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Virtual reality- The future of medical education or just another gimmick? Discussing the acceptance and potential of virtual reality in pharmacology

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ABSTRACT

Background: Many studies have revealed the impact of virtual reality (VR) and augmented reality (AR) in various educational domains. They have been shown to improve the overall learning and knowledge retention of students. The purpose of this study was to explore the usability and estimate the impact of VR & AR on pharmacology teaching and learning using the Oculus™ VR headset.
Materials and Methods: We enrolled 100 second-year medical student volunteers who were divided into 10 groups of 10 each. Each student experienced three different VR exercises using the Oculus™ VR for a total of 20 minutes, after which they were provided with a 12-point feedback form.
Results: More than 90% of the students responded positively to VR being a good replacement for conventional teaching techniques. 8% of the students reported uneasiness, dizziness, nausea, and drowsiness, both during and after the session.
Conclusion: The use of virtual reality and augmented reality holds promise in evolving the Pharmacology classroom to a more interactive and immersive experience.

1. Introduction

In 1992, Fleming and Mills suggested four modes of teaching/learning, namely visual, auditory, reading, and kinaesthetic, abbreviated as VARK.[1] Visual includes the depiction of info in the form of graphs, charts, diagrams, flowcharts, etc. Auditory modality comprises information heard or spoken. This includes live lectures or pre-recorded ones, podcasts, and group discussions. The reading modality is a preference for info displayed in the form of words such as in essays, manuals, textbooks, and articles. The kinaesthetic modality is learning via hands-on experience. This includes on-the-job training, internships, and simulation such as VR. Traditional chalk and board teaching cannot cater to the requirements of the various types of learners encountered in the modern-day classroom. This is especially important in the field of medical education where several concepts need the imagination to grasp. One needs to improvise and incorporate various modalities to invoke curiosity in the students and hold their attention for the span of the lecture/demonstration. This is where virtual reality (VR) and augmented reality (AR) comes into the picture.

Many studies have attempted to establish the validity and educational impact of a variety of VR and AR applications in a variety of fields, using a variety of hardware platforms. Some even offer a curriculum that incorporates these approaches.[2] However, studies have not been conducted to evaluate the utility and impact of VR and AR in pharmacology teaching and learning. The purpose of this study, which involved 100 second-year students at our teaching hospital, was to estimate the usability and impact of virtual reality and augmented reality on pharmacology teaching and learning, using the Oculus™ VR headset.

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2. Materials and Methods

The study was conducted amongst volunteer second-year MBBS students (n=100). They were divided into 10 groups of 10 each and were given an opportunity to experience VR using the Oculus™ VR headset at our teaching hospital. Each student experienced three VR exercises using freely available VR videos.

Exercise number 1 was a visualization of the mechanism of action of antibiotics which act by inhibiting protein synthesis. Exercise 2 involved hands-on experience with intravenous drug administration. Exercise 3 involved an industrial tour through a pharmaceutical lab to orient them to the process of drug development. Each student was allowed to use the headset for 20 minutes following which they were given a feedback form developed and validated by subject matter experts. The feedback form was shared using Google Forms and the students were asked to fill them out after the session. These sessions were spread out over a month to allow all 100 students to experience 20-minute VR sessions. The feedback form consisted of 11 close-ended binary questions and one close-ended quaternary question. Since there were no comparison groups, no scores were assigned to the questions answered. The feedback form was designed to assess the acceptance of virtual reality as a teaching-learning tool. The questions asked in the feedback form and their results have been summarized in Table 1.

The study protocol was approved by the institutional ethics committee.

3. Results

The majority of students were aware of the idea of VR & AR and their use in education. However, most of the students (60%) had not experienced it firsthand, before this study. The majority of students were for the inclusion of VR & AR in medical education to make learning more interesting and to help grasp complex concepts. 8% of the students did not feel comfortable during the sessions, with complaints of disorientation, nausea, and drowsiness during and after the session. Virtual reality sickness is a known phenomenon, caused not by actual motion but by a visually induced perception of motion.[3] This is a likely hindrance to the effective use of VR tools in education. (Figure 1) depicts the learning modality of the students who participated in this study, as per VARK model. Even though 55% of students were not visual learners or kinesthetic learners, they were still open to VR as a mode of learning. More than 90% were of the opinion that VR is a good alternative to traditional teaching methods and would help understand complex concepts easily and also make classes more interesting.

Table 1: Feedback from the participant students (n=100)

S.N.	Question	Response	
		Yes (%)	No (%)
1	Have you heard of virtual reality or augmented reality?	95	5
2	Are you aware of the use of virtual reality or augmented reality for educational purposes?	85	15
3	Have you experienced virtual reality or augmented reality before this session?	40	60
4	Do you think it would be a good idea to use virtual reality as an alternative to traditional teaching methods?	93	6
5	Do you think VR systems can help students actively learn and participate, instead of passively looking at 2D displays?	95	5
6	Do you think introducing virtual reality into the classrooms makes learning more interesting?	95	5
7	Do you think virtual reality is a good replacement for classroom teaching, during pandemics?	95	5
8	Do you think the use of virtual reality can enhance the understanding of complex concepts?	93	7
9	Did you feel comfortable during complete immersion in the virtual world?	92	8
10	Do you think it would be a good idea to use virtual reality for better communication with patients?	73	27
11	Do you think would be a good idea to use virtual reality to better understand the routes of drug administration?	95	5
12	What is your predominant learning modality?	Response depicted as Figure 1.	

4. Discussion

The virtual and real environment are often considered as two ends of a continuum with mixed reality falling in the middle between AR and VR.[4] Augmented reality in simple terms is an extension or enhancement of reality. This could be the integration of virtual objects or information into real world environments. A good example of this is the mobile based game, ‘Pokemon Go” which came out in 2016. Here the virtual Pokemon would be superimposed on the real environment in the display of the device. Another example is the ‘snow app’ which brings photos to life using artificial

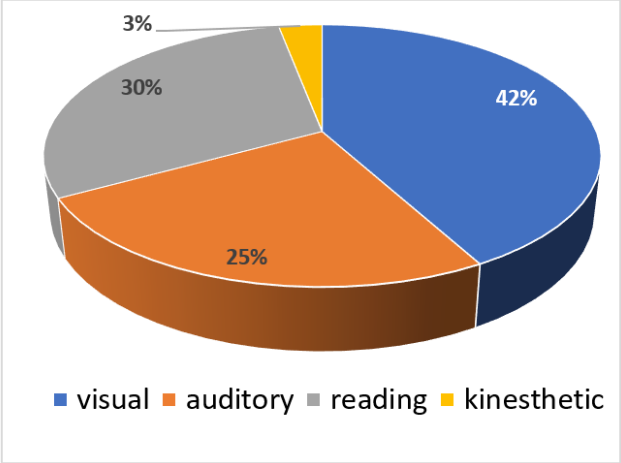

Fig. 1: Pie chart depicting the percentage of learning modalities in the study

intelligence (AI). Mixed reality is a combination of both VR and AR elements to create a different environment of its own. HoloLens by Microsoft is an example of an MR technology device.

VR and AR are two contemporary simulation models that are currently upgrading medical education. VR provides a 3D and dynamic view of structures and the ability of the user to interact with them. The recent technological advances in haptics, display systems, and motion detection allow the user to have a realistic and interactive experience, enabling VR to be ideal for training in hands-on procedures. Consequently, surgical and other interventional procedures are the main fields of application of VR. AR provides the ability to project virtual information and structures over physical objects, thus enhancing or altering the real environment. The integration of AR applications in understanding anatomical structures and physiological mechanisms has been found to be beneficial.[5]

4.1. Potential of AR/VR

Advanced VR tech allows users to be fully immersed in the virtual environment, where they can interact with virtual objects or individuals in real-time. The latest example of this is the Metaverse®. The hands-on experience employing haptics simulates real-world experiences and can present complex concepts in ways that are otherwise impossible. Students can visualize the whole journey of drugs, from their ingestion to absorption to receptor level mechanism and interactions. Experiences such as handling laboratory animals and pre-clinical testing can be practiced to improve technique. This technology also provides access to teaching material to students around the world, connecting them globally. The best teachers in the field can be accessed with the help of the right gadgets. In pharmacology, animal experimentation is no longer approved for the sake of training undergraduate students.[6,7] AR can help students with a more immersive experience of learning the different instruments used in screening. An instrument in the visual field of the user may open up access to details of the instrument and show how the instrument is used. Virtual classrooms may be more effective than watching pre recorded videos since the experience is more immersive and it transports the user mentally to a classroom. This in turn would be less distracting. One major challenge that students find in the subject of pharmacology is understanding the mechanism of action of drugs.[8] VR will help understand and recall these mechanisms through a mix of modalities, helping not just visual learners, but also auditory and kinaesthetic learners. VR/AR based games may be developed to generate interest and encourage involvement of the students. Concepts in pharmacology are best understood when they are clinically correlated. VR can help in teaching systemic pharmacology using simultaneous correlation of the clinical condition using VR modules. Mixed classes may be delivered where the students access the VR goggles on cue, during the class to visualise the presentation of the clinical condition being discussed.

Animal use in post graduate training is also being removed in a phased manner. VR may be used to train the students in techniques like feeding and injections and also invasive techniques like retro orbital blood withdrawal. Modules may be developed where the animal develops distress or dies when a technique is performed wrongly. Their skills may be improved with practice on VR headsets. They may be tested on these skills by projecting the visuals on a bigger screen for evaluators to view and assess.

A possible obstacle in the practicality of AR/VR implementation in education is the cost of the tech. Even though premium VR tech exists in the market, ordinary smartphones can also be utilized via the lesser-known and much cheaper alternative, Google cardboard ®. Researchers have been working on cheaper alternatives like anaglyph stereo lenses and polaroid lens.[9] In place of expensive immersive experiences, a cheaper alternative offered by VR is for users to enter pre-recorded 360-degree visual experiences, be it images or videos. Although less effective, they are useful as a means of visualization and a sense of space. Google has already made AR accessible to the public where they can place 3-dimensional digital objects in one's own space directly from the Google search bar. The maps feature has also become immersive with directions popping up in the field of vision and space. This helps one understand concepts with better context and scale.

Another challenge is the lack of realism in VR and AR simulations. The quality of the display is an important element of the user experience.[10] The better the graphics, the more real and immersive the experience becomes. The head mounted devices (HMDs) are heavy and can

cause fatigue to the users with long periods of use. VR related motion sickness is also a common problem faced, especially with first time users. Symptoms include headache, dizziness, nausea and vomiting.[11]

Also, as VR experiences become more advanced and immersive, the gap between the virtual and real world becomes blurred. Even though this may be considered an advantage in terms of experience, this can lead to users becoming addicted to the virtual world, ignoring their real world needs and life. It is easy to get engrossed and lost in a virtual world so much so that people skip meals, sleep and actual social interaction. This new universe helps you live out your fantasies and become something that you are not in real life. The users' perception of the real world and interactions may be influenced for the better or for worse.

4.2. Strengths of the study

To our knowledge, this is the first study that explores the utility of VR & AR in the subject of Pharmacology. The study used one of the best VR techs currently available in the market, the Occulus™ VR headset.

4.3. Shortcomings of the study

This study was conducted at a single teaching hospital, with 100 students. The results of this study may not be representative of the opinion of the actual student population.

5. Conclusion

Overall, it seems that VR brings intrigue and fascination to a subject like Pharmacology, otherwise considered 'dry' by most students. Though it cannot be a replacement for conventional methods such as chalk and board, this methodology would add a new dimension to the learning experience. However, an effort is required in the direction of developing educational content. Investment in content development and incorporation of these technologies would support further innovation. What makes AR/VR special is its capacity to share information in more engaging and interesting ways, offering virtual experiences of abstract concepts which are otherwise left to the imagination. This holds especially true for a subject like Pharmacology where visualisation is key to understand core concepts. VR/AR also help improve the reach of teaching material, breaking boundaries by providing access to high-quality content to anyone in possession of AR/VR tech. AR and VR will go a long way in enhancing the classroom experience and will open opportunities at various levels of learning.

6. Conflict of Interest

The authors declare no conflict of interest.

7. Funding sources

None declared.

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