Roller Coaster Tycoon 3 as a Performance Based Learning Tool Under Common Core State Standards for Middle School and High School Research Experiences for Teachers (RET) 2011

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Abstract

The RET project for 2011 at the University of Arkansas was to continue research in the area of computer simulation video games to provide students and teachers a meaningful method of Performance Based Learning (PBL) addressing Common Core State Standards (CCSS) while maintaining the previous objective of introducing and recruiting students in grades 6 through 12 to the field of Industrial Engineering. This was accomplished through a competition called The IE Challenge (https://sites.google.com/site/iechallengecompetition/). The IE Challenge competition was originally designed as an RET project to provide an engaging format for middle school and high school students to learn fundamental aspects of Industrial Engineering and is now being improved and refined to help teachers and students stay relevant under CCSS.

The IE Challenge has been held for the last five years at the University of Arkansas and has been increasing in student participation each year. The students compete in teams of two in either the junior (grades 6-8) or senior division (grades 9-12). Each team is sponsored by a mentor teacher whose role is to guide the team through the project requirements and be a resource for the students in times of need.

This project was completed at the University of Arkansas under the guidance of Dr. Richard Cassady and Dr. Ed Pohl through the Center for Engineering Logistics and Distribution (CELDi) at the University of Arkansas and funded by the National Science Foundation (NSF).

Background Research

Our goal is to continually improve the IE Challenge competition so that it is relevant to Jr. and Sr. High students as well as friendly to classroom teachers by addressing educational standards on which students are assessed. This means our research is ongoing and frequently changes directions. There have been several shifts in the research since the project began, going from our initial project where students had to develop an assembly line and work in teams of four to successfully assemble a product to our current project which uses a computer simulation game to address industrial engineering concepts as students develop and successfully manage a theme park.

Our initial research was directed at personally learning about Industrial Engineering. We were provided the textbook *Introduction to Industrial and Systems Engineering*[1] for a basic working knowledge of industrial engineering concepts. From this resource we were able to identify key

topics of industrial engineering that we were later able to incorporate into the IE Challenge such as workspace design for an assembly line, efficiency, productivity, and quality control as they pertained to the assembly line the teams used to produce the product of their choice. As our project continued to evolve into the use of a computer simulation game, we focused on the industrial engineering concepts such as facility layout, queuing structure, personnel management, and profitability.

The second phase of our research was focused in the area of using a computer based simulation game to introduce students to industrial engineering. Our research indicated that simulation games were a good way to engage students in problem solving. Princeton Professor of Sociology Paul Starr writes, "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."[2] After researching several different simulation games we decided to use Roller Coaster Tycoon 2 for the competition. We felt that the amusement park setting and in particular theme parks which featured a variety of roller coasters were exciting topics which would actively engage students in the exploration of the industrial engineering concepts which were utilized as the park was being constructed, and as the park was modified based on customer satisfaction ratings.

The third phase of our research was to incorporate our current Arkansas Curriculum Frameworks and national technology standards into our competition in an attempt to encourage teachers to participate as team sponsors in the program while assuring them that the state requirements for curriculum were being met as students worked through the stages of the competition. This has been a major concern for teachers because of accountability for student achievement on our state benchmark assessments. We provided lesson plans for the initial phase of the competition that were aligned with Arkansas frameworks for middle school math, middle school common core literacy, and middle school science, as well as pertinent high school frameworks and technology frameworks. We have also been continually attempting to increase the number of participants in the competition and expand the region from which we draw participants by targeting teachers of engineering classes, EAST, technology, gifted and talented, and core subjects such as math and science.

Our current phase of research is to transform the competition into a Performance Based Learning (PBL) activity that addresses Common Core State Standards (CCSS)[3]. George Mason Associate Professor Joel Foreman says, "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."[4] We were aware of the benefits of hands on learning early on in our research and we are excited that the current shift in the direction of education in general is towards PBL activities. Because our student teams are required to submit a paper as their initial entry, then a power point presentation which explained the industrial engineering concepts being explored as well as justifying the decisions that were made as the team developed their parks, we believe that it will lend itself well to being used as a performance based learning activity that teachers would be able to incorporate into their existing curriculums.

Project Description

For the past 4 years, the focus of our RET project has been to improve the IE Challenge competition to maximize participation for the purpose of exposing as many students, teachers, and parents as possible to the field of industrial engineering, hopefully, recruiting potential industrial engineering majors. Industrial engineering has historically been difficult to describe to the general public in terms of a job description. Therefore, our goal was to create an exciting method of communicating about the field of industrial engineering by creating a competition using a high interest simulation based video game. We chose Roller Coaster Tycoon 2 as the particular game because of its appeal to the age level of students we were targeting and because the game is interactive and players have to make decisions not only to solve current problems-, but also to avoid potential problems as the park goes through its day to day operation.

Students were required to investigate industrial engineering strategies within the game to maximize the Park Rating (PR) for the theme park that they built. The PR is a score assigned by the game that reflects the quality of the theme park based upon how well the park is designed and operated. In order to achieve a high park rating, student teams had to construct an exciting park that also catered to the needs of park visitors. The highest PR possible is 1000 points, but a PR over 800 is excellent. Park ratings can fluctuate rapidly based on decisions regarding ride selection, personnel, and park amenities.

The competition was composed of 2 divisions: Junior Division consisted of students from grades 6 through 8, and Senior Division consisted of students from grades 9 through 12. Junior division teams were required to base their entry on one of the Roller Coaster Tycoon 2 beginner level parks - "Crazy Castle", "Electric Fields", or "Factory Capers", or they may have chosen to use "Vanilla Fields" or "Goldrush!" from Roller Coaster Tycoon 3. Senior division teams were required to base their entry on the "Other Parks" - Build Your Own Six Flags Park from Roller Coaster Tycoon 2 or they may have chosen to use "Box Office" or "Fright Night" from Roller Coaster Tycoon 3. This increased the complexity of the competition from the junior level to the senior level. Teams of two students worked together using the game and Industrial Engineering concepts to design a profitable theme park with a high park rating. Students were asked to show special consideration to the following IE concepts:

- Facilities Layout
- Project Management - planning stages
- Queuing System Structure
- Progress and Status Reporting
- Personnel Management
- Profitability of the park

Each team of students was required to write a report on their investigations of these concepts and submit the report as their entry to the competition directors for judging. The papers were scored by rubric and the top five teams from each division were invited to participate in the final stage of the competition at the University of Arkansas on Saturday April 21, 2012.

The final competition consisted of two parts - a PowerPoint presentation and live game play. Each team was given five minutes to present a PowerPoint presentation of their project at Bell Engineering Center at the University of Arkansas. Team members were asked to discuss the processes used in designing their park, including decisions they made in regards to types of attractions, layout of the park, food and drink stalls, guest facilities, staff members that were hired, etc., and how quality control was achieved. These presentations were judged by a group of graduate students who also questioned the teams and scored the presentations with a rubric provided by the competition directors. This score consisted of 75% of the teams final score. Following the presentations, all teams were provided with a park scenario in the computer lab during which each team had forty-five minutes to improve the park that has been assigned and maximize their PR. The PR was scaled to account for the remaining 25% of the team's final score.

In order to give our competition participants more information about the fields of engineering, tours of the University of Arkansas, College of Engineering were given to all of the student finalists, sponsors, and their families on the day of the final competition. This was arranged with the recruiting office, which also assisted us by providing pizza and T shirts for our participants. The day concluded with the awards ceremony where the 1st through 3rd place teams were awarded cash prizes and trophies.

Observations/Conclusions

The progression of our RET project focusing on The IE Challenge using the Roller Coaster Tycoon 2 simulation game has been a continued growth both numerically and in the depth of the content and standards of the competition over the past 5 years. This year we had 27 senior division teams and 12 junior division teams for a total of 39 teams which was a 50% increase from the previous year and an all time high level of participation. This was achieved by developing stronger methods for contacting potential educator sponsors. We have learned that it is imperative to get the information about the competition directly to the teachers. During our first year with Roller Coaster Tycoon 2, we contacted building administrators throughout Arkansas. This was ineffective and resulted in few entries. We will continue our efforts to get participants from an expanded region including Arkansas, Oklahoma, and Missouri. The next progression is as a PBL activity that teachers can incorporate into their CCSS lesson plans.

During the computer simulation portion of the competition, while the students were engaged in the computer lab, we had a brainstorming session with the sponsoring teachers for each team. We asked for feedback either positive or negative in regards to the competition. We also brainstormed ideas for getting information about the competition out to the schools. This feedback is being used to revise the competition and hopefully make it even stronger in the future.

This year we saw an increase in the preparedness of the competitors at the final competition in April and the scores were extremely close to determine the top three. In our top five finalist teams from both divisions, the quality of the entry papers submitted were significantly higher than those from past competitions. The power point presentations showed varying levels of understanding of the industrial engineering concepts that the students were exploring as they

developed their parks. Our judges did an excellent job of drawing out additional information from the teams through the questions that they asked following each team's presentation. This really helped teams that had the information in their slides, but did not fully develop their explanations during the presentation due to inexperience to this type of competition and nervousness.

We have begun tracking our participants to determine the success rate for recruitment into fields of engineering. So far from our senior division, although the number of students who have graduated from high school is relatively low, we have had 50% of the students declare engineering as their major. In polling student teams informally, the interest in engineering is high, with several students indicating that they are very interested in pursuing a career in this field. We will continue to track this data and update our records as additional students graduate from high school.

References

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Biographical Information

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Melissa Miller is a sixth grade teacher at Lynch Middle School in Farmington, AR. She has taught for 27 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 12 years of his teaching career. His Arkansas teaching certifications include math, physical science, and physics. This is his eighth year as an Industrial Engineering RET teacher.