Chapter 38
The Roadmap for Experimental Teaching of Science and Engineering Based Subjects: Innovative Technology and Social Media in Higher Education

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ABSTRACT

The continual development of technology represents a challenge when preparing engineering students for future employment. At the same time, the way students interact in everyday life is evolving: their extra-curricular life is filled with an enormous amount of stimulus, from online data to rich Web-based social interaction. This chapter provides an assessment of various learning technology-driven methods for enhancing both teaching and learning in the science and engineering disciplines. It describes the past, present, and future drivers for the implementation of hands-on teaching methods, incorporating industry standard software and hardware and the evolution of learning experiments into all-encompassing online environments that include socializing, learning, entertainment, and any other aspect of student life when studying science and engineering.

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INTRODUCTION

The argument for and against experimental learning is an old one and the developments of teaching and learning in this domain within the last century were driven by the professional institutions. Although there is still a significant number of educators who seek further evidence of the benefits of experimental learning, the advocates of this approach are very excited by the range of developments in computer technology, web tool. The fast adoption of the web based content, especially by a student population, offers new opportunities for web-based experimental learning.

They believe that it is necessary to develop the experimental learning methods, especially in an environment where a wide range of student backgrounds and motivational levels exists. This approach aims to achieve both short and long-term goals, such as optimizing the learning process, resulting in enhanced motivation, learning and retention and ultimately student satisfaction. This will enhance students' employability by learning to function as a team member, make decisions; be able to develop, discuss and present concepts and generally practice the engineering profession.

At undergraduate level, this approach aims to bridge the basic concepts from the electronic, mechanical and software engineering fields, resulting in seamless curriculum integration. It is a particularly good approach to delivering these concepts to applied engineers (e.g. Aeronautical, Civil or Automotive students), who often do not have a deep interest in either of the three fields, but are more interested in the applications. The benefits of the approach include learning fundamental scientific concepts and their inter-links, familiarization with new technology and software for enhanced employability, applied learning, which is beneficial to a wider group of students (part of a blended learning strategy), improved student experience and more.

At postgraduate level, this approach aims to develop students' ability to think logically and independently, and to make complex design decisions, thus facilitating the full design process, from the feasibility study including hardware specification and costing to the final design. Hardware-software co-design is a particularly valuable approach, as it allows implementation and verification of a semi-custom industry-focused design; working with real hardware that can be customized allows rapid implementation. This develops both students' engineering design skills and confidence in their own ability. In addition to the undergraduate benefits, it teaches design methods and processes whilst delivering advanced concepts to further the learning.

This chapter aims to describe the past, present and future learning technologies and environments used in experimental teaching for science and engineering students worldwide. It discusses the developments required for a seamless integration and creation of modern, dynamic learning environments. These are expected to evolve from existing social networking environments into all encompassing online environments. The new environments are expected to include socializing, learning, entertainment, and any other aspect of student life. Factors such as improved bandwidths, the 'explosion' of social networking tools, allied with the demand for a flexible learning approach and the high price of experimentation resources are all strong drivers for the implementation of modern teaching methods. These not only incorporate industry standard software and hardware, but also use remotely controlled experiments, and virtual environments as elements of the curriculum re-vitalization process. It starts by identifying the motivation and resultant broad learning outcomes achieved from experimental learning. This is followed by the specifics of modern experiments such as remotely controlled experiments, both virtual, and real, including

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