

**AC 2007-542: USING ENTREPRENEURSHIP AND SERVICE-LEARNING TO
INCREASE ENGINEERING AWARENESS IN HIGH SCHOOL**

Lisa Zidek, Milwaukee School of Engineering

Cynthia Orndoff, University of Missouri

Susan Blanchard, Florida Gulf Coast University

Using Entrepreneurship and Service Learning to Increase Engineering Awareness in High School

Academic preparedness is a fundamental concern for every educational system; elementary schools must prepare students for middle school, middle school for high school, high school for college, and college for graduate education or a career in a chosen field. There is an increasing concern in the United States that high school students are lacking in math and science skills leaving them ill-prepared for college programs in the sciences, technology, engineering and mathematics (STEM).¹ According to a recent report from the US Department of Education, the United States ranks 27th in the world in mathematics problem solving,² reiterating the point that US high school students are not well prepared for college after completing high school math classes. At one Southwest Florida university, more than 60% of the first year students were not academically prepared for college calculus, prolonging their entry into the engineering program and increasing the time the students will spend in college. These deficiencies create many challenges for both the students and the university including decreased satisfaction among the students and lower retention rates. Other ramifications include increased costs to students coupled with loss of potential income and decreased interest in engineering, as well as other STEM programs, because students do not believe they have the potential to succeed in such programs. One solution is to increase awareness of STEM programs in high school and address the needs of students interested in pursuing these fields, in particular those interested in engineering.

Florida high schools are implementing a new A++ program requiring all high school students to select a major in the arts, advanced studies, or career preparation. One possible major in high school will be engineering. Although this is a very exciting and ambitious approach to high school education, the current model for math and science instruction is not adequate to sustain a technical major. Offering a technical major in high school but continuing to approach mathematics education in the traditional sense will not benefit the high school students or the colleges attempting to recruit these students. A recent interview with a high school math teacher indicated the need for mathematical course material that is entertaining, provides immediate gratification, and provides relevance to everyday applications.³ Developing material relevant to a particular field is extremely challenging for the high school teachers, not only due to time considerations, but also because of the knowledge base required. Programs such as Project Lead The Way⁴ and other similar programs are a step in the direction of educating the educators; however, these programs require a significant time commitment and may not be feasible for many high school math teachers.

A High School and College Collaborate

In developing the curriculum for three new engineering programs, a Southwest Florida university incorporated a series of two classes, Engineering Entrepreneurship and Service Learning in Engineering. Engineering Entrepreneurship is the prerequisite course for Service Learning in Engineering, and the courses are scheduled to run consecutively. The courses were designed so that students in Engineering Entrepreneurship develop an idea and research the potential market and then students in Service Learning develop the ideas into deliverables for the intended audiences. In addition, the initial offering would focus on immediate needs of the Southwest Florida community. The project was further narrowed upon evaluation of the first two pre-

engineering classes and the lack of math preparation of the incoming pre-engineering students. Although somewhat focused, the project still allows for entrepreneurial growth and development providing the students the opportunity to use their skills as engineers to develop products or services for the next phase of potential engineering students.

The A++ program instituted in Florida was a perfect opportunity for the engineering program in Southwest Florida to collaborate with a new high school in the area structured around the concept of high school academies, including engineering. The faculty members teaching the Engineering Entrepreneurship class scheduled a meeting with one of the high school Vice Principals and the Math Coordinator at the high school to discuss the possible collaboration between the high school and the university on a course specific basis. This meeting proved to be very successful and resulted in a project for the Engineering Entrepreneurship and Service Learning in Engineering classes.

Course Content

The Engineering Entrepreneurship course was being taught for the first time as this paper was being written. The course was co-taught with one engineering faculty member and one faculty from the college of business. The content of the course ranged from discussions regarding why entrepreneurship is important to engineers to basic business concepts. One defining aspect of the class was the philosophy of the engineering program to teach all classes in an integrated lecture/lab format, incorporating in class activities and interactive discussions as the primary learning tool.

The course began with an interactive discussion of entrepreneurship and why engineering should care about entrepreneurship. Students were asked to define entrepreneurship, developing a class definition, which was then supplemented with information from the text as well as other resources. Using this definition the students were then asked to explain why an engineering program would include entrepreneurship among the core curriculum courses. By the end of the first class the students were asked to distinguish the major differences between managers and entrepreneurs. During this class the students were also introduced to the concept of the course project and provided a “team application” to complete as homework.

The course continues with a case study on the movie “October Sky” which is followed up with a class discussion on the case and the entrepreneurial spirit displayed in the movie. The course instructors then supplied a second case and the students were required to analyze the case in their newly formed teams. Teams were assigned by the instructors using the “team application” to create teams that were interdisciplinary (based on the three engineering majors in the class), diverse and mixture of traditional and non-traditional students.

Creativity and ideation were the next topics covered. Following brief discussions regarding methods of increasing creativity, the students participated in in-class exercises demonstrating the creative process. In-class activities included writing a story about an abstract picture, as a team, devising answers to hypothetical questions and using dissimilar fields to solve a common problem.

Identifying needs, opportunity identification and interviewing potential customers were then discussed. This subject was key to the following class where the students were required to meet at the participating high school to conduct interviews and identify needs of both the high school students and the high school math teachers. The ideal situation for the interviews were that each group would interview two to three students from a particular math class, and then interview the teacher from that class. This activity proved to be a challenging exercise where the students learned that creativity and flexibility are paramount to the entrepreneur. In the end, the teams were able to interview two to three high school students, although they were not from the same class. Each team also interviewed a high school math teacher. The class consensus was to keep the math teacher as the contact and work with the class the teacher identified as having the most significant need. The engineering students were strongly encouraged to return to the high school and conduct extended interviews or observe the identified class. Additional class time would be devoted to the project alter in the semester.

The second phase of the class dealt primarily with the quantitative aspects including marketing strategies, quantitative and qualitative decision models and financial aspects including basic engineering economics, developing financial statements and valuation. In-class activities were designed to supplement the project work. Examples of class activities included developing a scoring model to evaluate alternative solutions related to the entrepreneurial project, analyzing the market potential of the chosen product or service identified by the team and preliminary financial analysis.

The third phase of the course incorporated guest speakers regarding funding opportunities such as debt financing, equity financing including angel investors, and intellectual property. This phase also included discussions on ethics, building teams and teamwork, change management, elevator pitches and presentation techniques. The elevator pitch class period consisted of each team developing an elevator pitch, selecting one team member to present the pitch, and receiving peer reviews of the elevator pitch. The teams also worked through an ethics case and were lead through change management exercises.

The class concluded with the presentation and poster session describing a conceptual overview of the product or service the team developed. The projects will be prototyped and tested in the service learning course which will be offered in the following semester.

Service Learning in Engineering is not yet fully developed, but will focus on the concepts of service in the community, why service is important and relevant to engineering, and how engineers can benefit from service. The Service Learning in Engineering course will be co-taught by two engineering faculty, and the overall objective of the course will be to advise the students as they progress through their project.

Course Project

The link between Engineering Entrepreneurship, Service Learning in Engineering, and the high school was the class project. The Engineering Entrepreneurship class worked with the high school math teachers and the high school math students to identify a need in the high school math program. The Engineering Entrepreneurship class was divided into ten teams of 4 to 5 students. The teams were assigned after students completed a "Team Application" to identify

strengths and weaknesses of the each student, as well as other time commitments, identification of commuter students, full-time students, and various other criteria. The faculty also attempted to make the teams interdisciplinary (within the engineering programs) as well as diverse.

The high school has nine mathematics faculty members and several hundred students in various levels of high school math. Each engineering team was assigned to one high school faculty member, with the exception of the most senior teacher who had two engineering teams. During the Engineering Entrepreneurship course, the students were required to interview their math faculty member as well as students in the respective math classes. The interviews were one source of information for the engineering students in identifying a need for high school mathematics. The engineering students also researched the market, developed an elevator pitch, performed a preliminary financial analysis, and developed a business plan for the product or service they had develop for the high school math programs. The project will be continued during the Service Learning in Engineering course where the students will be required to develop a prototype, test and analyze the potential of the product or service identified during Engineering Entrepreneurship. The goal of the Service Learning in Engineering course is to have a deliverable for each high school math teacher that can be incorporated into the classroom and has the potential to be sold to other high schools not only in Florida but also throughout the United States.

The products or services developed by the engineering students provided a wide variety of approaches to solve the significant need of the high school math program while incorporating engineering into the solutions. Examples of the proposed products and services included: developing a partnership between the Florida Engineering Society students and the high school math program to provide students to teach supplemental math classes using engineering problems to stimulate interest in math as well as in engineering; developing an advertising campaign featuring engineers and other individuals in technical fields as guest speakers and on posters to emphasize how “cool” math is and to combat the peer pressure reported by the students who actually like math; a board game using engineering examples to reinforce the concepts presented in a specific math class; and a program modeled after the “Accelerated Reader” program that uses engineering and other technical examples to create a competitive nature to develop math skills. These examples, as well as the other products and services develop during the Engineering Entrepreneurship emphasize the engineering students’ grasp of the importance of math in an engineering education as well as the everyday applications of both engineering and math.

Current Status

The Engineering Entrepreneurship course was in its initial offering during the writing of this paper. The project was defined, and the local high school was more than enthusiastic about interviewed high school students and faculty members to identify a critical need in the math program and developed engineering related products and services to meet these needs. The final business plans were turned in at the end of the semester, and the Service Learning in Engineering projects will commence in fall.

Although the final results of the Engineering Entrepreneurship and Service Learning in Engineering projects will not be available for several months, the university faculty are

cautiously optimistic that these projects will be very successful. There are several factors that are indicative of success including the enthusiasm of the high school faculty, the enthusiasm of the high school students, and the enthusiasm of the engineering students involved in the project, in particular with respect to their commitment to improving mathematics education at the high school level using their engineering skills to guide them to appropriate applications, and finally due to the commitment of the faculty involved in both cases. The project provides an entrepreneurial learning experience for the engineering students as well as the opportunity to impact the local community through service learning. The interaction between the university and the high school may be the first steps in helping improve the math skills of high school students in Florida and across the country.

Bibliography

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