

AC 2009-1399: A NOVEL CREATIVITY AND INNOVATION COURSE FOR ENGINEERING STUDENTS

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Revised Paper

A Novel Creativity and Innovation Course for Engineering Students

Abstract

A new engineering entrepreneurship minor program was launched in the College of Engineering in Fall 2008. The first course in this program focuses on Creativity and Innovation. This course has been designed to introduce sophomore engineering students to a variety of creativity and innovation concepts heretofore unfamiliar to them. Differences between creativity and innovation are made clear and then in-class exercises to allow the students to practice different problem solving techniques are used. Guest speakers from various arts fields tell about how they use different creativity techniques to develop their various art forms. Finally, over the 12 weeks of the course, the class is divided into teams with the goal of developing a novel game or toy for kindergartners. The-goals of this course are to provide students with tools to provide the students with a clear understanding of the difference between creativity and innovation, to enhance their creative approach to problem solving, to improve their powers of observation and nonlinear thinking, and how to better determine and understand customers' needs. Assessment of course work related to these goals and an evaluation of how well the goals were met are presented in addition to the details of the course content.

Introduction

Innovation and entrepreneurship have been the cornerstones of economic development in the United States. Particularly the development of new automotive, communications, computer, medical, and information technologies has spawned huge new industries.

These industries, especially the communications and software industries, have become worldwide enterprises. With off shoring of basic design, manufacturing, and software development to lower cost labor regions, particularly India and China, there is a real concern that the US-educated engineering student of the 21st century must be educated in a different way to the traditional engineering curriculum. The United States still leads the world in terms of having a complete vertically integrated infrastructure supporting business development. The elements of this infrastructure include a supportive culture for entrepreneurship, small business financing vehicles, intellectual property protection and a supportive business tax and legislative structure. Yet with all this support, not many universities provide entrepreneurship education to undergraduates within their curricula. Some universities that do include Lehigh University, the University of Maryland, and Pennsylvania State University. In September 2007, our university received a grant from the Kern Family Foundation to develop a new curriculum for a minor in Engineering Entrepreneurship open to students in all of the engineering disciplines. The general framework of this program has been presented elsewhere [1]. The first course in the sequence was taught to a first cohort of students during the Fall 2008 term. The course is titled *Creativity and Innovation* and was offered to first semester sophomore engineering students from all disciplines. The details of this course are presented below.

Course Objectives and Pedagogical Approach

The four primary goals of the *Creativity and Innovation* course are to:

1. Teach students the difference between “creativity” and “innovation”

2. Provide students with tools and techniques to help discover and improve their creativity

3. Expose students to a variety of non-linear problem solving techniques

4. Teach students how to uncover and understand customer needs

A fifth goal was to do all this in a way that was fun for the students!

The pedagogical approach to the course was to provide students with a lot of opportunities for hands-on learning through in-class exercises. The class met once a week for two hours on Friday between 2:30-4:30 p.m. The first 10-15 minutes of the class would be spent introducing a particular tool for creative problem solving, e.g. lateral thinking. The students would spend the next 20-30 minutes working on in-class exercises using that particular tool. More details on the guest speakers are presented below.

One class was used for a field trip. The classes spanned the first eight weeks of the semester. For the remainder of the semester the students worked on a term project.

Details of the term project are presented below. The textbook used for the course was “The Art of Innovation” by Tom Kelley and students were assigned readings from this book as homework exercises.

Creativity Tools

The creativity tools taught in the course are well-established techniques such as “Brainstorming” and “Provocation”. DeBono’s “Six Thinking Hats” and “Lateral Thinking” were also described and used. After a brief description of the particular technique, the students would be given a particular scenario and asked to apply the technique to the specific situation. As an example, students were asked to use

provocation to come up with creative ways to quickly provide additional teachers in a rural community with limited trained teachers. This particular case was taken from one of De Bono's books and the particular provocation technique used was choosing a random word from the dictionary to trigger a different path to explore. In De Bono's "Lateral Thinking" book [2] he suggests the word "tadpole" as a random word to provoke a new direction for the problem of increasing number of "teachers" in a community with few trained teachers. He considers the tail of the tadpole as a means of bringing along assistants to shadow a teacher, thereby learning the techniques used by the teacher.

Guest Speakers and Field Trip

Five guest speakers who had different specialty artistic skills presented at the classes. Three of these speakers were professors at the university - a music professor, an art professor, and an acting professor. The music professor showed the students how to think about music and the structure of music composition. He showed how complex musical structures were simply composed of very simple steps with one built upon another to create the work. By the end of the class he had the students composing a simple song, even if they had no musical training. The art professor took the class on a tour of the university's art gallery and an art studio. He showed what to look for in a painting, explained some of the "business" issues related to art, and emphasized to the students that they all have innate artistic talent that they could develop through practice and guidance. The acting professor had volunteer students perform improvisation scenarios. For example, he would ask a male and a female student to act out a scene in which the female student comes home from work to a stay-at-home husband who has just painted the

kitchen. She does not like the color and asks him to change it and he has to defend the color and not change it. The message that the acting professor was conveying was how it is important to really feel the role that the actor is trying to perform in. Also, while role-playing the students were forced out of their comfort zones. This is an important message for entrepreneurship students because so often entrepreneurs are forced into situations with which they are unfamiliar but must deal with to survive. The final two guest speakers were a pair of young entrepreneurs who started their own advertising company. They talked not only about their creative activities but also related some of the difficulties and excitement of running their own company [3]. Their talk excited and inspired the students and taught them much about the process of innovation.

One of the key concepts we wanted to drive home to the students was that the entrepreneurial spirit does not reside exclusively in small start up firms, but that same excitement, attitude and vision can be found in businesses of all sizes and maturity levels. In fact, the entrepreneurial force is a key component in the continued success of some of the largest businesses in the world. To illustrate the point, a field trip to the Advanced Technology Laboratory (ATL) of Lockheed Martin Corporation was arranged to provide the students the opportunity to see intrapreneurship in action. A Lockheed manager explained that encouraging intrapreneurship is a key goal in ATL's strategy. Even the largest, most successful company needs new ideas to keep fresh and grow, and most of all it needs the intrapreneurial employees who are anxious to take on the difficult and often risky task of reinventing a well established corporation. The manager explained to the students how Lockheeds' history rife with innovators who, with the same skills and

dreams of a start-up entrepreneur, who were responsible for a wide variety of successful products and business units within Lockheed. The manager stressed however that success was not guaranteed even within the confines of a large thriving corporation. Many great technical and business ideas never found their way to the market. The primary reason for the failures was not lack of funds, skills or other resources, but rather because there was no true market opportunity for them. He gave examples of how daring and bold intrapreneurs were the driving force within the company to champion many successful products, and demonstrated some of the works in progress that excited both the business and technical aspects of the students' imaginations.

Term Project

The students were given a term project that consisted of two parts. The first was to invent a new game or toy for kindergartners. For the second part, the students had to produce a 30 second commercial to promote their team's game or toy. The commercial was required to have a script, a video, and a jingle. The purpose of the commercial was to provide the students with an opportunity to produce a piece of artwork with a lot of freedom to exhibit their creative talents. The earlier lessons of the artist, the actor, and the designers all came into play.

Students visited a kindergarten to interact with the children to watch how they play, how they think, and their physical capabilities, e.g. gross and fine motor skills. The purpose of these observations was to develop a sense of the "customer needs" as the students designed their toys/games.

The students worked on their projects in teams of five students. The teams were arranged

to have at least one musician, a diversity of engineering majors, and a mix of male and female students.

Assessment

There were three contributions to the students' final grades. The first was active class participation. In the various in-class exercises and classroom activities, students were to actively participate. Almost all the students were engaged in the classes and participated in classroom discussions. The second component of the students' grades was their performance on the term project. All of the projects were outstanding and exceeded the expectations of the judges. Each team produced a prototype of its particular game/toy and demonstrated their concepts very visually. The ideas were generally creative and a kindergarten teacher who observed the presentations was impressed with how well the students had really considered the social and physical development stages of the kindergarten children. The teams displayed a lot of creativity in the production of each of their commercials. It was clear that all the student teams had done a lot of work. The final component of the grade was peer assessment on the project teams. The students were required to distribute (confidentially) a fictitious bonus to each of their team members based on their contribution to the team project, reflecting peer evaluation of how each member had performed on the team. In most cases the bonuses were divided evenly between the team members, although in a few cases, particular students were recognized for extraordinary contributions to the projects.

Outcomes Assessment

The students were issued pre- and post-course surveys with various questions related to the development of an entrepreneurial mindset. These same questions will be used throughout the engineering entrepreneurship minor program to assess how well their understanding of the various facets of entrepreneurship is developing. The question on this survey most relevant to the present course was: *“How confident are you in your ability to create new products and services?”* The question had four possible answers: Not confident, somewhat confident, confident, and very confident. Ten students responded to both the pre-course and post-course surveys. These survey results are shown in Table 1 where the students are identified by a letter.

Table 1. Pre- and Post-Course Survey Responses to the Question: *“How confident are you in your ability to create new products and services?”*

Student Label	Pre-course Survey Response	Post-course Survey Response
A	Confident	Confident
B	Confident	Very Confident
C	Confident	Confident
D	Very Confident	Very Confident
E	Not Confident	Confident
F	Very Confident	Very Confident
G	Somewhat Confident	Confident
H	Somewhat Confident	Confident
I	Not Confident	Somewhat Confident
J	Somewhat Confident	Somewhat Confident

At the beginning of the course two students indicated that they had no confidence in their ability to create products and services whereas by the end of the course, no students responded “Not confident” to this question. Furthermore, two students indicated that they had improved their confidence level from “Somewhat confident” to “Confident”. Finally, one student indicated that their confidence level improved from “Confident” to “Very Confident”. The rest of the students did not indicate any improvement in their level of confidence to create new products and services. Clearly, several students’ level of confidence in their abilities to create new products and services had significantly improved as a result of taking the class.

Conclusions

We have described a new *Creativity and Innovation* course taught to engineering entrepreneurship minor students in the College of Engineering. The emphasis of the course was to provide young engineering students with a sound understanding about the important differences between the concepts of Innovation and Creativity and introduce students to the use of various tools to enhance their creativity capabilities. Another goal was to increase the students’ powers of observation for the purpose of seeing market opportunities and understanding customer needs. Even though the class was offered from 2:30-4:30 p.m. on Friday, attendance was never an issue. The pedagogical approach used in the class involved as much hands-on, interactive learning as possible. The students were very engaged with both the in-class activities and with guest speakers. They were divided into teams of students to work on a project and put a lot of time into their projects, far more than was expected for a one-credit course. Student feedback indicated

they enjoyed the class and applied many of the skills that they had learned in the course to their term project. Pre- and post-course assessments indicated that the students' confidence in their ability to create new products and services had significantly improved in the case of several students as a result of taking the class. Most of the students who took this class are now continuing in the engineering entrepreneurship minor program.

Acknowledgements

The authors gratefully acknowledge the support of the Kern Family Foundation. The authors are also grateful to Mr. Gerry Mayer for hosting the tour to Lockheed Martin Corporation's Advanced Technology Laboratory.

References

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