

Session

“Developing Collaborative Relationships for Education Relating to Invention, Innovation, and Entrepreneurship”

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Abstract

The Electrical Engineering Department (EE) at the University of Nevada, Reno (UNR) has since 1986 been teaching a special senior level Capstone class. This multidisciplinary class involves students from electrical and mechanical engineering, and students from the College of Business. The course teaches the fundamental principles of invention, innovation, and entrepreneurship. A version of the class has also been taught to groups of K-12 teachers who in most cases have carried the information they learned back into their respective classrooms. Even though the course has already been reported several times in the open literature, there still seems to be a growing interest in hearing about the success and failures that are characteristic of such a dynamic and changing topic.

This course necessitated the establishment of several collaborative relationships between the University Colleges of Engineering, Business, and Education, and with the Washoe County Public School System. Forming such collaborative relationships sounds like a great and simple idea, but in practice they can be very difficult to achieve. This paper describes in some detail the problems, roadblocks, and stumbling blocks encountered during the creation, operation, and assessment of the course. Issues such as scheduling conflicts, credit load differences, widely different backgrounds for the students, communications, and the general group dynamics must be addressed.

Discussion

There is a growing need to teach the fundamentals of invention, innovation, and entrepreneurship, as well as to develop new ways to produce more well trained and technically literate individuals in our society. Beyond educating students about invention, innovation, and entrepreneurship, educators must increase the innovative and entrepreneurial content in education by starting earlier in the education process. Whether or not entrepreneurship has a place in K-12 education, or even at the college level, is currently a topic of debate. Despite this

uncertainty, many universities are considering developing courses aimed at teaching entrepreneurship to engineering students.

One of the major roadblocks to teaching these subjects at the university level is the lack of “buy in” by other faculty members. The topics are considered “non-traditional” and do not appear to support an engineering research program. Young faculty members may therefore consider the field too “risky” to become involved.

A study conducted by the Southern Technology Council found that few universities are rewarding faculty involved in innovation and entrepreneurship [1]. Additionally, the most common reward is simply an acknowledgment. The report recommends that universities adopt inventing and technology transfer as part of the tenure and promotion process. All faculty members learn that a balance must be maintained between teaching, research, and service. However, entrepreneurial activities often cross these traditional boundaries and are, thus, difficult to categorize and quantify.

A special capstone course for senior electrical and mechanical engineering students has been developed at the University of Nevada, Reno. The class also includes students from the College of Business Administration. All phases of new product development including innovation, patent law, product liability, business, sales, marketing and venture capital are covered. Student "companies" are formed and are comprised of a blend of EE, ME, and business students. Each company must complete all phases of the product cycle including the actual design and fabrication of a working prototype. The class is funded by the Lemelson Foundation and has been featured at the Museum of American History at the Smithsonian and on the Discovery Channel. Some very important and fundamental knowledge has been gained as a result of teaching this class and has been reported [2] – [4].

While the course material focuses on innovation and entrepreneurship, the goal of this course is not necessarily to produce entrepreneurs, but rather to produce engineers better prepared to enter the workforce. To achieve this goal, students form companies that are charged with the responsibility of generating product ideas, evaluating and selecting one of the ideas, developing a working prototype, and performing market and financial analyses to determine if the product could sustain an actual business.

By providing engineering students with exposure to the business world prior to graduation, they are better prepared for both engineering and management positions. They gain a better understanding of the process required to develop marketable products; become engineers capable of working on multidisciplinary teams; they understand product development, marketing, and finance as well as the technology; and they gain the ability to communicate effectively to their peers, suppliers, and customers.

This course necessitated the establishment of a collaborative relationship between the University of Nevada, Reno Colleges of Engineering and Business. A clearly defined arrangement was designed and implemented wherein the engineering and business professors “swap” lectures, assign joint homework assignments, and share in grading and course assessment. It is important to make it clear to the students enrolled that this multidisciplinary aspect of their class does not

mean “extra work,” but rather it is a “normal” load requirement for the class. This is especially true if part-time graduate MBA students are involved, since their schedules usually do not easily interface with the engineering undergraduate students.

It is also important that the students enroll using a class number in their respective discipline and not a general course number. This eliminates problems related to the accounting of which department or discipline will get the credit for teaching the class. This also eliminates the need to have each program create an acceptance of “outside the major” credits for their own degree program. This may sound like “plumbing” problems, but are important points to developing a truly working collaborative relationship in a university environment.

For K-12 education there appears to be three major obstacles to generating an interest in invention, innovation, and entrepreneurship education, [4]:

- The education of K-12 teachers does not include courses that cover these topics, or even courses that would promote an understanding of these topics.
- State science standards do not recognize invention, innovation, and entrepreneurship topics as something that should be taught by K-12 science and mathematics teachers.
- There are few textbooks written that include information on the principles of invention, innovation, and entrepreneurship. In fact even at the college level, it is difficult to find a textbook that integrates these subjects into a traditional curriculum context.

Some comments from the high school teachers do an excellent job of describing the current situation:

- "Teaching innovation in the schools calls for an innovative teacher. Unfortunately, teachers are groomed, and not by their collegiate education, to teach to the standards and do it through the text. Students are not benefiting from this in my opinion."
- "I think that the concepts of invention and innovation are potential pathways to unlocking a student's creative thinking skills."
- "The question is not, 'How can we use all of the information presented over the last three days within my classroom,' but, 'How can I not?'"

The "bottom line" is the fact that K-12 educators need to integrate the fundamentals of invention, innovation, and entrepreneurship into all levels of the curriculum. The "how to do it" then becomes a question that needs the most attention at this time.

An accelerated version of the senior Capstone class described earlier was designed and taught to a group of high school math and science teachers. The class was compressed into an intensive three-day period. The books and tuition for the teachers were paid for using a grant from the Lemelson Education Assistance Program (LEAP) and the Washoe County School District. The

classes began early in the morning and continued until 6:00 p.m. All meals were catered into the classroom in order to save time.

World-class speakers were brought into the class to supplement the materials provided. A special "on-line" two hour session on patent search was also provided by the University library.

This course was specially structured to have three specific goals and outcomes:

- Provide Washoe County math and science teachers with a basic knowledge of the elements of invention, innovation, and entrepreneurship;
- Develop a framework for how these topics can be taught at the high school level;
- Develop an awareness at the high school level of the role that engineers play in the development of new products, and the creation of a higher quality of life for area residents.

The Lemelson Center, located in the Electrical Engineering Department on the campus of the University of Nevada, Reno, was uniquely qualified to host this course.

The class was very well received by the teachers, and many plan to incorporate what they learned into their high school classes. A representative from the State Board of Education attended and offered comments on how the material could easily be incorporated into the high school curriculum. It is expected that this class will result in an ongoing program of cooperation between the College of Engineering at the University of Nevada, Reno and Nevada's high school math and science programs.

Conclusions

It is concluded that in order to create, establish, and sustain collaborative relationships to teach invention, innovation, and entrepreneurship in university and K-12 environments, it is necessary to involve a broad spectrum of resources. It is critical that a program or course have the following elements:

- a well thought out organizational structure with one faculty member in charge;
- a detailed course syllabus with a time and date set for each class to help facilitate the faculty and students' busy and conflicting schedules;
- a crisp and well thought out system for providing course grades so that there is no doubt or confusion about what is expected from the students to achieve a desired grade;
- the ability to schedule classes so that full time business students, as well as part time business students can attend classes and work along with the full time engineering and/or education majors;

- a capability for testing students prior to the start of the class or at the very beginning of the class so that appropriate student “companies” can be formed;
- a method for obtaining assessment data and channels to create changes in the course as appropriate;
- have a mechanism in place to handle the faculty time and student load credits in a transparent manner;
- request grant support or other additional resources to provide support for the class that is above and beyond the existing funding level for each of the Colleges/Departments and/or public school districts that are involved; and
- the ability to schedule classes so that K-12 teachers can attend.

References

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Biographical Information

John Kleppe, Ph.D., P.E. is Chair of the Electrical Engineering Department at the University of Nevada, Reno. He is also the director of the Lemelson Center for Invention, Innovation, and Entrepreneurship. He has been active in developing and teaching senior Capstone classes and first year experience classes for electrical engineering students.