Literature Review

THE ROLE OF VIRTUAL REALITY AS A LEARNING TOOL IN ORAL AND MAXILLOFACIAL SURGERY

A THESIS

Submitted as Partial Fulfillment of The Requirements for

The Attainment of The Degree of Bachelor of Dentistry

MUHAMMAD DAFFA YUDHISTIRA HILALA

J011191101

DEPARTEMENT OF ORAL AND MAXILLOFACIAL SURGERY

FACULTY OF DENTISTRY

HASANUDDIN UNIVERSITY

2022

Literature Review

THE ROLE OF VIRTUAL REALITY AS A LEARNING TOOL IN ORAL AND MAXILLOFACIAL SURGERY

A THESIS

Submitted as Partial Fulfillment of The Requirements for

The Attainment of The Degree of Bachelor of Dentistry

MUHAMMAD DAFFA YUDHISTIRA HILALA

J011191101

DEPARTEMENT OF ORAL AND MAXILLOFACIAL SURGERY

FACULTY OF DENTISTRY

HASANUDDIN UNIVERSITY

2022

HALAMAN PENGESAHAN

Judul : The Role of Virtual Reality as A Learning Tool in Oral and Maxillofacial Surgery

Oleh : Muhammad Daffa Yudhistira Hilala/ J011191101

Telah Diperiksa dan Disahkan

Pada Tanggal: 04 April 2022

Oleh:

Pembimbing

Prof. drg. Muhammad Ruslin, M.Kes., Ph.D., Sp.BM(K).

NIP. 19730702 2001 12 1 001

Mengetahui,

Dekan Fakultas Kedokteran Gigi

Universitas Hasanuddin

Prof. drg. Muhammad Ruslin, M.Kes., Ph.D., Sp.BM(K)

NIP. 19730702 2001 12 1 001

iii

SURAT PERNYATAAN

Dengan ini menyatakan bahwa mahasiswa yang tercantum di bawah ini :

Nama : Muhammad Daffa Yudhistira Hilala
NIM : J011191101
Judul : The Role of Virtual Reality as A Learning Tool in Oral and Maxillofacial Surgery

Menyatakan bahwa judul skripsi yang diajukan adalah judul yang baru dan tidak terdapat di Perpustakaan Fakultas Kedokteran Gigi Universitas Hasanuddin

Makassar, 04 April 2022

Koordinator Perpustakaan FKG Unhas

Amiruddin, S. Sos
NIP. 19661121 199201 1 003

iv

PERNYATAAN

Yang bertandatangan di bawah ini:

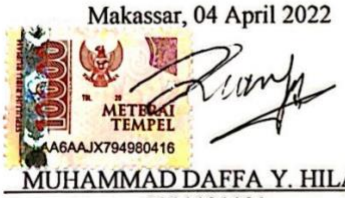
Nama : Muhammad Daffa Yudhistira Hilala

NIM : J011191101

Dengan ini menyatakan bahwa skripsi yang berjudul "THE ROLE OF VIRTUAL REALITY AS A LEARNING TOOL IN ORAL AND MAXILLOFACIAL SURGERY" adalah benar merupakan karya sendiri dan tidak melakukan tindakan plagiat dalam penyusunannya. Adapun kutipan yang ada dalam penyusunan karya ini telah saya cantumkan sumber kutipannya dalam skripsi. Saya bersedia melakukan proses yang semestinya sesuai dengan peraturan perundangan yang berlaku jika ternyata skripsi ini sebagian atau keseluruhan merupakan plagiat dari orang lain.

Demikian pernyataan ini dibuat untuk dipergunakan seperlunya

Makassar, 04 April 2022



MUHAMMAD DAFFA Y. HILALA

J011191101

v

KATA PENGANTAR

Segala puji syukur penulis panjatkan kehadirat Allah SWT atas segala berkat rahmat, taufik dan hidayah-Nya sehingga penulis dapat menyelesaikan penulisan dan penyusunan skripsi dengan judul **"The Role of Virtual Reality as A Learning Tool in Oral and Maxillofacial Surgery"**. Penulisan skripsi ini bertujuan sebagai salah satu syarat penyelesaian studi dalam mencapai gelar sarjana kedokteran gigi pada Fakultas Kedokteran Gigi Universitas Hasanuddin. Salawat dan salam juga penulis haturkan kepada junjungan nabi besar Rasulullah Muhammad SAW sebagai teladan yang membawa manusia dari jalan yang gelap menuju jalan serba pengetahuan.

Penulis menyadari, bahwa penyusunan skripsi ini tidak lepas dari dukungan banyak pihak. Kesempatan ini, penulis pertama-tama ingin mengucapkan terima kasih serta penghormatan dan penghargaan kepada kedua orang tua penulis yakni **Kadria Hilala** dan Ibunda **Nurhaidar Pakaya** karena doa dan restunyalah sehingga rahmat Allah tercurah, serta atas kasih sayang dan kesabarannya dalam memberikan dukungan baik materil maupun moril sehingga skripsi ini dapat terselesaikan.

Tidak lupa penulis ucapkan banyak terima kasih dan penghargaan yang sebesar- besarnya kepada :

1. **Prof. Muhammad Ruslin, drg., M. Kes. Ph.D. Sp.BM(K)**, selaku dekan Fakultas Kedokteran Gigi Universitas Hasanuddin dan dosen pembimbing skripsi yang telah memberi bimbingan baik itu bersifat akademik dan non-akademik, motivasi, arahan, waktu dan tenaganya dalam penyelesaian skripsi literature review ini. Semoga Allah SWT senantiasa memberikan nikmat kesehatan dan keberkahan kepada beliau.

2. **drg. Andi Tajrin M.Kes., Sp.BM(K)** selaku penguji skripsi dan dosen penasihat akademik yang telah memberikan masukan maupun saran yang membangun sehingga penyusunan skripsi kajian literatur ini dapat selesai tepat waktu dan terima kasih atas bimbingan, nasihat, dukungan dan motivasi yang tak henti-hentinya diberikan kepada penulis selama perkuliahan.
3. Kepada **drg. Hasmawati Hasan, M.Kes** selaku penguji skripsi yang telah memberikan masukan maupun saran yang membangun sehingga penyusunan skripsi kajian literatur ini dapat selesai tepat waktu.
4. **Seluruh dosen, staf akademik, staf TU, dan staf perpustakaan FKG Unhas** yang telah banyak membantu penulis
5. Untuk saudara penulis, **Davina Shafa Felisha Hilala** yang selalu memberikan dukungan saat menempuh pendidikan maupun terselesainya skripsi ini.
6. Teman seperjuangan skripsi dari Departemen Ilmu Bedah Mulut dan Maksilofasial, **Afifa Aroyani Afra** yang senantiasa memberi semangat dan masukan-masukan dalam penyusunan skripsi literature review ini
7. Untuk sahabat penulis, **zhira, chaca, ira, muflih, wisnu, ecin, bagas, dilaks, fauzan** yang telah meluangkan banyak waktu, menemani, menghibur dan memberi pendapat dalam membantu penyusun untuk meningkatkan kualitas dari isi skripsi.
8. Untuk keluarga besar penulis, **vira, afdal, fito, nazwa, k zell, k zy, k ayu,** dan seluruh **kerabat Mohutato** yang selalu memberikan motivasi dalam pembuatan skripsi ini. Semoga kalian selalu diberikan kesehatan, keberkahan dan kebahagiaan dunia dan akhirat.
9. Teman-teman **Kelas Internasional 2019**, terima kasih atas semangat dan dukungannya dalam penyusunan skripsi ini
10. Teman-teman angkatan **Alveolar 2019**, yang tentu saja penulis tidak bisa sebutkan satu persatu, terima kasih atas segala dukungan dan semangat kepada penulis selama masa perkuliahan.

11. Dan bagi semua pihak yang tidak penulis sebutkan namanya, terima kasih telah memberikan kontribusi dan semangat dalam penyusunan skripsi ini.
12. Last but not least, I wanna thank me, I wanna thank me for believing in me, I wanna thank me for doing all this hard work. I wanna thank me for having no days off. I wanna thank me for never quitting. I wanna thank me for always being a giver and trying to give more than I receive. I wanna thank me for trying to do more right and wrong. I wanna thank me for just being me at alll times.

Penulis menyadari sepenuhnya bahwa skripsi ini masih jauh dari kesempurnaan, karena kesempurnaan hanya milik Allah semata. Oleh karena itu, penulis memohon maaf bila ada kesalahan dalam penulisan skripsi ini. Kritik dan saran kami hargai demi penyempurnaan penulisan serupa dimasa yang akan datang. Besar harapan penulis, semoga skripsi ini dapat bermanfaat dan dapat bernilai positif bagi semua pihak yang membutuhkan.

Makassar, 28 Maret 2022

Penulis

ABSTRAK

The Role of Virtual Reality as A Learning Tool in Oral and Maxillofacial Surgery

Muhammad Daffa Yudhistira Hilala

Mahasiswa S1 Fakultas Kedokteran Gigi Universitas Hasanuddin, Indonesia

daffah93@gmail.com

Latar Belakang: Realitas virtual dapat menjangkau rumah tangga melalui perangkat elektronik konsumen seperti smartphone. Ini akan melibatkan munculnya teknologi ini di lingkungan pendidikan dengan mendukung gaya belajar yang berbeda dan memfasilitasi proses belajar mengajar. Dalam bidang kedokteran khususnya kedokteran gigi, simulasi *virtual reality* dikatakan mampu menggantikan metode tradisional dimana mahasiswa menggunakan manekin menyerupai pasien sebagai alat pembelajaran. Pendidikan kedokteran gigi sendiri merupakan perpaduan antara teori dan praktek klinik, dimana mahasiswa dituntut untuk tidak hanya mengetahui teori tetapi mahir dalam praktek klinik. Namun seiring berkembangnya *virtual reality*, teknologi tersebut kini dapat digunakan di berbagai bidang dalam kedokteran gigi, salah satunya adalah Bedah Mulut dan Maksilofasial.**Tujuan:** mengetahui peran dari teknologi virtual reality sebagai alat pembelajaran dalam bedah mulut dan maksilofasial. **Metode:** Desain penulisan ini adalah *literature review*. **Kesimpulan:** Saat ini penggunaan teknologi *virtual reality* dalam pendidikan praklinis masih sangat terbatas, belum ada kajian literatur atau penelitian yang secara khusus membahas penggunaan *virtual reality* dalam pendidikan praklinis. Selama ini pendidikan praklinis hanya menggunakan prosedur konten video 360º yang digunakan dengan *Head-Mounted Display (HMD)* untuk menampilkan konten prosedur pembedahan seperti pencabutan gigi. namun dalam penggunaannya dalam pendidikan klinis telah dipastikan bahwa teknologi ini mampu memberikan efektivitas yang memadai bagi mahasiswa kedokteran gigi..

Kata Kunci: *Virtual reality, VR in dental education, Virtual reality in oral surgery*

ABSTRACT

The Role of Virtual Reality as A Learning Tool in Oral and Maxillofacial Surgery

Muhammad Daffa Yudhistira Hilala

Faculty of Dentistry, Hasanuddin University

daffah93@gmail.com

Background: Virtual reality can reach households through consumer electronic devices such as smartphones. This will involve the emergence of these technologies in educational environments with different learning styles and facilitating the teaching and learning process. In the field of medical medicine, virtual reality simulation is said to be able to use traditional methods where students use mannequins resembling patients as learning tools. Dental education itself is a combination of theory and clinical practice, where students learn not only to know theory but to be proficient in clinical practice. However, along with the development of virtual reality, this technology can now be used in various fields of dentistry, one of which is Oral and Maxillofacial Differences. **Purpose:** Knowing the role of virtual reality technology as a learning tool in oral and maxillofacial surgery. **Method:** The design of this paper is a literature review. **Conclusion:** Currently the use of virtual reality technology in preclinical education is still very limited, there is no literature review or research that specifically discusses the use of virtual reality in preclinical education. So far, preclinical education only uses 360º video content procedures that are used with Head-Mounted Display (HMD) to display the content of surgical procedures such as tooth extraction. but in its use in clinical education it has been ensured that this technology is able to provide adequate effectiveness for dental students.

Keywords: Virtual reality, VR in dental education, Virtual reality in oral surgery

TABLE OF CONTENTS

TABLE OF FIGURE

TABLE OF TABLE

CHAPTER 1

INTRODUCTION

1.1. Background

Technology was first discovered in the 17th century and was only a simple machine. As time goes by, technological innovation continues to be developed from year to year until now technology has become the main means of society in doing various things. An example of technological innovation that is growing rapidly in recent times is virtual Reality.

Virtual reality is a computer-based simulation using specialized electronics of an image or entire environment, allowing users to exist in an alternative environment resembling the real world of three-dimensional (3D) virtual objects and information. This uses additional data such as graphics and sound. Virtual reality technology was first discovered by Morton Leonard Heiling. Morton's findings that made him dubbed as the father of virtual reality are machines that provide 3D visuals, sound and also have immersive motor sensors.[1,2]

Virtual reality is a computer interface that allows users to interact in real time, in a three-dimensional space generated by a computer, using their feelings, through special devices. Users can see the virtual world through windows built by a monitor screen or projection screen or can be entered into the real world through a helmet (HMD) or multi-projection room and interaction devices.[2]

Virtual reality can reach households through consumer electronic devices such as smartphones. This will involve the emergence of these technologies in the educational environment by supporting different learning styles and facilitating the teaching and learning process. The use of virtual reality in the educational environment is expected to improve the standard of education and student learning outcomes. Virtual reality can be an interactive learning media that can reduce the passive nature of the student, the student will be interested to learn something if delivery like using virtual reality. When compared with in traditional graphic research, virtual reality technology is more sophisticated and modern because it emphasizes the interaction between the system and the user. Users can enter and feel the digital environment so that it makes users feel like they are in the real world.[3]

Over the past ten years, virtual reality technology has been developed and applied from the entertainment industry to clinical medicine. Researchers and doctors have studied the impact of virtual reality simulations on physical rehabilitation, pain management, surgical training, anatomy education and treatment of psychiatric illnesses. Virtual reality technology is considered superior to conventional methods because it is more cost-effective and efficient in these field.[4]

In the field of medicine, especially dentistry, virtual reality is generally used as a tool to control children's anxiety during dental procedures. Virtual reality simulation is said to be able to replace traditional methods where students use mannequins resembling the patient as a learning tool. Dental education itself is a combination of theory and clinical practice, where students are required to not only know the theory

but be proficient in clinical practice. But as virtual reality is developed, the technology can now be used in various fields in dentistry, one of which is Oral and Maxillofacial Surgery.[5]

In the procedures of Oral and Maxillofacial Surgery such as dental implants, orthognathic surgery, and mandibular reconstruction are procedures that are most often performed using virtual reality simulations. With the three-dimensional (3D) capabilities of virtual reality, it allows student to see and study the anatomy of the mouth and teeth.[6]

There are many advantages to using virtual reality for the education of oral surgical procedures. First, using virtual reality when practicing oral surgery can avoid the risk of damage to the original tool. Second, the use of virtual reality can allow us to simulate the use of expensive laboratory equipment like the actual process[7]. In surgical training, virtual reality simulators will focus on the interaction of operating devices and anatomical structures and can also be used for virtual planning to reduce postoperative risk.

Based on a search of research journals and publications, several analyzes were found regarding the use of virtual reality in oral and maxillofacial surgery that can be useful in the health sector for clinical and preclinical students to practice skill development. Therefore, the authors are interested in knowing "Use of Virtual Reality as a learning tool in oral and maxillofacial surgery".

1.2. Problem Formulation

Based on the background that has been explained, the formulation of the problem can be taken is how is the role of Virtual reality as a learning tool in oral & maxillofacial surgery?

1.3. Writing Objective

Based on problem formulation the purpose of this study is knowing the role of virtual reality as a learning tool in oral & maxillofacial surgery

1.4. Writing Benefits

Based on the background of the problem, the literature review is expected to provide several benefits including:

a. The theoretical benefit

   Are expected to be as the material information about the use of virtual reality as a learning tool in oral & maxillofacial surgery

b. The practical benefits

   As information on the latest developments regarding the role of virtual reality as a learning tool in oral and maxillofacial surgery and can be used as reading material for research in the field of oral and maxillofacial surgery

CHAPTER 2

LITERATURE STUDIES

2.1. Virtual Reality

2.1.1. Definition of Virtual Reality

Virtual reality is an advanced technology that has motor sensors that can display visuals and sounds with three-dimensional capabilities. Virtual reality's three-dimensional capabilities make the resulting visuals look real. In other words, virtual reality can manipulate the virtual environment into a real environment as we see it every day. this allows users to enter and explore the virtual world and also interact with objects in it.[8]

Head-mounted display (HMD) based virtual reality is well known and used by many people. HMD is a stereoscopic technique, and is a device worn on the head or as part of a helmet. It has a small optical screen in each eye (figure 1).[3]

The HMD for virtual reality is classified according to the type is divided into PC virtual reality and Mobile virtual reality. Virtual reality for PC is divided into Oculus Rift, HTC Vive and Sony PSVR, and Mobile VR is divided into Samsung Gear VR, Google Cardboard and Google Daydream. In addition, according to contents type is classified into image-based VR and graphic-based. VR. Image-based VR is divided into 360- degree video and graphic-based VR is divided into VR game and VR experience.[9]

(Figure 1) Head-mounted display and gesture sensor *(li Y. et al. 2021. The Current Situation and Future Prospects of Simulators in Dental Education)*

Virtual reality has 4 important elements. The first is the virtual world, which is an environment that is realized by media that has a 3D component. The second is immersion, the acknowledgment of physical presence in the non-physical world, feelings or auras created by virtual reality for users to feel like they are in a real environment, even though they are fictitious. immersion is divided into 3, namely, mental immersion (making the user's mentality like in a real environment), physical immersion (making the fictitious environment created by virtual reality physically felt by the user), mentally immersed (feeling or aura generated by virtual reality so that users can sense and dissolve in the created fictional environment). the third element is sensory feedback, this element makes virtual reality require a lot of the user's senses to be simulated. such as sight, hearing, touch, etc. the last element is interactivity, useful for responding to actions from users so that users can interact directly.[10]

2.1.2. The Advantages and Disadvantages of Virtual Reality

Virtual reality has several advantages, namely:

a. Able to conduct various experiments because they are free to interact with objects in virtual reality and other students to make the learning process more interesting.
b. Can motivate students because of the attractive display so students can have an immersive experience, while studying 3D models that enhance learning.
c. The technology is affordable and easily accessible. Virtual reality can be accessed via smartphones, tablets, or video game devices. This eliminates the need for complex devices, and students can access virtual reality content through online platforms such as YouTube. For students with disabilities, virtual reality is very helpful in terms of interacting with virtual objects and other students because it is easy to access.
d. Virtual reality technology allows for more interaction than conventional learning materials.

This ability can make users experience more, making virtual reality an interesting technology to be applied in various fields.[11]

There are also disadvantages of virtual reality, namely:

a. Possibly high monetary costs of securing a framework. A Virtual Reality framework consists of a computer program for visualization control, a computer for running the software, and innovation for show and interaction. Show devices such as head-mounted shows are costly with generally few manufacturers. In

spite of the fact that the innovation is generally unused, it'll still be a moderately costly elective to routine instructing methods.

b. Lack of realism/fidelity/skill exchange issues. In terms of authenticity and constancy the question is how closely the VR reenactment takes after the situation being modeled or visualized. This issue bargains with visual authenticity as well as elements and interaction authenticity. The starting visualization utilized in VR was not idealize and needed that kind of authenticity. There are two reasons for this. First, the methods utilized to deliver practical design are exceptionally restricted and not however completely created. Second, to preserve interactivity, graphical show overhauls ought to be as high as conceivable (and over 15 outlines per second).

c. Physical impacts on end-users. The weight of the HMD implies there's a plausibility of moving the head inside the device itself coming about in an misaligned show. There's also the potential for weariness after the client has worn the screen for long periods of time and, in spite of the fact that the focal points within the HMD are near to the eyes, there's also a decreased field of see which suggests the wearer has got to make more head movements than usual. Another issue is eye strain due to destitute optical alterations and other impacts such as flashing on the screen. Once more typically imperative as it were after delayed utilize and the as it were arrangement is to constrain the amount of time the client spends wearing the HMD.[12]

2.2. Learning

2.2.1. Definition of Learning

According to the KBBI learning is the process/action of making people or living things learn. According to the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, that learning is an interaction between educators and students in one environment. Learning is a learning process carried out by students. The learning environment has a major influence in the learning process because this process is important in the world of education[13,14].

Learning is a complex aspect of activities and cannot be fully explained. In simple terms, learning can be interpreted as a product of continuous interaction between development and life experience. Another meaning of learning is an effort from educators to carry out their obligations, namely providing knowledge to students so that they get their rights as students with the same goal. Current learning is still transmitive, that is, students passively absorb the knowledge provided by educators or only in textbooks.[13]

2.2.2. Learning Media

1. Print Media

Print Media is a simple and easy to get media anywhere and anytime. The advantages of using print media are easy to obtain, flexible, easy to carry everywhere, and economical. For example, books, brochures, leaflets, modules, student worksheets, and handouts. Print media also tend to be used for directions

and cannot interact reciprocally. Print media such as textbooks tend to be used only to teach the curriculum and not to achieve learning objectives.[15]

2. Media Display

Media display divides exhibition media into realia, models, and kits. The use of this media is done by installing or displaying it in a certain place; in front of the classroom, on the classroom wall, next to the blackboard, or anywhere else where it is possible to convey information or learning messages.

Realia is the original object that is used as a medium to convey information. Realia cannot be manipulated and does not change at all. The use of realia in the classroom can motivate and attract the attention of students because they can see the object directly.

Other display media are models that can be understood as substitute objects whose function is to replace the actual object. Diaroma is a form of static object on display designed to convey information about real events that occurred in the past or present or describe the future in three-dimensional form. While the kit is a medium that can be touched, seen, heard, and can be observed through the five human senses. In the learning process using the kit, the kit user must be involved and interact directly with the objects that are part of the kit collection. However, in learning, educators can use photos or videos to demonstrate manipulatively if they cannot provide a kit for their learning.[15]

3. Audio Media

Audio media is a learning media that only involves the sense of hearing. The message to be conveyed is poured into auditive symbols, both verbal (into spoken words) and non-verbal. Examples such as radios, cassette recorders, and LPs. In its development, audio media has changed according to technological advances, for example, now there are audiotape, compact disk (CD), MP3 and MP4.[15,16]

4. Visual Media

Visual media is media that can only be seen, and does not contain sound elements. Included in the visual media are slide films, photographs, transparencies, paintings, pictures and printed materials such as graphic media. Visual media is a medium that has several elements in the form of lines, shapes, colors, and textures in its presentation.

Visual media in the concept of visual learning can be in the form of pictures, models, objects, or other tools that give students a real visual experience. In its use, visual media aims to introduce, shape, and clarify understanding of abstract material to students, develop affective functions, and encourage further student activities.[17]

5. Video Media

Video media is a tool used by educators to stimulate the feelings, thoughts and desires of students by displaying ideas, messages and information in an audio-visual way. The use of instructional video media can stimulate students' motivation to learn because there is student curiosity about the videos displayed so that they can

increase students' understanding of the material provided. The most used video formats are videotape, DVD, Video Disc, and Internet Video.[18,19]

6. Multimedia

Multimedia is defined as a form of text, audio and graphic transmission in the same period interpreted as a computer-based interactive communication system capable of creating, storing, presenting and re-accessing information in the form of text, graphics, sound, video or animation in digital format. The use of multimedia can be adapted to learning abilities and supported by adequate facilities and facilities. Many methods and strategies can be used to use multimedia effectively and interactively.[20]

7. Computer Equipment

Computer based learning is the management of learning by utilizing computer equipment, both hardware and software. The use of computer equipment is also often identified with the use of internet site networks, but actually computers are not limited to computers and the internet but also include information media such as television, radio, multimedia player, cellphone and others.[21]

2.3. Virtual Reality in Dentistry

Virtual reality is a very innovative technology in dentistry. This technology is applied to train the skills of pre-clinical students in a university environment which

positively affects the quality of learning. This technology is more flexible for use in learning than using conventional tools such as mannequins.[22]

Currently, most dental schools use conventional methods with pedagogical tools such as preclinical laboratories where students practice their skills on the head of a mannequin which has a rubber sheet resembling the cheeks and mouth patients which contain typodont teeth. Although this teaching method has become the standard of teaching for preclinical students, this method has limitations in providing quantity and quality effects for preclinical students.[23,24]

Comparing the perception of skills of preclinical students who used virtual reality simulation between not used virtual reality, that ergonomic development and technical performance were positively affected by virtual reality training. Virtual reality is the best educational tool when compared to other traditional methods. It continues to provide distinct benefits such as improved skills, coordination, and training. By adopting this technology, there is a better experience, and it proves to be an important part of modern education. Virtual Reality technology will be an important tool in dentistry of the future. As such, it has wide applications in education, clinical care and development.[6]

In dentistry there are two types of dental virtual reality simulators that are frequently used in dental schools and are available: firstly, mannequin-based dental simulators where dental procedures can be performed using plastic dental instruments such as DentSim. This unit allows students to visualize their preparation on a

computer screen, while giving them the ability to work on plastic teeth. This ability to imitate real-life situations allows students to practice independently and improve clinical skills, thereby reducing training costs (Figure 2).[23,25]

Secondly, based on haptic simulators that use Haptic features or touch based. Haptic dental simulation use has evolved and appears to be a promising virtual reality-based teaching tool for the training of preclinical dental students. Haptic technology provides the ability to sense the tooth surface through a feedback mechanism and provides the ability to differentiate between soft and hard tissues. Examples of dental simulators that use haptic features are Simodont and Voxel Man TempoSurg Simulator.[26,27]

(Figure 2) The components of the DentSim (A) Phantom Head, (B) Overhead Infrared Camera, (C) Light Source, (D) Infrared Sensor. *(Roy et al. 2017. The need for virtual reality simulators in dental education: A review)*

Simodont provides real touch in a virtual environment to allow users to "feel" realistically what they are doing. This system features a two-way interface between the virtual world and the user, so that the user can feel the tactile sensation when drilling with a dental bur to remove caries. The use of Simodont in a pre-clinical

environment can assist student skills training by evaluating student work progress by Simodont student application software (Figure 3).[26]

(Figure 3) A Dental Skills Trainer, the SIMODONT *(Stokes C. et al. 2019. A scoping review of the use and application of virtual reality in pre-clinical dental education. British Dental Journal).*

Voxel Man TempoSurg Simulator is a VR surgery simulator which mainly consists of a 2D monitor, simulated surgery handle, pedals legs, and 3D glasses. The system provides different training modes depending on the participant's level, with different display interfaces and different operating instructions. The three selectable modes are the main mode, the advanced mode, and the exam mode (Figure 4).[28]

(Figure 4) Design of Voxel-Man *(Varoquer M. et al. 2017. Construct, Face, and Content Validation on Voxel-Man,, Simulator for Otologic Surgical Training. International Journal of Otolaryngology)*

This simulator system has been applied to teaching dental procedures for example, restorative procedures as well as in other fields of dentistry, such as prosthetics and oral surgery. because it is considered a promising tool for complex treatment and can positively give good results.[22]

2.4. Virtual Reality in Oral and Maxillofacial Surgery

As virtual reality technology advances in dentistry, this allows virtual reality to be applied to the field of oral & maxillofacial surgery. Oral and Maxillofacial Surgery refers to a clinical specialty that involves surgical procedures in the mouth, neck, face, and jaw area. It will be very beneficial for dental students or novice surgeons to simulate surgical operations through virtual reality systems, this will affect users in terms of understanding of surgical procedures and improvement of surgical operation skills.[29,30]

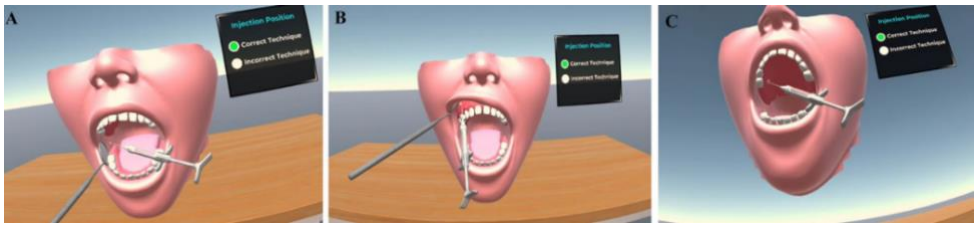
Advances in computing power have made simulation images much more realistic and faster than ever before. The concept of virtual reality requires the development of special software to manipulate 3D images recorded from dental and Oro-facial morphology. Therefore, it is important to highlight the existing methods for recording 3D tooth structure, skeleton, and soft tissue from dentofacial anatomy. In virtual reality surgery, immersive virtual reality experiences are developed using Oculus quest and Leap Motion devices. This is a multi-sensory holistic surgical training technology, which demonstrates maxillofacial surgery techniques (Figure 5).[29,31]

(Figure 5) Oculus quest Devices and Leap motion

The utility of VR glasses before surgery to improve understanding of surgery in cases of deeply impacted third molars, mandibular fractures, and oncological resection. The authors state that preoperative examination with virtual reality glasses can help to better understand and plan the surgical site, being an innovative piece of advanced technology for displaying anatomical data (Figure 6).[22,32]

(Figure 6) Users with Virtual Reality Glasses

The use of 3D visualization in dental training was also reported where dental injection for haptic inferior alveolar nerve blocks as well as a virtual training system of oral and maxillofacial surgery with advanced haptic feedback and immersive experiences were developed (Figure 7).[29]



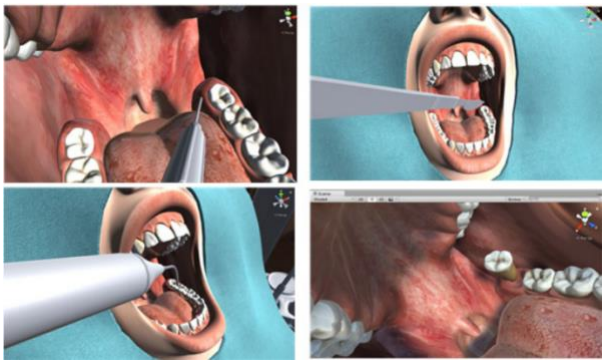
(Figure 7) Demonstration of virtual reality local anesthetic administration techniques. A). Inferior alveolar nerve block. B). Buccal supraperiosteal infiltration. C). Palatal supraperiosteal infiltration. *(Zafar et al. 2021. Pedagogical development in local anesthetic training in pediatric dentistry using virtual reality simulator)*

One of the procedures in oral and maxillofacial surgery that can be performed using virtual reality as a learning tool in preclinical education is Tooth extraction. Virtual reality is developed to make sure the preclinical students are learning the procedure of tooth extraction. After using the head-mounted display (HMD), students will feel and see a new world. they will see like they are in a clinical practice room in which there are patients and tools to carry out the tooth extraction procedures. (Figure 8)[33]

(Figure 8) Animation VR using Head-Mounted Display (HMD) *(JongTae Park et al. 2018. Development of Educational Content for Dental Extraction Skill Training Using Virtual Reality Technology)*

Tooth extraction procedures include extraoral and intraoral disinfection, anesthesia, incision of the angular ligament, separation of the tooth from the surrounding soft tissue, tooth extraction, granulation tissue removal, tooth extraction

and cleaning, and suturing. it's all designed in such a way as to do it on a real patient. In order to make it look like real surgery, the tooth extraction data was investigated, and the patient's facial anatomy and surgical environment were modeled in 3D through data surveys. (Figure 9).[33]



(Figure 9) Making the patient's facial anatomy through 3D modeling. *(Jong-Tae Park et al. 2018. Development of Educational Content for Dental Extraction Skill Training Using Virtual Reality Technology)*

Apart from being a learning tool in educating preclinical students, virtual reality technology can also be applied in learning for clinical students and novice surgeons. such as dental implant surgical procedures, orthognathic surgery, and mandibular reconstruction. All of those surgical procedures are the most ever performed using virtual reality technology.

Students indicated that simulated feedback of haptic pressure, 3D spatial perception, and simulator image resolution are key features for virtual training of dental surgical procedures. students also have the ability to assess their own performance for improvement in surgical technique. The application of virtual

surgery using 3D reconstruction of patient anatomy can help surgeons to plan complex surgical procedures.[29]

The importance of virtual reality in standardizing clinical education to facilitate learning and practice has been highlighted. Virtual reality is a promising tool in preoperative learning and planning. Further evaluation in the software is required before this technique can be implemented in dental practice learning in schools. With this, virtual reality technology can encourage students to learn effectively because they get accurate feedback with 3D images.[29,32]