71 Statistical evaluation of e-learning through virtual lab for haemodialysis machine: Barriers and future scope

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Abstract

Due to the Covid-19 scenario across the world, the university education system for the student moved towards offline mode to online mode. The classes can run in online mode through the different meeting platforms but the lab cannot be conducted through the video. The virtual lab is a boon for the technical student as they can perform the experiment with internet-enabled devices (laptop or smartphone). The virtual lab can be operated at any time and students can perform the experiment multiple times without visiting the actual lab. For medical background students, many machines having the electronics components can be covered through the virtual labs. The medical instrument is very costly and it cannot be available in every institute the haemodialysis is among one of the electronics instruments which need to be studied by biomedical engineering, lab technicians and nursing undergraduate university students. In this paper, we conduct a short survey among the undergraduate students who worked with haemodialysis machine virtual lab and real haemodialysis machine. The result of the survey is very encouraging and most students are comfortable with the haemodialysis virtual lab.

Keywords: virtual lab, e-learning, haemodialysis machine, dialysis process

Introduction

Virtual lab plays a great role in the learning of different biomedical machines for undergraduate and postgraduate biomedical engineering students' virtual lab gives easy access to costly machines [1]. It gives a similar environment that is the same as the actual machines in the lab or their respective destination according to use [2]. Through the virtual lab, students can perform the experiment on the internet-enabled computer or laptop or smartphone. Students can perform the experiment at any time and do not depend on the particular lab time or the ability of the machine. The virtual lab is a boon for the students of that institute of poor countries which have a lack of proper laboratory settings or adequate sophisticated instruments which are very expensive [3, 4]. The project of the virtual lab is started by the Indian government to

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help not only the student of India but also the student of the low-income country to get the knowledge about the experiment and machines to doubt having in physical form. There are many experiments for biomedical engineers which are based on these costly machines. Haemodialysis machine, ECG machine, EMG machine are among the famous machines which are used mostly in the hospitals for the treatment of the patients, and are somehow expensive, therefore by the help of virtual they can be easily practiced by the student at low cost [5, 6]. Present paper is divided into the five sections. In the second section, we give a brief idea about the haemodialysis machine used in the hospitals, which is followed by the detail description of the virtual haemodialysis machine. The forth part discusses the outcome of the survey which was conducted on the 200 responders and at last in conclusion we discuss about the suggestions how to improve the virtual lab in future.

Haemodialysis Machine

The word "hemo" is a Greek word meaning "blood", dialysis, "dissolution"; from dia, "through", and lysis, "loosening or splitting", thus haemodialysis came from the combination of three words "hemo" and "dialysis" which means the diffusion of solute molecules via semi-permeable membrane usually passing through the membrane filter from the side of higher concentration to that of lower concentration. The kidney is the vital organ that plays the role of dialysis in the human body, while haemodialysis machine does the same function as the kidney does, the haemodialysis machine is also referred to as artificial kidney [7]. Haemodialysis is a form of dialysis that removes wastes and excess fluids from the bloodstream using a machine with an artificial filter. This therapy also aids in the regulation of the body's chemical balance and blood pressure. Each treatment lasts around four hours and is repeated three times every week. The haemodialysis machine is therapeutic device that is used to treat patients with renal failure. The inventor of the haemodialysis machine is called Dr. Willem Kolff, a Dutch Physician, he invented the first dialyzer (artificial kidney) in 1943 by this development Dr. Willem Kolff ultimately became the world's top biomedical engineer [8]. Though all medical devices has different mode of operation, and design from one manufacturer to another but they all have the same anatomical physiological characteristics. The dialysis machine is a very expensive and a very complex machine that requires competency in operation and maintenance as well, thus it should be properly maintained according the instructions given by the specified manufacturer in the user manual of the machine provided [7].

Virtual Hemo Dialysis Machine

Similar to the 3D games on computers, mobile phones and play stations the virtual haemodialysis machine is designed in such way [5]. As seen in the Figure 71.1 the whole haemodialysis settings is designed and by using the internet connectivity the user can operate the machine by inserting the required parameters such as blood flow rate in which the normal range is 200 to 2500 ml/min and the followed by the blood pressure at inlet which is the pressure of the blood from the patient via the access to the machine. The alarm systems as heard beeping they indicate any dis-function in the machine. The blood flow to the dialyzer and get filtered. There is a blood leakage

detector that detects any leakage of blood. The two containers are simultaneously used during the dialysis process. The green container contains the dialysate solution while the red container contains the waste product obtained from the blood (urine). The control parameters can be set according to the desired ultrafiltration and process time in the hour which can be 3 to 4 hours per session. The air bubble detectors detect the Presence of bubbles in the blood before getting back to the access if air bubble is present the alarm system will beep to notify the technician that there is problem. Dialyzers are manufactured from a fibrous, thin substance through which finer particles and liquids can flow through the semipermeable barrier formed by the fibres. Due to the difference in constituents of the blood of each patient and perhaps there may be some bacterial, fungal or some viral infections in the blood of some patients and also the dialyzer also gets clogged after the dialysis process, the dialyzer is cleaned, checked for efficacy and reliability, high-level disinfected or sterilised, and preserved for future use in a sterile situation. The dialyzer can be reused for about 4 times and it is very costly so there is a need to re clean and reuse it using the Dialyzer processor. The dialyzer processor uses the principle of osmosis (reverse osmosis) to re clean the dialyzer. Figure 71.1 shows working of the virtual haemodialysis machine on the internet enable laptop.

Discussion

The survey contains respondents of students from medical related fields that deal with haemodialysis machine operation and biomedical engineering students that had experienced many other virtual labs. Around two hundred students participated in the survey and the finding of the survey is presented here. The questions were asked to the students through the Google form (Figures 71.2 and 71.3).

Approximate we make around 85.3% of responders are fully satisfied with the information through virtual lab while 14.7% are tentatively satisfied, there is no responders who is unsatisfied with the virtual lab experiment. It has been noted that

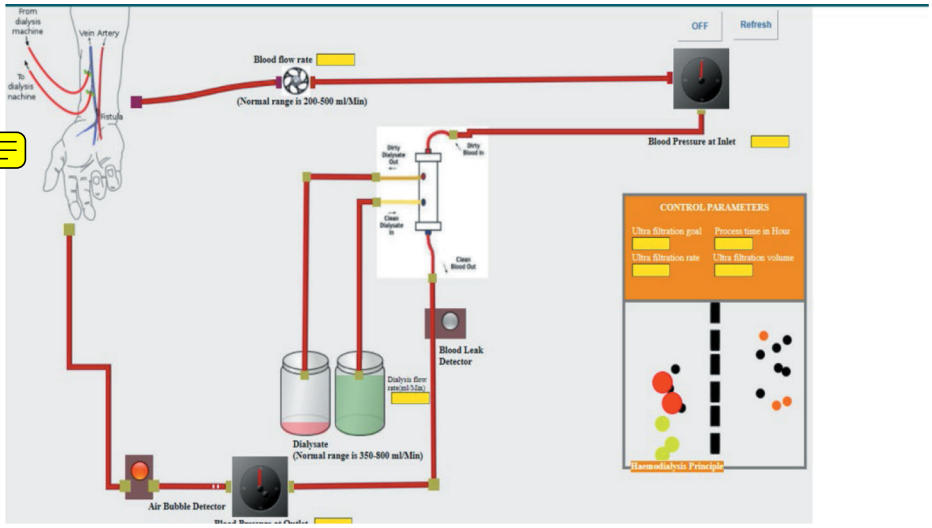

Figure 71.1: Working of virtual haemodialysis machine [9]

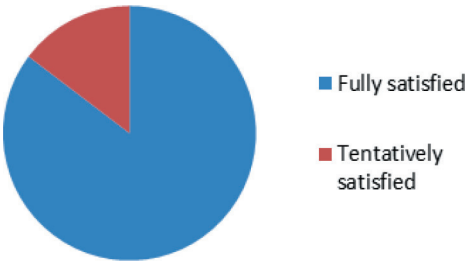

Figure 71.2: Satisfaction among the responders of the survey

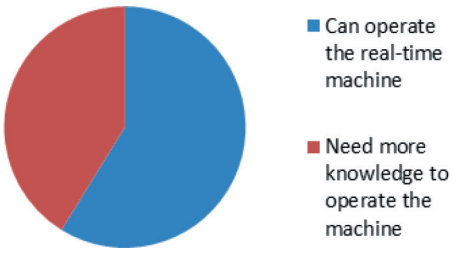

Figure 71.3: Working knowledge of the machine

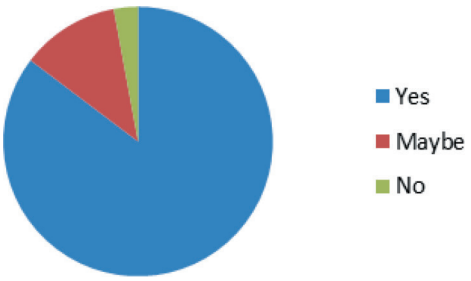

Figure 71.4: Learning skill enhancement through the virtual lab

about all student are satisfied with the virtual lab experiment. The respondents were asked if they were able to operate real time machine after learning the virtual lab simulation 58.8% of the respondents said yes, they were able to operate real time machine after using the virtual lab machine to learn how to operate the haemodialysis machine via virtual lab while 41.2% of the respondents said they needs more additional information before they can be able to operate real time machine after using virtual lab. In Figure 71.4, the respondents were asked if virtual lab helps them to learn skills faster in comparison to the online theory mode of learning. About 85.3% of the respondents said yes virtual lab helps them to learn skills faster in comparison to the online theory mode of learning while 11.8% of the respondents said maybe.

In Figure 7.55, the survey the respondents were asked about what they think about the virtual lab, if it is easy and why. About 92% of the respondents said yes it easy and have given their reasons for why it is like easy and 8% of them said it is not easy.

The important part of this survey is the question that we asked our respondents if virtual should be implemented in their curriculum before accessing the real-time machine practical. The 69.7% of the respondents said yes it should be implemented

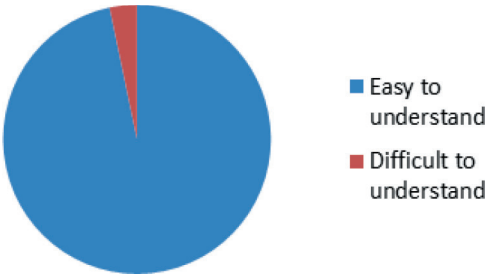

Figure 71.5: Learning through the virtual lab

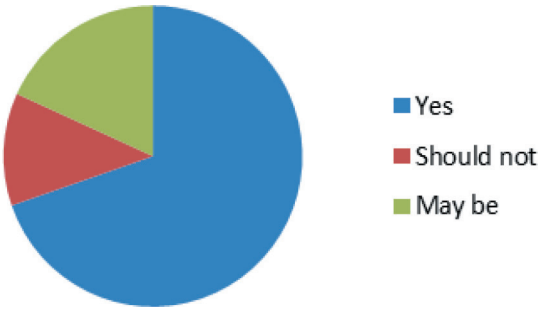

Figure 71.6: Implementation of the virtual lab

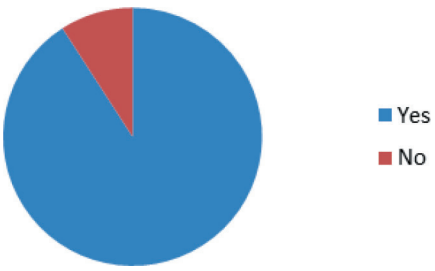

Figure 71.7: Motivated through virtual lab

in their curriculum and 12.1% said no it shouldn't be implemented while 18.2% said maybe it should be implemented. The result is shown in Figure 71.6.

As presented in Figure 71.7, 90.9% of respondents get motivated using virtual lab and performed the lab experiment for multiple times with different scenarios while others are not comfortable with the virtual lab.

Conclusions

The simulation of haemodialysis machine via virtual lab is realised and also there some crucial things to consider as per the response of the survey paper, many suggested the main drawback of the virtual lab is the internet access, therefore virtual lab should be made non-internet usage so that those in rural areas with poor network could access it. Some suggestions regarding the haemodialysis virtual lab is that there is a need to design a similar for the dialyzer processor virtual lab for dialyzer processor which is not available in the virtual lab.

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