Chapter 14
Opportunities in Virtual Laboratory Experiments in the Teaching and Learning Process

Kapilan N.
Nitte Meenakshi Institute of Technology, India

Rana Pratap Reddy
Global Academy of Technology, India

Vidhya P.
SRSMN Government First Grade College, India

ABSTRACT

The teaching and learning process in the laboratory is different from theory classes. The students get better knowledge and understanding of the concept when they perform experiments in the laboratory. The hands-on practice will help the students to remember the concept. However, the lack of facilities and limitations in the laboratory infrastructure may affect the student learning process. In India, few technical institutions lack adequate laboratory facilities, and hence, the government of India has started a new initiative called the virtual laboratory to overcome this issue. The Government of India provided funding to the premier institutions in India to establish virtual laboratory facilities to help the institutions which do not have sophisticated laboratory facilities. The advancement in IT and Internet facilities helps this initiative. In this chapter, basics of virtual laboratories, different types of virtual laboratories, impact of virtual laboratories in students learning process, opportunities, and limitations of the virtual laboratories were discussed.

1. INTRODUCTION

The science subjects can be taught properly and effectively with the help of laboratory experiments and hence it is an integral part of the science education (Çepni et al., 1995). The advantages of using

DOI: 10.4018/978-1-7998-7607-6.ch014

laboratory in science education is to assist the students in gaining experience through concrete materials as natural and applied sciences, improving students working habits, problem solving skills, enhancing students abilities to understand practical problems and improving students attitudes towards education (Tamir, 1978). In engineering education, laboratory plays a key role in understanding the theoretical concept and also helps to improve the students communication, observation capability, team work, results analyzing skill, ethics etc. Hence it is necessary to introduce laboratory components in each subject for better understanding of the concepts. The conventional laboratory setup may not able to meet course outcomes (Feisel & Rosa, 2005c). It is necessary to develop innovative design oriented laboratory to motivate the students to engage and spend long time in the laboratory. In the conventional laboratory setup, students follow standard laboratory protocol and perform experiments to meet the pre determined outcome. It helps the students to understand the experimental techniques, collection data, interpretation of data, report writing etc. The level of critical thinking to perform the experiments and deep learning is low in this setup. Few researchers suggest that the innovative approach is needed to integrate knowledge and learning process which helps in solving problems, increasing team and helping in designing new experiments (Julie & Barry, 2010; Yeung et al., 2011). The students' satisfaction in laboratory is very important parameter. It is suggested that the students' laboratory experience can be recorded and critically analyzed to provide the solutions because this practice increases the students learning. The students learn necessary laboratory skill sets only if the laboratory has good laboratory facilities and committed laboratory instructors. A number of studies discusses laboratory management and suggest method to increase effective utilization of laboratory resources, quality and safety (Nikolic et al., 2015). The laboratory experiments conducted at school level and college levels are different (Demir et al., 2011; Şahin et al., 2000). The effective time spent by the students in the laboratory greatly affects the students' learn-ability (Kirschner & Meester, 1988). The engineering laboratory should have well maintained latest equipment, competent staff and faculty members (Edward & Ernst, 1983).

A survey reports an improvement in student learning process in theory course due to effective learning process adopted in the laboratory experiments (Gian Paolo Cimellaro & Domaneschi, 2018). The outcome of the qualitative survey conducted on the students shows that the students give priority for the assessment marks and hence it was suggested that the course work of the laboratory can be modified for the effective alignment between students and faculty goals (Santos-Díaz et al., 2019). The students should be exposed to good practices adopted in industries through laboratories (Rossiter et al., 2018). The research work carried out to find the students' perceptions about the team roles shows that the students lack team activities in the laboratory environment and students do not perceive team roles as a key parameter in productivity. It is suggested to establish strong students' teams in laboratory environment (Ott et al., 2018). A study carried out at universities under graduate students about safety in chemical laboratory shows that the most of the students had poor to fair attitudes about laboratory safety; however the assessment of students' shows fair to good practices. It is concluded that the safety procedures should be implemented in the chemical laboratory in professional way (Al-Zyoud et al., 2019). The students should use laboratory safety tools such as goggles, gloves etc depends upon the type of experiments and the teacher's supervision is essential to enhance the laboratory safety (Duban et al., 2019). The instructions given in the laboratory helps the students to get practical experience. Also it helps the students to understand laboratory safety, learning safety labels, Indentifying, understanding, storage and handling of hazard materials. Hence the laboratory experience provides safety awareness among the students (Artdej, 2012). The engineer is expected to manipulate materials, design, energy etc, for the benefit of humankind. Hence the knowledge gained by the students in theory and laboratory is very