

## Virtual Reality for Chemical Engineering Unit Operations

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**Abstract :** Experiential learning is dubbed as a highly effective way to enhance learning. Virtual reality (VR) is thus a helpful tool in providing a safe, memorable, and interactive learning environment. A class of 49 fluid mechanics students participated in starting up a pump, one of the most used equipment in the chemical industry, in VR. They experience the process in VR to familiarize themselves with the safety training and the standard operating procedure (SOP) in guided mode. Students subsequently observe their peers (in groups of 4 to 5) complete the same training. The training first brings each user through the personal protection equipment (PPE) selection, before guiding the user through a series of steps for pump startup. One of the most common feedback given by industries include the weakness of our graduates in pump design and operation. Traditional fluid mechanics is a highly theoretical module loaded with engineering equations, providing limited opportunity for visualization and operation. With VR pump, students can now learn to startup, shutdown, troubleshoot and observe the intricacies of a centrifugal pump in a safe and controlled environment, thereby bridging the gap between theory and practical application. Following the completion of the guided mode operation, students then individually complete the VR assessment for pump startup on the same day, which requires students to complete the same series of steps, without any cues given in VR to test their recollection rate. While most students miss out a few minor steps such as the checking of lubrication oil and the closing of minor drain valves before pump priming, all the students scored full marks in the PPE selection, and over 80% of the students were able to complete all the critical steps that are required to startup a pump safely. The students were subsequently tested for their recollection rate by means of an online quiz 3 weeks later, and it is again found that over 80% of the students were able to complete the critical steps in the correct order. In the survey conducted, students reported that the VR experience has been enjoyable and enriching, and 79.5% of the students voted to include VR as a positive supplementary exercise in addition to traditional teaching methods. One of the more notable feedback is the higher ease of noticing and learning from mistakes as an observer rather than as a VR participant. Thus, the cycling between being a VR participant and an observer has helped tremendously in their knowledge retention. This reinforces the positive impact VR has on learning.

**Keywords :** experiential learning, learning by doing, pump, unit operations, virtual reality

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