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Entrepreneurial Mindset: Integrating Creative Thinking and Innovation into a Graphical Communications Course

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Abstract

Nationwide, leaders in business and industry have increasingly acknowledged the importance of entrepreneurship. Several areas of the country showcase the importance of entrepreneurship such as Silicon Valley in California where a large number of start-up companies in science, technology, engineering and math (STEM) fields are located. To meet the needs of business and industry, institutions of higher education prepare students for future employment by offering rigorous and relevant coursework in areas such as entrepreneurship. Collegiate faculty and staff can use fundamental engineering courses to instill an entrepreneurial mindset – a set of beliefs, attitudes, and behaviors that drive innovation – in their students. This paper will explore an open-ended team project within a freshman-level engineering graphics course in which instructors encourage an entrepreneurial mindset in students. The goal of the course project is to develop engineering students' critical thinking and innovation skills while preparing them for their future professions. An end-of-semester course-wide poster competition allowed students to practice teamwork as well as innovative thinking and communication skills.

Introduction

Future engineering professionals must be prepared to investigate the *Grand Challenges of the 21st Century*, which impact the social, environmental, and economic progress of the world (American Society of Engineering Education [ASEE] Board of Directors, 1999; Byers, Seelig, Sheppard & Weilerstein, 2013; National Academy of Engineering [NAE], 2004; United Nations, 2002a; 2002b). Therefore, engineering students must be taught how to use the knowledge they learn in the classroom to solve real-world problems (Oswald Beiler & Evans, 2014). They should also be taught how to apply nontraditional, creative thinking to address stakeholders' needs (Oswald Beiler & Evans, 2014). If engineering graduates leave their respective universities with an understanding of business principles and entrepreneurship then they will be well-equipped to become future technical innovators.

How can we train engineering students to be more entrepreneurially-minded? To answer the previous question, we used an open-ended team project within a freshman-level engineering graphics course to encourage an entrepreneurial mindset in students. The goal of the course project was to develop engineering students' critical thinking and innovation skills while preparing them for their future professions. An end-of-semester course-wide poster competition allowed students to practice teamwork as well as innovative thinking and communication skills.

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Students completed several deliverables for the project. Students submitted preliminary and final reports so instructors could evaluate students' project management ability, innovative ideas, problem-solving approaches, and written communication skills. Students conducted peer evaluations so instructors could determine students' collaboration, leadership, and teamwork skills. Students also gave an oral presentation in teams and received feedback from their instructors. Lastly, after the student poster competition, students completed a preliminary questionnaire to provide insights into their perceptions of the competition and overall project.

Course Curriculum

The freshman-level engineering graphics course was designed to familiarize students with the basic principles of drafting and engineering drawing, to improve three-dimensional (3-D) visualization skills, and to teach the fundamentals of computer-aided design (CAD). Classes met in a computer laboratory twice a week for one hour and forty-five minutes to fulfill the requirements of the three credit-hour semester-long course. To investigate the Grand Challenges of the 21st Century as well as the demand for creative and innovative thinking, students completed an open-ended design project. Students worked in self-selected teams of two to four students. Per the requirements of the project, students designed an existing product and then considered how to improve it. Students received approval from their instructors regarding their design idea along with their innovative and creative methods for solving the problem. Students incorporated sustainability concepts into their design, which involves engineering design feasibility, environmental impact, social and political consideration, and economic and financial feasibility. To address the importance of sustainable design, students were shown example CAD parts or they watched a series of screencasts by Autodesk (2012) that contained real-world examples.

Throughout the semester, instructors served as facilitators to ensure that student projects were completed on time. However, direct guidance was limited to a minimum. Specific class time was dedicated to the project so students could collaborate with their teammates and work on the project. Students were encouraged to think outside of the box and systematically design their project. Before the last day of class, students submitted all project deliverables such as dimensioned drawing sheets, 3-D part models, and PowerPoint slides. On the last day of the class, students wore business casual or professional attire to present their work as a team. Each presentation lasted 8-10 minutes, and was followed by 2 minutes of question and answer time.

Students completed confidential peer evaluation forms in order to evaluate their own performance and that of their teammates. Criteria was considered such as contribution and quantity of work, interaction and collaboration of the team, problem-solving skills and quality of work, time management, and willingness to be a team player. During the oral presentations, students completed a team evaluation for other groups in the class. Crite-

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ria were evaluated such as organization, slide content and aesthetics, presentation skills, and team member participation. Students were strongly encouraged to leave comments, as well as recommendations, to support their evaluation. At the end of the presentation, the instructor summarized the student projects and the top two teams were selected to attend the end of semester student poster competition for all sections of the course. Selected student teams made posters and presented their work to students and faculty on campus. During the poster competition, faculty, staff, graduate students, and past student winners served as judges. Different awards such as best poster design, most sustainable design, most sophisticated design, best presentation, people's choice award, and the best of best awards were given to the student teams.

Poster Competition Feedback

Likert scale and open-ended responses from the Spring 2017 semester provide preliminary insight into students' perceptions of the graphics course-wide poster competition. Of the approximately 70 undergraduate engineering students who participated in the Spring 2017 poster competition, 29 students completed a preliminary seven question survey about their overall experience and satisfaction with the event. The 70 student participants presented 11 posters from 11 course sections. Specific demographic information was not obtained for participants in the poster competition but generally students who take the course are first-year engineering students from aerospace, mechanical, and civil engineering departments. As of Fall 2016, undergraduate students from the campus are 54% White, 20% female, 13% international students, 9% multi-racial, 6% Black, 5% Asian, 4% Hispanic, and 33% in-state students with an average age of 21.

Overall, students were satisfied with the organization and execution of the poster competition, as indicated by the following responses to Likert-scale questions. Using a 5-point scale from *poor* to *excellent*, nearly 83% of student respondents rated the poster competition as *very good* or *excellent*. See Figure 1 below for more details.

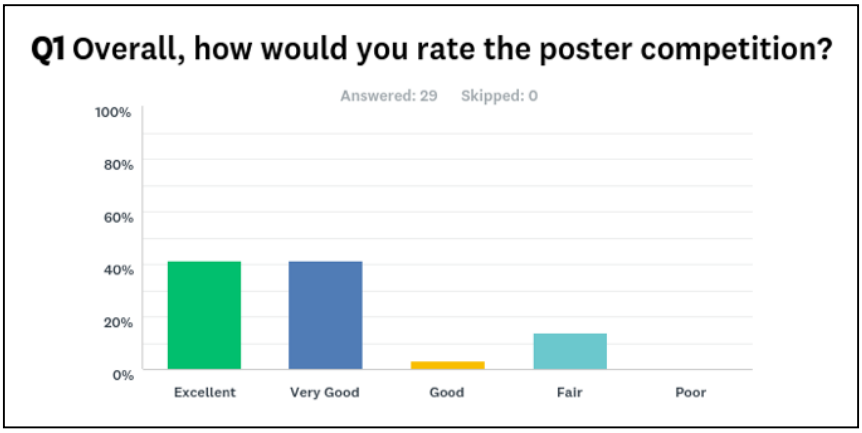

Figure 1. Student responses to survey question about the overall event

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In terms of organization, using a 5-point scale from *not at all organized* to *extremely organized*, over 86% of student participants believe the event was either *very organized* or *extremely organized*. See Figure 2 below for more details.

Figure 2. Student responses to survey question about organization of the event

When asked about the length of the two-hour long poster competition, using a 7-point scale from *much too short* to *much too long*, more than 65% of student participants indicated the length of the event was *about right*. See Figure 3 below for more details.

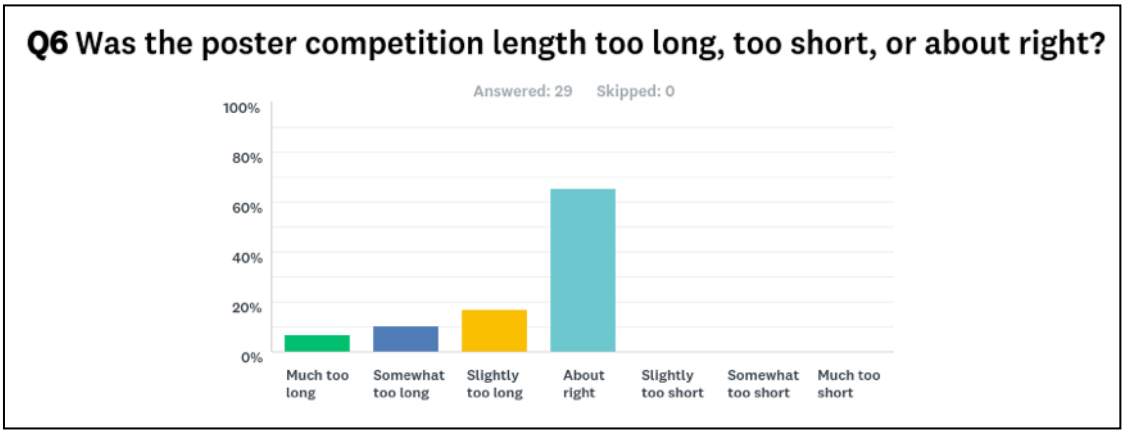

Figure 3. Student responses to survey question about length of the event

Using a 5-point scale from *none of the information* to *all of the information*, over 55% of participants believe they received *most of the information* or *all of the information* they needed before the poster competition. Although, a majority of students felt prepared, the event organizers can certainly focus on ensuring that more students receive the material they need prior to the competition. See Figure 4 below for more details.

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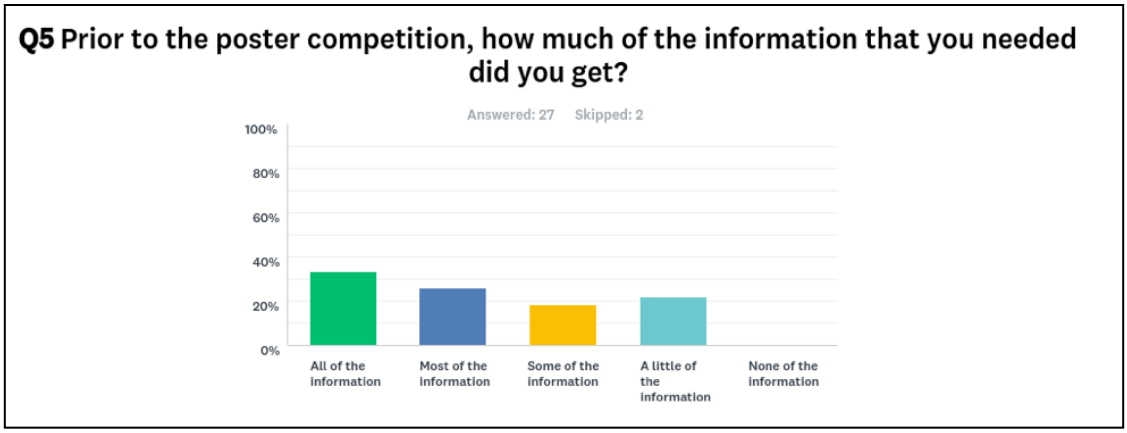

Figure 4. Student responses to survey question about obtaining information needed for the event

While the above Likert-scale survey items mainly focused on structural aspects of the poster competition, open-ended survey items allowed students to reflect on their individual experiences. Students benefited in several ways from their completion of the course project and participation in the poster competition, as evidenced by the following preliminary survey excerpts. In alignment with an entrepreneurial mindset students talked about the creativity and innovation they witnessed by saying they liked viewing “new ideas” and “seeing lots of ideas in one place.” Students also mentioned liking “the diverse selection of posters,” “the application of engineering principles” and “different [design] modifications in each project.” Students mentioned other benefits of the design project and poster competition. Student participants talked about their enjoyment when describing the event as “fun!” and a “fun way to evaluate a project and get good experience.” When describing social interactions with peers and faculty, students said they liked “meeting the other groups and seeing their ideas,” receiving “constructive comments of the judges,” and attending an event that was “open to the public.”

Despite the aforementioned positive reflections, there were aspects of the poster competition that student participants disliked. When reflecting on their experiences, several students complained about “standing” the entire time and not getting “chairs.” Numerous students said we “should have more posters” and they didn’t care for “the fan vote” used to choose an award for the most popular poster. As seen in the Likert-scale survey responses, some students also stated in the open-ended survey items they disliked “the length of the competition” and wanted “more information ahead of time.”

Conclusions

By describing a unique team-based project and student poster competition, this paper highlights an approach for allowing students to focus on innovative thinking while also practicing their teamwork and communication skills (Long and Jordan, 2016). The

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open-ended team project offered students an opportunity to learn the type of design engineering that emphasizes environmental, economic, and social responsibility. It also gave students an opportunity to inquire into, collaborate on, design, assemble, and present their work. A preliminary questionnaire was used to assess students' perceptions of the graphics course-wide poster competition and overall project. Preliminary results indicate that the poster competition and overall project provided students with a positive and satisfactory experience, which enabled them to develop and practice critical thinking and innovation skills. Overall, students were able to think "outside of the box" and solve real-world problems, which help to prepare them to ultimately solve challenges within their future companies, country, or even the world (Reid and Ferguson, 2011).

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