

Chapter 42

Developing Educational Games for Engineering Education: A Case Study

Vinod Srinivasan
Texas A&M University, USA

Karen Butler-Purry
Texas A&M University, USA

Susan Pedersen
Texas A&M University, USA

ABSTRACT

This chapter presents an experience with the development of an educational game focusing on digital systems design for undergraduate electrical engineering students. The project was motivated by the ineffectiveness of traditional instructional methods, particularly in engineering education and research, indicating that educational games have the potential to improve learning and motivation among players. The chapter presents an overview of the literature on engineering education and game-based learning, followed by a detailed look into the process by which this project was approached, starting from obtaining funding for the project to the actual design, development, implementation, and assessment of the game itself. The emphasis in this chapter will be on the challenges faced and the lessons learned during the course of this ongoing project. The challenges are common to other similar projects, and the lessons learned can provide valuable guidelines to other researchers and educators engaged in similar endeavors.

INTRODUCTION

In this chapter we present our experience with the development of an educational game for electrical engineering students in a formal educational

setting at the undergraduate level. The subject matter for the game is digital systems design, which addresses several complex concepts that students find difficult to grasp. Our goal was to develop a game that could be used to supplement the laboratory portion of courses that deal with this topic. Preliminary testing indicates that our

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approach has the potential to produce positive results, both in terms of student learning as well as motivation for the subject matter. We present an overview of the academic issues pertaining to engineering education and game-based learning, followed by a detailed look at the project, starting from obtaining funding to the design, development, implementation and assessment of the game itself. Given that our project is still in the formative stage and a comprehensive evaluation of its impact has not yet been conducted, our objective in this chapter is to document the challenges we faced and the lessons we learned in this ongoing project. The challenges are likely to be common to other similar projects. This chapter will provide guidelines to other researchers and educators engaged in similar endeavors.

MOTIVATION

Issues in Engineering Education

Digital Systems concepts are taught at various stages of the Electrical and Computer Engineering (ECE) curriculums and many approaches have been explored to effectively teach the material. These approaches include the use of Computer Aided Design (CAD) tools, Software (SW) and Hardware (HW) simulations, designers' viewpoint, industrial practice, etc. (Adamo, Guturu, & Varanasi, 2009; Carpinelli & Jaramillo, 2001; Castra, et al., 2000; Grover & Ugweje, 2002; Kleinfelder, Gray, & Dudevoir, 1999; Mahmoud, 2006; Mealy & Parks, 2007; Potkonjak & Wong, 2007; Slivovsky, Mealy, & Liddicoat, 2005; Tseng, 2008; Wuttke & Henke, 2002). With the recent interest in improving first-year retention in engineering, major efforts are focusing on identifying appropriate content for an effective introductory engineering course. This includes the possibility of a freshman level digital design course (Reisslein, Tylavsky, Matar, Seeling, & Reisslein, 2007; Tylavsky, 1999).

One of the authors of this chapter has taught an Introduction to Digital Design course for the past twelve years. The course addresses several complex concepts that some students find difficult to grasp. For example, thinking in terms of binary numbers and variables, viewing design from a systematic approach, and sequential concepts/feedback systems are new or abstract concepts that some students are slow to grasp. Course readings and support lectures are selected to address these concepts; however she found that many of the students do not read the assigned materials because it is not their preferred approach for knowledge intake. The laboratory component of the course tries to introduce the students to course concepts from an experimental perspective to address students whose learning styles would be best suited by a concrete teaching style. Sometimes concepts are introduced in the lab before they are covered in the lectures. The level of student learning in the lab, therefore, depends on the individual teaching assistant's (TA) ability to convey the design rules that students need to design their lab circuits without previous exposure to the design concepts and the students' ability to extend that information into working designs. Since the TAs teaching skills vary, the laboratory component of the course receives the most student complaints in reference to the quality and consistency of the course instruction. Further, it is common for a subset of the students to copy the laboratory design from a fellow student, and implement it without fully understanding how to design the circuit. A considerable number of students also convey boredom or lack of challenge with the laboratory assignments.

The literature on engineering education provides additional background on the issues described above. In one of the pioneering studies in this field, Felder and Silverman (1988) found that the learning styles of most engineering students and teaching style of most engineering professors are incompatible. They found that engineering students are visual, sensing, and active, and some

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