

Simulation-Based Approach to Teach Electronic Circuit Design

Yuqing Chen*, Yu Wang, and Meng Ding
Xi'an Jiaotong-Liverpool University

Abstract

Engineering students often consider complex real-world systems with complex structures and uncertainties. The engineering practices in traditional education systems could only offer limited opportunities for students to understand the concrete properties of the real-world systems, limiting the performance of students. In this action research, simulation-based education (SE) is considered to improve the performance of the students in engineering practices. We introduce virtual simulation platform to help students get familiar with the considered systems; because students could practice with the systems with unlimited trials, they could get sufficient practices in the considered systems and improve their performances when dealing with real-world systems. Feedbacks are collected from questionnaires after the module is completed and the results demonstrate that the introduction of virtual simulation platform helps students get more familiar with the real-world systems and improve their performance compared to previous records.

Keywords: simulation-based learning, experiential learning, engineering education, higher education, action research

*Corresponding author: Yuqing Chen. E-mail: Yuqing.Chen@xjtlu.edu.cn

Introduction

In higher education, students are facing the pressure of preparing for their future profession and their professional competences should involve a range of 21st-century skills (Chernikova et al., 2020). Students in engineering departments often deal with complex real-world systems like electronic circuits, robots, deep neural networks. These systems are often high-dimensional, being influenced by the thousands of parameters that could change the behavior of the complex systems (Kutz et al., 2016). Moreover, the complex systems in real-world are often subject to external perturbations or internal uncertainties, making the engineering education challenging to students as the practices offered by university are often limited compared to the requirements of the teaching criterions (Byers et al., 2013). This is the main drawback in traditional teaching systems where students often have limited understanding of the complex real-world systems and thus they need more training after graduation and before they could engage in the engineering works (Gruler et al., 2019).

According to Juan et al. (2017) that employing virtual simulation platforms could help students better understand the abstract concepts and enhance the learning experience through repetitive explorations in the simulation platforms.

Simulation-Based Education

Simulation-based education (SE) is first identified as a useful tool to enhance learning experience in 60s last century (Boocock & Schild, 1968) and continues its development in higher education. Simulation-based learning provides students' learning with "the approximation of practice, allows limitations of learning in real-life situations to be overcome, and can be an effective approach to develop complex skills" (Chernikova et al., 2020, p. 502). Beaubien and Baker (2004) define simulation as a tool that replicates the real-life characteristics of situations and scenarios. A more specific definition suggested by Cook et al. (2013) stated that simulation is an "educational tool or device with which the learner physically interacts to mimic real life" (p. 876). The simulation training sessions often partner with the stages of the experiential cycle, combining the active experiential component of the simulation exercise and effective reflection on the learning experience (Chernikova et al., 2020).

Simulations are now increasingly used in higher education (Chernikova et al., 2020). In science, technology, engineering, and mathematics (STEM) education, they are used to facilitate a deeper understanding of concepts and relationships between different disciplines, advance inquiry,