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Research Education Article

User experience design in virtual reality medical training application

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Abstract

Objectives: To investigate the effects of design parameters on the user experience of virtual reality medical training.

Methods: The quantitative study was conducted from July 2018 to October 2018 and comprised final year students from eight medical colleges in Pakistan. Each respondent was given to experience laparoscopy operation in text, video and virtual reality-based learning methodologies. User experience and usefulness was assessed against a pre-validated scale and compared with the three learning methodologies.

Results: Of the 87, students, 50(57.5%) were male and 37(42.5%) were female. The overall mean age was 22.5±4 years. Result of virtual reality was better than others (p<0.05). Data was analysed using SPSS v20

Conclusion: Virtual reality-based learning provided better user experience than traditional learning methodologies.
Key Words: User Experience, UX, Video-based learning, VBL, Virtual reality, VR.

Introduction
Technology revolution has been rapid over the past few decades to encourage human computer interaction (HCI). The significant use of technology has been highlighted within the medical education sectors, helping the students to enhance their learning experience and improve their learning competence. Technologically improvised learning experience boosts the level of student motivation, provides them hands-on learning experience and increases the academic outcome. Learning experience and learning competence, on the other hand, are considered to be an important part of enriching the education system excellence. Studies have identified the effects of using virtual reality (VR) simulation-based learning (SBL) to teach medical students and examine their learning experience and competence.

Over the past few decades, VR has incredibly transformed the HCI prospect by contributing new prospective and unique ideas. VR, with its immersive control display, has created a simulation environment for the users that looks and feels real-world to some extent. This immersive technology, thus, engages students by capturing their full attention, and, in turn, producing better learning results.

The term “user experience” usually refers to design research. Design researchers working on Apple Systems in the 1990s were responsible for helping complement human interface by working among divisions and design processes. Previously, the HCI domain was more focused on user interfaces; their usability, ease of use and ease of learning. This work is still going on, but contemporary technological advancements in the last few years have switched the focus more towards how the overall user experience (UX) can be improved. There is no accepted UX definition, but there is a promising consensus that user experience is determined by user’s historical experience, user’s internal
condition, user’s needs and goals, and user’s external circumstances.\textsuperscript{4} International Organization for Standardization (ISO) further defines UX as the user’s collective personal experience and perception of the use of a service, product or system.\textsuperscript{3}

Due to increasing complexity in UX design, an adoption approach of traditional and contemporary user-centric design procedure has been established by many. The process requires collaboration between multi-disciplinary domains of software engineers, graphical design, sales people and marketers in order to create a seamless and pleasurable UX.\textsuperscript{5}

VR is a platform used to create simulated computer-generated environments placing its user inside an immersive experience. Instead of viewing interfaces on a screen, users wear VR goggles which are able to track their head’s movements, and controllers that allow them to interact with three-dimensional (3D) worlds. VR has recently gained a lot of popularity because of the improvement in performance on cellular phones.\textsuperscript{6} VR is primarily used for entertainment purposes, but its potential far exceeds that, such as education, training, physical and mental rehabilitation.\textsuperscript{7}

Various improvements have been made to the VR technology to stimulate a better reality-based experience closely related to the real-life conditions. Different display sizes are offered and there are numerous models for VR goggles; each having its own unique features.\textsuperscript{8} Over the years, the human senses have been affected with the improvement in VR and sight, hear, and touch have progressed considerably since these senses adapt to VR. Despite these updates, there has been minor attention paid to the sense of smell and taste.\textsuperscript{9}

Visual displays are a result of various configurations. Virtual reality can be used in multiple types of displays such as a large projection screen, or numerous projection screens interconnected with each other, monitors with the feature of tracking, and even head mounts which are commonly used in helmets.
VR also constitutes audio output which includes headphones, entertainment systems, and a series of speakers. Managing audio effectively is important because it helps in stimulating a real-time picture along with real-time sound, adding more to the concept of reality in a virtual world. In short, VR is one of the most useful and different human experiences. VR helps in making the most use out of a human brain where the entire information is processed in different ways. According to Harry Houdini, “What the eyes see and the ears hear, the mind believes.” This technology is an actual representation of the line where seeing and hearing creates a reality the in human mind. Based on virtual reality, the normal brain reacts just like it is the actual reality. Various algorithms help in presenting the real world virtually in a way such that our senses and our mind combine together for a real experience.

Driving a car in real life could be easy but learning to prepare for different unforeseen circumstances and scenarios is possible only when multiple different scenarios are put forward to a driver with the help of VR technology. Such scenarios may include blurred display, night drive, low-lighting drive, rainy drive, and fish eye effects. VR can help the drivers in many situations, such as drink-and-drive, and prepare them to handle the worst too. The conducted tests led to results that were surprising. The drivers were making more mistakes in the drunk scenario and had to improve.

VR is still not a complete replacement for what is called real-life case. Drivers trained on a VR system tend to have more accidents compared to the ones facing real-life situations. VR-based environments can allow for learning but depending on a VR system entirely is not feasible. On the contrary, augmented reality (AR) can mix up real-life situations with virtual situations, leading to somewhat better experience towards computer simulation and immersive experience. In this way, AR can be considered a better learning facility since there are a lot of dynamic real objects enhancing a learner’s mental effort.
Various VR technologies are now being marketed on commercial basis which is growing a new market for VR technologies. VR systems can be divided into two categories. A room-scale VR is the one in which movement of the user is not restricted and real-time movements are possible considering the various effects a user faces while the head mount is being used. A stationary VR restricts movement by allowing the user to control the application with a controller rather than physical movement. A room-scale VR is more expensive than a stationary VR. The current study was planned to investigate the effects of design parameters on the user experience of VR-based medical training.

Methods and Results
The quantitative study was conducted from July 2018 to October 2018 and comprised final year students from eight medical colleges in Pakistan. Ethics approval was obtained prior to the study from an independent review committee. Multiple universities were contacted through email for participation in the study, eight of which agreed to offer its students. 87 students were enrolled using simple random sampling, 50 (57.5%) were male and 37 (42.5%) were female. The overall mean age was 22.5±4 years. Content based on a laparascopy operation was used to compare VR experiences with the conventional video and text formats. All the students passed through each of the selected learning method one by one in order to evaluate individual UX. The VR experience was based on a VR application (Medical Realities [MR]) which is available on both Android and Apple’s iOS operating systems. MR has multiple categories which can further drill down into related modules and provide its user with a real-time feel in the operation theatre (OT) positioned next to the surgical team. User can easily move in all possible directions for getting better understanding of the process. The 360-degree movement provides awareness about how the surgical team coordinates and reacts in different situations. Depending upon the process, this can include laparoscopic, a 3D close-up feed and a microscope feed.
The video application was based on the same content accessible through the official YouTube page of MR. A doctor / medical academic lecturer was consulted to prepare the text file based on the VR application and the video. The text file was proof-read by a senior medical practitioner.

In phase 1, the subjects were provided a brief VR introduction, its learning and the MR application. Proper instruction about navigation of the menu along with selection of appropriate module was given to each respondent. The total VR briefing and instruction lasted about 5 minutes. Each respondent was then asked to experience MR through VR glasses (Figure 1). Minimum VR experience time was mandated at 4 minutes. After the completion of the VR experience, the respondents were asked to complete a proforma about the effects of VR user experience (VRUX) and VR usefulness (VRUL).

It is also important to explain that in phase 2, video-based learning (VBL) and its effect VBUX and VBUL were explained before exposing the students to a video of the same that they had experience during the VR session. The duration of video was about 1 minute (Figure 2). After watching the full video, the respondents were asked to complete a proforma about VBUX and VBUL.

In phase 3, briefing was given about text-based learning (TBL), TBUX and TBUL after which a printed text file was given to the respondents for learning about the same procedure they had already experienced during VR and VBL sessions. Finally, they were asked to complete a proforma regarding TBUX and TBUL.

The data-collection tool was adapted from literature. Both the UX and UL categories had four questions each and the respondents used a Likert scale ranging from 1 to 7 for their feedback.

VR values were better for both UX and UL followed by TBL and VBL (Figure 3). Using SPSS version 20, mean values were calculated on the basis of 6 pairings (Figure 4).
Discussions
Results showed that UX and perceived UL was highest for VR compared to the two other methodologies, while they were the lowest for VBL. In our view, it was due to the immersive experience that the VR provides. Furthermore, we believe that the students are more comfortable with the conventional TBL resources, and, hence, leaned more towards TBL compared to VBL.
The small sample size was a limitation of the study, but it was determined on the basis of financial and time constraints. Large-scale studies comprising data from all over the country are needed to substantiate the findings of the current study.

Conclusions
VR-based learning provided better user experience than the conventional TBL and VBL methodologies.

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References


19. Medical Realities [Internet]. 2018 [cited 2018 May 1]. Available from: https://www.youtube.com/channel/UCIRT6AGqh7fPzEEjwjI5azw
Figure 1: Participant undergoing the virtual reality (VR) Learning Experience

Figure 2: Screenshot of video-based application

Figure 3: Survey results comparing User Experience and Usefulness of Text-Based, Video-Based, and VR-Based Learning Methodologies.
Figure 4: Results of Paired Samples Test

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<th>VRUL - TBUL</th>
<th>VBUX - TBUX</th>
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