

# Chapter 31

## A Novel ‘Game Design’ Methodology for STEM Program

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### ABSTRACT

*A novel approach to teaching concepts using game design in the graduate sustainability and engineering management programs is illustrated. These student-built games tied to demonstrate the course learning outcomes (CLOs) were tested in a classroom environment. This pilot study’s impact on student learning, motivation, creativity, engagement, innovation, team interactions, and instructor leadership, and its contribution towards the achievement of CLOs were assessed in multiple courses. The results from this pilot study involving students indicated that the game design, creation, and play is an effective and innovative pedagogical tool that could promote student engagement, motivation, critical thinking, and learning skills with minimal educational tools. In addition, this innovative teaching tool could help change the declining and waning interest in STEM+ programs at the graduate level.*

### INTRODUCTION

Novel educational technologies and methodologies that create student excitement and promote learner engagement are becoming instructional priorities across STEM (Science, Technology, Engineering, and Mathematics) based disciplines (Ernest and Clark, 2012). This has led faculty and administrators in higher education to seek innovative ways of engaging and motivating students in STEM disciplines (Shaffer, 2008). Their efforts have resulted in vast arrays of digital media-oriented technologies that are now directly accessible for classroom use. These range from traditionally licensed software to web-based applications (Branoff & Scales, 2010). However, many of these dynamic tools call for supplemental instructional design. Hence these dynamic tool technologies add additional learning and time requirements for both instructors and students. To overcome the time and cost of creating these supplemental

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tools, students are now assigned the task of designing games that would facilitate the learning of the concepts that are fundamental to each of these disciplines (Prensky, 2008). It has been proven that student activating learning environments deepen the approach to learning (Struyven et al., 2006) and hence it is believed that enlisting students to create games that would teach basic concepts would be effective since they would have to first understand the concept thoroughly to create a meaningful and logical game. (Masuch and Nacke, 2004). Also, using games as tools to teach concepts are effective because they provide a fault tolerant environment, which allows students to make mistakes in a safe setting (McGonigal, 2011). Since games allow progress to be measured, players can easily see how much they have advanced from one level to another (Rieber, et al., 2004; Ray, and Coulter, 2010). This feature of educational games motivates students to be persistent as they seek and achieve goals (Kapp, 2012). Developing the persistence attribute is particularly important for STEM students as mathematical and complex problem solving require in depth knowledge in the subject matter and repeated engagement in order to achieve the desired outcomes for the course (Jaurez et al., 2010). Game design is a process that includes the creation of rules and contents of a game. The contents include both the general idea as well as detailed documentation describing all the elements that make up the game: conceptual, functional, artistic, and others (Bates, 2004; Rollings and Morris, 2003; Schell, 2008). Problem based learning often resembles this similar self-paced process found in games, as it also encourages and facilitates the independent progression through course materials and concepts (Horsley, 2010). These affordances in time and achievement create a custom experience for the player and facilitate the learning process for each student (Shaffer, 2008; Prensky, 2008).

The main objective of this work is to investigate whether development and implementation of game pedagogy in the sustainability and engineering management programs could increase student innovation, motivation, and engagement in learning complex STEM topics. It is, therefore, that this work focuses on the design and creation of games. The students are assigned the task of creating every step of the games.

- First, students develop game objective(s) to support and demonstrate one or more of the course concepts and learning outcomes.
- Once students identify the game objective(s), they turn their attention to other aspects of the game such as players, strategies, rules of play, and a game board (virtual electronic or other).
- Finally, students present and play their games in front of the class and answer questions relating to how they created the game “engine” and other elements while developing the creative thinking skills.

During the entire process of game creation, students work in teams which promote communication and interaction similar to what they would experience while working on projects in real work environments.

## **BACKGROUND**

Numerous studies have shown that games can facilitate and promote learning in many ways. Games provide opportunity for engagement, and this can help one to gain subject knowledge. Games include rules, goals, feedback, conflict, challenge, competition, and interaction, and hence they are effective pedagogical tools (Prensky, 2001). In fact, the pedagogical role of games in education has been well documented (Squire and Jenkins, 2003; Demirbilek, 2010). Games also engage players as decision

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