Work-in-Progress – Impact of highlighting ethical considerations in the engineering design process through a service-learning based freshman-to-sophomore bridge

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***Abstract* - Bridge Opportunities Offered for the Sophomore Transition (BOOST) is being developed for freshman Engineering students at California State University, Los Angeles (CSULA) as they transition into their core engineering courses, often first encountered during their sophomore year. The objective of BOOST is to provide a service learning based freshman-to-sophomore bridge which exposes these students to engineering tools and gives them an opportunity to use these tools in a peer-mentored engineering design project which serves their local community. The students are required to take an Engineering Ethics and Professionalism course during the Spring term of their freshman year, before the summer bridge component of BOOST. During this course, students are taught to consider how ethical principles and professional guidelines can and should influence their project designs. Subjective results indicate that teaching ethics in the context of their service learning projects is shaping their view of the engineering profession to take on a more holistic perspective.**

Index Terms – service learning, engineering ethics, sophomore slump, freshman-to-sophomore transition.

RATIONALE FOR BOOST

Service learning has been promoted as a vehicle to achieve teaching soft skills such as leadership and communication, as well as social responsibility [1], to give students practical experience in their field[2], and to help students connect more with faculty[3]. Despite all these positive benefits of service learning, it still is not a part of many engineering programs; rather the literature on service learning lies predominantly in the social science fields [4]. Furthermore, service learning has not been targeted at engineering students transitioning between their freshman and sophomore years, which has been shown in the literature to be a critical formative period for college students.

Bridge Opportunities Offered for the Sophomore Transition (BOOST) is being developed for freshman Engineering students at California State University, Los Angeles (CSULA) as they transition into their core engineering courses, often first encountered during their sophomore year. The objective of BOOST is to provide a service learning based freshman-to-sophomore bridge which exposes these students to engineering tools and gives them an opportunity to use these tools in a peer-mentored engineering design project which serves their local community. The service learning component of this first-year design experience is expected to help students view their ultimate goal as college engineering students not to merely graduate with a degree and paper diploma but to become an engineer truly prepared to contribute to bettering society.

BOOST PROGRAM STRUCTURE

The BOOST program consists of a 5-week summer bridge, at the heart of which are peer-mentored service learning engineering projects, and an associated Engineering Ethics and Professionalism course in the Spring term preceding BOOST summer bridge. The main objectives of the BOOST program are:

1) to provide contextualized / authenticated learning in the engineering field through service learning
2) to introduce students to engineering tools that they will use throughout their engineering program and in their future careers
3) to reinforce physics and math concepts learned during their freshman year
4) to develop engaged learners by helping them to see the motivating need for ethical, professional, and competent engineering; and
5) to encourage this holistic, engaged perspective on the engineering profession in the peer mentors.

The core of the BOOST program is the service learning project component. Table 1 outlines the structure and timeline of the program. Partnerships were forged with three community organizations with the assistance of the Office of Service Learning at CSULA. The 17 freshmen BOOST students were assigned to one of the project groups in teams of 5-6; each team also was assigned a peer mentor and a faculty mentor. Site 1 is an advocacy organization for vulnerable, at-risk youth, which includes a special education school as well as a community of residential cottages for children in the foster system who have been in and out of multiple homes. Site 2 is an organization that provides a number of critical services to adults with mild to severe developmental disabilities, including basic grooming, socialization, and basic vocational training. Site 3 is an elementary school in the Los Angeles

Unified School District, which serves traditionally low-income families with fewer than 46% of the adults holding high school diplomas.

The teams will work together to design, implement, and deliver a project which requires engineering and serves their local community by meeting one of the community partner organization's needs. The structure of the BOOST program is outlined in Table 1.

Activity	Desired deliverables	Time
Recruitment	20 students for pilot year (2016)	* Winter qtr ('16) * end of Fall, ('17 and beyond)
	30 students in ensuing years	
General orientation	Lay out program guidelines and timeline	* Spring qtr, 1st week – ('16) * Winter intercession – ('17 and beyond)
	Give background information on community partners	
	Initial community building	
Mentor training	Peer mentors learn how to facilitate project design work without doing the work for them	* end of Spring term * end of year
	Clarify roles and time commitment	
Ethics & Prof. Course	Define project objectives	Spring term
	Brainstorm ideas	
	Consider ethical issues	
	Create first draft of design	
Summer bridge	1st parts order; shoring up design	Summer Wk1
	Prototyping, mock-ups. Building / implementing.	Summer Wk2
	Modular testing; debugging / modify design	Summer Wk3
	Debugging / modify design; integrated testing.	Summer Wk4
	Finalize products / systems and present. Reflections	Summer Wk5

Table 1) BOOST structure and timeline

BOOST Engineering Ethics Course Description

To promote a holistic Engineering identity by which students better understand the role they would play and the positive impact they can have on society through their career in the Engineering profession, BOOST participants were required to enroll in a special section of the Engineering Ethics and Professionalism course. The conventional objectives of ethical and professional standards in engineering profession are reviewed and discussed throughout the course. In addition, students were taken on field trips to each of the three community partner sites to get to know the staff and clients, and learn more about the services provided there. After each field trip, the students were asked to write reflections on their visit; e.g., what were the most striking memories; what design considerations did the visit inspire them to make; what outstanding questions did they have regarding the project.

They also began defining the project objectives for each BOOST project and brainstorming design specifications and design approaches. During that initial design process, students were asked to identify choices and decision-making processes they were having to undertake to create an ethical design. They also are identifying and practicing professionalism in interacting with the community partners, within their teams, and in communicating their thoughts and ideas for the projects.

A pre-BOOST questionnaire was administered to measure three validated scales: 1) engineering creativity and innovation; 2) engineering global preparedness; and 3) college independence and social capital. All assessment was conducted in accordance with a protocol approved by the California State University, Los Angeles Institutional Review Board (protocol #14-147).

Impact As Rising Sophomore Engineers

Responses of BOOST students from assignments in their Ethics and Professionalism course indicate that they are seeing themselves as professional engineers in the making with a holistic perspective on the ethical responsibilities required in addition to the technical skills and knowledge. Exposure to the community sites on the field trips elicited many thoughtful reflections on service the community partners provide, the quality of the staff, and their interaction with the clients. The students were asked three reflection short answer questions. Below is a sampling of selected responses which indicate that students are engaging with the community service organizations, and that community engagement is indeed motivating students to consider what role they can play as engineers in serving their local community.

- Q1) What was one of the most striking memories you have of the visit to [the community partner site]?
  - *My first striking moments was when I learned that these kids [at site 1] have gone through tough circumstances and this school is doing all it can to help them out.*
  - *One of the most striking memories that I had after visiting [community partner site 2] is how friendly and approachable the students are. Most, if not all students, shook my hand and told me their names with my surprise. I didn't expect that they are going to be as friendly as they are.*

- Q2) What are some design considerations you thought of during your field trip to [the community partner site]?

- *I have little design ideas, like making a small box to represent fractions but volume and area I am unable to imagine anything.*

- Q3) What questions did you come away with after the field trip today?
  - *What else can I do to help not only [this community partner site] but other people that need help? What can I do to further my engineering expertise?*
  - *What engineering skills will I have to learn and or improve during this project?*

The senior design (capstone) project at the end of their bachelor's degree program is typically the first formal client-driven design experience for students majoring in Engineering at Cal State LA; certainly the first and only one built into their curriculum. These reflection responses after the field trips illustrate that the BOOST students are more aware of community needs, and are considering how they can use and develop their engineering skills in order to meet those needs. The selected responses are exemplary for highlighting the potential BOOST has to impact the development of our students' engineering identity. As highlighted, these students have had little to no exposure to what engineering and producing a deliverable project to a real-world client entails. However, while they may not have initially been well attuned to the real-world needs of both engineering skills and ethical attitudes, the direct interaction with the community partners are breaking down stereotypes and motivating our students to strive toward excellence in engineering.

One of the later assignments, 6 weeks into the quarter term, required the students to respond to the following prompt.

> *Please describe some examples of ethical choices you may be faced with for each of the BOOST projects. Describe at least two for each project.*

The students demonstrated an understanding of their ethical responsibilities in designing these projects, as exhibited by the sample responses given below:

- *Using cheaper material that can easily malfunction but can save money*
- *Suggest the designed game not include violence even though kids may love it*
- *To conserve energy, the garden cover could be made removable using a pulley system, but there might be a problem with maintain the system lubricated*
- *When the final product is successfully built physically and internally according to the planned objective but it does not show visible danger before used, my group have to still test the product's usability*

Even if the design issues they bring up at this stage are not very likely, they are demonstrating the desire and ability to consider the ethical impact of their design choices.

To assess the baseline engineering ethics of students in the BOOST program, we utilized an engineering ethics subscale of Ragusa's Engineering Global Preparedness (EGPI) questionnaire. The mean score on this subscale 4.88 (SD=1.42) on a 6-point Likert-type scale. This score matches the range score of students at early undergraduate levels nationally, indicating that the BOOST students are in line with students with matched academic experiences nationally, with room for growth. This is a baseline score from which we intend to measure growth resulting from the full BOOST experience. The BOOST students overall engineering global preparedness baseline was a mean of 3.94 (SD = 2.03), which as slightly below the national average on the instrument (M=4.17) and the students scored highest on engineering community connectedness (M=4.97, SD=1.24). The baseline score of the BOOST students' Engineering Creativity and Propensity Innovation was 3.27 (SD=1.98), and their college social capital score was 2.97 (SD 1.04), which are both areas the BOOST program components are designed to target. The college social capital score of the students was particularly low at baseline, however importantly all but three of the BOOST students are first generation college students and many of their parents had not complete high school.

BEGINNINGS OF A HOLISTIC ENGINEERING IDENTITY

We have described a service-learning based summer bridge program which helps to fill an important need in that critic al transition from freshman to sophomore year. While we cannot make any conclusive remarks on the impact of BOOST, the students' responses to various assignments in the associated Engineering and Professionalism course and on the baseline questionnaire revealed the potential for growth through engineering design experience and the beginnings of a deeper, more holistic Engineering identity which includes a motivation to develop their engineering skills to serve their community.

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