



Virtual Reality in Medical Education in Saudi Arabia

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Abstract:

Medical students in Saudi Arabia currently learn their curricula through traditional tools and methods that prepare them to become medical professionals. Adding virtual reality (VR) as a new method of teaching can act as an educational tool to help students to learn by doing. This research discusses the impact of using VR in medical universities in Saudi Arabia on educating undergraduate medical students by assembling the perspective of medical universities professors to use VR as an educational aid to facilitate the teaching and learning inside university classrooms.

In this paper, the first chapter introduces the topic of “Virtual Reality in Medical Education”. Following that, the second chapter discusses the literature review. The main findings of this study suggest that the technology of VR is beneficial in medical education, VR simulation applications enhance learning results for an assortment of surgeries, and all possible challenges can be solved with the cooperation of the universities that will provide this technology. Next, the needs and objectives of this research will be stated. The third chapter discusses the chosen methodologies that were used. Finally, the fourth chapter will discuss all the findings that have been discovered from the previous research methods. The results of this research conclude that the use VR in medical education is superbly appropriate and shows a positive impact on medical education and is probably going to fill in as a basic tool in clinical schooling. In addition, the findings confirm the excitement of medical professors to use this technology in their classrooms. The findings are only limited to universities in Saudi Arabia as they do not apply to universities in other countries as the research was based on medical professors in Saudi Arabia.

Keywords: Virtual reality, simulation, medical education, literature review, Saudi Arabia.

خلاصة:

يتعلم حالياً طلاب الطب في المملكة العربية السعودية مناهجهم الدراسية من خلال الأدوات والأساليب التقليدية التي تعدهم ليصبحوا محترفين في المجال الطبي. يمكن أن تكون إضافة الواقع الافتراضي (VR) كطريقة جديدة للتدريس بمثابة أداة تعليمية لمساعدة الطلاب على التعلم بالممارسة. يناقش هذا البحث تأثير استخدام الواقع الافتراضي في الجامعات الطبية في المملكة العربية السعودية على تعليم طلاب الطب الجامعيين من خلال تجميع منظور أساتذة الجامعات الطبية لاستخدام الواقع الافتراضي كأداة تعليمية لتسهيل التدريس والتعلم داخل الفصول الدراسية بالجامعة.

في هذه الورقة، يقدم الفصل الأول موضوع "الواقع الافتراضي في التعليم الطبي". بعد ذلك، يناقش الفصل الثاني مراجعة الأدبيات. تشير النتائج الرئيسية لهذه الدراسة إلى أن تقنية الواقع الافتراضي مفيدة في التعليم الطبي، وأن تطبيقات محاكاة الواقع الافتراضي تعزز نتائج التعلم لمجموعة متنوعة من العمليات الجراحية، ويمكن حل جميع التحديات المحتملة بالتعاون مع الجامعات التي ستوفر هذه التكنولوجيا. بعد ذلك، سيتم تحديد احتياجات وأهداف هذا البحث. الفصل الثالث يناقش المنهجيات المختارة التي تم استخدامها. وأخيراً يناقش الفصل الرابع جميع النتائج التي تم اكتشافها من طرق البحث السابقة. نتائج هذا البحث تستنتج أن استخدام الواقع الافتراضي في التعليم الطبي مناسب للغاية ويظهر تأثيراً إيجابياً على التعليم الطبي ومن المحتمل أن يتم استخدامه كأداة أساسية في التعليم الجامعي. بالإضافة إلى ذلك، تؤكد النتائج حماس أساتذة الطب لاستخدام هذه التكنولوجيا في فصولهم الدراسية. تقتصر النتائج على الجامعات في المملكة العربية السعودية فقط لأنها لا تنطبق على جامعات في دول أخرى حيث استند البحث إلى أساتذة الطب في المملكة العربية السعودية.

الكلمات المفتاحية: الواقع الافتراضي، المحاكاة، التعليم الطبي، مراجعة الأدبيات، السعودية

Introduction:

Virtual Reality (VR) has massive educational potential and will probably become the basis of future-generation simulations used by medical professionals at all levels. VR-based education and training could provide students with captivating three-dimensional visuals of anatomic structures. Surgical residents would be introduced to new techniques or practice procedures prior to performing the actual operations. An infinite number of virtual patients, along with the current curricular system, would enhance the real human contact experience with patients, improve skills, and eventually better the quality of healthcare (Smith, 2018).

Medical students in the Kingdom of Saudi Arabia are limited to learn and study their course materials from either a book or a computer screen. Many medical students in Saudi Arabia are dissatisfied with the passive, lecture-based method of teaching (Almoallim et al., 2010). In Addition, medical students first see someone perform the procedure on a human being then they assist in performing it then they perform it themselves for the first time, as there is no way for them to practice a procedure independently first unless it was on a human being. Only a few studies have been made regarding medical education from a teaching perspective.

This study is focused on studying if virtual reality can be a beneficial educational tool in the medical education sector and reflecting its potential for teaching undergraduate medical students.

Virtual Reality

Virtual reality is the use of software to create an immersive simulated environment. Unlike traditional user interfaces, to experience VR, users put on a head-mounted display (HMD) which places the user inside an experience, where they can engage with the environment and virtual characters in a way that feels real. VR has a unique power, more than any other technology that has ever existed, to make users *believe* they are in a different environment. This allows them to learn from

experience as they would do in real life. This ability to deliver experiences on-demand is where the power of VR lies (Pottle, 2010).

Simulation

Simulation is an educational technique that involves creating situations that replicate real life, letting a learner act as they would do in real life, then providing feedback and debrief on performance (Pottle, 2010).

3D stands for three-dimensional, something that has width, height, and depth. The physical environment we live in everyday is three-dimensional.

Importance Personal:

Seeing how my close friends and family are struggling in studying medicine by having a hard time understanding their course materials, I am interested in conducting this research because I would like to contribute to society and try to ease and better their education. I hope that using virtual reality will help them understand better and prepare them for the real world more competently.

Global:

Educating the people of Saudi Arabia in a greater matter is one of KSA's 2030 Vision's goals (Ministry of Education, 2019). Using VR technology in the medical sector would do just that, as it's taking the educating level from books and computer screens to a virtual reality where students can almost physically experience what they're learning in a simulated environment.

This research discusses the impact of using VR in medical universities in Saudi Arabia on educating undergraduate medical students by assembling the perspective of medical universities professors to use VR as an educational aid to facilitate the teaching and learning inside university classrooms.

Primary Target Audience:

All level medical professors in medical universities. These professors would benefit from using this technology to assess and teach their students. They were chosen as a primary target audience because they must be willing to teach using this technology in order for this technology to be implemented efficiently in medical universities and colleges in Saudi Arabia.

Secondary Target Audience

All level students in medical universities. These students would benefit from VR technology because students in the first two years struggle the most with understanding the curricula and medical terminologies specifically, and the third year and above is when medical students physically begin to practice their studies (Saeed,

2020). They were chosen as a secondary target audience because they are the end-user.

Research Questions:

1. What are the benefits of learning by using VR for medical university students?
2. What type of fidelity level of interaction is needed to help medical students learn?
3. What possible challenges might make the application of this research unfeasible and how to over-come them?
4. What is the best way to promote VR technology to the medical sector?
5. What applicable solutions are best suitable for the target audience?

Research Objectives:

This research aims to find out the benefits of learning by using VR for medical university students, and in order to determine if this research can be applicable, it also explores the type of interaction that is needed to help medical students learn in the most efficient way. Additionally, this research aims to inspect the possible challenges of this research and how to overcome them. And finally, to discover the best way to promote VR technology to the medical sector and examine applicable solutions to figure out the best suitable option for the target audience.

Literature Review:

The purpose of this review is to assess different literature within the past three years and discuss how medical education in Saudi Arabia can benefit from the technology of virtual reality. This literature review includes basic assessments of material that has been electronically published, it will include quantitative and qualitative impacts. This review will cautiously recognize and integrate three relevant papers to examine their specific research question, substantive domain, methodology, and thereby provide readers with the highest level of general understanding of the research topic. This literature review will debate the efficiency of virtual reality (VR) in medical This research discusses the impact of using virtual reality in medical universities in Saudi Arabia on undergraduate medical students by collecting the perspective of medical educators to reflect the motivational value of the virtual reality technology in terms of student undergraduate academic and post-graduation practical performance.

The first study, An Experimental Study on Usefulness of Virtual Reality 360° in Undergraduate Medical Education. Which was conducted by Sultan, L., Abuznadah, W., Al-Jifree, H., Khan, M., Alsaywid, B., Ashour, F. (2019). This paper aimed to improve healthcare services in Saudi Arabia by adding modifications to medical education

strategies using the approach of competency-based medical education through smartphone-based virtual reality. This paper mentioned how university-level education and post-graduation medical practice is constantly developing from basic knowledge attainment to medical-based training, which is where VR technology's role comes in regarding the evolvement of medical education. This research took place at the College of Medicine, King Saud bin Abdul-Aziz University for Health Sciences in Jeddah, Saudi Arabia.

The authors completed their study by forming a problem-based learning workshop about the integration of basic and clinical sciences to investigate how students' knowledge retention, skills acquisition, and satisfaction levels are affected by using VR. They divided a total of 169 students into two groups, the first group contained 57 participants where they finished their tasks using VR, whereas the second group which contained 112 participants finished their tasks using standard experiential learning methods. The authors performed a survey, and its outcome was that the VR 360° videos for communication and joint effort aptitudes indicated a factually critical improvement for undergraduate medical students in their knowledge retention, skills acquisition, and satisfaction levels. (Gunn et al., 2020) authors of "The use of virtual reality computed tomography simulation within a medical imaging and a radiation therapy undergraduate program," aligned with this (Sultan et al., 2019) where they argued that the confidence of students entering clinical placement is important not only to enhance the student experience but to see a flow-on effect of student efficiencies in the clinical environment (Therese et al., 2020).

Discoveries by (Sultan et al., 2019) uphold the utilization of VR as a teaching method to give a rich and intelligent engaging context for students, hence supporting experiential learning-by-doing. The investigation has reasoned that VR shows a positive impact on medical education and is probably going to fill in as a basic tool in clinical schooling. Moreover, the authors also showed that VR could take part in interprofessional education to permit undergraduate medical students to learn about each other's roles to improve collaboration and communication skills for better health care. The investigation has experienced a few restrictions, for example, the quantity of females was less when compared with the quantity of males. (Sultan et al., 2019) support the research as they experimented with the same target audience as this research whilst using VR technology in medical education in Saudi Arabia. By analyzing the use of smartphone-based VR and communication training with simulated patients and environments, the authors provided various uses of VR technology that is helpful for medical students to learn better as they proved how effective and beneficial it can be for undergraduate medical students in Saudi Arabia.

The authors established that further investigation regarding VR simulation is required to certify VR as an educational method. In addition, medical educators may hope to organize such advancements in medical education to make the material even

more interesting, less difficult to learn, and to acclimate to the new generation of technology.

The second study, Using Virtual Reality Simulation Environments to Assess Competence for Emergency Medicine Learners. Which was conducted by Mcgrath, J. L., Taekman, J. M., Dev, P., Danforth, D. R., Mohan, D., Kman, N., Bond, W. (2017). This paper stated its aims to discuss the needs for the determination of areas of focus for VR training and assessment, development and exploration of virtual platforms, automated feedback within such platforms, and evaluation of effectiveness and validity of virtual simulation (VS) education. The authors propose that VR technology is progressively utilized for preparing clinical students and is foreseen to turn out to be more applicable in the setting of confined clinical training hours and to be more focused on patient safety. This paper examined limitations and challenges in implementing VR into medical education curricula. They also discussed the function of virtual environments in formative and summative assessment. Moreover, they suggested targeting future exploration inspecting VR technology for assessment where high-risk procedures are included. Advancement and investigation of virtual platforms, assessment of adequacy and legitimacy of VR education, and automated feedback were also suggested for further research by the authors.

The authors of the first study support this study as they quoted the medical education program accreditation standards in the United States and Canada, “if a medical student does not encounter patients with a clinical condition, the medical student should be able to remedy the gap by a simulated experience” (Sultan et al., 2019).

This paper relates to the research where it provides evidence of the benefits of using VR technology for medical learning. Moreover, the context discussed is very relative to the issues we face here in Saudi Arabia in the medical education sector such as the issue that a medical student first sees someone perform the procedure on a human being then they assist in performing it then they perform it themselves for the first time, as there is no way for them to practice a procedure independently first unless it was on a human being (Saeed, 2020).

The authors concluded that emergency medication (EM) resident performance on a conventional oral assessment was correspondent to performance on an avatar-based assessment, virtual simulation is a suitable platform for high-risk procedures, VR simulation applications enhance learning results for an assortment of surgeries.

This paper communicated its limitation where patient-based simulations need explicit surveillance by faculty to produce feedback. This can be expensive and may limit simulation implementation in distant places. Currently, VR is superbly appropriate for the delivery of embedded feedback focusing on treatment decisions

and diagnostic reasoning. Moreover, limitations in existing artificial intelligence and natural language processing technology restrict the ability to automate feedback for communication-based skills.

This work includes requirements for research attempts and recognizes potential limits and arrangements that should be furthermore examined. (McGrath et al., 2017) added that proceeding with a joint effort between university professors, engineers, and clinicians is important to progressing the development and execution of virtual simulation-based training in emergency medicine.

The third study, The Use of Virtual Reality Computed Tomography Simulation Within a Medical Imaging and a Radiation Therapy Undergraduate Program. Which was conducted by Gunn, T., Rowntree, P., Starkey, D., Nissen, L. (2020). This research aimed to investigate the impact of a computer-based VR Computed Tomography (CT) software simulation within the undergraduate curricula for medical imaging (MI) and radiation therapy (RT). These authors aimed to measure the impact of learning via VR CT sim on the confidence of the MI and RT undergraduate students. This research assesses how VR technology could impact students' information memorization, knowledge absorption speed, and overall procedure performance.

After a group of undergraduate medical students experienced instructional exercises using VR CT simulation, a voluntary paper-based anonymous survey was conducted after the exercise. The authors found that the utilization of VR within magnetic resonance spectroscopy education is encouraging. Also, undergraduate medical students concurred that using VR was beneficial to their clinical CT, the significance of safe practice in a low-pressure environment can improve clinical confidence. Nonetheless, undergraduate medical students have demonstrated through the conducted survey a requirement for guided and managed practice when utilizing the VR CT sim while concurrently featuring that one of its favorable benefits is for self-directed learning.

From reviewing the findings of this study, this research recognizes that the findings establish the significance to identify individual student needs and to make varied learning opportunities available for them to engage with. The authors from the second study support this paper's findings where they stated "VS may extend feedback capabilities to include skills such as efficiency in communication (Jillian et al., 2017).

The findings introduced in this study that is written by (Gunn et al., 2020) allude to student recognized confidence which is difficult since this is an emotional measure and should be examined in the knowledge that personal, behavioral, and environmental determinants are all factors for general confidence.

This paper has revealed difficulties that this research may confront, for example, the likelihood that the instructors may not acknowledge focusing on learning through

another method of educating since they are not the creators of the technology and have no background in it. Likewise, medical professors may get low student engagement if students do not interact with the innovation. An additional challenge is if the software needs updates regularly or continuous maintenance and information technology (IT) support.

All variables for broad confidence and learning exercises are evaluated in this paper. However, further examinations are needed to research whether the incorporation of VR CT sim improves student technical skills. Moreover, the authors of this study have demonstrated that there is potential for undergraduate medical students to pick up time-learning CT abilities in a secure and low-pressure environment. Although the authors investigated one part of the academic perspective to organized CT skill acquisition, they neglected to investigate different perspectives that could be significant to survey the effect of undergraduate medical students utilizing VR innovation as part of their curricula.

This paper relates to the research as it discusses the expansion of the use of virtual reality (VR) simulation in the education of healthcare professionals by reporting on the student experience. It also enriches the research with data and analysis on student's experience of the integration of VR education. Moreover, it proved that the integration of innovative learning opportunities such as VR CT simulation has the potential to increase student confidence and improve student preparation for the clinical environment.

Even though all three papers study the use of virtual reality technology in the medical field, the authors of the first article approached the topic by studying what can be done to evolve healthcare services in Saudi Arabia and the role VR would need to play to accomplish that. Whereas the second article focused on the assessments and examination part of medical education similarly to the third article as it examines virtual reality's role to assess competence for medical learners.

Despite the fact that all three articles had different samples from different counties in different years, they all agree that using VR technology in medical education is, in fact, beneficial to undergraduate medical students who will later become medical professionals that based on research will result in better outcomes for patient treatment.

Although the studies that have been reviewed in this literature all indicate that there is indeed an area for improvement where virtual reality technology would prove to be beneficial for undergraduate medical students, the perspective of medical professors has not been thoroughly explored.

Research Methodology:

This methodology chapter aims to collect information directly from the target audience to find and test examples of the visual outcome of this research followed by an analysis. The methodologies used in this paper are a survey and visual research followed by a focus group that was conducted to test existing visuals of videos that promote virtual reality in medical education. These research methods provided the researcher with the knowledge on the preferences of their target audience, what result turned out to be superb, and it gave a clearer concept of the visual outcome that will be made as a result of this research.

To test the research question that VR can improve medical education in Saudi Arabia, the first research method was conducted in a form where an online survey was distributed to 39 medical professors in Saudi Arabia. The snowballing sampling method was used to reach the target audience. In addition, the survey was sent in an email to medical professors who have provided their emails on their university website. The respondents were supportive of the concept and willing to teach medicine using the technology of VR. The results showed that 76% were excited to practice teaching using VR if it was offered by their university. This research method kept the study ethical as a consent cover page was used prior to the survey questions and therefore by answering the survey, the participants have understood and agreed to its terms.

The first question was demographic, it asked, “What is current job title?” and it was to confirm that the response was valid and it was from the correct target audience, as any other response that answered no was disregarded before analyzing the survey final results. Therefore, 100% of the 39 valid participants have confirmed to be a part of the target audience.

What university/college are you currently working at?

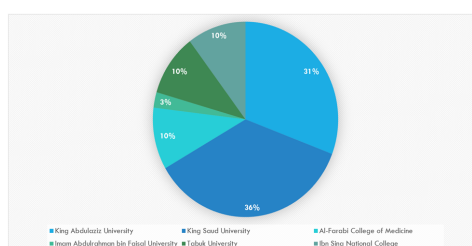


Figure 1

The second question (figure 1) which asked “What university/college are you currently working at?” was also a demographic; however, it was to document which

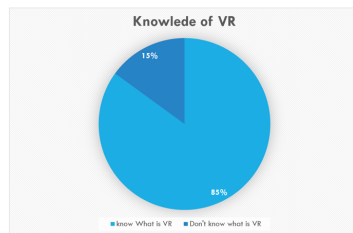
universities have responded in addition to figuring out if the responses from governmental universities differed from the responses from private universities.



Figure 2

The aim of the third question (figure 2) which asked “For how long have you been a professor, and at this university specifically?” was to test if professors with more experience are used to traditional teaching methods and are not open to trying new methods of teaching such as VR. The average teaching experience of the survey participants ranged from 6 months to more than 30 years.

Do you know what is virtual reality technology?



virtua

Figure 3

Have you ever experienced virtual reality?

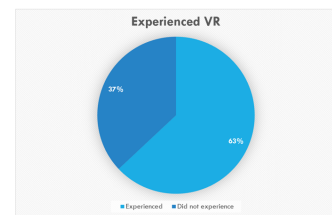


Figure 4

virtual reality?” was to test the knowledge and experience of the target audience regarding virtual reality in order to compare them to their level of excitement to teach using this technology. For the fourth question, 85% answered yes. 15% answered no. The results of this question indicate that most of the target audience know what is virtual reality. For the fifth question,

What is the average number of students in your classroom?

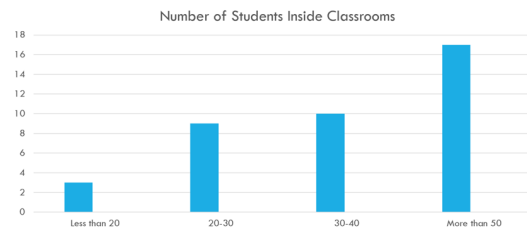


Figure 5

63% answered yes. 37% answered no. The results of this question indicate that most of the target audience have experienced virtual reality.

The aim of the sixth question (figure 5) “What is the average number of students in your classroom?” was to discover if there was a relation between the number of students they teach and their willingness to manage the classroom alone using VR considering their number of students. 8% answered less than 20 students. 23% answered 20-30 students. 26% answered 30-40 students. 43% answered more than 50 students. The results of this question were related to the second demographic question as professors who teach at governmental universities have a larger number

Do you think you could manage the class alone if you were trained on how to use the technology

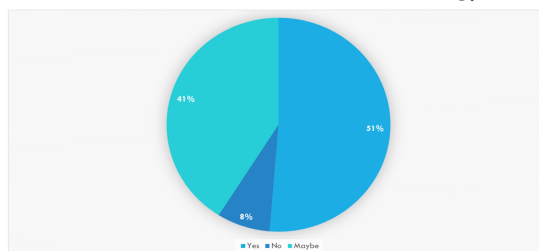


Figure 6

of students.

The objective of the seventh question (figure 6) “Do you think you could manage the class alone if you were trained on how to use the technology?”. This question relates to the previous questions as it was to find out if their level of knowledge and experience regarding VR affects their willingness to manage the classroom alone using VR technology. 51% answered yes. 42% answered maybe. 8% answered no. The results of this question showed that most of them were willing however some were unsure or against using it. This is why the researcher prepared a follow-up question that asks for justification for those who answered no.

The eighth question asked “if no, why not?”. The purpose of the question is to figure out why the responders would answer no to the previous question in order to discover the problem and find a solution. 4 participants answered no in which they stated their reason to be due to their large number of students, possible technical issues/bugs and glitches and because their students would need to be trained on the VR model. The results of this question should be considered by the university which decided to use this technology as a part of their medical education curricula.

The aim of the ninth question “What is your opinion on VR in medical education?” is to gather the target audience’s overall opinion on the topic to find out how accepting they are of the idea as they are free to phrase their opinions in their own words. They provided a variety of answers which the researcher has divided into

two categories; general and constructive. Their general opinions as stated: very helpful based on studies that were published in this field, it's helpful for basic years students, it will be perfect if they used it, an excellent method to communicate with students, great technology if it is well utilized, I have a positive attitude toward the technology, and I believe it can be a great tool to supplement the students' learning experience, nothing, great tool, never try it in medical education, great opportunities for innovation in dental education, do not know, creative way of teaching, the student could be more interactive during class, full support, it would be beneficial in presenting practical skills, promising, creative and needed tool, very helpful tool for education, great idea, very promising, engaging, it can add a great impact on teaching and understanding, very good for training before practicing on patients, a new method which supports education it can be helpful and very useful in demonstrating skills. practical in the stimulation, adjunctive tool to supplement student learning, can enhance the learning experience and enrich it with components that are difficult to simulate or dangerous, it would be a good educational tool good learning aid, it adds new information to the student via enhancing their imagination, could benefit from it. Their constructive opinions as stated: like any other technology, careful planning & understanding of its potential is necessary before its full adoption, currently not feasible, still under evaluation, laboratory experiments only, have to experience, may help during COVID-19 crisis, needs to be experienced to assess the effectiveness, I am not sure if it would be of great help in dentistry where skills acquisition depends totally on demonstration and simulation environment, it needs special software and hardware and could be unreliable all the times and with all the students in the class. The results of this question conclude that professors support using virtual reality in medical education and that careful planning and evaluation is necessary before fully implementing this research.

The objective behind the tenth question (figure 7) is to see which advantage does the target audience agree on the most, the options were: Provides outstanding visualizations that aren't possible in the traditional classroom which was chosen by

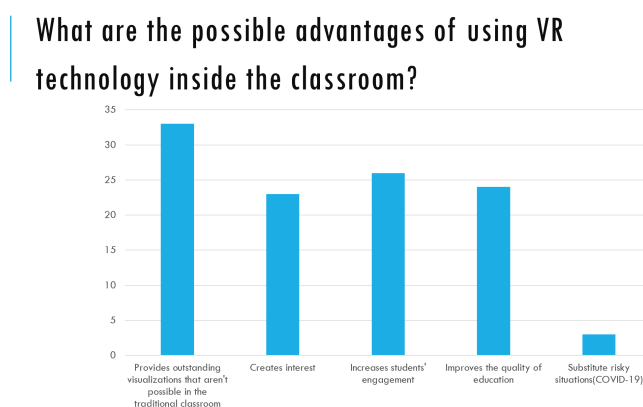


Figure 7

84% of the respondents, creates interest which was chosen by 59% of the respondents, increases students' engagement which was chosen by 66% of the respondents, improves the quality of education which was chosen by 61% of the respondents, and other in which 7% of the participants agreed that it can act as a substitute for risky situations related to COVID-19. The result of this research indicates that the main advantage for medical professors is that it provides outstanding visualizations that aren't possible in the traditional classroom.

What are the possible disadvantages of using VR technology inside the classroom?

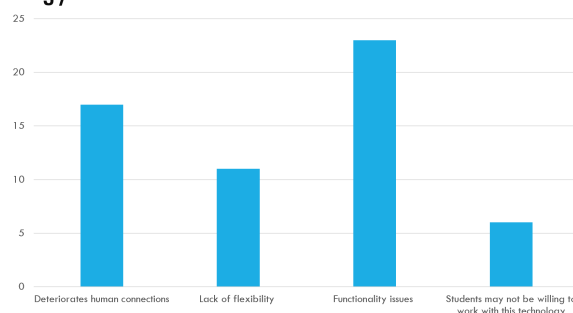


Figure 8

The purpose behind the eleventh question (figure 8) is to see which disadvantage does the target audience agree on the most, the options were: Deteriorates human connections which was chosen by 43% of the respondents, lack of flexibility which was chosen by 28% of the respondents, functionality issues which was chosen by 23% of the respondents, students may not be willing to work with this technology which was chosen by 15% of the respondents, and other which was chosen by 15% of the respondents. The result of this research indicates that the main disadvantage for medical professors is possible functionality issues.

If this technology was offered by your university, would you be excited to use it?

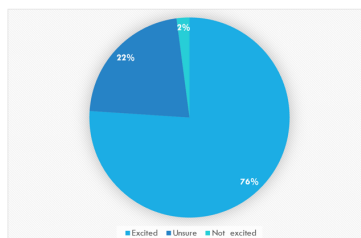


Figure 9

The aim behind the twelfth question (figure 13) "If this technology was offered by your university, would you be excited to use it?" is to determine the overall level of excitement the professors had to teach their students using this technology. 76% answered yes. 22% answered maybe. 2% answered no. The result of this question

indicates that most of the professors are excited to use the VR technology if it was offered by the university they teach at.

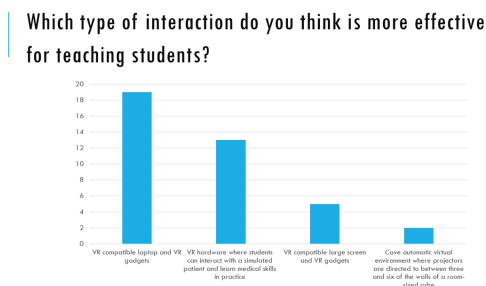


Figure 10

For the thirteenth and final survey question, the participants were asked to look at different types of interaction which were presented in a form of images and choose which type of interaction did they think was more effective for teaching students. 5% chose a cave automatic virtual environment where projectors are directed to the walls of a room-sized cube. 13% chose VR compatible large screen and VR gadgets. 33% chose VR hardware where students can interact with a simulated patient and learn medical skills in practice. 49% chose VR compatible laptop and VR gadgets. The results of this question suggest that VR compatible laptop and VR gadgets is the best and preferred option from the perspective of medical professors in universities in Saudi Arabia.

To conclude, medical professors in universities in Saudi Arabia are in fact supporting the idea of VR in medical education and they are excited to use outstanding visualizations that are not possible in the traditional classroom that only virtual reality technology can provide. This confirms the idea of this research, which is using VR in medical education as a teaching and learning tool that professors can use to take the traditional curricula to a whole new level.

The second research method that has been used in this research was visual research which was followed by a focus group. The purpose of the visual research was to observe existing visuals in order to find out which visuals are most similar to the intended outcome of this research in order to test them in the focus group. Through the focus group, the researcher was able to collect specific information and opinions from 3 medical professors from universities in Saudi Arabia regarding the visuals that were presented.

Two promotional infographic videos that demonstrated the use of VR in medical education were analyzed. They were analyzed in order to evaluate the strengths and weaknesses of each visual with the intention of knowing what to implement and what to avoid when creating the final visual outcome of this research.

The analysis criteria were style of animation, suitability for visualizing the topic, clarity in delivering the information, beneficial and informative, and attention-grabbing.

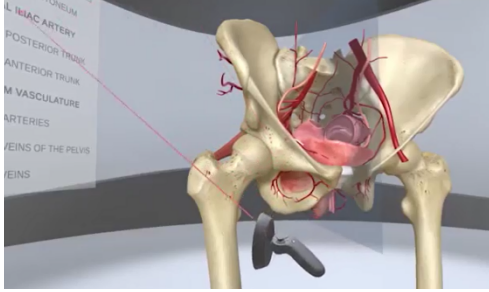


Figure 11

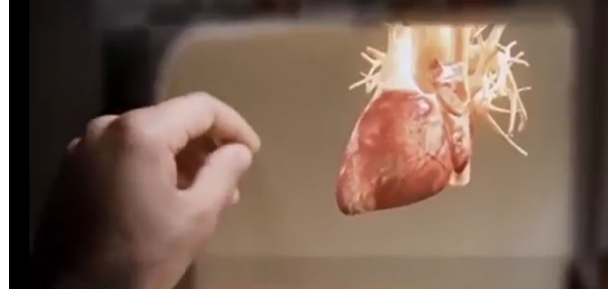


Figure 12

The previous figures (figure 11-12) are screenshots from the first visual figure which a video created by Cleveland Clinic titled “Virtual and Mixed Reality for Medical Education” and it was uploaded on YouTube in 2018. It demonstrated the benefits of using VR in medical education by combining filming, 3D visuals, and narrative audio. It also demonstrated the different types of interactions VR technology has to offer however it did not include head titles and parts of the video were only a moving image which could have made the video better. Regarding the context of the video, Cleveland Clinic made sure to show how to rotate and view visuals through hand gestures, demonstrate laptop-compatible VR controllers, present simulated patient interaction, display the use of VR headsets and gesture control. They used voice-over and they composited the visuals with video. Cleveland Clinic also showed how VR can be used in training for medical procedures and the opportunity to practice medicine with computer simulation. All these factors contributed to making this video succeed in delivering its message.



Figure 13



Figure 14

The previous figures (figure 13-14) are screenshots from the second visual figure which a video created by Arch Visual titled “VR Medical Simulation and Training from Arch Virtual, Developers of Acadicus” and it was uploaded on YouTube in 2018. It demonstrated similar content to the first video except that it did not include narrative audio, only background music and simple dialogue between people and it included head titles. Regarding the context of the video, Arch Visual made sure to present the use of VR in medical operation training, head titles, VR headset and gadget, operating instructions through VR, how VR can be used in different fields of medicine through different types of interaction, and how the use of VR in medical education can be beneficial to medical students of all levels. The video could have been better if they used voice-over or narrative audio but other than that, all the other factors mentioned above contributed to making this video a success.

The focus group was conducted after the researcher used the snowballing technique in order to collect the participants’ phone numbers. The researcher chose WhatsApp as a medium to conduct the focus group considering the difficulty to be able to perform it in person due to the outbreak of COVID-19, therefore WhatsApp seemed to be the most efficient and elaborative method to collect the necessary information and discuss the responses with three medical professors who taught at medical universities/colleges in Saudi Arabia. This research method kept the study ethical as a consent cover was signed by the participants.

Regarding the style of animation, the participants agreed that the second visual was better in terms of style of animation, the way the visuals were presented, and the fact that it demonstrated the use of VR in surgeries. As for suitability for visualizing the topic, they all agreed that creating an infographic video that combines filming and 3D and 2D visuals is suitable for visualizing the topic. In terms of clarity in delivering the information, two participants agreed that the second visual caught their attention more as one stated she could imagine herself teaching her students using the technology that was presented. The other participant chose the second visual because of the variety of VR uses that were demonstrated and because it had head titles. While the other participant disagreed as he stated that he understood the concept more easily from the first video because it had narrative audio. When asked “Which video did you find to be more beneficial and informative?” A participant chose the first video because it included everything and demonstrated virtual reality better. The other participant agreed because the audio mentioned the advantages of using this technology. The last participant disagreed as thought the second video was more beneficial because it had more variety of VR demonstrations. When it came to using VR in medical education after watching these two videos, they were all excited to use VR technology in medical education after watching the two videos. And finally, when asked “Which video grabbed your attention more, and why?”, A participant chose the second one because it’s simpler and more direct with high demonstrations of how VR

will be applied. The other participant agreed because it demonstrated multiple uses of VR. The other participant disagreed and chose the first because of the reasons he had previously mentioned (because it included everything and demonstrated virtual reality better, it had narrative audio, better animation, and quality of motion graphic).

To conclude, the results of the focus group were positive, and they provided the researcher with a better understanding to create a visual outcome for this research. From the focus group, the researcher was able to collect information that did not come up in the previous research methods. From the findings of this method, the researcher has concluded that she will create an infographic video that combines filming and 3D and 2D visuals. The outcome will follow the style of animation as the first visual figure, include surgery operated using VR technology, demonstrate the use of VR using VR compatible laptop and VR gadgets, include narrative audio that describes the benefits of using VR, and include head titles.

Discussion:

The current school curriculum in medical universities in Saudi Arabia does not include VR as a teaching aid or learning tool which limits student's learning potential and overall performance as this research presents all the benefits the students can be exposed to if VR technology was used as a part of the curriculum. This research aims to find out if the implementation of VR in medical education can indeed improve the education system in the medical field. The literature review findings discussed the main benefits of using VR in medical education, different types of interactions, and challenges this research may encounter when integrating virtual reality in medical education such as in (Mcgrath et al. 2017). The challenges discussed included how patient-based simulations need explicit surveillance by faculty to produce feedback. (Gunn et al., 2020) added further challenges such as medical professors may not agree to using VR technology because they are not familiar with it and that medical professors may get low student engagement if students do not interact with the innovation. To argue these challenges, this technology does in fact need surveillance by professors when students use it and they can assess the students based on it, as for the professors themselves. The researcher suggests that the university provides a training program on the use of VR technology before the beginning of the semester as they did when virtual classrooms were introduced to the curricula as teaching tool because of COVID-19. Additionally, the survey results disagree with the challenges that Gunn and the other authors mentioned in their study as 76% were excited to use the technology. As for low student engagement, the survey results suggest that only 6 of the participants thought that students may not be willing to work with the technology. The literature review and survey findings agreed upon the possibility that some professors may not be encouraged or excited to use the technology which is a challenge that may differ from one university to another.

The limitation of this research is that it cannot fully confirm the acceptance of VR from the medical education sector in Saudi Arabia because there are other factors that have not been considered such as feasibility. Even though it received positive feedback from medical professors and the literature review confirms positive feedback from students as well, it does not confirm the acceptance from universities' management in Saudi Arabia. Another complication is that the findings of this research is only limited to medical universities in Saudi Arabia and no other countries. In addition, this research did not conduct an empirical study and the gathered information are limited to professors' opinions and concerns.

The suggested a possible solution to these limitations is that if those who oversee medical universities/colleges in Saudi Arabia are interested in implementing this research, they should take into consideration all types of interaction that were suggested and chose the best suitable one for their professors and students based on their budget. This research also suggests that if the classroom had more than 40 students then the professors to those students should have a professor's assistant that is also trained to use this technology to help him/her to manage the classroom using VR technology.

Conclusion:

This study discusses using virtual reality in medical universities in Saudi Arabia. From the literature review and methodology, the researcher has concluded that using VR in medical education suggested that to be of many benefits and if it was used as an educational tool in the medical sector, it would enrich the students many skills that would better prepare them for working as medical professionals. In addition, the methodologies that were conducted in this research provided critical findings for the end outcome of this research. In summary, VR in medical education would be a great step in developing the curricula and even a greater step on the advancement of education in Saudi Arabia. The deliverable of this research and its findings and results will be a promotional infographic video that will be created to demonstrate the benefits of VR in medical education, how to easily all medical professors and students in Saudi Arabia can use it through VR compatible laptop and VR gadget. All findings of this research are only helpful to universities in Saudi Arabia as universities from other countries have been excluded from this research to provide accurate information to the target audience; however, this research can be helpful to anyone who wants to know more about the topic.

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