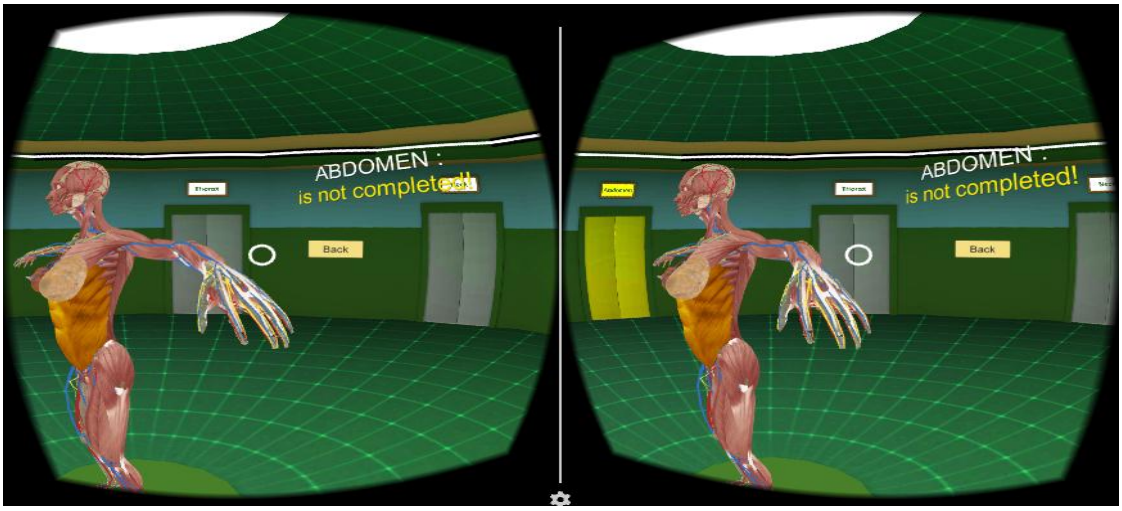


Figure 18Mobile view of the current level of the VLE

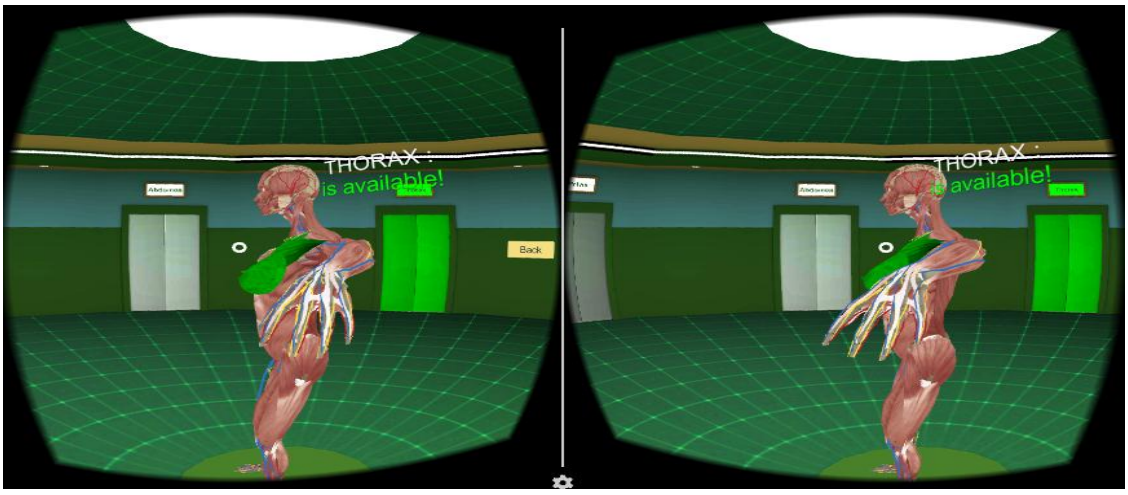


Figure 19 Mobile view of higher level than current level of the VLE

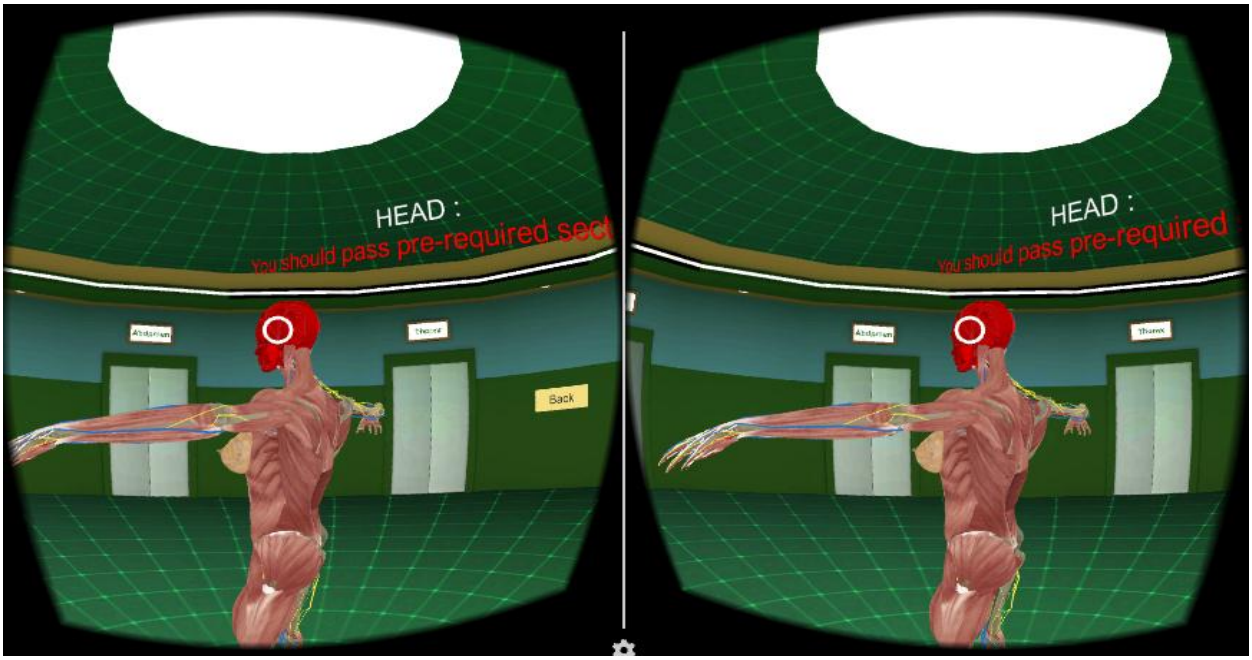


Figure 20 Mobile view of lower level than current level of the VLE

It is shown that the elements are flying on the space or standing on panels and walls, while interacting with those elements are done by aiming the center point by moving the head around and clicking on enter button on VR headset or using wireless remote control. The level is expressed as (an integer) starting at 0 and ending at 86 according to the number of existing lessons. The order of lessons starts from the Thorax section (fig. 15 and 20), which consists of lessons,lesson 0 tolesson 6.Then Abdomen section (fig. 18), which consists of lessons from lesson 7 to Lesson 20 and so on. The value of the level is calculated and through,we can specify the stage reached by the student. Thus, we reduce the data entryto and from the database instead of expressing the level by (string) value.In addition to increasing the efficiency and speed of the programming code basing only on the numerical value (the level) and its analysis to get the stage reached by the student.

In the middle of the virtual room, a human body appears in a three-dimensional (3D) form, in addition to eight evenly distributed doors (shown in fig. 17). When clicking on

any area in the human body, the system examines the area that was pressed according to the student's data that was invoked from the database represented by the level and the stage.The result is as follows:

- If the area pressed by the student is in his/her current level, a message appears on the screen stating that the area being pressed is partially available to him and a positive sound is issued. In addition, the area color is also changed to orange (fig. 19) and the color of the door for this stage. Within two seconds the body of the viewer will be moved to the door of this stage and when approachto him/her, the door opens and when entering the room of the stage, the door closes.
- If the area, pressed by the student, is higher than his/her current level, a message appears on the screen stating that the section he or she has pressed is not available and a sound indicating that isnegative. The color of the area and its door get changed to the red color (fig. 20) and the student will not move to this section.
- If the area pressed by the student is less than his/her current level, a message appears on the screen stating that the pressed section is fully available and a voice indicating it's positive is issued. The color of the area gets changed to green (fig. 21). In addition to the door of the stage and within two seconds, the student will be transferred to the section as in the first step.

When entering the main screen (fig. 13), the system checks the level of the student. In the case where the level is the first lesson in the section, it shows a button to change the instructor associated to him/her. By clicking on his/her name, the list of instructors appears and thus the student chooses one of them.Once selected, the system makes update to the name of the instructor associated with him/her in the database.

- **Virtual Tour Example of Examination**

Examination (Exam) (fig. 21) module has been implemented in the VLE with the following features. Nine exams were adopted, divided into 3 semesters. In each semester, the exam is conducted in three levels: first exam (25 degrees), second exam (25 degrees) and final exam (50 degrees). Depending on the level reached by the student(which we talked about earlier), the process of identifying the subject and the quality of the exam (first, second and final) is related to the level reached by the student. When the student login, the level will be checked. If the level reflects the first lesson in each section, the system invokes the questions of the department as follows: If the student has completed the first section and moved to the first lesson in the second section, the first exam related to the first semester will be invoked. In case the second section is completed and once entering the third section, the second exam related to the first semester will be invoked. Upon completion of the third section and beginning to enter the first section of the second semester, the final exam will be invoked, and so on. Each question of each test consists of the question text and five (5) answer options. In addition to the explanatory picture of the question, if the student answers the question correctly, a value of 2.5 score will be counted in his balance, which will appear at the top of the screen and he/she will move on to the next question. If the score is high, all lessons will be activated for the section following the current section of the student. If the score is intermediate, the student continues the lessons sequentially from the next section. If the score is low, the student will be returned to the level he reached from the first lesson. A message will be sent to the instructor responsible for that student and asked if he wants to repeat the same previous videos to the student or he wants to change these videos, and he will change the

links and create new videos. The student level on the database will be automatically updated once all the questions have been completed (fig. 22).

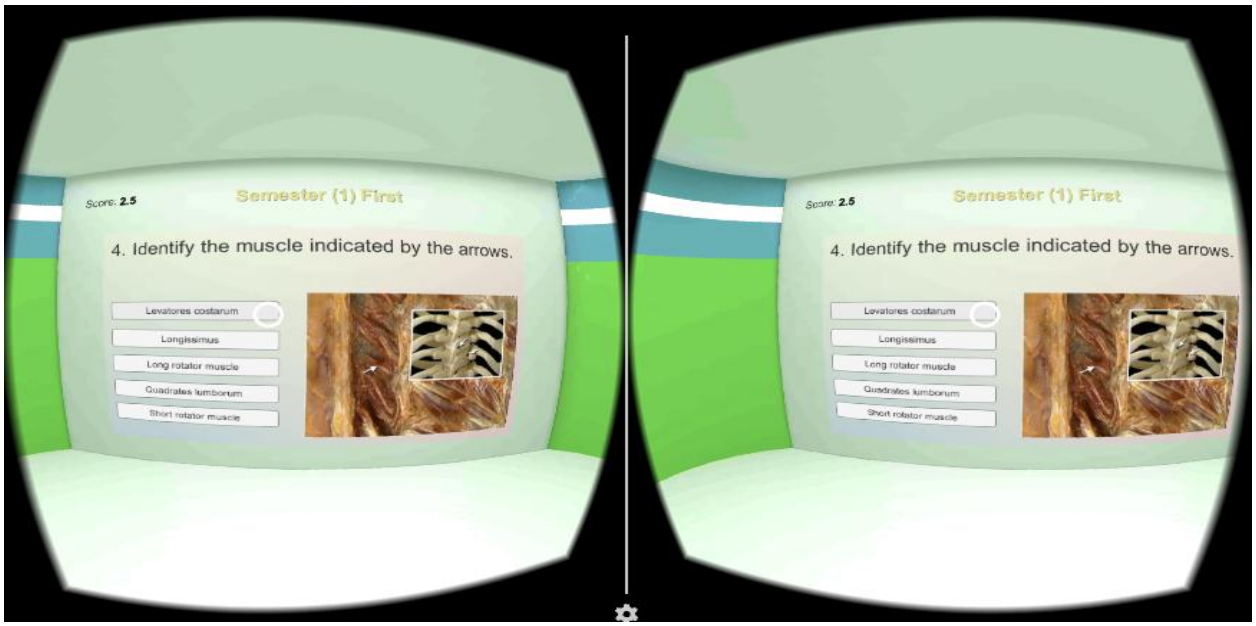


Figure 21 VLE interface of learner's examination

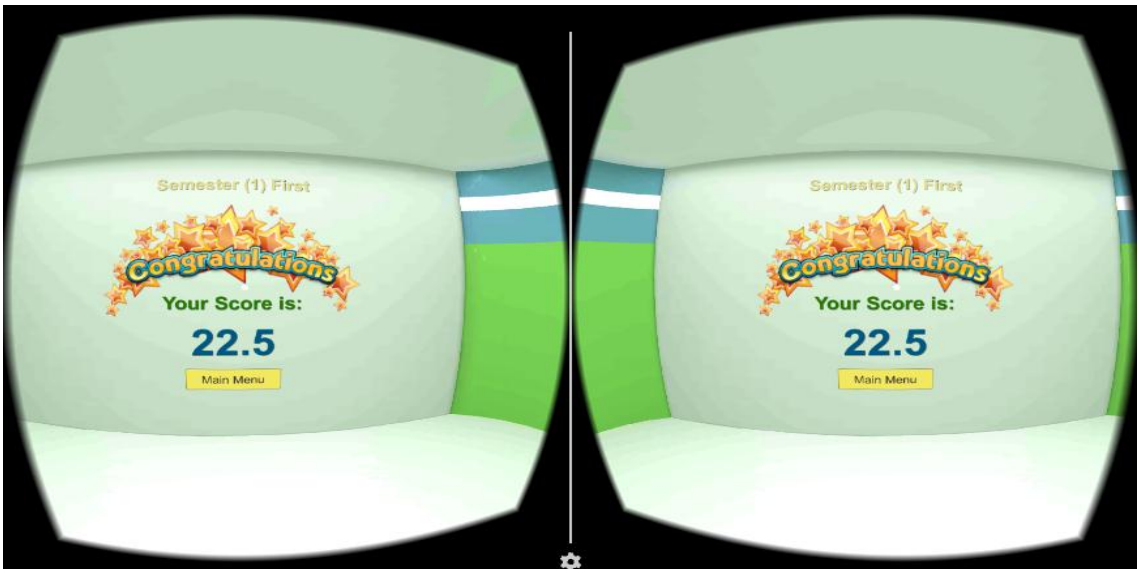


Figure 22 VLE interface after successful completion of a exam level by a learner

- **Learner Adaptation Issues**

When clicking on any section on the human body in the main screen of the student, the body will move to the room of that section, and shows the part of the human body of this

section and the links to video lessons from the database will be invoked and analyzed. The part of the current section will be chosen and split in the form of buttons and placed within the scroll window using the parsing process. The lessons chosen by the instructor are associated with the student. Each button in the video list consists of the name of the lesson and an indication icon indicating if the lesson is available or not. If the lesson is available, the button is activated and a green indicator is displayed. If the lesson is not available, the button is disabled and has no correct indication. The current level is checked then and it is compared to the start and end of the level number of the 86 videos and reducing the area that relates to the section. It gives a correct signal from the beginning of the section's level to the level reached by the student. The rest is to disable the buttons and to hide the correct signal from them. The process of watching the lessons are sequentially from the first lesson until the last lesson of each section and in the case of watching the half of the duration of the video (fig. 24). The lesson that follows the current lesson will be activated, so that the level is updated on the database and the next lesson is activated automatically. Following fig. 23 and 24 present the interfaces of VLE users are experiencing, while learning in the adaptive environment.

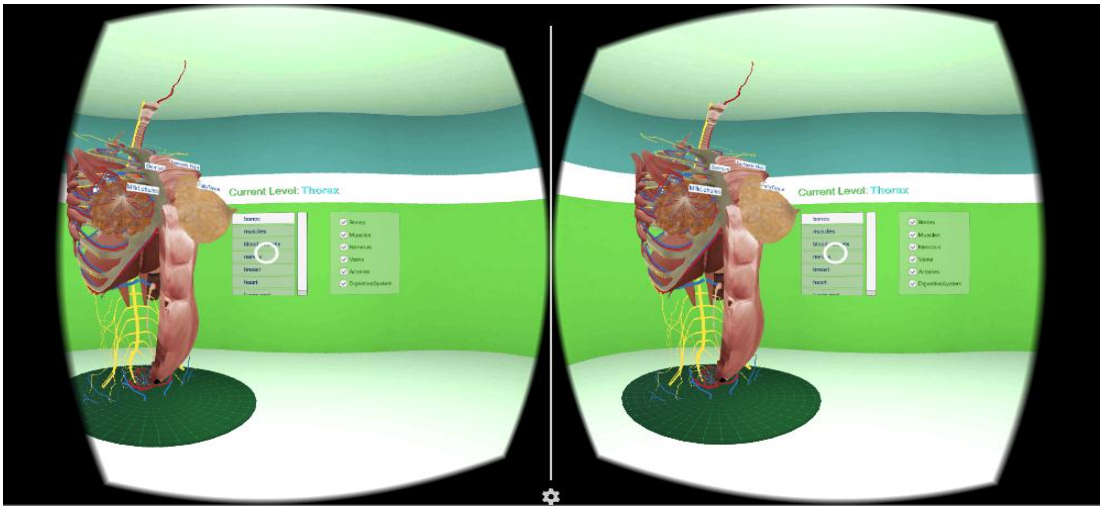


Figure 23 VLE front wall shows the list of the lessons

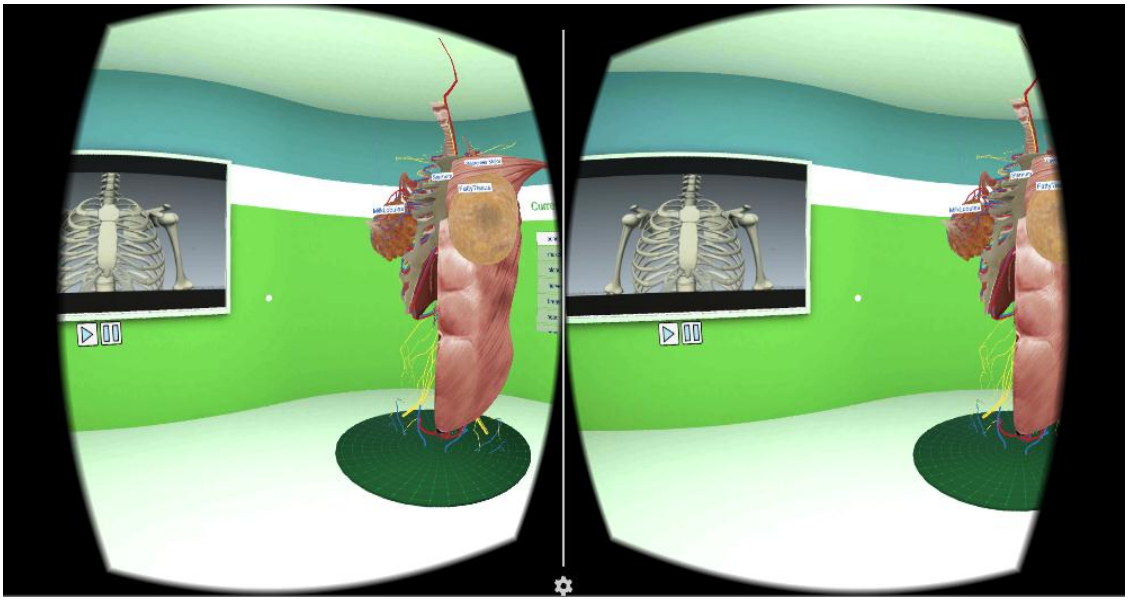


Figure 24 Video lesion shown in the VLE

In the room of level that is pressed, a moving part of the human body appears turning around Y axis continuously. The front wall shows the list of the lessons mentioned above (fig. 23). When you press on any lesson, the system starts loading the part of the lesson

that was pressed from the private server of the system to start playing the video and explaining the lesson.

2. Instructors Utilities in the VLE

- **User Registration and Login**

The process of registration and logging for instructors are similar to students' registration and logging except the difference in internal database manipulations. If 'the instructor does not have an account', s/he can register a new account by clicking register button and filling his or her data (name, email and password). Here s/he needs to select the links of videos for each lesson (level) and the number of the links is 86, which is in a form of list within scroll window. The links are default links for all teachers who intend to register in the program and can be changed according to specific conditions given below.

- The process of naming must start with the name of the section (thorax, abdomen)) followed by the (_) and then the name of the video lesson and then (mp4).
- The video file link should be included in the streaming assets folder in order to increase the protection and security of playing video files and not play any videos from suspicious links. In addition, this folder is the only one that Unity3D handles to play videos that require Streaming process.

Following Figure (25) presents the interface of instructor's registration and login.

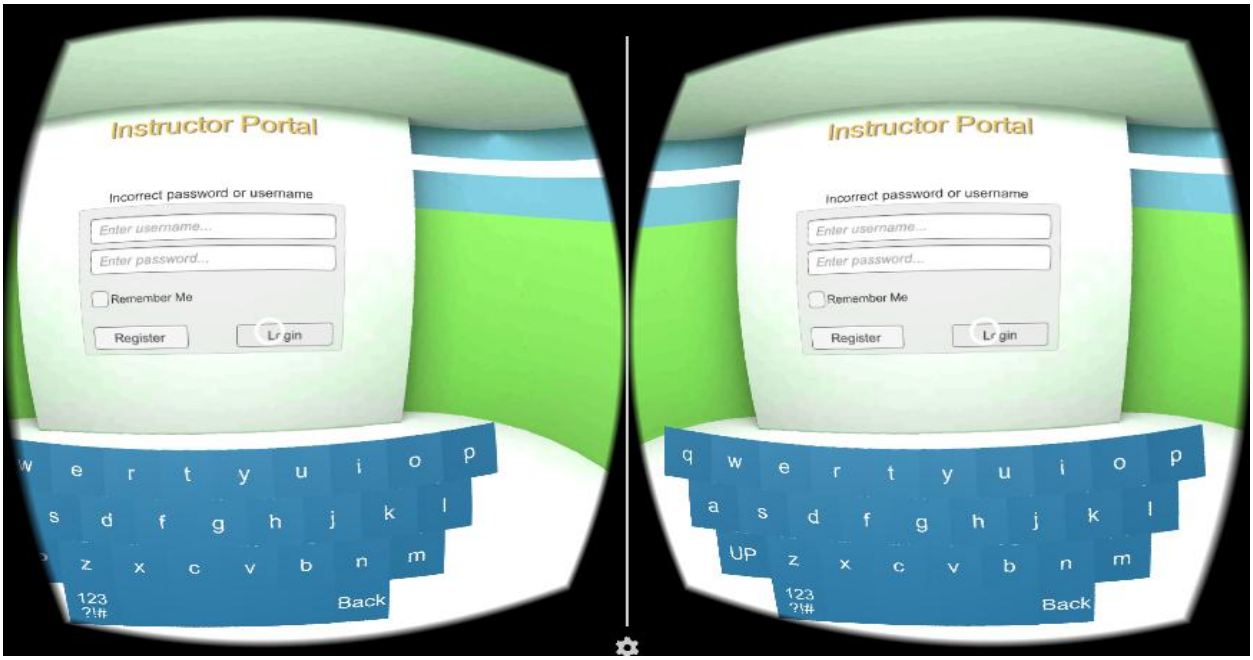
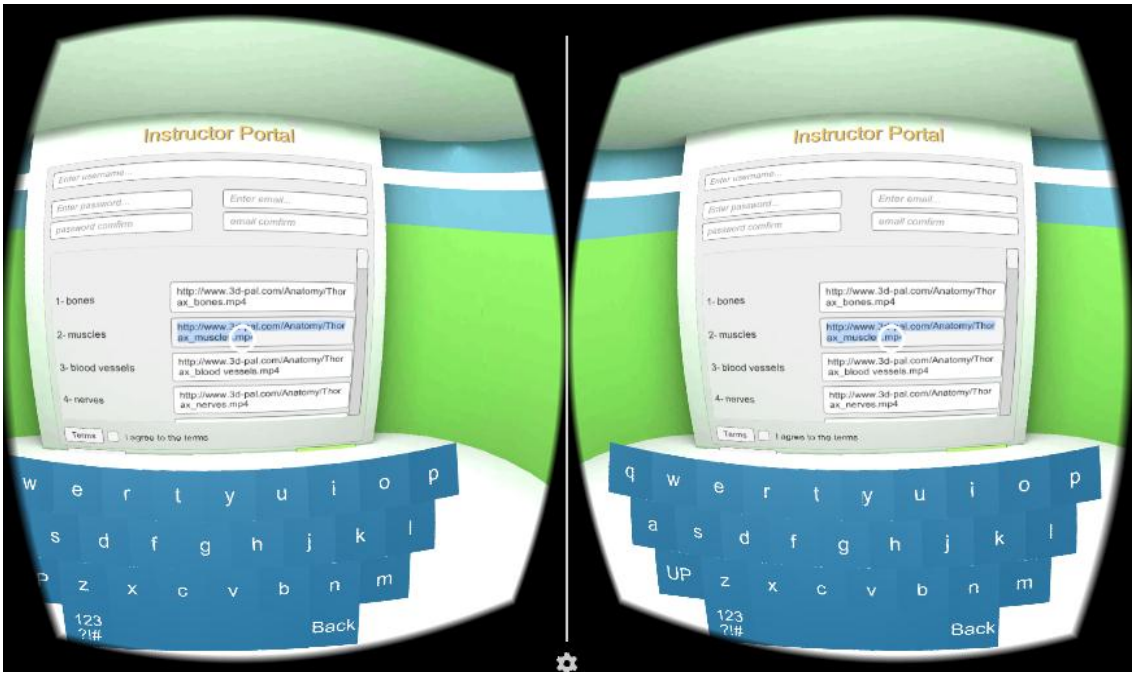


Figure 25 VLE interface of instructor's registration

- **Instructional Design Issues**

If instructors already have an account, s/he can enter the login name and password and then click the login button. Upon successful login, all the names of the student's associated to the instructor will be invoked from the database and put inside the buttons within the scroll window. The following fig. 26 presents this scrolling window for instructors for navigation.



Example of VLE instructional design for instructors26 Figure

When instructor clicks on a student's name, the 9 test scores (previously mentioned) are invoked in a form of string, containing each exam score in order and separated by a comma (,). Parsing is done on the student's scores and inserted in order, in numbers and a diagram showing the relationship between each exam and the degree obtained by the student. The process of labeling and charting depends on the creation of Prefabs containing the form of the outline, the mark and the type of the exam. These Prefabs are created in order for each exam starting from the first exam until the ninth exam respectively. The creation of these Prefabs depends on the exam not finished by the student, and thus it shows only the scores of the exams passed by the student.

4.5 Summary and Conclusions

This chapter presented the results of some investigations of developing an application to provide adaptation issues for audio, video and communications in the context of adaptive 3D VLE, specifically for the Android OS platform. Audio and video annotations based

web platforms primarily helped to facilitate the adaptation features of audio, video and communications in the said VLE. Necessary software designs issues of the present development are explored with the help of presented class diagram, component diagram, sequence diagram and user interfaces of the developed software as a case of 3D adaptive anatomy course development for medicine students to offer VLE interfaces. This work offers audio and video adaptation featured comparable to that presented by (Alam ,Ullah ,2016) for a chemistry course as a case. Such experiences may be useful for developing applications for other platforms like Windows, IOS and could be explored in future if web platform seems insufficient for the said purpose. The results proves that the above 3D VLE offers adaptive behavior as an evidence of our enhancement in this research which is presented based on the above reported investigations. Adding some more pedagogical aspects of learning, may be expected within the adaptive environment from the developed VLEs with suitable choice of media elements and interactivities.

Chapter V - Evaluation

5.1 Introduction

Research evaluation is a vital tool where the purpose of research is anchored . Without research evaluation, it would be difficult to judge and validate the quality of the proposed approach. Therefore, this chapter presents a detailed methodology for evaluating our proposed system's prototype, as well as, the research techniques that are followed to ensure the research topic was effectively analyzed, with the exploration of important and informative related literature. Also, for statistical analysis, this study employed descriptive statistics, stylized facts (data plot) and correlation matrix. These tests were performed to ensure that the objectives and goals of the study were achieved. Conclusively, this chapter constituted; type of research, research design, a method of data collection, questionnaire design, purpose of research evaluation, data analysis, and statistical tests employed.

5.1 Type of research

This research is descriptive because it deals with the findings of facts to support the research claim by either, proving or disproving the research hypotheses. According to (Tondon,1989), descriptive research has to do with the implementation of survey and information gathering to examine a particular event or research problem. One of the goals of descriptive research is to evaluate an event, by stating objectively its implication to a certain scenario at a point in time. Descriptive research is perceived to be unbiased because the researcher has no control over the outcome of the research. The research results are obtained from statistical tests, and they exclusively reflect the data analyzed. In other words, in descriptive research, the researcher is only expected to interpret a result

as projected by the research, but not allowed to influence the research findings from a subjective point of view.

The variables used are control free as their behaviors cannot be influenced by the researchers but the outcome can be estimated, and recommendations can be prescribed on the bases of the results interpreted.

In this chapter, we conducted an evaluation of the application from two important aspects: first, measuring the impact of using this application on students' results and whether it has an impact on improving their achievement results. The other side is the evaluation of the application by the user in terms of user satisfaction and ease of use through the online questionnaire

5.2 Student result evaluate

In this section we have followed the method of evaluate the application based on the results obtained by the students during the use of the application and this method has been adopted by many studies and research, including studies looking at subjects close to the study, as mentioned in Chapter 2.5 to measure the impact This application improves the level of cognitive student and is done based on the following steps:

1- In the first stage, the course was explained to the students through the doctor who gives the material and then the doctor conducted a theoretical examination for the students who number 15 students.

2. After the test, the students were divided into two groups:-

A - The group A used the application and re-attend the explanation of the substance of the Thorax, but this time through the application and when the completion of the

explanation of the material using the application were tested through the application in the article again and the results were as shown in the following table:

Table2:group A result

		Theoretical exam thorax	App exam thorax
1	Raya.yassin7@gmail.com	19	21
2	Nooon.1995a@gmail.com	15	19
3	mabulubade97@gmail.com	18	21
4	drshifaanamer1917@gmail.com	20	23
5	ayasoroghle40@gmail.com	22	23
6	raimona@list.ru	19	21
7	faten. badah18@gmail.com	18	21
8	la.ballout@gmail.com	71	20

b- The group B of students was explained the following part of the substance of the Thorax, namely the abdomen , but through the application only without prior explanation by the doctor who gives the article and therefore this group has been explained by the Thorax through Dr. who tested them and then used the application to see and learn to explain the article Following the anatomy and then take the exam within the application and the results are as shown in the following table:

Table3:group B result

		Theoretical exam thorax	App exam abdomen
1	Nadiehabdallah@gmail.com	18	22
2	S.o.sh-love@hotmail.com	20	23
3	Olfat20_2_1993@hotmail.com	12	17
4	An98anfel@gmail.com	17	18

5	wassandamrah96@yahoo.com	20	20
6	L.thuluth@gmail.com	16	17
7	abeer.arman12@hotmail.com	12	20

As noted in the previous results of the students, the results showed significant progress in the results of the students during their use and dependence on the application to explain the anatomy and this is an

5.3 Methodology and the goal of the quantitative research

As mentioned in Section 1.5 (Research methodology), there are two fundamental approaches in research analysis namely quantitative research approach and qualitative research approach (Kesby, 2000). While qualitative research is concerned with the subjective analysis of an event or a phenomenon and allowing the research to explicitly exhaust a point of view that is skewed to the perspective of the researcher, giving room for the evaluation of the behavior of the research topic (Wyse, 2011). Quantitative research on the other hand is an objective analysis of variable and quantitatively generated data primary to the research scope (Wyse, 2011). Quantitative research approachis quantify the problem by generating numerical data that can be transformed into suitable statistics, quantify attitudes, opinions,behaviours . This research is a quantitatively driven research, analyzing and investigating the possible adaptation techniques for audio-visual in the context of adaptive 3D virtual learning environment using Anatomy VR course. To capture the objective of the research, it requires an inferential approach of quantitative analysis and also requires the formulation and collection of data and using the data to make inferences and/or draw conclusion on the relationship of the research population. The use of inferential technique necessitates the

execution of a survey analysis capturing population sample which will be studied and analyzed on the construct of the research questions. Hence, this study shall adopt an inferential technique of quantitative research to critically evaluate the objectives and further bring to understanding the research questions of this study.

This study requires the development of a survey, formulation of questionnaire and the collection of data which is achievable using an inferential approach of qualitative analysis.Based on the opinion of experts in this fieldwe captures a population sample which can be exclusively examined systematically with quantitative inferential analysis.

The goals of this study were encapsulated in the questionnaire drafted to collect relevant primary data, directly from the participants of the survey. These data contained information regarding the study objectives of this research. However, the goals, in general were analyzed in the group, accordingly in the sections reflected in the questionnaire as follows:

5.3.1 Evaluation Setup

It is imperative to incorporate the right sample into a population in a survey to ensure reliability and research authenticity. This study was restricted to a particular age group from (18-29). It is nonetheless restricted to people in medical profession such as medicine and nursing students, and dental doctors.. It aimed to guarantee that the right sample for this study was encapsulated in the survey.

- **Usability - System Usability Scale (SUS)**

This section of the questionnaire depicts system usability and it is a measurement tool used in assessing usability of a survey analysis .It constitutes a close-ended questionnaire

with five response options. SUS can be used to examine a wide range and collection of variables. The goal of this section is to make sure that the opinion of respondents are collected, and measured to make easy statistical estimation and interpretation of the results.

SUS is beneficial to this study because:

Participants can conveniently reply to the questions in this section because they are easy to answer, and the section contains an easy scale of measurement to this study. It can significantly capture both a large and a small sample size and still provides a reliable result. It simplifies complex questions requiring complex answers.

With the system usability scale, statistical analysis and evaluation were performed with the collected primary data reflecting the view of the respondents on the average.

- **Acceptance: Subjective Impression Questionnaire (SIQ)**

For this study the questionnaire reflects the subjective impression is close ended. However, it is imperative to note that the purposes of the section are to evaluate people's evaluation of a particular product, event, service or phenomena. For this study, the evaluation of respondents in the survey analysis regarding the Anatomy VR course tool expresses the satisfaction with the Anatomy VR course, how they feel the tool would benefit other students, and the added value. They perceived the Anatomy VR course would have on their wealth of knowledge were evaluated. Basically, this section was about consumers' satisfaction.

- **Workload Perception Questionnaire (WPQ)**

Workload perception has to do with the demanding nature of a particular event or work. According to (Rodrigo, 2016) student's participation in a particular course is determined by the workload of the course. In other words, if a particular course requires little effort and participation, students are more compelled to take such a course. Students' workload perception is highly connected with time and energy required by a particular course including their time cost of studying, especially, when effort and workload is dignified and computed in terms of the amount of time spent is studying (Burdett, 2009). The purpose of this section was to evaluate respondent's view of the effort, commitment and time demand by Anatomy VR Course, the time cost and energy spent on Anatomy VR Course including the average performance of participants/users of Anatomy VR course.

- **Qualitative feedback:** User Feedback Questionnaire – Qualitative Feedback (UFQQ)

This is an open-ended questionnaire section. It is opened to users comment. The purpose of this section is to explore all individual respondents' view on Anatomy VR Course. Without attaching a measurement scale, and also averaging the result of the information gathered, the feedback section gave this study an in-depth knowledge into how participants really felt about Anatomy VR Course. Recommendations provided per participant in the survey were analyzed in this section and possible future improvement will be made base on the results obtained from this section and other sections of this questionnaire. It is essential to note that feedback summaries every reliable survey analysis and that the results from this section are vital to this study.

5.3.2 Questionnaire Design

Using an online questionnaire can inspire participants to be opened and provide feedbacks by writing and commenting on open-ended formulated questions (Kothari, 2004). Therefore, an online questionnaire instead of a paper-based questionnaire was used in this study.

The questionnaire was designed to give the feedback from the participants about their views on Anatomy Virtual Reality Course Evaluation. This helped the study identifies usability problems and also assessed whether the advantages of the course outweigh the disadvantages.

- **Why online survey?**

According to (Wright, 2005) , there are three main benefits associated with online survey analysis and they include: accessibility, time-efficiency and cost-efficieny.

- **Accessibility:** It is more convenient to carry out an online survey than a paper survey, because online survey gives the researcher the chance of getting and including more samples to the population. It is also more convenient for participants to fill out the questionnaire ,as they can easily assess the questionnaire from home or at work with their internet devices.
- **Time-efficient:** In a matter of minutes, the researcher can easily add more samples to the survey. More willing participants can easily fill out the questionnaire at any point in time. Also, analysis is easily done with the report from online survey, because the stress of manual computation is eradicated. In addition to time efficiency, online survey eradicates typing errors associated with paper survey.

- **Cost-efficient:** The cost of printing questionnaires and transportation to places for the purpose of distributing the questionnaires are eliminated by the use of online survey. Hence, general research cost is reduced when online survey is employed in place of paper survey.

The questionnaire is constituted five categories: Demographic Questionnaire for Learners (DQL), System Usability Scale (SUS), Subjective Impression Questionnaire (SIQ), Workload Perception Questionnaire (WPQ), and User Feedback Questionnaire – Qualitative Feedback (UFQQ).

The questions were design on two fundamental styles namely; opened questions and closes ended questions. The first section of the questionnaire contained two open ended questions and three close ended questions. Every other section apart from the feedback section was strictly composed of close ended questions, and the feedback section was exclusively designed of open ended questions. The representative variables summarize the research objectives and hypotheses testing. Before drafting survey questions, it is paramount to understand the implications and expected feedback from the questions to be asked. Explained below are two types of questions designed for this study:

- **Open - ended question:** This group of questions avails respondents or survey participants the chance to explore all their options by stating their opinions subjectively in their respective way as a reaction to the questions asked.
- **Close ended question:** This type of questions is designed to portray the qualitative view of the research or research goals. The closed ended survey questions

direct survey participants towards a more goal achieving responses. In close ended questions employed in this study, multiple answers were attached to each question and participants were expected to choose only one answer from the list of alternatives.

5.4 Evaluation Analysis Principles

The questions were developed using online Google drive questionnaire form. The questionnaire was shared to participants via e-mail, Whats-App, and Face book. In addition to the primary data sources utilized in this research paper, secondary data was also collected. The secondary data that was collected include journal publications, articles, web publications and textbooks.

5.4.1 Analysis of questionnaire

Generally, there are 43 questions in the entire questionnaire and these questions were subdivided into five sections. They are analyzed as follows:

The demographic section of the questionnaire contained 5 questions. The first question requires the respondents to input their age themselves without suggesting an age brackets, making it an open ended question. The second question focused on collecting information about how often respondents use Virtual Reality (VR) or 3D Environments. The third question focused on obtaining information about how often participants used e-learning applications (including coursera, udemy, edx, etc.).The fourth question was concerned with the duration of time each respondent used VR application. Finally the fifth question sought to ascertain the average number of times a respondent spend on the Anatomy VR course.

The usability analytical section of the questionnaire contains 12 questions. All the questions collectively were formulated for the sole purpose of understanding how

respondents perceive Anatomy VR course. Question 2, 4, 8, and 10, were drafted to capture the technicality and complexity of the Anatomy VR course. These questions were targeted towards getting responds about how students and users of Anatomy VR course App felt about the complications associated with using the Anatomy VR course. Furthermore, question 1 and 11, capture users likeliness of the course, and question 7 and 12 reflect on the participants view about future users of Anatomy VR course, suggesting their valuation and satisfaction of how possible it is for them to recommend anatomy VR course to other users. Question 3, 4, 5 and 9 relate to users appreciation of Anatomy VR course, their opinion of how flexible the app is, and the usability of the app.

The suitability and acceptance of Anatomy VR course motivates the drafting of 17 questions with all converging at the point where users state their views on how impressed they are with anatomy VR course. In order to be able to evaluated user acceptability of anatomy VR course, user's opinion on the level and regularity at which they patronize the app is necessary for analyzing the consumers' loyalty. Performance of the app was dependent on the study in the questionnaire.

Workload perception seeks to further explore the rigidity of anatomy VR course by analyzing the mental and physical demands of the app. and the performance of users using it. The frustration associated with using the app. especially when users are not getting it right in terms of task accomplishment.As well as, the hardship in accomplishing a particular task. In general, this section contains 5 questions.

The final section of the questionnaire summarieses users' comments, opinions, and recommendations regarding Anatomy VR course. There are three questions in this section that allow participants to state their opinions. Participants are allowed to present

their thoughts in writing, in contrast with the closed ended questions asked in previous sections, where they are limited to choose their answers from multiple choice, provided by the research.

5.5 Data analysis

For critical analysis and interpretation of results, this study employed the use of SPSS statistical tool. With this software package, the primary data collected would be tested and relationship between the variables drafted from the research questions would be analyzed, providing results for interpretation and policy implementation. At this stage, following analysis and tests were utilized in this study:

- **Stylized fact:**

The demographic components of this study shall be plotted on a bar chart, to represent the distribution of age of participants in the utilized survey analysis.

- **Descriptive statistics**

This gives a summary statistics of the variables employed in this study. The descriptive statistics is used to test for irregularities in variables by ascertaining outliers, and explosiveness of the data relative to the variables.

- **Reliability and validity**

In order for a research to achieve its targeted goal, it should be justifiable and consistent. If both, reliability and validity criteria are met, it can be demonstrated that the research methodology is honest and safe to trust the results obtained from the analysis (Bryman& Bell, 2007). The research applies the Chronbach Alpha test in ascertaining reliability.

- **Correlation test**

This test is conducted to establish the relationship exhibited between variables of the study. With the correlation test, any kind of relationship between and/or among variables can be evaluated. Expected relations between variables include positive low, positive high, negative low, and negative high relationships. With the correlation test, the relation between anatomy VR course usability and anatomy VR course acceptability shall be established. The relationship participants view of the complexity of Anatomy VR course and how, often the app. is used, shall also be evaluated. Finally, correlation between simplicity and benefits of anatomy VR courses, and how frequent participants use patronize anatomy VR course was also established.

5.6 Results

This section elaborates the results finding of data analysis. This is comprised of demographic data of participants, descriptive statistics, reliability and validity test, and correlation test. 4 questionnaires are for demographic data, 12 questionnaires are provided to gauge the usability of anatomy virtual reality course, 17 questionnaires are used to evaluate the suitability and acceptance of anatomy virtual reality course, 5 questionnaires are intended to measure the workload perception, and 3 questionnaires are provided to assess participant's opinions.

Reliability test is intended to measure the consistency of the questionnaires to construct underlying model in quest. The Cronbach Alpha test is conducted and its results are discussed. The Likerts scale is recoded inversely for questions that are negatively phrased.

5.6.1 Demographic Data

Data Demographics are the ranges of age among participantst from 19 to 30 years, choosing a total of 32 people.

- **Questionnaire 1 results**

The respondents use several times a week, where this condition is favorable to the objectives of the research to evaluate the interviewee's perception of the environment, especially, the virtual reality course of anatomy.

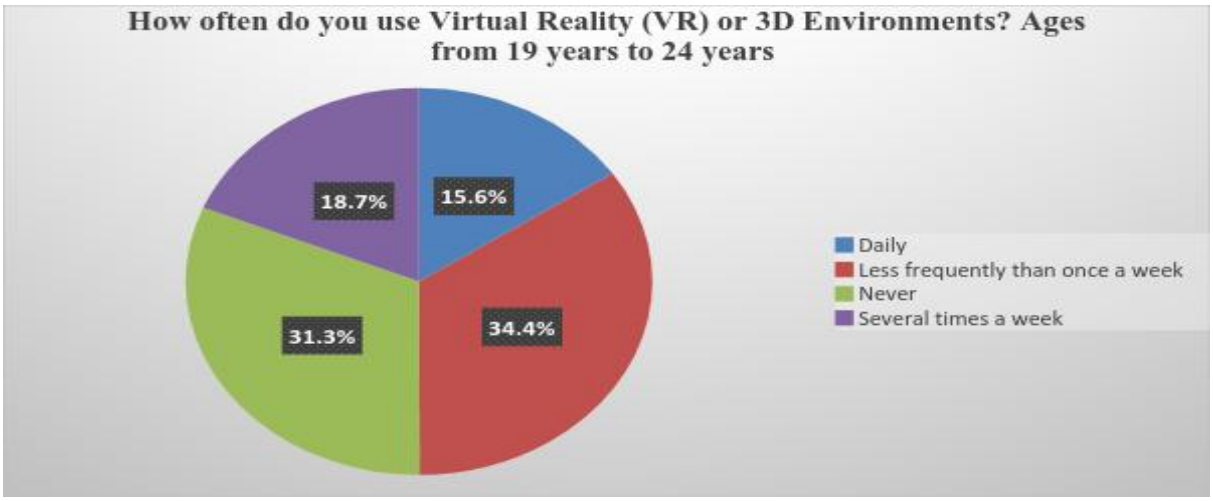


Figure 26 How often do you use Virtual Reality (VR) or 3D Environments?

Figure 1 shows the representation, in percentages, of the frequent use of Virtual Reality (VR) or 3D Environments, which shows 15.6% daily, 34.4% less frequently than once a week, 31.3% never and 18.8% several times a week.

Table2222How often do you use Virtual Reality (VR) or 3D Environments? Ages from 25 years to 30 years

Ages from 25 years to 30 years

		Percent
Valid	Daily	8.6%
	Several time a week	15.3%
	Never	36.2%
	Less frequently than once a week	39.9%
	Total	100.0%

Table (2) shows the respondent's time usage of virtual reality or 3D environment. More than half respondents are never or less frequently use the environment. This condition is favorable to the research's aims to assess respondent's perception about the environment, especially the anatomy virtual reality course.

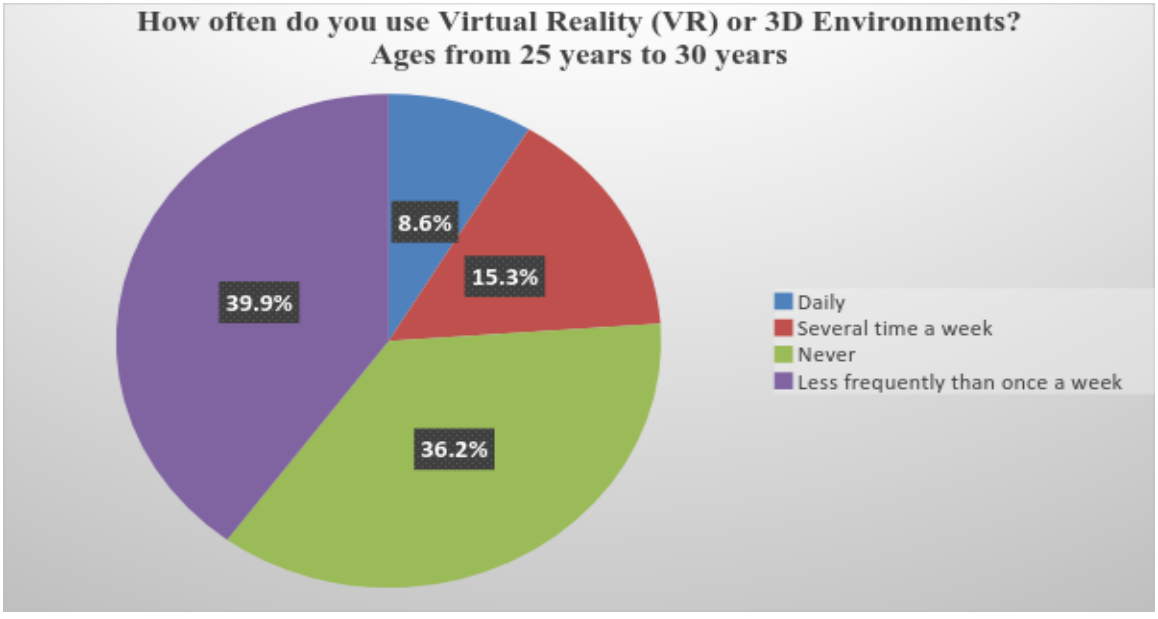


Figure 27How often do you use Virtual Reality (VR) or 3D Environments?(Ages from 25 years to 30 years)

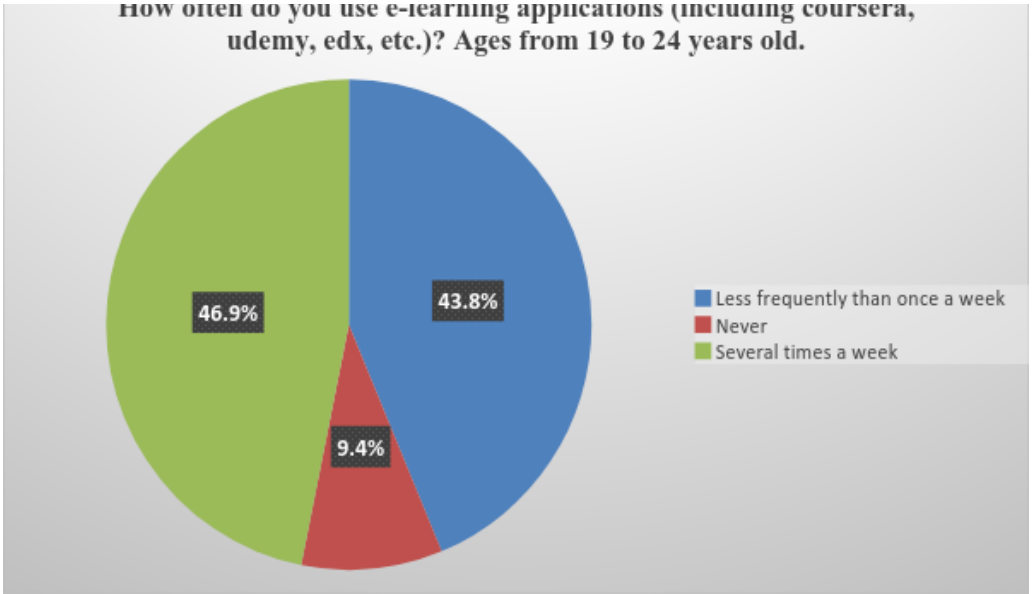
Figure 2 shows the representation, in percentages, of the frequent use of Virtual Reality (VR) or 3D Environments, which shows 8.6% daily, 39.9% less frequently than once a week, 36.6% never and 15.3% several times a week.

- **Questionnaire 2 results**

Table113How often do you use e-learning applications (including coursera, udemy, edx, etc.)? Ages from 19 to 24 years old.

Ages from 19 to 24 years old.		
		Percent
Valid	Less frequently than once a week	43.8
	Never	9.4
	Several times a week	46.9
	Total	100.0

Table (3) shows the experiences of the interviewee in e-learning course. The respondents have experience in the use of e-learning application. Experience will also be useful for this research goal as it allows respondents to compare the environment favorably. In the



frequency columns, people who responded to the assigned mode are represented, (Daily, Less frequently than once a week, Never, Several times a week), while in the other columns, they are represented as a percentage.

In Figure (29), the representation, in percentages, of the frequent use in applications of learning is shown, where 43.8% is less frequently than once a week, 9.4% never and 46.9% several times a week.

.Table4How often do you use e-learning applications (including coursera, udemy, edx, etc.)?Ages from 19 to 24 years old.

Figure29How often do you use e-learning applications (including coursera, udemy, edx, etc.)?

Ages from 25 to 30 years old		
		Percent
Valid	Less frequently than once a week	44.2%
	Never	28.9%
	Several times a week	26.9%
	Total	100.0

Table(4): shows the experiences of the interviewee in the e-learning course. The respondents have little experience in the use of e-learning application. The sample of the results will also be useful for this research objective since it allows the respondents to compare the environment favorably.

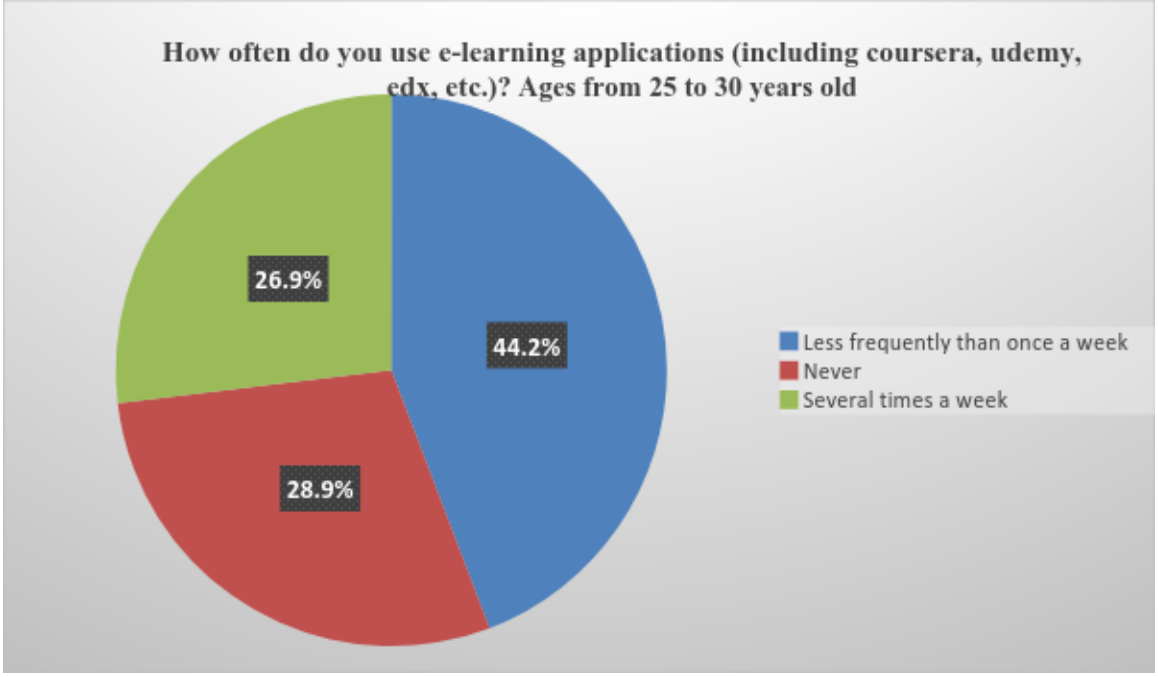


Figure 28 How often do you use e-learning applications (including coursera, udemy, edx, etc.)?Ages from 25 to 30 years old

Figure (30) shows the percentage representation of frequent use in learning applications, which shows 44.2% less frequently than once a week, 28.9% never and 26.9% several times a week

- **Questionnaire 3 results**

Table5How long have you been using VR applications?

Ages from 19 years to 24 years		
		Percent
Valid	For about 1 year	46.9%
	For one to several months	10.5%
	For years	25.1%
	Haven't so far	17.5%
	Total	100.0

The experience time span of the respondent using virtual reality application is shown in Table (5). The respondents have been using the application for about one year

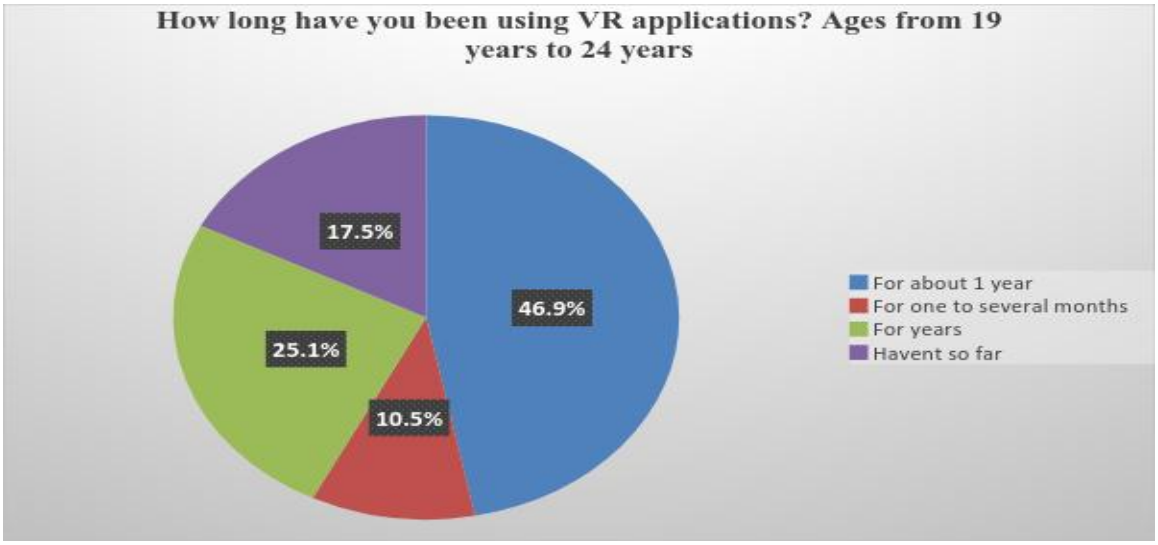


Figure 29 How long have you been using VR applications?Ages from 19 years to 24 years.

Figure (31): shows the percentage representation of the time of frequent use in VR applications, which shows 46.9% for about 1 year, 10.5% For one to several months, 25.1% for year and 17.5% Haven 't so far.

Table 6 How long have you been using VR applications? Ages from 19 years to 24 years.

Ages from 25 to 30 years old		
		Percent
Valid	For about 1 year	26.9%
	For one to several months	30.5%
	For years	15.1%
	Haven’t so far	27.5%
	Total	100.0

The experience time span of the respondent using virtual reality application is shown in Table (6). The respondents have been using the application for about months.

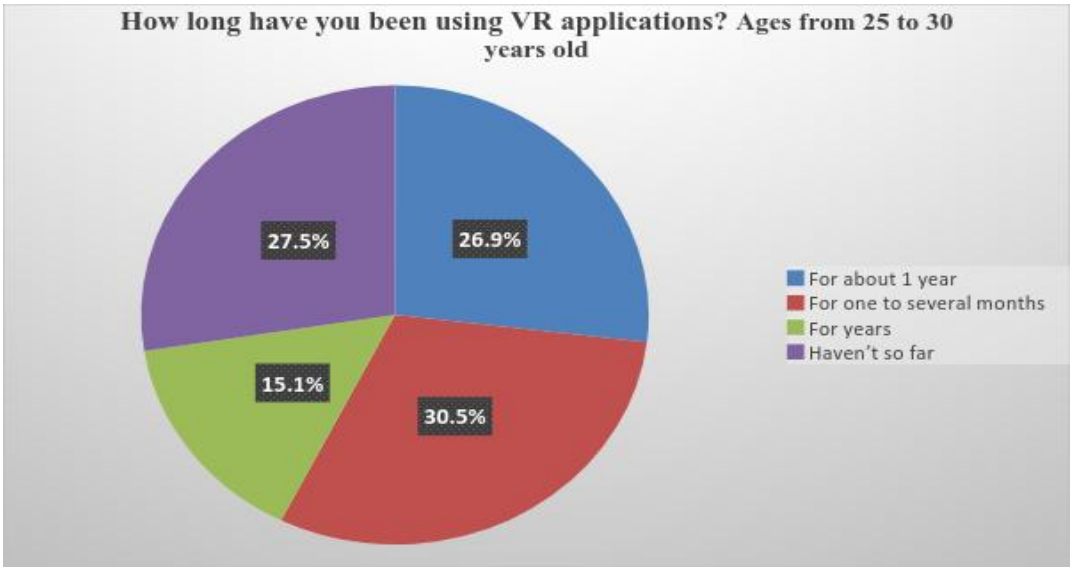


Figure 30How long have you been using VR applications?Ages from 25 years to 30 years.

Figure (32) shows the percentage representation of the time of frequent use in VR applications, which shows 46.9% for about 1 year, 26.9% For one to several months, 25.1% for year and 17.5% Haven 't so far.

- **Questionnaire 4 results**

How much time in minutes did you spend approximately on the provided 7 Table adaptive course?

Ages from 19 years to 24 years		
Hours.		**Percent**
Valid	30min – 1 hours	25%

	3hours-5hours	49.5%
	6hours-8hours	25.5 %
	Total	100.0

The time spent in minutes of the respondent using the virtual reality application is shown in Table (7). Respondents spend 3 to 5 hours with the percentage of 49.5% maximum.

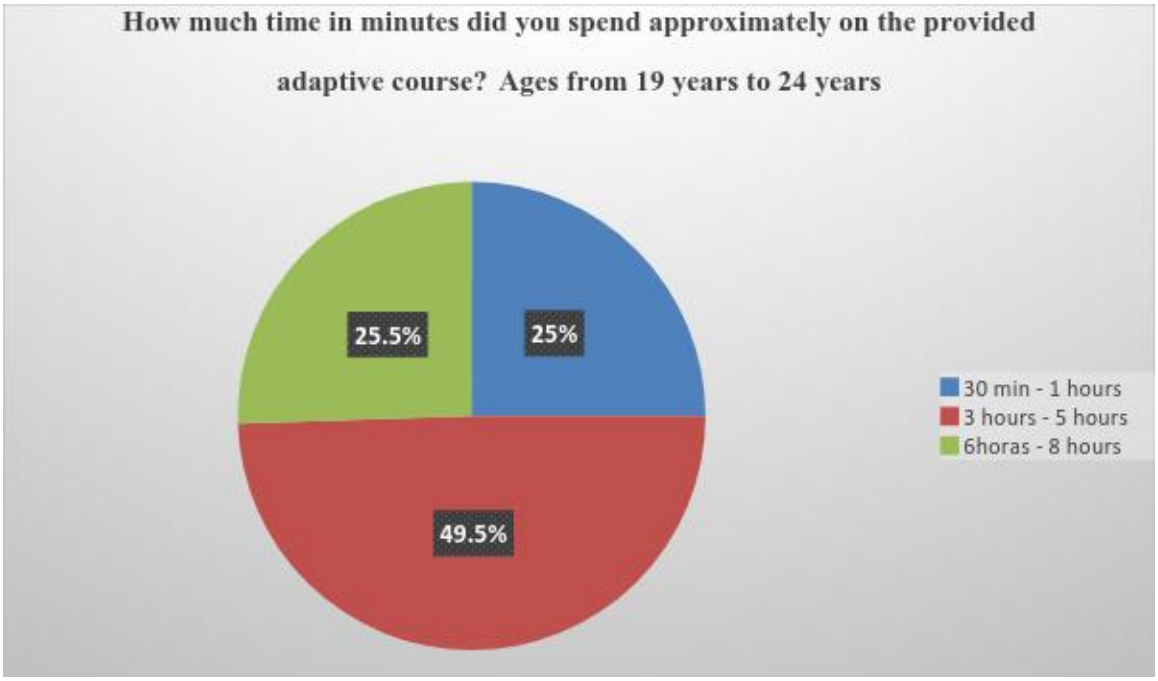


Figure 31 How long have you been using VR applications?Ages from 19 years to 24 years

Figure (33) shows the percentage representation of the time spent for weekly learning, which shows 49.5% 3hours - 5 hours, 25.5% 6hours - 8 hours, and 25% of 30min - 1 hours.

Table 8How long have you been using VR applications?Ages from 25 years to 30 years.

Ages from 25 to 30 years old		
Hours.		**Percent**
Valid	30min – 1 hours	44.5%
	3hours-5hours	25.5%
	6hours-8hours	30%
	Total	100.0

The time spent in minutes of the respondent using the virtual reality application is shown in Table (8). Respondents spend 30minutes to 1 hour with the percentage of 44,5% maximum.

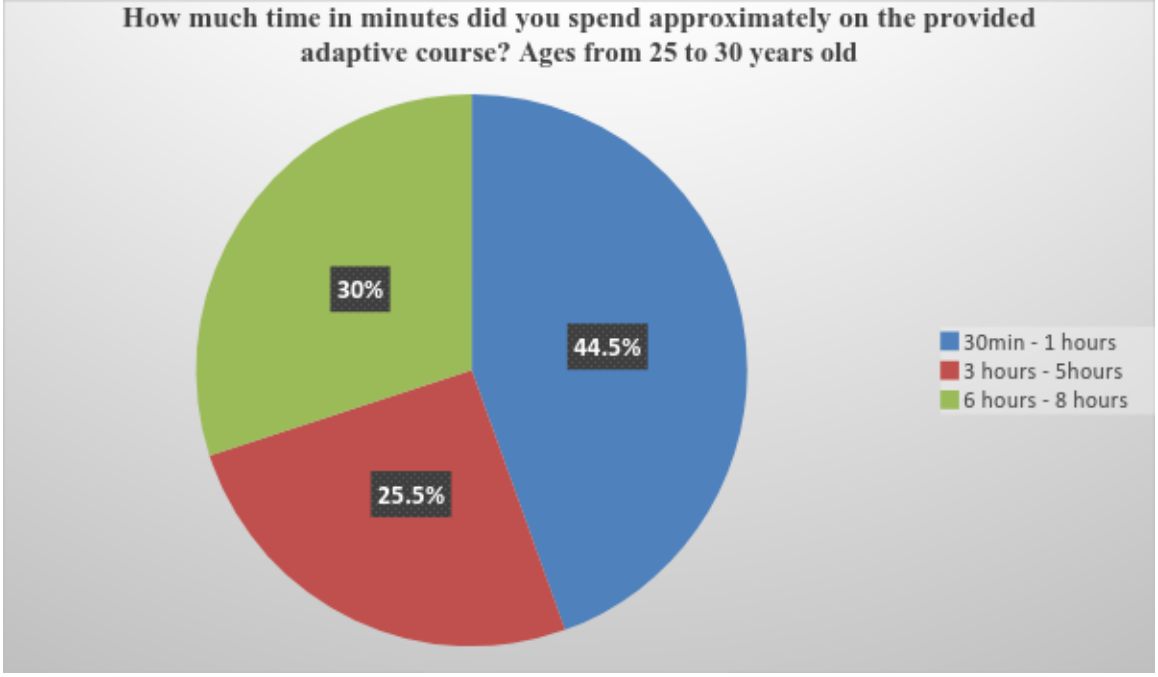


Figure 32How long have you been using VR applications?Ages from 25 years to 30 years.

Figure (34) shows the percentage representation of the time spent for weekly learning, which shows 25.5% 3hours - 5 hours, 30% 6hours - 8 hours, and 44.5% of 30min - 1 hours.

Reliability Data and Quality

1. Dimension: Usability

Usability analysis tries to capture technicality and complexity of the Anatomy VR course. The questionnaires are constructed to measure respondent's perception of the course. The lower scales represent the negative perception, while the higher scales represent the positive perception. The Likert's scales used are (1-5) representing from Strongly Disagree (1) to Strongly Agree (5).

The frequency distribution table in Table 9 shows that 5 positive questionnaires get high percentage of Strongly Agree and Agree scale. This indicates that the respondent perceive the usability of the anatomy virtual reality course in a positive way. The indication is also confirmed by the mean and standard deviation in Table 7, which gives 10 questionnaires having mean ($\bar{x}$=3.3).

Table 9SUS frequency distribution

#	Item	%F	F	%F	F	F%	F	%F	F	%F	F
		Strongly Agree		**Agree**		**Neutral**		**Disagree**		**Strongly Disagree**	
1	I think that I would like to use the ANATOMY VR course.	43.80%	14	46.90%	15	6.30%	2	0%	0	3.10%	1
2	I found the ANATOMY VR course unnecessarily complex.	0%	0	15.60%	5	31.30%	10	53.10%	17	0%	0
3	I think the ANATOMY VR course is easy to use.	15.60%	5	75%	24	3.10%	1	3.10%	1	3.10%	1
4	I think that I would need the support of a technical person to be able to use this ANATOMY VR Course in the future.	12.50%	4	21.90%	7	34.40%	11	28.10%	9	3.10%	1

5	I found the various parts in this ANATOMY VR Course were well integrated.	15.60%	5	56.30%	18	25%	8	3.10%	1	0%	0
6	I think there is too much inconsistency in this ANATOMY VR Course.	6.30%	2	15.60%	5	31.30%	10	46.90%	15	0%	0
7	I would imagine that most of my classmates would learn to use this ANATOMY VR Course very quickly.	25%	8	65.60%	21	6.30%	2	3.10%	1	0%	0
8	I found the ANATOMY VR Course very cumbersome to use.	9.40%	3	28.10%	9	37.50%	12	21.90%	7	3.10%	1
9	I felt very confident using the ANATOMY VR Course.	18.80%	6	46.90%	15	28.10%	9	6.30%	2	0%	0
10	I needed to figure out a lot of things before I could get going with this ANATOMY VR Course.	9.40%	3	21.90%	7	53.10%	17	15.60%	5	0%	0
11	I would like to use this ANATOMY VR Course in the future.	43.80%	14	46.90%	15	9.40%	3	0%	0	0%	0

12	I would recommend this ANATOMY VR course to my colleagues.	40%	13	50%	16	6.30%	2	3.10%	1	0%	0

Among the highly rated questionnaires regarding usability, the statement "I think that I would like to use the anatomy virtual reality course" and "I would recommend this course to my colleagues" are rated high by 14 participants (out of 32) respectively. Meanwhile, the statement "I found the course unnecessarily complex" gets low score by 17 participants (out of 32).

This result reflects that the participants who recommend the course to their colleagues trust in what they are learning and that this method is a dynamic form of acquiring knowledge. On contrary, those who answered the course is unnecessarily complex, describe it as a more didactic method and does not recognize the potential that it can provide as a study tool.

Table 10SUS mean and standard deviation

Item	Mean	Std Dev
I think that I would like to use the ANATOMY VR course.	4.28	0.851
I found the ANATOMY VR course unnecessarily complex.	2.63	0.751
I think the ANATOMY VR course is easy to use.	3.97	0.782
I think that I would need the support of a technical person to be able to use this ANATOMY VR Course in the future.	3.13	1.07
I found the various parts in this ANATOMY VR Course were well integrated.	3.13	0.723
I think there is too much inconsistency in this ANATOMY VR Course.	2.81	0.931
I would imagine that most of my classmates would learn to use this ANATOMY VR Course very quickly.	4.13	0.66
I found the ANATOMY VR Course very cumbersome to use.	3.19	0.998
I felt very confident using the ANATOMY VR Course.	3.78	0.832

I needed to figure out a lot of things before I could get going with this ANATOMY VR Course.	3.25	0.842
I would like to use this ANATOMY VR Course in the future.	4.34	0.653
I would recommend this ANATOMY VR course to my colleagues.	4.28	0.729

The Table (10) reflects the average of each item and the standard deviation where each value of the latter reflects the difference of results that has between each item.

Cronbach Reliability Test Result

The Cronbach's Alpha result of 0.730 indicates that the questionnaires reliability isaccepted as reliable. This is the second tryof the Cronbach's Alpha calculation after Cronbach's Alpha if item deleted as shown in Table 14. The initial Cronbach's Alpha result was 0.628. Further items deletion is not necessary because the reliable score of 0.730 has been reached.

The ANOVA test as shown in Table 19 gives the grand mean of ($\bar{x}$=3.9) and p-value less than 0.05. The grand mean indicate the high scale of usability perception and the same time p-value suggest that there are no correlations between items is rejected due to “not enough evidence” and there are correlation between items is accepted.

As forthe questionnaires for usability dimension are reliable and the conclusion that respondents positively perceive the anatomy virtual reality course as usable is supported and validated.

Table11SUS Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	0.0
	Total	32	100.0

a. List-wise deletion based on all variables in the procedure.

Table (11) shows that the 32 participants did not exclude any, obtaining 100% as a percentage, allowing better reliability in the responses.

Table 12SUS Reliability Statistics

N of Items	Cronbach's Alpha Based on Standardized Items	Cronbach's Alpha
9	0.742	0.73

Table (12) For reliability in research the cronbach alpha was used to provide a 0.730 result of its Cronbach Alpha based on the standardized 0.742 indicating that the reliability of the questionnaires should be accepted as reliable, where 9 items are considered for this study.

Table 13SUS Item Statistics

	Mean	Std.Deviation
PLikebility	4.28	0.851
PComplexity	3.38	0.751
PEaseofUse	3.97	0.782
PTechSupportNeed	3.13	1.070
PWellIntegrated	3.84	0.723
PQuickLearnbyClassm	4.13	0.660

ates		
Pconfident	3.78	0.832
PFutureUse	4.34	0.653
PrecommendTo Colleague	4.28	0.729

Table (13) reflects the items to be studied for each one, and their mean was calculated and their standard deviation was obtained, taking into account that for each item the 32 participants were used.

Table14SUS Inter-Item Correlation Matrix a

	PLikebility	**PComplexity**	**PEaseofUse**	**PTechSupportNeed**	**PWellIntegrated**
PLikebility	1.000	0.385	0.595	0.279	0.178
PComplexity	0.385	1.000	0.295	-,060	0.111
PEaseofUse	0.595	0.295	1.000	0.313	0.276
PTechSupportNeed	0.279	-0.060	0.313	1.000	-0.016
PWellIntegrated	0.178	0.111	0.276	-0.016	1.000
PQuickLearnbyClassm	0.165	0.228	0.195	0.114	0.110

ates					
Pconfident	0.272	0.342	0.138	0.394	0.317
PFutureUse	0.401	0.189	0.464	-0.017	0.391
PrecommendToColleg ue	0.440	0.096	0.129	0.078	0.086

Table 15SUS Inter-Item Correlation Matrix b

	PQuickLearnb yClassmates	**Pconfident**	**PFutureUse**	**PrecommendT oCollegue**
PLikebility	0.165	0.272	0.401	0.440
PComplexity	0.228	0.342	0.189	0.096
PEaseofUse	0.195	0.138	0.464	0.129
PTechSupportNeed	0.114	0.394	-0.017	0.078
PWellIntegrated	0.110	0.317	0.391	0.086
PQuickLearnbyClassmates	1.000	0.228	0.271	0.461
Pconfident	0.228	1.000	0.262	0.211
PFutureUse	0.271	0.262	1.000	0.400

PrecommendToCollegue	0.461	0.211	0.400	1.000

The correlation matrix explains how each of the variables is related to another variable. Its diagonal will always contain the value of 1. If it has a value of 0, it will indicate that it has no relation with that variable, at least non-linear; that is, it may have a quadratic or other degree relationship.

When the correlation is positive, this indicates that its projection of the linear regression will tend to grow along with the counter variable.

When the correlation is negative, this indicates that its projection of the linear regression will tend to decrease along with the counter variable.

SUS Summary Item Statistics16 Table

	Mean	**Minimum**	**Maximum**	**Range**	**Maximum/ Minimum**	**Variance**	**N of Items**
Item Means	3.903	3.125	4.344	1.219	1.390	0.180	9
Item Variances	0.628	0.426	1.145	0.719	2.686	0.048	9
Inter-Item Correlations	0.242	-0.060	0.595	0.655	-9.885	0.022	9

The general values of the 9 items, according to each element, are shown as mean, minimum, maximum, range, Maximum / Minimum and variance.

Table 17SUS Item-Total Statistics

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Squared Multiple Correlation**	**Cronbach's Alpha if Item Deleted**
PLikebility	30.84	11.814	0.611	0.572	0.666
PComplexity	31.75	13.742	0.324	0.374	0.719
PEaseofUse	31.16	12.523	0.538	0.565	0.683
PTechSupportNeed	32.00	13.097	0.242	0.430	0.749
PWellIntegrated	31.28	14.015	0.291	0.261	0.724
PQuickLearnbyClassmates	31.00	13.871	0.367	0.312	0.713
Pconfident	31.34	12.555	0.486	0.454	0.691
PFutureUse	30.78	13.338	0.492	0.450	0.695
PrecommendToColegue	30.84	13.491	0.390	0.470	0.709

The "Scale average if element is deleted" indicates the value that the average would have in the event of deleting each element. As we can see in the last window of "SUS Summary Article Statistics", the mean of the scale is 35.13.If we eliminate question 1 the scale would stay at 30.84.

The "element-total correlation cumulative" is the corrected homogeneity co-efficient. If it is zero or negative it is deleted. For this case it does not apply.

"Cronbach alpha if element is deleted", is equivalent to the value of Alpha if we delete each item. Thus, for example, we can see that if we eliminate the zero or negative element of the "element-total correlation run", Alfa would improve, but in this case it does not apply because Cronbach's alpha gave us 0, 730 being acceptable according to its parameters.

Table 18SUS Scale Statistics

Mean	Variance	Std. Deviation	N of Items
35.13	16.113	4.014	9

Table (18) shows the average variance and the standard deviation in general of the 9 articles that are being developed in the research.

Table 19SUSANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		55.500	31	1.790		
Within People	Between Items	45.965	8	5.746	11893	0.000
	Residual	119.813	248	0.483		
	Total	165.778	256	0.648		
Total		221.278	287	0.771		

Grand Mean = 3.90

Dimension 2: Acceptance

Acceptance analysis tries to assess respondent's impression of the Anatomy VR course. The scale is as the same as the usability's that is the lower scales represent the negative perception. The higher scales represent the positive perception. It applies the Likert's scales: 1-5 representing from Strongly Disagree (1) to Strongly Agree (5).

The frequency distribution table in Table 17, shows that 14 positive questionnaires get high percentage of Strongly Agree and Agree scale. It suggests that the respondent perceive the acceptance of the anatomy virtual reality course in positive way. The indication is also confirmed by the mean and standard deviation in Table 18, which gives 10 questionnaires having mean ($\bar{x}$=3).

The statement “Using the anatomy virtual reality course is a good idea” gets high score by all participants, 15 score as Strongly Agree and 17 score as Agree. The easiness perception regarding the statement “Using the anatomy virtual course is easy for me” is chosen by 26 participants (out of 32) as Agree and Strongly Agree. Nevertheless, the negative statement “I prefer to follow a classical course without using virtual reality” gets low score from 19 participants (out of 32).

Table 20 SIQ frequency distribution

#	Item	%F	F	%F	F	%F	F	%F	F	%F	F
		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
1	I would use the ANATOMY VR Course whenever possible.	21.90%	7	68.80%	22	3.10%	1	3.10%	1	3.10%	1
2	I would use the ANATOMY VR Course frequently when it is available.	25%	8	65.60%	21	9.40%	3	0%	0	0%	0
3	Using the ANATOMY VR Course is a good idea.	46.90%	15	53.10%	17	0%	0	0%	0	0%	0
4	Using the ANATOMY VR Course is unpleasant.	0%	0	0%	0	9.40%	3	68.80%	22	21.90%	7
5	Using the ANATOMY VR Course would be beneficial to my learning.	28.10%	9	59.40%	19	#####	4	0%	0	0%	0
6	Using the ANATOMY VR Course is easy for me.	21.90%	7	59.40%	19	#####	6	0%	0	0%	0

7	It was easy for me to become skillful at using the ANATOMY VR Course.	15.60%	5	65.60%	21	#####	6	0%	0	0%	0
8	I find the ANATOMY VR Course easy to use.	18.80%	6	68.80%	22	#####	4	0%	0	0%	0
9	I find the ANATOMY VR Course to be flexible to interact with.	15.60%	5	68.80%	22	#####	4	0%	0	3.10%	1
10	Integrating videos helps me to understand 3D objects being studied.	31.30%	10	59.40%	19	9.40%	3	0%	0	0%	0
11	Video adaptation techniques within the ANATOMY VR Course areclear and understandable.	25.00%	8	50.00%	16	#####	6	6.30%	2	0%	0
12	It is easy to know which part is required for more study using Video adaptation techniques.	18.80%	6	56.30%	18	#####	8	0%	0	0%	0
13	It is useful to navigate through VR learning objects	6.30%	2	62.50%	20	#####	9	3.10%	1	0%	0
14	Synchronization between Videos and 3D Objects draws your attention.	21.90%	7	59.40%	19	#####	5	3.10%	1	0%	0

15	VR course is needed for better understanding of a course (e.g. Anatomy course)	21.90%	7	62.50%	20	#####	5	0%	0	0%	0
16	VR and video adaptations are needed for better understanding of a course (e.g. Anatomy course)	18.80%	6	65.60%	21	#####	5	0%	0	0%	0
17	I prefer to follow a classical course without using VR (e.g. Anatomy course)	6.30%	2	15.60%	5	#####	6	46.90%	15	12.50%	4

The questionnaires on acceptance were rated high, the statement "Using the ANATOMY VR course is a good idea." high rating of 15 participants (out of 32) respectively. Meanwhile, the statement "Using the ANATOMY VR course is unpleasant". Score (disagree) low by 22 participants (out of 32).

This result reflects that the participants who recommend the course to their colleagues trust in what they are learning, and that this method is a dynamic form of acquiring knowledge; on the contrary, those who responded that the course is unnecessarily complex describe it as it is one more method without seeing potential that it can provide as a study tool.

Table 21SIQ mean and standard deviation

#	Item	Mean	Std Dev
1	I would use the ANATOMY VR Course whenever possible.	4.03	0.822
2	I would use the ANATOMY VR Course frequently when it is available.	4.16	0.574
3	Using the ANATOMY VR Course is a good idea.	4.47	0.507
4	Using the ANATOMY VR Course is unpleasant.	1.88	0.554
5	Using the ANATOMY VR Course would be beneficial to my learning.	4.16	0.628
6	Using the ANATOMY VR Course is easy for me.	4.03	0.647
7	It was easy for me to become skillful at using the ANATOMY VR Course.	3.97	0.595
8	I find the ANATOMY VR Course easy to use.	4.06	0.564
9	I find the ANATOMY VR Course to be flexible to interact with.	3.94	0.759
10	Integrating videos helps me to understand 3D objects being studied.	4.22	0.608
11	Video adaptation techniques within the ANATOMY VR Course are clear and understandable.	3.94	0.84
12	It is easy to know which part is required for more study using Video adaptation techniques.	3.94	0.669
13	It is useful to navigate through VR learning objects	3.72	0.634
14	Synchronization between Videos and 3D Objects draws your attention.	4	0.718
15	VR course is needed for better understanding of a course (e.g. Anatomy course)	4.06	0.619
16	VR and video adaptations are needed for better understanding of a course (e.g. Anatomy course)	4.03	0.595
17	I prefer to follow a classical course without using VR (e.g. Anatomy course)	2.56	1.105

The Table (18) reflects the average of each item and the standard deviation where each value of the latter reflects the difference of results that has between each item.

Cronbach Reliability Test Result

The Cronbach's Alpha result of 0.840 suggests that the questionnaires are considered reliable. This is one try of the Cronbach's Alpha calculation and no item deletion after Cronbach's Alpha if item deleted.

The ANOVA test as shown in Table 26 gives the grand mean of ($\bar{x}$=4.02) and (p<0.05). The grand mean indicate the high scale of acceptance perception and the same time p-value indicate that there are no correlations between items is rejected because there is not enough evidence and there are correlation between items is accepted.

Therefore, the questionnaires for acceptance dimension are reliable and the conclusion that respondents positively perceive the anatomy virtual reality course acceptance is supported and validated.

Table 22SIQ Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	0.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Table 23SIQ Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.840	0.868	17

Table (20) is for reliability in research, the cronbach alpha was used to provide a 0.840 result of its Cronbach Alpha based on the standardized 0.868 which indicates that the reliability of the questionnaires should be accepted as reliable, where 17 elements are considered for this study.

Table24SIQ Item Statistics

	Mean	Std. Deviation	N
Acc Whenever Possible	4.03	0.822	32
Acc Frequently When Avail	4.16	0.574	32
Acc Good Idea	4.47	0.507	32
Acc Unpleasant	4.13	0.554	32
Acc BeneficialToLearning	4.16	0.628	32
Acc UseEasyforMe	4.03	0.647	32
Acc UseMadeMeSkillful	3.97	0.595	32
Acc Course EasytoUse	4.06	0.564	32
Acc Course easyto Interact With	3.94	0.759	32
Acc Video Integration Helpful	4.22	0.608	32
Acc Video Adaptation Techniques Clear	3.94	0.84	32
Acc Video Adapt GoodFor Identifying Weak Study Areas	3.94	0.669	32
Acc Useful To Navigate Through VR Learning Objects	3.72	0.634	32
AccVidand3DObjectsSynchronizationDrawsAttention	4	0.718	32
Acc VR Course Improves Anatomy Learning	4.06	0.619	32
Acc VR and Vid Improved Anatomy Course Learning Experience	4.03	0.595	32
Acc Classical Course Preference without VR	3.44	1.105	32

Table (21) reflects the items to be studied for each one, and their mean was calculated and their standard deviation was obtained taking into account that for each item the 32 participants were used.

Table 25SIQ Inter-Item Correlation Matrix

	AccWheneverPossible	AccFrequentlyWhenAvail	AccGoodIdea	AccUnpleasant
Acc Whenever Possible	1	0.194	0.505	0.204
Acc Frequently When Avail	0.194	1	0.294	0.038
Acc Good Idea	0.505	0.294	1	0.359
Acc Unpleasant	0.204	0.038	0.359	1
Acc Beneficial To Learning	0.615	0.199	0.371	0.313
Acc Use Easy for Me	0.18	0.247	0.347	0.169
Acc Use Made Me Skillful	0.53	0.204	0.585	0.306
Acc Course Easy to Use	0.482	0.367	0.571	0.49
Acc Course easy to Interact With	0.675	0.097	0.414	0.249
Acc Video Integration Helpful	0.244	0.268	0.389	0.204
Acc Video Adaptation Techniques Clear	0.096	0.155	0.222	0.225
Acc Video Adapt Good For Identifying Weak Study Areas	0.062	0.11	-0.101	0.196
Acc Useful To Navigate Through VR Learning Objects	0.45	0.036	0.423	0.195
AccVidand3DObjectsSynchronization DrawsAttention	0.437	0.391	0.443	0.324
Acc VR Course Improves Anatomy Learning	0.313	0.335	0.212	0.165
Acc VR and Vid Improved Anatomy Course Learning Experience	0.262	0.174	0.271	0.184
Acc Classical Course Preference without VR	0.02	-0.162	0.025	0.329

	AccBeneficiai	Acc Use Easy	Acc Use Made Me	Acc Course

	l To Learning	for Me	Skill full	Easy to Use
Acc Whenever Possible	0.615	0.180	0.530	0.482
Acc Frequently When Avail	0.199	0.247	0.204	0.367
Acc Good Idea	0.371	0.347	0.585	0.571
Acc Unpleasant	0.313	0.169	0.306	0.490
Acc Beneficial To Learning	1.000	0.464	0.532	0.518
Acc Use Easy for Me	0.464	1.000	0.590	0.701
Acc Use Made Me Skillful	0.532	0.590	1.000	0.679
Acc Course Easy to Use	0.518	0.701	0.679	1.000
Acc Course easy to Interact With	0.630	0.201	0.567	0.536
Acc Video Integration Helpful	0.161	0.474	0.465	0.523
Acc Video Adaptation Techniques Clear	0.141	0.241	-0.004	0.281
Acc Video Adapt Good For Identifying Weak Study Areas	0.178	0.452	0.319	0.438
Acc Useful To Navigate Through VR Learning Objects	0.600	0.415	0.660	0.591
AccVidand3DObjectsSynchronizationDrawsAttention	0.286	0.417	0.377	0.557
Acc VR Course Improves Anatomy Learning	0.306	0.237	0.268	0.265

Acc VR and Vid Improved Anatomy Course Learning Experience	0.246	0.584	0.368	0.378
Acc Classical Course Preference without VR	0.038	-0.245	-0.322	-0.200

	Acc Course easy to Interact With	Acc Video Integration Helpful	Acc Video Adaptation Techniques Clear	Acc Video Adapt Good For Identifying Weak Study Areas
Acc Whenever Possible	0.675	0.244	0.096	0.062
Acc Frequently When Avail	0.097	0.268	0.155	0.110
Acc Good Idea	0.414	0.389	0.222	-0.101
Acc Unpleasant	0.249	0.204	0.225	0.196
Acc Beneficial To Learning	0.630	0.161	0.141	0.178
Acc Use Easy for Me	0.201	0.474	0.241	0.452
Acc Use Made Me Skillful	0.567	0.465	-0.004	0.319
Acc Course Easy to Use	0.536	0.523	0.281	0.438

Acc Course easy to Interact With	1.000	0.170	-0.158	-0.071
Acc Video Integration Helpful	0.170	1.000	0.217	0.510
Acc Video Adaptation Techniques Clear	-0.158	0.217	1.000	0.165
Acc Video Adapt Good For Identifying Weak Study Areas	-0.071	0.510	0.165	1.000
Acc Useful To Navigate Through VR Learning Objects	0.632	0.248	0.148	0.261
AccVidand3DObjectsSynchronizationDrawsAttention	0.355	0.517	0.214	0.336
Acc VR Course Improves Anatomy Learning	0.009	0.305	0.194	0.477
Acc VR and Vid Improved Anatomy Course Learning Experience	0.076	0.515	0.004	0.572
Acc Classical Course Preference without VR	-0.235	-0.243	0.343	-0.180

	Acc Useful To Navigate Through VRLearning Objects	Acc Vid and 3D Objects Synchronization Draws Attention	Acc VR Course Improves Anatomy Learning	Acc VR and Vid Improved Anatomy Course Learning Experience
Acc Whenever Possible	0.450	0.437	0.313	0.262

Acc Frequently When Avail	0.036	0.391	0.335	0.174
Acc Good Idea	0.423	0.443	0.212	0.271
Acc Unpleasant	0.195	0.324	0.165	0.184
Acc Beneficial To Learning	0.600	0.286	0.306	0.246
Acc Use Easy for Me	0.415	0.417	0.237	0.584
Acc Use Made Me Skillful	0.660	0.377	0.268	0.368
Acc Course Easy to Use	0.591	0.557	0.265	0.378
Acc Course easy to Interact With	0.632	0.355	0.009	0.076
Acc Video Integration Helpful	0.248	0.517	0.305	0.515
Acc Video Adaptation Techniques Clear	0.148	0.214	0.194	0.004
Acc Video Adapt Good For Identifying Weak Study Areas	0.261	0.336	0.477	0.572
Acc Useful To Navigate Through VR Learning Objects	1.000	0.283	0.046	0.195
AccVidand3DObjectsSynchronizationDrawsAttention	0.283	1.000	0.363	0.604
Acc VR Course Improves Anatomy Learning	0.046	0.363	1.000	0.520
Acc VR and Vid Improved Anatomy Course Learning Experience	0.195	0.604	0.520	1.000

Acc Classical Course Preference without VR	-0.049	-0.122	0.006	-0.169

	Acc Classical Course Preference without VR
Acc Whenever Possible	0.020
Acc Frequently When Avail	-0.162
Acc Good Idea	0.025
Acc Unpleasant	0.329
Acc Beneficial To Learning	0.038
Acc Use Easy for Me	-0.245
Acc Use Made Me Skillful	-0.322
Acc Course Easy to Use	-0.200
Acc Course easy to Interact With	-0.235
Acc Video Integration Helpful	-0.243
Acc Video Adaptation Techniques Clear	0.343
Acc Video Adapt Good For Identifying Weak Study Areas	-0.180
Acc Useful To Navigate Through VR Learning Objects	-0.049

AccVidand3DObjectsSynchronization DrawsAttention	-0.122
Acc VR Course Improves Anatomy Learning	0.006
Acc VR and Vid Improved Anatomy Course Learning Experience	-0.169
Acc Classical Course Preference without VR	1.000

The correlation matrix explains how each of the variables is related to another variable. Its diagonal will always contain value 1. If it has a value 0, it will indicate that it has no relation with that variable, at least non-linear. That is, it may have a quadratic or other degree relationship.

When the correlation is positive, this indicates that its projection of the linear regression will tend to grow along with the counter variable.

When the correlation is negative, this indicates that its projection of the linear regression will tend to decrease along with the counter variable.

Table 26Summary Item Statistics

	Mean	**Minimum**	**Maximum**	**Range**	**Maximum / Minimum**	**Variance**	**N of Items**
Item Means	4.017	3.438	4.469	1.031	1.300	0.047	17
Item Variances	0.472	0.257	1.222	0.965	4.753	0.053	17
Inter-Item Correlations	0.278	-0.322	0.701	1.023	-2.178	0.051	17

The general values of the 17 items according to each element are shown as mean, minimum, maximum, range, Maximum / Minimum and variance

Table 27 SIQ Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation
Acc Whenever Possible	64.25	32.129	0.586	0.796
Acc Frequently When Avail	64.13	35.855	0.304	0.411
Acc Good Idea	63.81	34.480	0.594	0.759
Acc Unpleasant	64.16	34.975	0.457	0.749
Acc Beneficial To Learning	64.13	33.274	0.636	0.772

Acc Use Easy for Me	64.25	33.548	0.575	0.889
Acc Use Made Me Skillful	64.31	33.448	0.650	0.845
Acc Course Easy to Use	64.22	32.822	0.794	0.914
Acc Course easy to Interact With	64.34	33.910	0.428	0.856
Acc Video Integration Helpful	64.06	34.190	0.522	0.566
Acc Video Adaptation Techniques Clear	64.34	34.749	0.285	0.567
Acc Video Adapt Good For Identifying Weak Study Areas	64.34	34.814	0.382	0.816
Acc Useful To Navigate Through VR Learning Objects	64.56	33.,673	0.570	0.804
AccVidand3DObjectsSynchronizationDrawsAttention	64.28	32.596	0.629	0.643
Acc VR Course Improves Anatomy Learning	64.22	34.693	0.439	0.597
Acc VR and Vid Improved Anatomy Course Learning Experience	64.25	34.387	0.506	0.822
Acc Classical Course Preference without VR	64.84	38.588	-0.112	0.667

The "Scale average if element is deleted" indicates the value that the average would have in the event of deleting each element. As we can see in the last window of "SUS Summary Article Statistics", the mean of the scale is 68.28, if we eliminate question 1 the scale would stay at 64.25.

The "element-total correlation cumulative" is the corrected homogeneity coefficient. If it is zero or negative it is deleted. For this case does not apply.

"Cronbach alpha if element is deleted", is equivalent to the value of Alpha if we delete each item. Thus, for example, we can see that if we eliminate the zero or negative element of the "element-total correlation run", Alfa would improve, but in this case it does not apply because Cronbach's alpha gave 0.840 which is being acceptable according to its parameters.

Table28SIQ Scale Statistics

Mean	Variance	Std. Deviation	N of Items
68.28	38.273	6.187	17

This table (25) shows the average variance and the standard deviation in general of the 17 articles that are being developed in the research.

Table29SIQ ANOVA

		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig**
Between People		69.792	31	2.251		
Within	Between	23.882	16	1.493	4.132	0.000

People	Items					
	Residual	179.176	496	0.361		
	Total	203.059	512	0.397		
Total		272.851	543	0.502		

Grand Mean = 4.02

Dimension 3: Workload

Workload analysis tries to assess respondent's impression of the rigidity of the Anatomy VR course. The scale is as the same as the usability's. That is the lower scales represent the negative perception, while the higher scales represent the positive perception. It applies the Likert's scales: 1-5 representing from Strongly Disagree (1) to Strongly Agree (5).

The frequency distribution table in Table 27, shows that 3 negative questionnaires get high percentage of Strongly Disagree and Disagree scale. It suggests that the respondent perceives the rigidity of the anatomy virtual reality course in negative way. The indication is also confirmed by the mean and standard deviation in Table 36, which gives questionnaires having meaning around($\bar{x}$=3).

Table30SIQ ANOVA

#	Item	%F	F	F%	F	%F	F	%F	F	%F	F
		Strongly Agree			**Agree**	**Neutral**		**Disagree**		**Strongly Disagree**	
1	Mental Demand: How mentally demanding was the task?	3.10%	1	37.50%	12	59.40%	19	0%	0	0%	0
2	Physical Demand: How physically demanding was the task?	6.30%	2	21.90%	7	50.00%	16	18.80%	6	3.10%	1
3	Performance: How successful where you in accomplishing what you were asked to do?	12.50%	4	56.30%	18	31.30%	10	0%	0	0%	0
4	How hard did you have to work to accomplish your level of performance?	9.40%	3	18.80%	6	50.00%	16	21.90%	7	0%	0
5	Frustration: How insecure, discouraged, irritated, stressed and annoyed where you using the ANATOMY VR Course?	6.30%	2	15.60%	5	37.50%	12	34.40%	11	6.30%	2

The statement in relation to the performance “Performance: How successful where you in accomplishing what were asked to do?” gets high score from 22 participants (out of 32), 4 scores as Strongly Agee and 18 scores as Agree and 10 participants score as neutral. Furthermore, the hardness of the course inferred from statement “How hard did you have

to work to accomplish your level of performance?" get feedback from 7 participants as Disagree, 16 as neutral. However, the negative phrased statement "Frustration: How insecure, discouraged, irritated, stressed and annoyed where you using the virtual course?" the participants give low scores, 11 participants (out of 32) consider it as Disagree and 12 participants (out of 32) consider it as Neutral.

Among questionnaires that were rated high, the statement "Using the ANATOMY VR course is a good idea." high rating of 15 participants (out of 32) respectively. Meanwhile, the statement "Using the ANATOMY VR course is unpleasant" scores (disagree) low by 22 participants (out of 32).

This result reflects that the participants who recommend the course to their colleagues trust in what they are learning. This method is a dynamic form of acquiring knowledge. On the contrary, those who responded that the course is unnecessarily complex, describe it as one more method without seeing potential .It can be provided as a study tool.

Table31WPQ mean and standard deviation

#	Item	Mean	Std Dev
1	Mental Demand: How mentally demanding was the task?	3.44	0.564
2	Physical Demand: How physically demanding was the task?	3.09	0.893
3	Performance: How successful where you in accomplishing what you were asked to do?	3.81	0.644
4	How hard did you have to work to accomplish your level of performance?	3.16	0.884
5	Frustration: How insecure, discouraged, irritated, stressed and annoyed where you using the ANATOMY VR Course?	2.81	0.998

The Table 28 reflects the average of each item and the standard deviation where each value of the latter reflects the difference of results that has between each item.

Cronbach Reliability Test Result

The Cronbach's Alpha result of (α=0.691), which can be rounded to (α=0.70), indicates that the questionnaires reliability is considered as reliable. This is one attempt of the Cronbach's Alpha calculation and no item deletion after Cronbach's.

The ANOVA test as shown in Table 36, gives the grand mean of ($\bar{x}$=3.3) and (p= 0.05). The grand mean indicates rather neutral scale of workload perception. The same time p-value indicates that there are no correlations between items rejected because there is not enough evidence, and correlation between items is accepted.

So, the questionnaires for workload dimension are reliable, and the conclusion that respondents rather neutrally perceive the anatomy virtual reality course's rigidity, is supported and validated.

Table32WPQ Case Processing Summary

		N	%
Cases	Valid	32	100.0
	Excluded[a]	0	0.0
	Total	32	100.0

a. Listwise deletion based on all variables in the procedure.

Table33WPQ Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.691	0.748	4

Table (30) is for reliability in research, the cronbach alpha was used to provide a 0.691 is rounded to 0.70 result of its Cronbach Alpha based on the standardized 0.748 which indicates that the reliability of the questionnaires should be accepted as reliable, where 4 elements are considered for this study

Table34WPQ Item Statistics

	Mean	Std. Deviation	N
MentalDemandVRCourse	3.44	0.564	32
PerformanceImprovementVRCourse	3.81	0.644	32
DifficultyVRCourse	3.16	0.884	32
FrustrationVRCourse	2.81	0.998	32

WPQ Inter-Item Correlation Matrix**Table35WPQ Inter-Item Correlation Matrix**

	MentalDemandVRCourse	PerformanceImprovementVRCourse	DifficultyVRCourse	FrustrationVRCourse
MentalDemandVRCourse	1.000	0.588	0.570	0.437
PerformanceImprovementVRCourse	0.588	1.000	0.393	0.495
DifficultyVRCourse	0.570	0.393	1.000	0.071
FrustrationVRCourse	0.437	0.495	0.071	1.000

The correlation matrix explains how each of the variables is related to another variable. Its diagonal will always contain the value of 1. If it has a value 0, it will indicate that it has no relation with that variable, at least non-linear; that is, it may have a quadratic or other degree relationship.

When the correlation is positive, this indicates that its projection of the linear regression will tend to grow along with the counter variable.

When the correlation is negative, this indicates that its projection of the linear regression will tend to decrease along with the counter variable.

Table36WPQ Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum/ Minimum	Variance	N of Items
Item Means	3.305	2.813	3.813	1.000	1.356	0.180	4
Item Variances	0.628	0.319	0.996	0.677	3.127	0.100	4
Inter-Item Correlations	0.426	0.071	0.588	0.517	8.292	0.033	4

The general values of the 4 items, according to each element, are shown as mean, minimum, maximum, range, Maximum / Minimum and variance.

Table37WPQ Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
MentalDemandVRCourse	9.78	3.402	0.715	0.533	0.533
PerformanceImprovementVRCourse	9.41	3.281	0.648	0.435	0.542

DifficultyVRCourse	10.06	3.286	0.356	0.385	0.710
FrustrationVRCourse	10.41	2.959	0.365	0.337	0.732

The "Scale average in case of the deletion of element" indicates the value where the average would have in the event of deleting each element. As we can see in the last window of "SUS Summary Article Statistics", the mean of the scale is 13.22. If we eliminate question 1, the scale would stay at 9.78.

The "element-total correlation cumulative" is the corrected homogeneity co-efficient. If it is zero or negative, it is deleted. For this case, it does not apply.

"Cronbach alpha if element is deleted", is equivalent to the value of Alpha if we delete each item. Thus, for example, we can see that if we eliminate the zero or negative element of the "element-total correlation run", Alfa would improve, but in this case, it does not apply because Cronbach's alpha gave us 0.691 rounded to 0.70 being acceptable according to its parameters.

Table38WPQ Scale Statistics

Mean	Variance	Std. Deviation	N of Items
13.22	5.209	2.282	4

Overall results for 4 items

Table39WPQ ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		40.367	31	1.302		
Within People	Between Items	17.273	3	5.758	14.288	0.000
	Residual	37.477	93	0.403		
	Total	54.750	96	0.570		
Total		95.117	127	0.749		

Grand Mean = 3.30

Qualitative interpretation

The goals of the qualitative questionnaires, which are implemented by three open-ended questions, are to assess participant's comments, opinions, and recommendations regarding anatomy virtual reality course.

Relating to the idea that the participants think as best about the course (in answering the question "*What did you like best about the system and the ANATOMY VR Course?*"), (29 out of 32) participants perceive the course positively. Only three participants perceive it as neutral. Participants who think it as an easy tool are (7 out of 32). Other answers on the questions from the participants are interesting, flexible, providing a lot of information, imaginative, and the best way to learn anatomy.

In response to question “What did you like least about the system and ANATOMY Virtual Reality Course?” (10 out of 32) participants answer are “Nothing,” which suggest that course is positively perceived. (9 out of 32) participants perceive the course to be least liked. The least liked answers range from that it cannot work in iPhone. It is better to be used on computer than it is hard to pass the levels.

The last assessment of participants’ recommendation is the statement “*What should be improved and how?”* that gets (10 out of 32) participants answer are “Nothing,” which again indicate that course is positively perceived. Four participants recommend the cross-platform applicability of the system.

In general, the participants comments, opinions, and recommendation inferred from the tree qualitative questionnaires, suggest participants’ positive perception about the anatomy virtual reality course.

Conclusion

Data analysis results conclude that the respondent’s perceptions in general are positive towards the anatomy virtual reality course.

The dimensions of usability questionnaires are showing statistically significant correlation between items. It gives grand mean of ($\bar{x}$=3.9). The reliability test of Cronbach Alpha result givesreliable and valid.

The dimensions of acceptance questionnaires also give correlation between items that is statistically significant. The grand mean is as high as (μ=4.02). The Cronbach Alpha’s level is at (α=0.840), which quite high and considered as reliable and valid.

The dimensions of workload questionnaires, on the contrary, give grand mean of ($\bar{x}$=3.3) which is the level of neutrality perception.It leads to a conclusion that the respondents perceive the anatomy virtual reality course as not rigid system. However, Cronbach Alpha's level is at (α=0.70), which is high enough to be considered as reliable and valid.

In addition, qualitative analysis also indicates participant's positive perceptions about the course.

To sum up, the research indicates that the anatomy virtual reality course has positively perceived as usable and accepted by participants, while its rigidity is perceived as neutral.

Chapter VI - Conclusion

6.1 Introduction

This research describes an approach to support adaptation, not only for 3D models inside the 3D VLE, but also multimedia resources such as video and audio. The approach is innovative from different aspects. It may conclude that the adoption of the hypermedia technologies has become central in the e-learning field. There are many current surveys based on literature, that facilitate the workers for the approval of the relative parts of e-learning, as well as, the search of the gap of technology for all the problems that are under observation regarding this issue. Now, the human civilization is being able to find the gaps in knowledge that is in abundance. As there exists, a lot of technologies that can identify the area of this gap accurately.

It could be said, that with the arrival of ICT (Information and Communication Technologies), as well as, the development of the technology that is based on computer, the civilization of human being has to face different types of milestones. The research attempts to identify the significance of 3D virtual learning environment in all the fields, and not just one which makes the results of the study generalizable. There are several factors that improve the learning environment out of which the 3D audio visual resources are considered. These resources are not specific to one dimension of learning, but all of them. As a result, the findings of this project, can be applied by 3D VLE engineers and developers to construct an adaptive 3D VLE. It is important to mention that, most of the adaptive 3D VLEs are developed by well-skilled programmers or researchers. Besides, nearly every adaptive 3D VLE has its unique way to deliver 3D contents and materials adaptively.

There are certain type of issues in the development as well as the adoption of the applications for video, audio, and communication in the relation of 3D VLE, particularly for the Operating System of the platform of Android. The web platform that is based on the explanation of audio and video may provide help to facilitate the feature of adoption in communication, video, and audio in VLE. The design issue of the necessary software that presented to explore the development with the help of diagram like: component diagram, class diagram, sequence diagram, as well as, the interface of the users. In order to develop a software, like in the case of adaptive anatomy course of 3D, one may use for the progression of the students of medicines.

It may also conclude by the analysis of data, that the perception of the respondents is positive to the course of anatomy virtual reality. There is significant correlation between its items. The value of mean is also huge, and the result of Cornbrash Alpha is also valid. Additionally, it can be said that the qualitative analysis on this issue also explains positive thinking about this course. To sum up, it can be concluded, that the researcher confirms that this course perceived positively, accepted, and is usable by the participant, as well as, rigidity is natural.

6.2 Contributions

The primary focus of the research was on the use of a technique of adoption on sound and video inside the 3D VLE, like the annotation that is manual, assembly by relying on Metadata related to this video, fragmentation and the use of another adoption as adding audio, and video, pause frame, play frame. The application is also used to help the medical students in anatomy course with the help of division of the course in different levels, which

may be further divided according to the video lesson sequence for each, and every part of the human body and the examination of first, second as well as the final stage.

The easiness is also provided in the learning phase of this course. The 3D realistic model was used and explained by displaying glasses based on virtual reality and enable us to display the model wonderfully. Additionally, a portal was also developed for students' registration, which is followed up by different types of instructions that are selected at the time of registration. It is also a fact that the exam of all levels and stages was important, to test the progress as well as to monitor the level of seriousness of the students by the exam that has three levels.

The result, also, helps the instructor to decide upon the other parts of learning methods to the other type of lesson based on video, as well as, all other aspects under the control of the instructor. This can be created by opening the portal for the instructor by the application manager. The final application may be published for mobile phones that support virtual reality. This may give more advantages for students in public medicine, as a result of the virtual reality presentation and its impressive features.

6.3 Limitations

The efforts are made to make the application, like a website that may connect to the database, WebGL and unity 3D. Many complications were encountered in this process, probably because technology is still in the process of trial, and also needs more updates to overcome the problem of security, as a consequence of communication with the with the attached data's database server. Such type of problems can be with proper and adequate follow-up.

The website is also made on Google Chrome website, but the update is made by Google on safety as well as security tools, that may lead towards the emergence of the problems that may be greater than those problems faced previously. All these lead to the move towards the application of the mobiles as the environment of the virtual reality that is supported well in the devices of the mobiles that are modern, then no defect is found in security.

6.4 Future Work

This study provides adaptation techniques that can be applied to audio, video learning resources, and different communication techniques inside the 3D Virtual Learning Environments, which can be used in different domains such as medical, computer science, dental surgery, and other domains.

The future scope of this work can be extensive. ICT is becoming an integral part of modern information and technology. More software may develop in the future to resolve issues related to this matter, that will also assist Sciences students with more efficiency. It will become a more important part of the activities of human, and the use of this technology is extensive. It covers almost all the aspects of human activities like economic, cultural war and social. So, it is necessary to work efficiently on it in the future, and the findings of this research work can be used for further research like investigate adaptation techniques in different contexts such as e-commerce and mobile application

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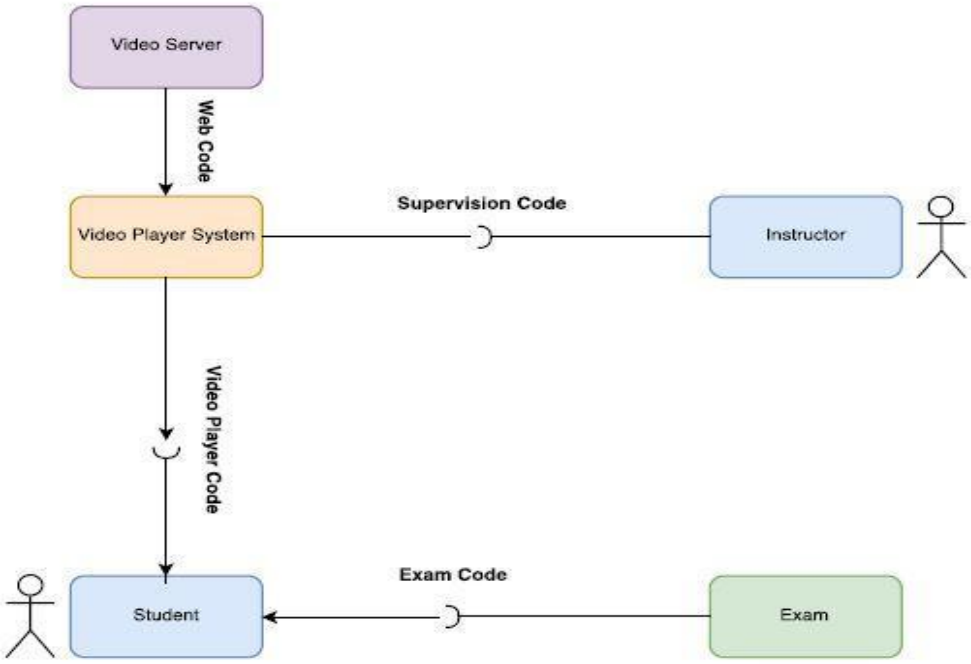
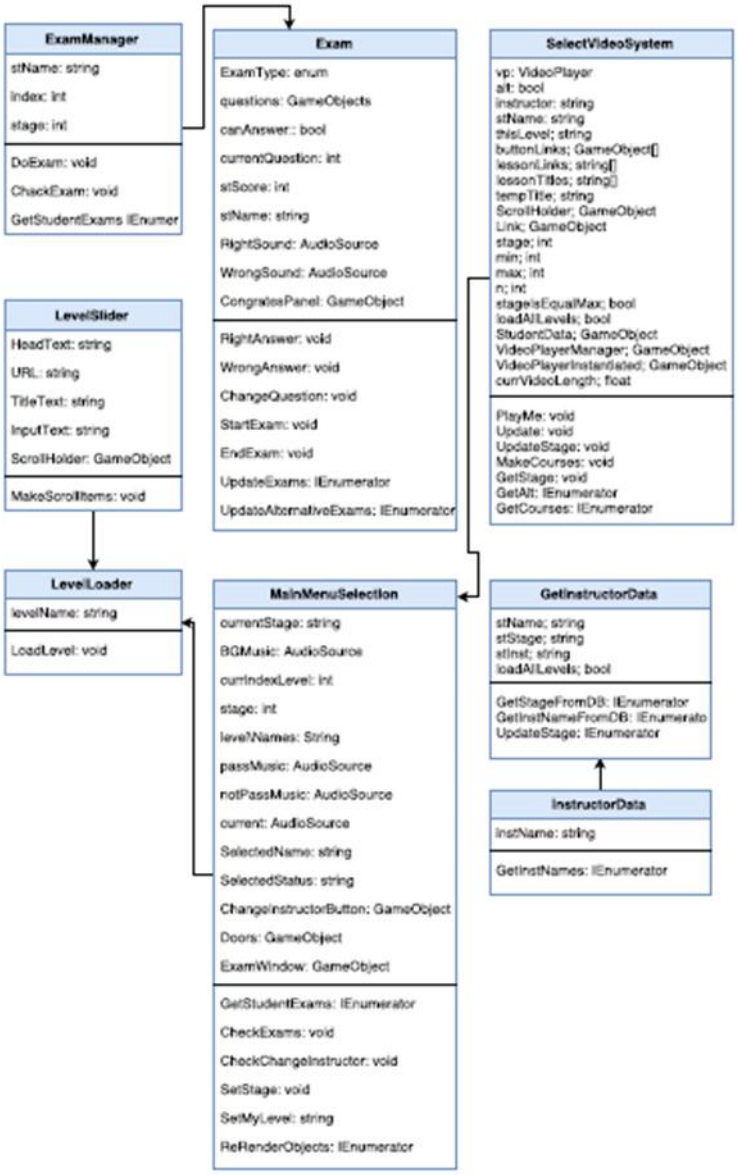
Appendices

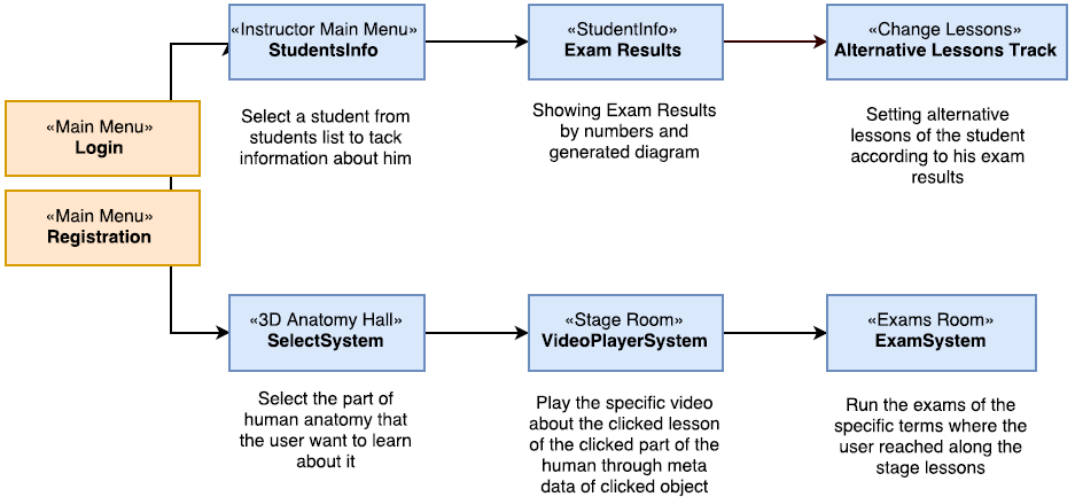
Appendix 1: Component Diagram



Appendix 2: Class Diagram



Appendix 3: Sequences Diagram



Appendix 4:questionnaire

Anatomy VR Course

Evaluation Questionnaire

Information and consent to participate in evaluation of anatomy virtual reality tools.

You have been asked to participate in the Anatomy Virtual Reality Course Evaluation. This study aims at evaluating the tool called the Anatomy VR Course. We would like to get your feedback on the tools, their usability and possible benefits or drawbacks. The outcomes of the evaluation will give evidence of the quality of the Anatomy Virtual Reality Course and will be used to derive ideas on how the system can be further improved. In general, there are no right or wrong answers. We want to know your opinion and viewpoints. The information that is obtained in connection with this study will be kept anonymous in the context of the overall Anatomy evaluation. In respect for each other, we also ask you to keep responses confidential.

If you have any questions about the study, please feel free to ask.

I understand this information and agree to participate.

There are 43 questions in this survey

A. Demographic Questionnaire for Learners (DQL)

Thank you for participating in this study! First we would like to collect some background data that are relevant to our research work. Please answer the questions below. Your data and the information collected in this evaluation will be treated anonymously.

1. Age.....
2. How often do you use Virtual Reality (VR) or 3D Environments?
   Please choose only one of the following:
   - Never
   - Less frequently than once a week
   - Several times a week
   - Daily
3. How often do you use e-learning applications (including coursera, udemy, edx, etc.)?Please choose only one of the following:
   - Never
   - Less frequently than once a week
   - Several times a week
   - Daily
4. How long have you been using VR applications? Please choose only one of the following:
   - Haven't so far
   - For one to several months
   - For about 1 year
   - For years
5. How much time in minutes did you spend approximately on the provided adaptive course? .....

B. Usability - System Usability Scale (SUS)

Please answer the questions below – record your immediate response to each item, rather than thinking about it for a long time. Please respond to all items – if you have the feeling you cannot answer a particular item, check the centre point of the scale.

1=strongly disagree 5=strongly agree

1. I think that I would like to use the ANATOMY VR course.

1		2		3		4		5	

2. I found the ANATOMY VR course unnecessarily complex.

1		2		3		4		5	

3. I think the ANATOMY VR course is easy to use.

1		2		3		4		5	

4. I think that I would need the support of a technical person to be able to use this ANATOMY VR Course in the future.

1		2		3		4		5	

5. I found the various parts in this ANATOMY VR Course were well integrated.

1		2		3		4		5	

6. I think there is too much inconsistency in this ANATOMY VR Course.

1		2		3		4		5	

7. I would imagine that most of my classmates would learn to use this ANATOMY VR Course very quickly.

1		2		3		4		5	

8. I found the ANATOMY VR Course very cumbersome to use.

1		2		3		4		5	

9. I felt very confident using the ANATOMY VR Course.

1		2		3		4		5	

10. I needed to figure out a lot of things before I could get going with this ANATOMY VR Course.

1		2		3		4		5	

11. I would like to use this ANATOMY VR Course in the future.

1		2		3		4		5	

12. I would recommend this ANATOMY VR course to my colleagues.

1		2		3		4		5	

C. Acceptance: Subjective Impression Questionnaire (SIQ)

The following sentences describe thoughts and feelings you may have regarding the use of the ANATOMY VR Course. For each of the following statement please indicate how much you can agree on the given scale.

1=strongly disagree 5=strongly agree

1. I would use the ANATOMY VR Course whenever possible.

1		2		3		4		5	

2. I would use the ANATOMY VR Course frequently when it is available.

1		2		3		4		5	

3. Using the ANATOMY VR Course is a good idea.

1		2		3		4		5	

4. Using the ANATOMY VR Course is unpleasant.

1		2		3		4		5	

5. Using the ANATOMY VR Course would be beneficial to my learning.

1		2		3		4		5	

6. Using the ANATOMY VR Course is easy for me.

1		2		3		4		5	

7. It was easy for me to become skilful at using the ANATOMY VR Course.

1		2		3		4		5	

8. I find the ANATOMY VR Course easy to use.

1		2		3		4		5	

9. I find the ANATOMY VR Course to be flexible to interact with.

1		2		3		4		5	

10. Integrating videos helps me to understand 3D objects being studied.

1		2		3		4		5	

11. Video adaptation techniques within the ANATOMY VR Course is clear and understandable.

1		2		3		4		5	

12. It is easy to know which part is required for more study using Video adaptation techniques.

1		2		3		4		5	

13. **It** is **useful to navigate through VR learning objects**

1		2		3		4		5	

14. Synchronization between Videos and 3D Objects draws your attention.

1		2		3		4		5	

15. **VR course is needed for better understanding of a course (e.g. Anatomy course)**

1		2		3		4		5	

16. **VR and video adaptations are needed for better understanding of a course (e.g. Anatomy course)**

1		2		3		4		5	

17. **I prefer to follow a classical course without using VR (e.g. Anatomy course)**

1		2		3		4		5	

D. Workload Perception Questionnaire (WPQ)

The purpose of this short questionnaire is to measure the perceived workload while learning and working with the ANATOMY VR system (subsequently referred to as 'task').Please answer the questions below by rating each item based on your subjective impression.

1-Very Low 5=Very High

1. Mental Demand: How mentally demanding was the task?

1		2		3		4		5	

2. Physical Demand: How physically demanding was the task?

1		2		3		4		5	

3. Performance: How successful where you in accomplishing what you were asked to do?

1		2		3		4		5	

4. How hard did you have to work to accomplish your level of performance?

1		2		3		4		5	

5. Frustration: How insecure, discouraged, irritated, stressed and annoyed where you using the ANATOMY VR Course?

1		2		3		4		5	

E. Qualitative feedback: User Feedback Questionnaire – Qualitative Feedback (UFQQ)

1. What did you like best about the system and the ANATOMY VR Course?

Please write your answer here:

2. What did you like least about the system and ANATOMY Virtual Reality Course?

Please write your answer here:

3. What should be improved and how?

Please write your answer here:

Thank you for your participation in the ANATOMY Virtual RealityCourseEvaluation.

ملخص الدراسة

بدا في السنوات الأخير التركيز على دراسة البيئات الافتراضية ثلاثية الأبعاد والبيانات بداخلها يكتسب اهتمامات متزايد في الدراسات الأكاديمية خاصة فيما يتعلق بتقنيات التعليم الالكتروني, لما توفره هذه التقنيات من ميزات عديدة ميزته عن التعليم التقليدي أو الكلاسيكي , ورغم ذلك فان استخدام موارد الوسائط المتعددة مثل مقاطع الصوت والفيديو واجه العديد من التحديات والصعوبات كان أهمها قابلية الاستخدام داخل البيئات الافتراضية ثلاثية الأبعاد , وفاعلية هذا الاستخدام داخل البيئة الافتراضية, إلا أن الدراسات المكثفة التي ركزت على هذا المجال أوجدت عددا من الطرق للتغلب على هذه العيوب والتحديات , وإحدى هذه الطرق هو القيام بتوفير بيئة افتراضية ثلاثية الإبعاد تتكييفية أي أن هذه البيئة قادرة على أن تتكيف مع هذا الواقع بشكل ديناميكي بناء على سلوك وتصرفات ومواصفات الشخص المتعلم المتواجد داخل هذه البيئة , ويتم ذلك عن طريق استخدام تقنيات التكيف داخل بيئات التعليم الافتراضي ثلاثي الأبعاد.

وبناء على ذلك قمنا بهذا البحث الذي يبحث في التحقق ومن إمكانية استخدام تقنيات التكييف التي من الممكن تطبيقها على مصادر التعليم , مثل مقاطع الفيديو والصوت داخل البيئة الافتراضية ثلاثية الأبعاد باعتبارها من أهم مكونات البيئات الافتراضية ثلاثية الأبعاد , حيث أن استخدام هذه التقنيات سوف يطور ويحسن من مخرجات ونتائج التعليم في بيئات التعلم الافتراضي ثلاثي الأبعاد . من خلال هذا البحث قمنا بوصف النهج الذي اتبعناه لدعم وتطبيق التكيف ليس داخل النماذج ثلاثية الإبعاد فقط وإنما تطبيقها على مصادر الوسائط المتعددة وخاصة الفيديو والصوت , ويختلف النهج الذي اتبعناه واقترح في هذا البحث عن باقي النهج القائم في باقي الدراسات من نواحي عدة, أولا؛ من ناحية النهج في تعاملنا فيه مع الطالب داخل هذه البيئة حيث يتم دعمه ومساعدته ليتمكن من عرض ومعرفة الأجزاء المتاحة والتي يحتاجها من ملفات الفيديو والصوت,ثانيا ؛ من خلال هذا النهج سيكون هناك مزامنة بين عرض ملفات الصوت والفيديو وعرض النماذج ثلاثية الإبعاد المرتبطة بتلك الملفات بحيث أن هذه المزامنة تسهل بشكل كبير على الطالب عملية التعليم , ثالثا؛ قمنا من خلال هذا النهج بتوظيف عدد من أدوات التكيف على مصادر الوسائط المتعددة بحيث دعمت بشكل كبير عملية التعليم ومن الممكن تطبيقها في مجالات أخرى.

قمنا في هذا البحث ببناء نموذج أولي هو عبارة عن فصل دراسي تكييفي , وقد تم بناءة بالاعتماد على النهج الذي قمنا باقتراحه في هذا البحث من حيث استخدام عدة أدوات تكييف على ملفات الصوت والصورة , ومن ثم قمنا بتقييم النهج المقترح من خلال تقييم النموذج الذي قمنا ببنائه وذلك من خلال استخدام طرق تقييم كمية ونوعية من عدة جوانب سواء من ناحية سهولة الاستخدام, والفائدة التي حصل عليها الطالب , وسهولة الحصول على تلك المعلومة من قبل الطالب باستخدام تقنيات التكييف , والتزامن بين عرض النماذج ثلاثية الأبعاد ومصادر الوسائط المتعددة وغيرها من النواحي. وقد أظهرت نتائج التقييم لهذا النهج فعالية كبير و رضا كبير عن النهج المقترح في هذا البحث