# AC 2008-268: SERVICE LEARNING IN ENGINEERING EDUCATION: IMPACT ON FACULTY AND STUDENT ATTITUDES.

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# Changes in Engineering Student Attitudes with Respect to Service Learning: A Response to a Curricular Intervention?

Abstract: In the fall of 2004, a study was completed the Colorado School of Mines that compared engineering faculty and student attitudes with respect to community service. The primary purpose of the investigation was to acquire baseline data prior to the implementation of the new undergraduate Humanitarian Engineering Program. The purpose of this program is to prepare engineering students for careers that will interface with and directly benefit the underserved global community. Given this, it was anticipated that one outcome of the revised curriculum would be improved attitudes on the part of participants with respect to community service. The current paper compares student attitude data collected in a sophomore required course in 2004, before students had participated in the revised Humanitarian Engineering curriculum, to that of data collected from seniors in 2007, after students completed, or at least became aware of the revised curriculum. The results of this investigation indicate a difference in the students' attitudes between the two administration periods but a direct link could not be established between the differences in attitudes and the new program.

## I. Introduction

As a field, engineering has always served the needs and desires of people. According to the Merriam-Webster on-line English dictionary, one definition for engineering is "the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people" (http://www.m-w.com/dictionary/engineering). Yet, leaders in the engineering profession and engineering education have come to acknowledge that many Americans believe engineering is irrelevant to humanity's present and future needs[5]. Researchers have further found that engineering students and professionals are often perceived by the public to be concerned with their own personal interests and material goals rather than with the needs of society [1-4]. In other words, the public's perception of engineering and the goals of engineering as a field are inconsistent. The failure of society to recognize the important contributions of engineers and the field of engineering to society has been cited as a potential factor that has contributed to the steady decline in engineering enrollment over the last decade, as well as the persistent under-representation of women and minorities in the field[6].

In order to address these concerns, the Engineering Division and the Liberal Arts and International Studies Division at the Colorado School of Mines (CSM), with funding from the Flora and William Hewlett Foundation, have undertaken a curriculum development initiative that emphasizes the human component of engineering. This program embraces the concept that engineers and the field of engineering serve a critical role in society. This interdisciplinary collaboration at CSM has created a sequence of courses designed to help engineering students understand the ethical, cultural, historical and technical dimensions of engineering work applied to community development in the U.S. and abroad[7]. One of the primary goals of this effort is to create a culture of acceptance and value of community and international service activities among CSM's faculty and students.

This four-year project began at the start of the academic year 2003-2004, during which new courses, projects, and assessment activities were pilot tested. In the fall of 2004, baseline data was collected concerning both student and faculty attitudes at CSM with respect to service learning activities using the "Community Service Attitude Scale" (CSAS). This instrument was developed and validated by Shiarella, McCarthy and Tucker[8], but had not been used prior to the current efforts to measure attitudes within engineering education.

Based on the 2004 data, Bauer et al.[6] completed and published a comparative analysis of student and faculty attitudes with respect to community service. This analysis indicated that faculty had more positive attitudes with respect to community service than did students and that only minor differences existed based on participants' age and gender.

The current research builds from this prior effort. In Bauer et al., data were collected in the Multidisciplinary Engineering Laboratory, EGGN250, a sophomore level course in the fall of 2004. This course was selected because it was required of all students and it preceded the course requirements within the Humanitarian Engineering minor. In other words, the existence of the minor and the courses associated with that minor would not yet have impacted the students' attitudes. Using the same instrument, data was collected in the spring of 2007 in a senior level course, a time period when most of the original student respondents would be completing their senior year. The current investigation compares student attitudes as reflected in 2004 to those of seniors in 2007. The research questions that guide this investigation are:

1. Is there a difference in students' attitudes with respect to service learning activities as measured by CSAS from 2004 to 2007?
2. Can identified differences in student attitudes with respect to service learning be linked to the activities of the Humanitarian Engineering program?

## II. Methods

This section describes the Humanitarian Engineering program at CSM, the courses in which data were collected, the participating student population, and the analysis techniques.

### II.1. Humanitarian Engineering Program

The Humanitarian Engineering program at CSM has developed a community service component as part of the undergraduate engineering curriculum. This aspect of the curriculum provides an environment where students learn to utilize both their technical and non-technical knowledge and skills to solve real-world problems faced by economically disadvantaged populations throughout the world.

The Humanitarian Engineering curriculum combines both technical and non-technical coursework in a manner that supports students in understanding the history of humanitarianism and the importance of learning to effectively engage people from different backgrounds in pro-active community service. Students also learn how to use technical tools and engineering knowledge to implement and teach others to implement humanitarian based projects.

Eleven courses have been developed or modified at CSM to include a humanitarian emphasis and two minors in humanitarian studies are available, Humanitarian Studies and Technology (for non-engineering majors) and Humanitarian Engineering. One of the modified courses is a required course at the freshman level, Nature and Human Values, and the remaining ten courses are technical and non-technical electives at the junior and senior level.

Students enrolled in the Humanitarian Engineering minor are also required to complete a capstone senior design course that involves a hands-on community service engineering project at a local, national or international level. Projects include those that address the water, food, shelter and educational needs of people in disadvantaged communities. For more information concerning the courses and the minors, see Moskal et al.[7].

II.2. Data Collection

Data for this investigation were collected in two courses. Both courses are required of all engineering students at CSM regardless of specialty. Based on the curriculum, Multidisciplinary Engineering Laboratory I (MEL I), or similar measurements course, is supposed to be completed by students by the spring of their sophomore year. At this point in the students' undergraduate studies, they have not yet had the opportunity to complete a course that is offered through the Humanitarian Engineering Program. They have, however, heard lectures that address humanitarian engineering in a required freshman class called Nature and Human Values.

In the fall of 2004 and during the second and third week of classes, the 101 students enrolled in various sections of MEL I were asked to sign a project participation consent form. Students who agreed to participate in the investigation then completed the CSAS. To ensure consistency in the administration process, the five instructors leading the seven sections of MEL were given written administration instructions.

Seventy-eight of the 101 students (77.2%) agreed to participate in this study and completed the CSAS. Of these students, 14% were sophomores, 72% were juniors and 10% were seniors. The large representation of juniors and seniors in the course was unexpected, given that MEL I is a sophomore level required course. However, this course is not an explicit pre-requisite for Senior Design and many students may select to complete it late in their required sequence.

Follow-up data was collected in Senior Design II in the spring of 2007. Senior Design is composed of a required, two semester course sequence in which students collaborate in teams to complete faculty approved engineering projects that have been solicited from local business and industries. Depending on the scope of the project, the student design teams generally complete the design in the first semester and begin project implementation in the second semester. One of the pre-requisites for this course is that the student be of senior standing. In 2006 which is the most current data available, 25% of CSM students finished their degrees during their fifth year of study; therefore, there is likely to be overlap between the student populations surveyed in 2004 and 2007.

During the last two weeks of classes in the spring 2007, the 168 students enrolled in various sections of Senior Design were asked to sign a project participation consent form. Students who

agreed to participate in this investigation then completed the CSAS. To ensure consistency in the administration process, the eight instructors leading the eight sections of Senior Design II were given written administration instructions. Seventy-eight of the 168 students (46%) agreed to participate in this study and completed the CSAS.

II.3. Attitudes Scale (CSAC)

The CSAS was developed and validated by Shiarella et al.[8] and is used here with permission. According to Shiarella et al.[8], the CSAS was created based on Schwartz's altruistic helping behavior model which consists of the four phases displayed in Table 1. For a detailed explanation of each phase and how these stages apply to engineering, see Bauer et al.[6]. According to Shiarella et al,[8] students pass through each of these phases in a linear manner until reaching the fourth and final phase in which an individual is compelled to respond to a community service need. All 46 questions that comprise the original CSAS were administered to the participating students. The only alterations that were made to the CSAS for the purpose of this investigation were the addition of questions concerning demographic information.

| Phase | Phase Title | # of Questions |
|---|---|---|
| 1 | **Activation:** Perceptions of a need to respond | 18 |
| 2 | **Obligation:** Moral Obligation to respond | 8 |
| 3 | **Defense:** Assess the costs and benefits of community service and the seriousness of the need | 17 |
| 4 | **Response:** Engage in helping behavior | 3 |

Table1. Phases of the CSAS

II.4. Analysis

Student demographics and responses to the CSAS were entered into an Excel spreadsheet for analysis purposes. Each question on the CSAS was examined to determine whether a high score indicated a positive or negative attitude with regard to the given question. The coding of responses to negative questions was reversed before entering them into the database. In other words, a high score in the database always reflected a positive attitude. The scale offered a minimum value of one and a maximum value of seven, with four reflecting the divide between positive and negative attitudes.

Due to human subjects concerns, the investigators were not permitted to collect student identification information when administering the CSAS. This prevented the possibility of tracking individual students' attitudinal changes from 2004 to 2007. Therefore, it is unknown as to whether the same students or a different set of students completed both administrations of this instrument. More than likely, there is some overlap among the respondents to the two administrations of the instrument. Therefore, in the analysis of this data, neither independence nor dependence across administrations can be assumed.

This prevents the use of statistical testing procedures and limits our analysis to descriptive statistics. Additionally, in the original administration in 2004, a large percentage of the participating students were juniors and seniors (82%). The attitudes of these students may have already been impacted by the Humanitarian Engineering program prior to the original data collection, skewing the baseline results.

## III. Results

This section describes the comparison of the results of the analysis of the four phases of Schwartz's altruistic helping behavior from 2004 to 2007. As was discussed earlier, demographic information was collected along with the students' responses to the CSAS. Based on self-reported data, 90% of student respondents in 2007 had heard of the Humanitarian Engineering Program and 22% had knowingly completed courses within that minor. The sections that follow report the results of the analysis of the collected data by year and by phase.

### III.1. Phase 1: Activation

The first phase in this model is Activation and measures the extent to which the students recognize that there is a need to respond to community service activities. The mean response to this set of questions in 2004 (n=78) was 5.18 and in 2007 (n=78) was 4.16. This indicates that the 2004 respondents had more positive attitudes with respect to this phase than did the respondents in 2007.

In order to better understand this result, this analysis was narrowed in several manners. First, the mean was calculated for this phase for students that were in their sophomore year in 2004. This resulted in a mean of 5.34 (n=14). Second, the mean for seniors who responded to the instrument in 2004 was calculated, resulting in a mean of 5.55 (n=9). Seniors, overall, had a more positive attitude with respect to this phase in 2004 than did sophomores. Third, only students that indicated that they had completed a course in the Humanitarian Program were included in the calculation of the mean for 2007. The reader is reminded that students who responded in 2007 were assumed to be seniors. This resulted in a mean of 4.30 (n=17). The mean for seniors who were exposed to the Humanitarian Engineering Program in 2007 is lower than that of seniors in 2004 for this phase.

### III.2. Phase 2: Obligation

Phase 2, Obligation, is designed to measure the extent to which respondents feel a moral obligation to respond to community service. As was found in the previous phase, the 2004 student respondents had more positive attitudes than the 2007 respondents with respect to this phase. The mean response to this set of questions in 2004 (n=78) was 5.44 and in 2007 (n=78) was 4.91. Once again, additional analysis was warranted.

Restricting the data to students in their sophomore year in 2004, the mean for this phase is 5.48 (n=14). Seniors who responded in 2004 had a mean of 5.69 (n=9). Once again, seniors displayed more positive attitudes in 2004 than did sophomores. Restricting the data to students who

reported completing a course in the Humanitarian Engineering program in 2007, the mean for this phase is 4.94 (n=17). Regardless of how the data is subdivided, respondents in 2004 displayed more positive attitudes with respect to this phase than did respondents in 2007.

III.3. Phase 3: Defense

The third phase, Defense, refers to an individual's reassessment of a potential response to community service activities. The overall mean response to this set of questions in 2004 (n=78) was 4.15 and in 2007 was 4.29 (n=78). Here, student respondents in 2007 displayed more positive attitudes than did student respondents in 2004. Restricting the data to respondents who were sophomores in 2004 (n=14), the mean for this phase is 4.04. Seniors who responded in 2004 had a mean of 4.31 (n=9). Restricting the data to students who reported completing a course in the Humanitarian Engineering program, the mean for this phase in 2007 was 4.33 (n= 17). Respondents in 2007 displayed a slightly more positive attitude than did students in 2004 with respect to the third phase.

III.4. Phase 4: Response

The fourth phase, Response, refers to an individual's engagement in community service activities. The overall response to this set of questions in 2004 (n=78) was 4.61 and in 2007 (n=78), it was 5.09. Much like the previous phase, there was a positive difference between the data from 2004 and 2007. Restricting the data to students in their sophomore year in 2004, the mean for this phase is 4.40 (n= 14).

Seniors who responded in 2004 had a mean of 4.92 (n=9). Restricting the data to students in 2007 and who indicated they had completed a course in the Humanitarian Engineering program, the mean for this phase is 5.18 (n=17).

III.5. Summary of Results

Figure 1 displays the trends in student responses by phase for each year in which the data was collected. As this figure indicates, respondents in 2004 had a more positive attitude with respect to phases 1 and 2 than did respondents in 2007. Respondents in 2007 had a more positive attitude with respect to phases 3 and 4 than did respondents in 2004. In other words, students in 2004 were more likely to recognize a need for community service and to perceive a moral obligation to respond but they were less likely to respond through their actions than were students in 2007.

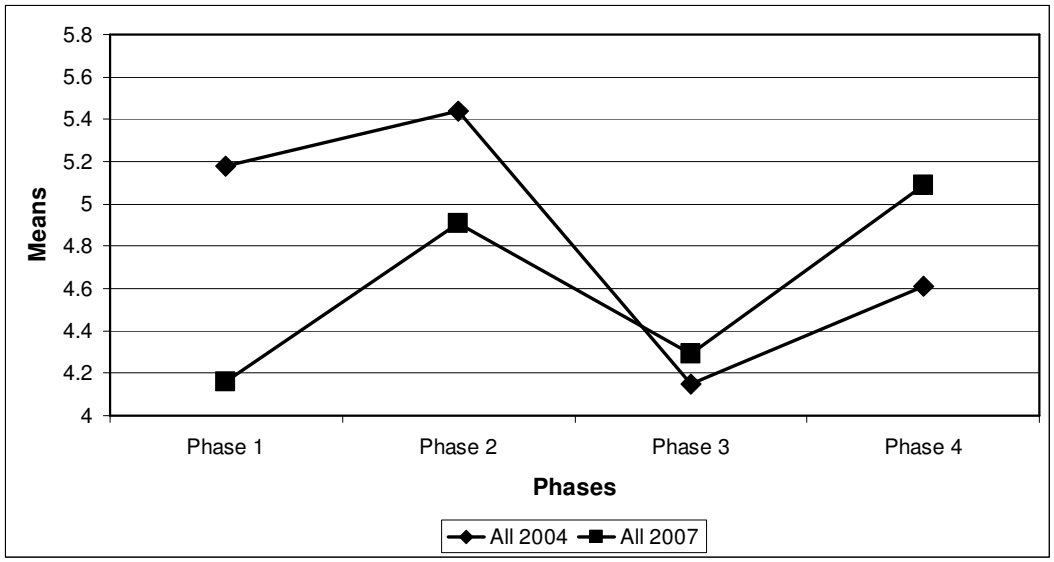


Figure1. Comparison of mean response by phase within year
Note: The mean scale on this figure ranges from 4 to 5.8. This results in a graph that displays very subtle differences in attitudes.

Figure 2 displays a comparison of the means within the previously defined subgroups. As this figure indicates, seniors in 2004 had more positive attitudes with respect to phase 1 and phase 2 than any other group that was examined. However, the students that participated in the Humanitarian Engineering Program in 2007 displayed the strongest positive response to phases 3 and 4. Phase 4 is the Action phase or the phase that must be reached in order to take action in response to a community service need.

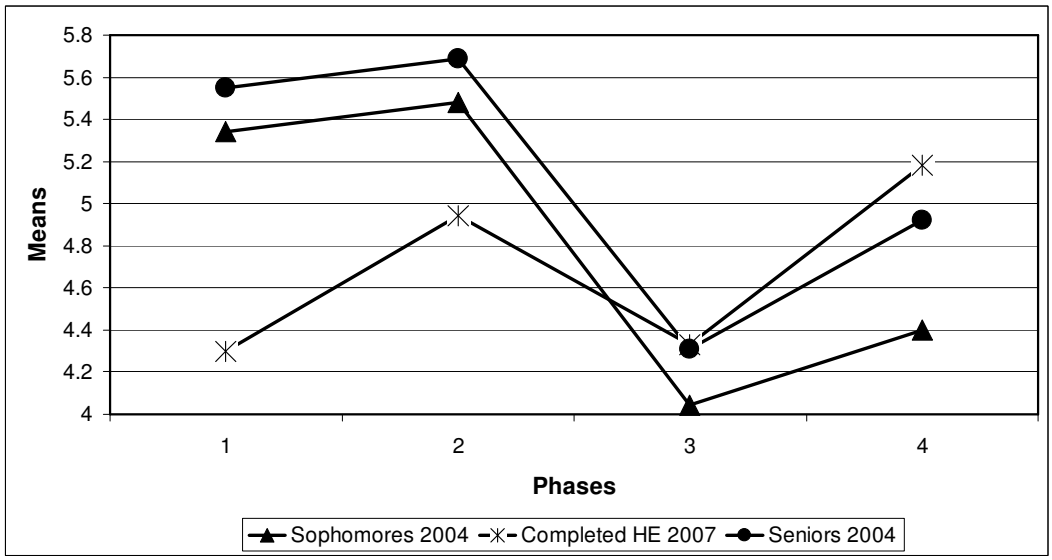


Figure2. Comparison of mean response by phase and subgroups
Note: The mean scale on this figure ranges from 4 to 5.8. This results in a graph that displays very subtle differences in attitudes.

## IV. Discussions and Conclusion

According to Schwartz's altruistic helping behavior model, in order for people to take action in the form of community service, they must pass through three prior phases. The final phase, Response, is the intention to engage in community service. The CSAS was developed by Shiarella et al.[8] to measure progression through these phases. As the data reported here suggests, students who participated in this investigation in 2004 had more positive attitudes with respect to phase 1 and phase 2 than did students who participated in 2007. In other words, respondents in 2004 were more likely to perceive a need for community service and to recognize a moral obligation to respond. However, student respondents in 2007 were more likely to assess the potential of a response (phase 3) and to respond (phase 4). One implication of this research is that it presents a challenge to Shiarella et al. theory: students with more positive attitudes in phase 1 and phase 2 are not necessarily more likely to respond in phase 4. Opportunity to respond may be a stronger factor when considering attitudes toward responding.

The difference between the two data sets appears to be a difference between thinking about needs and responding to needs. The respondents in 2007 were more likely to respond to the perceived needs than were those in 2004. Therefore, in response to the first research question, there is evidence to suggest that students' attitudes with respect to service activities were different between the two administrations of the CSAS. This observation was true regardless of whether the data was grouped by years or subdivided within years.

The next research question concerns whether the identified differences can be attributed to participation in the Humanitarian Engineering Program. This question, due to confounding factors, is far more difficult to address. Students who reported that they completed courses in the Humanitarian Program displayed more positive attitudes with respect to phases 3 and 4 than did any other groups. However, it may be that students who have positive attitudes toward responding to community service are also more likely to select into Humanitarian Engineering courses. Additionally, the overall mean for phases 3 and 4 in 2007 was greater than the overall mean in 2004. This suggests that even students that did not report completing a course in Humanitarian Engineering displayed more positive attitudes for these phases than those that were witnessed in 2004. An implication of this result may be that maturation or college matriculation explains the identified differences in attitudes between 2004 and 2007 rather than the impact of the Humanitarian Engineering Program.

To better understand the impact of maturation and matriculation, comparisons were made between senior level responses in 2004 to the responses in 2007. Due to a prerequisite that all students in Senior Design be of senior standing, it is assumed that all responses in 2007 were from seniors. If the witnessed differences can be explained through maturation or matriculation, senior level responses in 2004 should be comparable to senior level responses in 2007. They were not. Seniors in 2004 displayed the strongest positive attitude with respect to phase 1 and phase 2 when compared to any other examined group. Respondents in 2007 displayed the weakest attitudes with respect to the first two phases but the strongest positive responses with respect to the final two phases. In other words, the pattern of response was different for the two

groups of seniors, reducing the likelihood that maturation or matriculation is the influencing factor.

Another manner in which to interpret this data is that the Humanitarian Engineering Program did have an impact on students' responses to the CSAS. The less positive attitudes that were witnessed in 2007 with respect to phase 1 and 2 may be a reflection of students, overall, having a more realistic understanding of community service. In 2004, students may have been responding to the questions concerning the first two phases based on an idealistic and naïve understanding of service activities. By 2007, the majority of students should have been exposed to humanitarian concepts, regardless of whether they directly participated in courses offered through this program or not. This may have resulted in greater reluctance on the part of students to recognize needs as measured in phase 1 and 2. By not recognizing these needs, they were not obligated to respond. This interpretation of the data would explain the greater consistency that is witnessed in students' responses across phases in 2007.

Unfortunately, the data and interpretations presented here are not conclusive, warranting further investigation. Based on this analysis, a direct relationship between participation in the Humanitarian Engineering Program and improved attitudes with respect to community service cannot be drawn. In order to tease out the confounding variables, a next step in this research may be a longitudinal analysis that probes students' attitudes with respect to community service as they are being formed.

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