Use of Computer Simulation Games for Instructional and Recruiting Purposes in Middle School and Jr. High Research Experiences for Teachers (RET) 2010

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Abstract

The 2010 Summer RET program at the University of Arkansas provided an opportunity for two public school teachers to conduct further research in the area of using computer simulation games for instructional purposes as well as for the recruitment of potential industrial engineering students. Emphasis was placed on how industrial engineering concepts could be explored through the use of a simulation game that would provide a high interest classroom project based upon sound curriculum. The challenge for the project was to refine an academic competition involving a simulation-based video game relating to Industrial Engineering. The project was divided into 2 divisions, one for junior level students in grades 6 – 8 and one for senior level students in grades 9 – 12. Obviously, a major issue was designing the competitions with a proper level of difficulty for both age groups while keeping the subject matter relevant to meaningful engineering concepts and instructional frameworks.

The competitions were intended to help students acquire fundamental problem solving capabilities as well as a basic understanding of some tools used in Industrial Engineering and logistics. This project was completed under the leadership of two mentoring professors: Dr. Richard Cassady and Dr. Ed Pohl, who provided guidance and also secured funding necessary to support the implementation of the competition by providing the necessary supplies through the support of Dr. Russell Meller, director of the Center for Engineering Logistics and Distribution at the University of Arkansas.

Background Research

Dr. Richard Cassady and Dr. Ed Pohl, Industrial Engineering, our mentoring professors, provided information regarding past projects using simulation games. Independent reading of related articles was also helpful in understanding the scope of the project as well as how industrial engineering concepts relate to simulation-based video games. Since we have been able to work with this program now for several years, we also used knowledge gained from past experiences with competitions to continue to improve the program and expand it to cover a larger geographical area.

Our research was aimed at gaining a basic understanding of industrial engineering and logistics illustrated in a simulation video game. This background knowledge was acquired through the

Proceedings of the 2011 Midwest Section Conference of the American Society for Engineering Education
textbook, *Introduction to Industrial and Systems Engineering*, as well as other related research articles which are listed in the bibliography. Related articles on the use of simulation games for educational purposes were also an important source of information. Time was also devoted to researching specific simulation-based games. The selected games needed to have high interest levels and involve problem-solving that could be related to an introductory level engineering process. Games represent a performance-based environment. One cannot be passive when playing a game. According to Joel Foreman, Associate Professor at George Mason University, “Learning through performance requires active discovery, analysis, interpretation, problem-solving, memory and physical activity which results in the sort of extensive cognitive processing that deeply roots learning in a well-developed neural network.”

Through the use of simulation computer games, students can take a constructive approach towards several engineering concepts such as analyzing proposed products or services, improving existing products and services, determining the best facility layout, and performing operation scheduling.

Simulation games have become a significant part of the video game industry in recent times. Some thought has been turned towards harnessing the intrinsic appeal of these games for educational purposes. This RET project was intended to tap into that appeal to create an activity that would be meaningful, motivating, and engaging. Paul Starr, Professor of Sociology at Princeton University and co-editor of *The American Prospect*, says this of simulation-based video games: “New genres, such as simulation games, are emerging that challenge the user or player to build some complex creation—a city, species, business, or world—out of some given set of resources, or that put the student into a simulated environment or through a scenario to meet a challenge or learn a skill. The computer thereby turns the passive reader into a participant; it cues the student of a need to do something, but not necessarily what to do.”

A concern in the past was the availability of computers for students. Over the past few years, this has drastically changed. In a study conducted by the Kaiser Family Foundation in 2004, data was collected through a nationally representative survey of 2,032 third to twelfth grade students. This data reinforces the fact that young people in the U.S. inhabit an environment that is media saturated. Most homes contain most media, and the typical home contains multiple instances of most media. A substantial majority of kids have personal media, both in their bedrooms and in highly portable forms that travel with them. Eighty-three percent of the kids sampled reported that their family owned a video game console. Eighty-six percent of respondents sampled had a computer in their home.

**Project Description**

We implemented a simulation competition over the past two years. Since the competitions were developed for two age ranges of students, we chose two separate scenarios for the video game, Roller Coaster Tycoon II. This is a strategy-type interactive, computer-based video game that has been popular for several years and was considered to have a high interest level for the targeted age groups. This game requires the player to build, operate, and manage an amusement park. Each park is unique according to the player’s decisions including park layout, types of rides, number of rides, concessions, scenery, etc. The park guests play a vital role in the design
by providing a statistic called the park rating (PR). The PR is a number between 0 and 1000 that reflects the guests’ overall impressions of the park. A high PR is a result of good management decisions by responding to the needs of the park guests.

For our Junior Division, we opted for a beginner level scenario entitled Crazy Castle, with its established limiting factor of park size. Our Senior Division teams were given the additional challenge of using engineering concepts to construct their own Six Flags Theme Park. Industrial engineering topics were selected that had the potential to meet the requirements of the project including park layout, personnel management, and queuing theory. The waiting, or queue lines, in the theme park were a natural opportunity to investigate queuing theory, since most of the students have spent time waiting in line at theme parks.

Students in each division worked in teams of two to produce an entry paper. This paper was scored using a rubric to determine the top five teams in each division. This rubric included the following components: the problem being studied, performance rating and the factors that contributed to this rating, factors that had to be considered in order to increase park rating, analysis of the layout design, quality control, including steps taken to ensure a superior satisfaction rating, mathematical procedures used to determine optimum queue length, and guest population - both total number and satisfaction ratings. All of this information was readily available to all of our participants through our webpage that described the competition – (https://sites.google.com/site/techallengecompetition).

Initial entry papers were submitted from schools in Northeast, Northwest, and Central Arkansas. For the 2009-10 school year, we had nine senior level entries and six junior level entries. 2011 consisted of twenty-one senior level entries and five junior level entries. Entry papers were submitted electronically and the top five teams in each division were invited to the University of Arkansas for the second part of the competition. These teams put together a presentation of their project, explaining their rationale for the layout and design of the park, including the attractions, guest amenities, and queuing structure for the rides. They also explained their rationale for hiring and assigning personnel such as maintenance workers, mechanics, and entertainers. All of the components listed above in the entry paper guidelines were included as part of the presentation. These were delivered in front of a panel of judges composed of both undergraduate and graduate engineering students. Following these presentations, student teams ended the competition with a performance based component, where each team was provided with a computer station that had been preloaded with a scenario from Roller Coaster Tycoon II. The teams were given 45 minutes in which to improve the park and increase their park ratings. We did have a team of students who had participated in the first year of the program as a junior team return as a senior level team for the second year of the competition. The presentation that this team gave showed a marked increase in depth of understanding, and the students were able to respond confidently to questions posed by the judging panel.

The activities in this unit were designed to meet the specific needs of today’s learners. They were interactive and of high interest to the typical middle level and high school student. The park scenario enabled students to conduct problem-solving exercises in a real-world setting that they could relate to. “The main advantage [of simulation games] is that time between events can be
controlled and adapted, accelerating the learning process. Simulation Games are not limited to teaching cognitive learning goals. Moreover, skills like decision making, communication, and networking are implicitly promoted.”

Pablo Moreno-Ger, a member of a team of researchers from Madrid’s Complutense University who are analyzing the educational and technological aspects of integrating virtual graphic adventures into online education platforms, states “video games in virtual educational environments are a complement to traditional teaching for the student.” Making use of the interactive nature of these games helps to engage and capture the interest of today’s students. Students are highly motivated to be successful in the game they are playing, creating a natural desire to learn the skills necessary to achieve this success.

Observations/Conclusions

When we first began working on the IE Challenge competition, we limited our focus to assembly line production, thinking that active hands-on engagement would be appealing to students and teachers. Entry numbers for the two years we attempted this type of competition were relatively small, limited to only four school districts. We then redirected our efforts into putting together an interactive, game-based competition. We had some prior experience with the Roller Coaster Tycoon game from activities developed for our own classrooms, so decided to take this a step further and make it the foundation for a new competition which utilized industrial engineering concepts using the simulation game. The IE Challenge 2011 took place on April 23, 2011. Senior Division entries have increased significantly since our first competition in 2009. This past year, we had twenty-six entries from schools in Northwest Arkansas, Northeast Arkansas, and Central Arkansas. The number of Junior Division entries did not vary significantly in number, not showing quite the gains we have seen in the Senior Division. Our goal is to develop the IE Challenge into a regional competition. We began sending out information to school districts in Missouri and Oklahoma and will be taking this a step further this year, contacting RET teachers at CELDi institutions in those states in order to make additional contacts into the schools.

The 2011 winning team in the Senior Division consisted of the pair of students who had each entered our competition before. They achieved a high score on their entry paper, meeting the guidelines of the rubric provided. They also received a high score from the judging panel for their power point presentation, in which they explained the engineering concepts utilized in planning the layout of their park, queuing structures, and personnel management. Both boys have expressed their intent to major in engineering, demonstrating that the recruiting component is beginning to have some positive results. As of now, we have only had two teams of students who have graduated from high school, both from Sheridan, Arkansas. We did follow up on the senior level teams by contacting the school counselor at Sheridan. She was able to give us information regarding their fields of study at their respective institutions of higher learning. Of the four students who have graduated from high school, two students did choose to major in engineering. One is currently enrolled at the University of Arkansas, and the other is attending UALR.
Bibliography


Biographical Information

MELISSA MILLER
Melissa Miller is a sixth grade teacher at Lynch Middle School in Farmington, AR. She has taught for 26 years, primarily at the 5th and 6th grade level in math and science. She is a 2003 Milken National Educator, a 2001 Presidential Award winner, 2008-2010 NSTA District VII Director, and is currently serving on the writing team for the Next Generation Science Standards.

RANDALL REYNOLDS
Randall Reynolds is an eighth grade teacher at Gravette Junior High School in Gravette, AR. He has taught Pre-Algebra for all 11 years of his teaching career. His Arkansas teaching certifications include math, physical science, and physics. This is his seventh year as an Industrial Engineering RET teacher.