Utilizing Virtual Reality to Fortify Professional Skills in Engineering Education

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Active Student Engagement in Learning using Virtual Reality Technology in Engineering Education to Strengthen Professional Skills

Abstract

Several skills are needed and, most of the time, are required by the accreditation bodies as part of the preparation for entering the professional practice of engineering. Academic institutions require vision, planning, and time and budget allocation to achieve these objectives. Students are required to produce solutions to meet the specific consideration. For that reason, practical experience in engineering principles is the key to enhancing student knowledge in engineering education.

Virtual reality (VR) technology can be implemented to simulate the real workplace and for educational purposes. Applying VR can encourage students to advance their understanding of the course content. And also, the student should be able to actively engage in the learning process. Implementing this technology makes it possible to improve the effectiveness of education by simplifying what is normally challenging to understand in physical classrooms. In the case of the exploitation of energy resources to differentiate the operation of offshore oil and gas rigs, VR technology can be applied to enhance the understanding and visualization of the requirement and components of the types of equipment. This paper presents real-world petroleum facilities to the classroom with the help of VR technology in the Middle East campus.

As part of the innovative teaching methods in engineering courses, the main objective of applying VR is to overcome the challenge of the limited real trips, improve interest, and augment the student learning experience by applying innovative teaching methods. VR technology connects formal and informal learning processes with actual experiences. Several engineering concepts can be easily introduced thru the technology. Feedback from students shows their excitement and engagement in the learning process. Also, it supports promoting an active learning process for the new generation and engineering education.

Keywords: Virtual Reality, Practical Experience, Field Trips, Active Learning, Oil and gas rigs

Introduction

For students majoring in petroleum engineering, field trips are crucial to fostering the link between classroom learning and practical application. The hands-on experience boosted the learning process, stimulating interest and leading to questions and answers. However, it could be challenging to bring petroleum engineering students to the field operations due to logistical and safety reasons.

A computer simulation-generated interactive and immersive experience, virtual reality (VR), has become a breakthrough in STEM [1]. Giving the impression of being physically present in the non-physical world is made possible through it. The creation of a mechanical device called the Sensorama, which offered a multisensory sensation of riding a motorcycle in a three-dimensional world, was one of the first functional attempts at immersive virtual reality [2]. Since then, as computing power has increased and advances in human-computer interaction technologies have

been made, VR has developed to become more realistic [3]. HMD (Head-Mounted Display) and CAVE (Cave Automatic Virtual Environment) systems are the two most popular types of VR technology.

The HMD is a display device worn on the head. In front of each eye is a screen [4]. The screens are always in front of the viewers regardless of where they may turn their heads. It has a tracking system that lets the viewer observe the images from their perspective. Speakers are also included to offer audible feedback. There are two categories of HMDs: discrete and mobile [4]. The visuals for the displays are created by a discrete HMD connected to a PC. Oculus Rift® is an example of a discrete HMD in Figure 1. Mobile HMD, on the other hand, needs a smartphone mounted on the headset. Each of the two parts on the smartphone screen serves as a display for one eye. A mobile HMD (Samsung Gear ®VR) with a Samsung Galaxy ® smartphone attached is shown in Figure 2.

Figure 1. Discrete HMD (Oculus Rift)

Figure 2. Mobile HMD (Samsung Gear VR)

The popularity of HMDs is rising nowadays. Users can be realistically immersed in various environments by using them to transport them there [4]. They do, however, have some restrictions. Its primary drawback is that it entirely shields viewers from their surroundings. They cannot perceive their bodies, hands, feet, or barriers in the real world. Many first-time VR users bump into walls, furniture, or other people at work. In contrast, CAVE systems enable one user or a group of users to experience and share one user's perspective while surrounded by screens. While viewing their bodies and even one another, users maintain a connection to the reference frame of their surrounding reality [5].

This paper uses virtual reality (VR) technology to bring existing petroleum facilities from the Middle East campus to the classroom. The impediments to conducting real field visits, particularly those that take place offshore, are the motivation behind using VR technology for this purpose. Due to these limitations, students can't visit actual offshore drilling sites in this region of the world. The limitations can be summarized as safety considerations, logistical challenges, and cultural, climatic, and other issues. Therefore, the main goals of this study are to overcome the limitations associated with real field trips, increase future and existing students' interest in learning, and broaden their learning experience through the use of creative teaching techniques in petroleum engineering courses

Field Trip for Petroleum Engineering Student at Texas A&M U at Qatar

Field trips are another approach to provide variation to the curriculum, which boosts teaching efficiency and encourages student learning. Field trips link formal and informal learning by connecting the students to real-world situations. Students studying petroleum engineering visited a rig site and onshore drilling operations, as seen in Figure 3. The trip gave the students a chance to get additional knowledge about directional drilling, drilling rig components, drilling fluids, and drilling procedures. They also learn about professional engineers' working conditions in the oil and gas sector. The tour starts with a brief introduction to hydrogen sulfide to ensure students are aware of the hazards and characteristics of H_2S and the best course of action in an emergency. The petroleum engineering program's industrial trips and other forms of hands-on learning are essential for students to successfully connect what they learn in the classroom to practical applications in the workplace.

Although field trips are crucial for petroleum engineering students, they are difficult to organize for onshore operations and nearly impossible for offshore operations for various reasons. One reason is that some training, such as those for offshore operations, take days to complete while others, like the basic hydrogen sulfide training, need students to pass them before they can access an oil rig. The logistics challenges are another factor that makes such field trips challenging to organize. Since helicopters and boats are used for offshore field trips, this might be particularly challenging for kids with special needs. Furthermore, summer field trips are not feasible due to the harsh temperature in this region.

Figure 3. TAMUQ field trip to the drilling rig for Petroleum Engineering Students

Another reason, female students in the Middle East do not often gain permission to go on field trips with male pupils due to cultural restrictions. Because of this, the authors were inspired to create VR-based field trips that would enable petroleum engineering students to visit various locations for a fraction of the cost of traditional real field trips without limitations imposed by bad weather and poor accessibility. In fact, students who might typically be excluded from field courses due to observed cultural norms or even restricted physical capabilities will be able to explore offshore drilling rigs in relative comfort, addressing gender and disability equality within engineering education. This is made possible by TAMUQ's cutting-edge immersive visualization capabilities. In addition to all of this, as will be discussed in the next part, the VR-based field trips give the students access to the reservoir, which is not possible in reality.

HMD-based Virtual Reality application for Petroleum Engineering at Texas A&M U at Qatar

To give students a first-person experience of touring and exploring an offshore drilling rig, the HMD-based application was created [6]. The HMD application allows multiple students to use it at once, unlike the CAVE application, where only one viewer can be active at once. A group of students using Oculus Rifts to test out the HMD-based application is depicted in Figure 4. The VR experience begins at the helipad, typically where someone would be flown by helicopter from the ground to the rig. The viewer can then stroll or teleport to their selected location using the handheld motion controller. For the viewer's knowledge, the rig's major components are labeled. A few screenshots of the application are shown in Figure 5. In addition, a brief animation of the drilling process has also been added to the application.

Figure 4. VR application screenshots for the student using head-mounted VR devices

Figure 5. Application of the HMD VR for the offshore drilling rig [4]

Figure 6. Visualization using augmented reality for the onshore drilling rig [7]

Students can examine different pieces of equipment situated from the seabed to the well tops and observe the subsea reservoir using a different application that also uses virtual reality. Another application currently under development uses augmented reality to display a 3D model of 2D figures. With this application, a student might view 3D models of various oil and gas facilities and equipment overlaid over the 2D images from the textbook, as seen in Figure 6, using their smartphone or tablet. The models would be open for the pupils to investigate however they pleased.

Students Experience

A short survey is created to determine how students feel about field trips in general, the newly designed VR-based ones, and their advantages for teaching petroleum engineering. 34 TAMUQ undergraduate petroleum engineering students (17 freshmen, 3 sophomores, 11 juniors, and 3 seniors) are participating. As part of their coursework, the juniors and seniors had already toured an actual onshore field. The survey was conducted during spring 2019 and composed of seven Likert scale items having five scale levels from 'strongly agree' to 'strongly disagree,' which are coded as 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The seven questions given to students were as below:

1. Field trips are one way of adding variety to instruction, thus optimizing teaching effectiveness while motivating student learning.
2. Field trips help bridge formal and informal learning by connecting the students to real-world experiences.
3. The virtual reality-based field trip provides an effective way of emphasizing the learning process in petroleum engineering education.
4. Virtual reality can be used to help in visualizing and understanding the differences among the component of offshore rigs.
5. The technology creates amazing experiences for those who have never been in a drilling rig, and they feel it is exciting and engaging.
6. I felt interested in the activity, and the experiences were worthwhile.
7. The student develops a deeper understanding of content through Virtual Reality technology

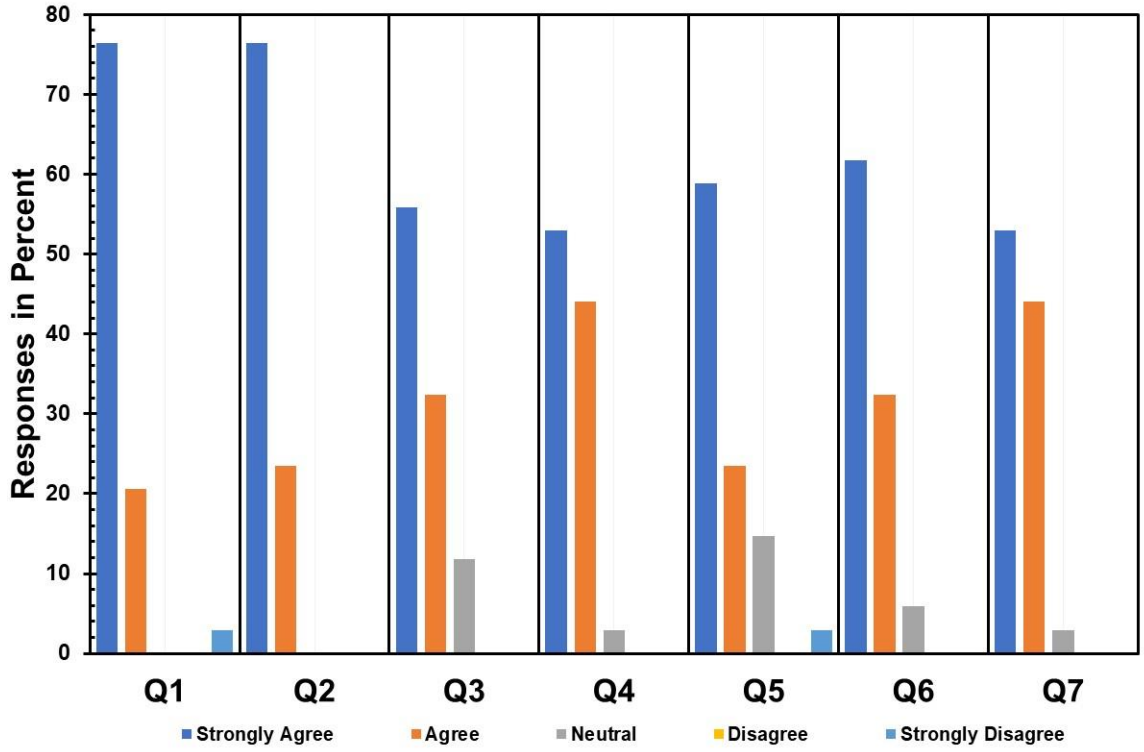

Figure 7. Survey of the use of virtual reality in petroleum engineering education.

This survey has a small sample size in terms of both participants and data collecting (students in the Petroleum Engineering Program at TAMUQ).

Students' opinions of both actual field trips and virtual reality excursions are generally positive (Figure 7). The findings reveal that most of the items are closer to 5 than to 4, with the average of all the items falling between 4 and 5 (strongly agree). Additionally, all responses are 5 (strongly agree), demonstrating that students believe both experiences are crucial and beneficial to studying petroleum engineering.

Students see field trips as an efficient and interesting approach to study while relating it to real-world situations. Furthermore, the majority was unanimous in their support of the use of virtual reality-based field excursions as a supplement to actual field trips to improve learning in petroleum engineering education.

Conclusion

Field trips are crucial for improving students' comprehension of petroleum engineering. Additionally, they boost student learning while enhancing instructional efficacy, making it easier to connect formal and informal learning by connecting students to real-world situations. But organizing such field visits has drawbacks, including security measures and logistical, cultural, and weather concerns.

VR-based field trips have been developed to overcome these restrictions, increase the interest of both present and prospective students, and broaden their learning opportunities in petroleum engineering courses. These VR-based field trips have advantages over traditional ones regarding logistics, accessibility, prices, and safety, even though they cannot substitute for actual field trips. Additionally, the initial field trip experiences of the pupils demonstrate how happy they are with what these excursions offer.

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