AC 2010-2183: INCREASING STUDENT INNOVATION BY IMMERSING STUDENTS IN AN INTENSIVE DESIGNING THINKING WORKSHOP

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Increasing Student Innovation by Immersing Students in an Intensive Design Thinking Workshop

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Abstract: Innovation is the currency of modern industry. Students need to possess an understanding of, and abilities directly related to innovation, where they possess the aptitude and capacity to generate, develop, and implement new and meaningful ideas. The purpose of this paper is to present how we are making this happen at our university. The paper outlines our curriculum decisions and development, associated instructional activities, and assessment and evaluation methods. The curriculum we have developed, has been culled from several resources: our personal research in creativity, collaboration with the Stanford d.School and IDEO, and several other educational and industry institutions. Our findings thus far according to the Torrance Creativity Test, and our own innovation student assessment survey suggests students who participate in collaborative cross-discipline innovation focused training, will increase in innovative understanding, aptitude and skill set. We believe the findings from our study thus far have broad implications for industry, higher education, and the K-12 environment.

Introduction

One of the goals of our college of technology and engineering is: increase student innovation. Despite the belief and desire to accomplish this goal, our college (like many other higher education, K-12, and industry institutions) has struggled at developing a method for making this happen. Consequently the college assembled a team of professors, and gave them the task to identify methods and ideas of how innovation might be more effectively taught and encouraged within the college. The intensive design thinking workshop, later titled, "The Innovation Boot Camp" was a product of their research and collaboration.

The *Innovation Boot Camp* is an intensive hands-on, collaborative experiential learning workshop. Its focus is to educate students on the principles of innovation by providing them several real-world problems they are to solve. The structure of the initial Innovation Boot Camp was a two-day experience, blending students and faculty from seven different programs/departments (Technology Engineering Education, Manufacturing Engineering, Industrial Design, Construction Management, Facility Management, Information Technology, and Animation) in the school of technology. The primary instructional techniques and curriculum was based on "design thinking." We define design thinking as being a method of innovation that is *User Centered*, has a tradition of *Prototyping*, and a *Trust in the Process* of: 1) Seeking inspiration for problem finding through the activities of Look, Do, and Ask; 2) Broad divergent ideation; 3) Implementation in the form of prototyping; and 4) Public Presentation using the activities of Show, Tell, and Act.

The purpose of this paper is to further describe the purpose, curriculum development, organization and logistics, activities developed and engaged in, and methods of instruction of the Innovation Boot Camp. Additionally, the paper will: a) outline the learning outcomes of the Innovation Boot Camp; b) describe the relative impact the Innovation Boot Camp is having on student understanding and skill development related to innovation; and c) discuss how the experience is impacting our college initiative to create a culture of innovation.

The Study

Sixteen Innovation Boot Camps will have been held by the start of the ASEE2010 Conference. Currently we have held ten Innovation Boot Camps and have gathered mostly qualitative data. We have, however, recently added a pre and post survey, and have administered the Torrance "Creativity Test" as a pre and post assessment of each student's creativity.

The purpose of this study is to understand the impact the Innovation Boot Camp is having on student innovation ability and aptitude. Holistically we feel the adoption and commitment to explicitly teach and provide students with innovation training is necessary. Notwithstanding, the plausibility of a college-wide buy in and adoption is difficult, due to a deeply traditional academic approach to teaching engineering and technology. The effort required to change this culture requires a significant amount of time and additional funding. Consequently this research study not only significant adds to the theoretical underpinnings of innovation and creativity pedagogy, but it provides insight into the needs and benefits of such an endeavor to an individual technology and engineering school or program.

In light of our interest to understand the influence the Innovation Boot Camp experience is having on our students and college, we have been gathering data throughout the entire Innovation Boot Camp experience (e.g., during curriculum development, during instructional time, and at the end of the Innovation Boot Camp.) The summative evaluation efforts have included an online survey, a focus group interview session, and follow-up one-on-one interviews. Additionally, by the start of the ASEE2010 conference we will have administered the Torrance "Creativity Test" to over 300 students, 200 of whom will have participated in the Innovation Boot Camp. The creativity tests will be given to the students prior to their participation in the Innovation Boot Camp, and then immediately following the experience. We will compare the pre and post experiences of those students who participate in the Innovation Boot Camp against themselves and with students who took the creativity test, but did not participate in the Innovation Boot Camp.

Statement of Problem

Dating from the foundation of the United States, one of its defining characteristics has been its ability to encourage and accept innovation. However, with the economic need and acceptance of outsourcing, and competition in global product development, among other things, many American engineering and technology companies and institutions are re-thinking and re-structuring the content and instruction of engineering and technology curriculum (McAloone, 2007). In an effort to address this issue, our college has established several school wide technology and engineering initiatives, which focus on issues of leadership, global awareness, and innovation. A committee was established within the college to investigate ideas of how to

promote innovation. The committee, or Innovation Design Team as they were called, travelled to several internationally recognized institutions known for their exemplary models of innovation (i.e., Stanford d-school, IDEO (international industrial design organization)), and performed a thorough literature review on innovation. One of the resulting ideas the Innovation Design Team developed, and hoped would make a positive impact on student innovation ability and aptitude, was to institute an Innovation Boot Camp. In short, the Innovation Boot Camp was an intensive workshop focused on teaching innovation in a collaborative hands-on environment.

Background

Kleppe (2001) noted dating from the late 1700's to modern day, "a major source of technological advancement has been the result of individual inventors [and] innovations" (p. 16); surprisingly, most technology and engineering programs around the U.S. do not explicitly teach innovation (Smoot, 2006). With the increasingly complex and competitive global market, and with new interest and concern over environmental issues, biotechnologies, and so forth, many companies (American and foreign) are reforming how and in what they do business. Additionally many academic institutions are calling for a "radical restructuring of the theoretical knowledge taught in academic education programs… in order to create competencies of professional value in today's business situations (McAloone, 2007, p. 770). In order to address the many challenges involved in the new global industrial arena, technology educators believe the theoretical restructuring that needs to occur must involve and center on innovation. Kleppe (2001) argues if we want to better prepare technology and engineering students to be globally competitive, we must expand and center our current curriculum on innovation. Despite the need to include innovation as a key component of technology and engineering curriculum, and although some universities have made restructuring efforts to include aspects of innovation, a study done by the Southern Technology Council found that there are very few universities supportive of innovation. The lack of support and inclusion of innovation in technology and engineering related programs stems from archaic mathematic and science curriculum standards, and immature technology and engineering curriculum standards. Although engineering programs have existed for over sixty years at the university level, most of the courses and degrees have focused on traditional engineering concepts (i.e., hard math and sciences) and have not bridged into the areas of creativity and innovation. It has only been in the last five years that universities have started to recognize creativity as a key component of engineering (Courter, 2006). In light of the need to ensure our students are ready for the challenges in our global economy, we as technology and engineering educators, need to ensure we are continuing to evolve our practices and curriculum – which at present time, demands the need to include innovation as a key component of technology and engineering curriculum.

Methodology and Findings

There are 3 phases to this research project: (a) developing and implementing the Innovation Boot Camp, (b) evaluating the Innovation Boot Camp experience, and (c) assessing and restructuring the Innovation Boot Camp. We discuss each in turn.

Innovation Boot Camp Development

The Innovation Design Team used the data they collected from their observations and visits of the various well-known innovation institutions, and the literature they read (i.e., *Handbook of Creativity, Six Thinking Hats, Lateral Thinking, Creative Toolbox*, various journal

articles, and so forth) to formulate several ideas of how to create a culture of innovation in our college of engineering and technology. Various ideas were hypothesized, however, ultimately it was decided an intensive experiential workshop highlighting the key principles of innovation would be first tried; this workshop was titled the *Innovation Boot Camp*. We are currently on our tenth iteration of the Innovation Boot Camp experience, and will have held over sixteen by the time of the ASEE conference.

The Innovation Boot Camp structure is currently organized in the following way: It is a two-day experience, where students from the various programs within the college collaborate to learn the principles of innovation and associated techniques to implement these principles. Typically there were two to three students and one faculty member from each of the six programs, averaging 18 - 24 participants in all. The students were split into 4 - 6 multidisciplinary groups of 4 – 6 students each, while the faculty members were put in their own group. We wanted to give the students a chance to work independent of the faculty, and not be influenced by any figures of authority. We also wanted to have a sense of competition between groups. During day one we first had the students take the Torrance Creativity Test. Then we introduced the students to the need and idea of innovation, and led the students to establish a working definition of it. Then we provided the students with the five key principles of innovation (Inspiration, Synthesis, Ideation, Experiment, Communication) and had them do an experiential activity highlighting each principle, which served as a tactical opportunity to semantically encode the principle. Each activity built upon the previous principle, which helped the students transfer and scaffold their learning from principle to principle. By the end of the day the students had developed an innovative product or system in result of working collaborative through each innovation principle and associated techniques (e.g., when talking about the principles of questioning, we had them use the tools of associated thinking, and random association). To conclude the first day each group of students presented the problem they identified and the innovative product or service they developed in result of going through each of the principles of innovation. At the conclusion of their presentations they were introduced to the capstone activity that would require them to go through the steps of innovation (principles) one additional time. The students were expected to work together over the course of 3 days to first identify a problem statement, then go through the innovation principles and activities in an effort to develop a new innovation product, process, or service. The purpose of the capstone experience was to evaluate if the students understood the principles well enough that they could go through each principle as steps towards identifying a problem and then developing an innovative solution. Consequently day-two of the Innovation Boot Camp consisted of each group showing how they came up with the problem and solution of their capstone project using the five key principles of innovation. A panel of judges from local design and engineering companies were brought in to evaluate the student's projects. Additionally, the students self and peer evaluated each other's projects, in an effort to help them further inculcate the principles and techniques of innovation. Awards were provided to the top three teams. Before the Innovation Boot Camp was completed, there was a final summary discussion session where students were asked to share their reflections of the Innovation Boot Camp, and to identify if, how, and what they learned and developed. At then end of the evening students were given a second Torrance Creativity Test – which we would later grade and compare with their results from when they first took the Creativity Test. Exit surveys were emailed to each student at the conclusion of the Innovation Boot Camp. Additionally, several students were randomly selected to participate in a focus-group exit interview.

Innovation Boot Camp Evaluation

As stated above formative and summative methods were used to evaluate the impact the Innovation Boot Camp experience had on the students and faculty. A video documentary was filmed of the event, and later used to critique and analyze the attentiveness and participation of each student. The instructors of the Innovation Boot Camp were also invited to watch the video to evaluate their instructional methods and the associated activities and content. Two outside observers from the college were also in attendance and were asked to take notes on what was done, how they perceived the instruction was being received, how the activities were helping the students understand the principles and concept of innovation, and how the students enjoyed or did not enjoy the experience and so forth. The students were also asked to provide summative feedback at the end of the Innovation Boot Camp experience in both a survey and exit interview. As stated above, the most recent Innovation Boot Camp participants have taken the Torrance Creativity Test before taking the Innovation Boot Camp, and then immediately following their Innovation Boot Camp experience. As this measure was only recently added, this preliminary paper submission will not include these findings (as we have yet to grade the tests; however, by ASEE 2010 we will have graded and analyzed the tests, and hope to provide telling data by that time.)

In light of the limited scope of this paper (conference proceedings) only a few of the key themes from the evaluations will be shared in this document. Overall survey results and interviews (n = 74) stated that 100% of the students reported they believed the Innovation Boot Camp should be continued. 71% of the students (n = 74) said they believed their time spent at the Innovation Boot Camp was *Effective.* A likert scale ranging from *Ineffective*, to *Not Very Effective*, to *Moderately Effective*, to Effective, and then to *Very Effective* was used for this question. When the students were asked to rate on a 1 – 5 scale (5 being high) how the Innovation Boot Camp influenced their understanding of innovation, the mean was 4.0. When the students were similarly asked to rate how they believe their propensity (interest and aptitude) for innovation was influence, 43% of the students said it made a significant amount. Then when the students were asked to rate how they believed their skills related to innovation were influence by the Innovation Boot Camp experience 86% reported they believe their skills were *significantly* influenced by the experience. Also, 85% of the students said they thought their time at the Innovation Boot Camp was spent either *effective* or *very effectively*. Although these findings simply result from self-reported questionnaires, we feel the findings provide a foundational understanding of the needs and beliefs of students regarding innovation. We also feel this foundational knowledge helps us proceed with a more thorough investigation of how the Innovation Boot Camp can influence student innovation. We anticipate our new data collection techniques (i.e., the Torrance Creativity Test) will inform these efforts.

Finally, the findings from the outside observers should be briefly reported. The outside observers found similar findings as stated above (e.g., the Innovation Boot Camp seems to making a positive impact on how students understand innovation) and although they proposed various suggestions (e.g., include more structured lecture), the majority of their findings centered on curriculum design issues and content. Their feedback however, was essential to further development of the Innovation Boot Camp.

Innovation Boot Camp Restructure

We recognize we are still in the preliminary stages of our development of the Innovation Boot Camp, however, we believe the findings from the surveys, interviews, and qualitative observations have provided helpful insight to how we might re-structure and continue to develop the Innovation Boot Camp experience. The primary areas of restructuring we have thus far experienced center on curriculum issues. We have found there are two primary sets of innovation principles common in innovation related literature. Although the principles innately suggest similar concepts, we feel it is important to solidify the language (i.e., vocabulary) being used. For example, in the first few Innovation Boot Camps we used the idea of "Design Thinking" and its associated principles of *"Think, Look, and DO"* (Welsh, 1993; Osborn, 1965; Sternberg, 1999; Kelly, 2005), while in the later Innovation Boot Camps we used the principles of: observing, questioning, idea networking, associated thinking, and experimenting (Dyer et al., 2001). We believe there is a need to continue to evaluate the Innovation Boot Camp experience, and anticipate continued restructuring of it. However, we also feel the results thus far have provided great insight to how the seeds of a culture of innovation might be initially planted.

Conclusion

Although our data-set is somewhat limited as yet (due to the Innovation Boot Camp's newness), we believe we are commencing on an important journey towards better preparing our students for the globally competitive technology and engineering market, where innovation is an essential and defining skill. We anticipate the Innovation Boot Camp experience will continue to evolve, and we predict the experience will help us develop a culture of innovation at our university.

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