AC 2008-2430: COMMUNITY SERVICE ATTITUDES OF ENGINEERING STUDENTS ENGAGED IN SERVICE LEARNING PROJECTS

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Community Service Attitudes of Engineering Students Engaged In Service Learning Projects

Abstract

One of the potential outcomes of incorporating service learning projects into engineering curriculum is that students may develop a greater sense of altruism and in their careers look for opportunities to use their skills to the benefit of society. It is of interest to see if service learning projects conducted in the context of a single semester design course can encourage students to value community service. The Community Service Attitudes Scale (CSAS) survey[1] was administered at the end of the semester in fall 2006 to a freshmen introductory Environmental Engineering course (EVEN 1000) and a senior design course in Environmental Engineering that incorporated service learning projects, and in fall 2007 at the end of an Engineering for the Developing World (EDW) course. Twelve students in the 2006 design course worked on a wastewater project for a community in Mexico, and the EDW students worked on a variety of domestic and international projects for developing communities. Some of the students in these courses were also participating in Engineers Without Borders (EWB) as an extracurricular activity. Based on the fall 2006 results, there were significant differences in the responses of the first-year versus senior design course for only 4 of the 61 questions. The fall 2007 EDW students were emailed the survey, and response rates were much lower than in the other two courses. Therefore, few differences due to gender, EWB participation, or other factors were evident. The results from this study are preliminary in nature due to the small number of survey respondents. However, at this time it appears that the curriculum made minimal impacts on community service attitudes. It also appears that differences in the attitudes of the senior/graduate student EWB participants in the EVEN design course on 10 questions ($p<0.05$; additional 4 questions with $0.1>p>0.05$) were probably due to differences in what leads students to voluntarily participate in EWB as opposed to attitude changes due to the EWB experience itself.

Background

Civil and environmental engineering (CVEN and EVEN) have a strong tradition of serving the public. It has been speculated that this "people serving" and humanitarian aspect of the professions may help attract a higher percentage of women and minorities than other engineering fields that are perceived as more associated with machines and technology than people. Some confirmation of this idea was the finding that the inclination to volunteer among first year college students was higher for females than males, and higher for minorities than whites.[2] However, traditional engineering curricula do not tend to emphasize the service-aspects of the profession, leading to non-retention of students who are motivated by these goals.

At the University of Colorado at Boulder, two programs are particularly interested in highlighting service opportunities in engineering. In the EVEN B.S. degree program, one of the educational objectives is to produce students who, within 3 to 5 years after graduation, "have served the needs of our society and protected the future of our planet in an ethical manner." In addition, one of the program outcomes is that our graduates have "adequate opportunity to

include service at the local, state, national, or global levels as an important part of their environmental engineering education." (http://www.colorado.edu/engineering/even/description.htm)

In the year 2000, the Engineering for Developing Communities (EDC) program at the University of Colorado at Boulder was born. The EDC program "educates globally responsible engineering students and professionals who can offer sustainable and appropriate solutions to the endemic problems faced by developing communities worldwide." (http://www.edc-cu.org/) The program encompasses service, education, and research/development facets. One established curricular aspect of the program is an EDC emphasis in the environmental engineering focus area of the Civil Engineering (CVEN) M.S. degree. A newer EDC emphasis for undergraduate CVEN majors was approved in spring 2007. A college-wide certificate in EDC open to students in any major is being planned. Many of the students in the EDC program participate in Engineers Without Borders (EWB) as an extra-curricular activity (http://www.ewb-usa.org). EWB projects serve communities around the globe. The EWB student chapter at the University of Colorado is very strong, with on-going projects in three countries, Nepal, Peru, and Rwanda.

The goals of this study were to determine: (1) if there are differences in the attitudes of freshman students toward community service (CS) based on selected major or gender; and (2) if the attitudes of senior and graduate engineering students differ from freshmen, in particular among students who have worked on service-learning projects for developing communities via curricular and/or extracurricular activities.

Assessment Instrument: The CSAS Survey

The Community Service Attitude Scale (CSAS)[1,3] is a written survey that was developed to measure student attitudes toward community service. The instrument has been validated for reliability and correlated with intentions to engage in community service. The CSAS survey has been previously used at the Colorado School of Mines (CSM), where it was given to engineering students and faculty in a study by the humanitarian engineering program.[4] Other published uses of the instrument beyond the initial validation were not found.

The average Community Service Attitudes score is based on Schwartz's model of altruistic helping behavior.[5] This model includes four sequential phases, summarized in Table 1, along with the abbreviations that will be used herein to refer to these phases and subparts. Each step influences the next, such that people are believed to progress to the next phase after all the steps within the previous phase have been realized.

The survey consists of 46 questions to evaluate attitudes, where students respond using a 7-point Likert scale (1=extremely unlikely, strongly disagree). The number of survey questions used to score each aspect of the students' attitudes toward community service are noted in Table 1. An additional 8 questions ask students to rate how likely various factors are to influence their ability to participate in a community service project in the next year. These factors include schoolwork, work, knowledge of opportunities, school credit, transportation, skills and knowledge to help, flexibility of work schedule, and discomfort with people who need help. Students rate these factors using a 7-point Likert scale, from extremely unlikely (1) to neither likely nor unlikely (4)

to extremely likely (7). An additional 7 questions ask students to rate their confidence level in various skills useful for community service. These skills are: time management, communication, interpersonal, team, and technical skills; overall knowledge, and confidence in ability to do the job. The students rate their confidence level on a scale of 1 to 10.

Table 1. Outline of Model for Helping Behavior

Phase	Steps	Explanation	Subparts	Abbrev-iation	# of survey questions
1	Activation	perceive a need to respond	awareness of need perceive actions could help recognize ability to help connectedness with need	1AW 1AC 1AB 1C	5 4 3 6
2	Obligation	moral obligation to respond	norms influence obligation obligation due to empathy	2N 2E	5 3
3	Defense	reassessment of potential responses	costs of helping benefits of helping seriousness of need	3C 3B 3S	6 6 5
4	Response	engage in helping behavior	Intention to help	4	3

Surveys and corresponding data analysis conducted by Shiarella showed that 8 factors emerged from principal components analysis.[1] These factors are listed in Table 2, with a description of the link of these factors to the phases of helping behavior summarized in Table 1 and the number of questions in the CSAS survey that evaluate each factor.

Table 2. Factors that Emerged from Analysis of CSAS Data by Shiarella et al.[1]

Factor	Descriptor	Phases	# of survey questions
1	Normative helping attitudes	1AC, 1AB, 2N	12
2	Connectedness	1C	6
3	Costs	3C	6
4	Awareness of need, empathy	1AW, 2E	8
5	Intentions to help	4	3
6	Benefits of helping	3B	4
7	Seriousness	3S	5
8	Career benefits	3B	2

The initial survey validation was conducted by Shiarella et al., with a survey given primarily to senior undergraduate students majoring in non-engineering disciplines.[1,3] This large data set provides information for comparisons to the engineering students.

Student Baseline: Freshmen

To establish a baseline for engineering student attitudes toward service learning, the CSAS survey was administered in a freshman Introduction to Environmental Engineering (EVEN) course in fall 2006. The purpose of the course is to help students understand the profession of

EVEN. Most of the students are freshmen that have declared EVEN as their major and are taking this 1 credit course during their first semester due to requirements of the degree program. Undeclared engineering freshmen who are fairly certain they are interested in EVEN also enroll in this course rather than a general engineering course which provides an overview of all of the engineering majors available within the college. In some cases, non-engineering majors take the course, either for general interest or due to their interest in possibly changing their major. The survey was administered in-class near the end of the semester, after the students had completed a variety of activities including a case study to determine an appropriate and sustainable wastewater treatment design for a Native American community[6] (3 week activity with in-class discussions) and an ethics assignment including Fred Cuny, a relief worker, as a moral exemplar example.[7] The demographics of students enrolled in the course and respondents to the survey are summarized in Tables 3 and 4, respectively.

Capstone Design Course

In fall 2006, an international service learning project was incorporated into the capstone Environmental Engineering Design course. This course is required for all students earning their Bachelor's degree in Environmental Engineering (EVEN). These students take the course during their senior year. The course is also taken by Civil Engineering (CVEN) students who select to emphasize environment and water, either as their capstone design course or as a technical elective. The course also is co-taught with a graduate section. Graduate students taking the course are earning an MS or PhD in Civil Engineering with an environmental emphasis. Most of the students either lacked a BS degree in engineering or were enrolled in the Engineering for Developing Communities (EDC) emphasis. Demographics of the students enrolled in the course are summarized in Table 3.

In fall 2006, the course included 3 projects. All of the projects served real clients and were service-learning oriented. Students self-selected their project of interest, and were placed into teams of 4 or 5. The projects were:

Dairy: a service-learning project arranged by the International Center for Appropriate & Sustainable Technology (iCAST; www.ic-ast.org) to explore environmentally responsible methods to minimize waste from an organic dairy that is planned to process goat milk into cheese, and handle waste that cannot be avoided. Four students elected to work on this project including 1 graduate student, 2 students earning dual degrees in EVEN and Chemical Engineering, and 1 EVEN major.

Biodiesel: a service-learning project arranged by iCAST to explore ways to utilize the by-products from biodiesel production at a community scale facility planned in eastern Colorado. Five students elected to work on this project including 2 earning a second BS degree in Chemical Engineering and 2 CVEN majors.

Pesqueira, Mexico, wastewater: this service-learning project was coordinated directly with persons at the University of Sonora and the Ministry of Social Development in Mexico (SEDESOL). Students had the opportunity to visit the community over an extended weekend in October. Travel expenses were paid via the EDW course grant from the National Collegiate

Inventors & Innovators Alliance (NCIIA). Three teams of students worked on this project, which was the most popular of the available options. Eight of the 12 students working on the project visited the community, including 3 graduate students, 3 CVEN majors, and 2 EVEN majors.

All of the students in the class wrote essays at the end of the semester describing the service-learning aspects and non-technical challenges of their projects. For example, the students who visited Pesqueira got a first-hand experience (albeit brief) with poverty. The meetings with community representatives were conducted in Spanish, as were most of the documents provided by SEDESOL. Cultural differences were not as critical for the dairy and biodiesel projects.

The CSAS survey was administered in-class near the end of the semester, during the week prior to Thanksgiving break. Four of the 21 students in the class did not complete the survey (81% response rate). Demographics of the respondents are summarized in Table 4.

Table 3. Demographics of Students Enrolled in the University of Colorado Courses

Course	Total # students enrolled	% female	% minority	% EVEN Major	% CVEN major	Year in College	% responded to survey
EVEN 1000 Fall 2006	29	48	17	48	0	55% frosh* 34% soph 11% other	97
EVEN Design Fall 2006	21	38	24	48	52	71% senior 24% grad. 5% other	81
EDW Fall 2007	20	60	15 25**	5	70	70% grad. 30% senior	55

* some first year students are listed in the University system as sophomores due to transfer and AP credits

** listed in the University system as "unknown"

Engineering for the Developing World (EDW) Course

The goals for the Engineering for the Developing World (EDW) course include to: (i) introduce students to open ended problems at the community level; (ii) help students develop the skills to solve those problems and provide holistic engineering solutions that are sustainable and appropriate to the community being served; (iii) help students develop cultural and social awareness; (iv) help students work in interdisciplinary teams; (v) give students the opportunity to reflect on the importance of their community service; (vi) give students a professional work ethic, and (vii) help students gain a better understanding of the importance of engineering in society and in community development. The course was first offered on a pilot-basis to 3 students in a full-year format in fall 2005/spring 2006. The students worked on an Engineers Without Borders (EWB) project in Rwanda. In 2006, the course was integrated into an existing capstone design course for environmental engineering, as described above.

In fall 2007, the course was again a stand-alone course but offered in the single semester format. (www.edc-cu.org/cven4838.htm) This course focuses on appropriate and sustainable technology

and small-scale sustainable community planning and development. Another unique goal stated for this course was that students would gain insight into what represents poverty and how to contribute to its eradication. The textbook for the course was Field Guide to Appropriate Technology, Edited by B. Hazeltine and C. Bull.[8] The projects served 3 developing communities in the U.S. and 2 international sites. In addition to the team project, the graduate students in the course wrote book chapters on sustainable community development. Enrollment in the course included 6 undergraduate students (33% female, 33% minority) and 14 graduate students (71% female, 7% minority and 29% unknown). The students spanned 4 different majors: architectural, civil, environmental, and mechanical engineering. There were 5 projects, each worked on by a team of between 2 to 6 students. The survey was sent to the students by email at the end of the semester, and students were requested to print out and return the survey. This method of survey administration resulted in a low response rate; overall 55%.

Results

Given the fairly small number of students that have responded to the survey to date, it is difficult to determine whether observed differences between various groups are statistically significant. However, a basic t-test was conducted in Excel (2-tailed, heteroscedastic), and a 95% confidence level for significant difference ($P<0.05$) was selected. A probable difference is inferred from the data when p was between 0.05 and 0.10. The groups for which CSAS data are available are listed in Table 4, with respondents self-reporting the demographic information presented. The CSAS results available include two previously published studies.[1,4] In the Colorado School of Mines (CSM) study[4], 77% of the students responded to the survey compared to 55% to 97% participation in the courses in this study (as shown in Table 3). As shown in Table 4, the students in the CSM survey are fairly similar to the engineering students in the EVEN 1000 course in terms of age, although there were many more female students in the EVEN course.

Table 4. Demographics of CSAS Survey Respondents

Group Surveyed	n	Majors	Rank	Age	% female	% minority
Shiarella et al.[1]	332	Business, Psych, etc	Senior	22-23	59	13
CSM Bauer et al.[4]	78	ENG	Frosh + Soph	20	~13	Not given
EVEN 1000	17/11	ENG/other	Frosh Soph	18.5 19.8	41 64	24 9
EVEN Design	17	EVEN and CVEN	Senior & Grads	24	35	24
EDW: grads seniors	7 4	CVEN, EVEN, other ENG	Grads Senior	22-38 22	71 50	14 50

Freshmen Course

The largest group of survey participants in this study were those in the EVEN 1000 course. Initial discussions will focus on those students. First, the general survey validity was confirmed by comparing the attitudes of the students who stated that they participated in community service

activities 2 to 4 times per year or more (n=19) vs. those who participated once per year or less (n=9). Given the small sample sizes, answers were significantly different on only 4 questions, with another 5 questions having a probable difference (of the 61 scaled questions). For the phases/subphases and factors, only phase 4 and factor 5 (intention to help) was higher for the more frequent CS participants ($p = 0.09$). For all of the other phases/subphases and factors except costs (phase 3C and factor 3), the more frequent CS participants had slightly higher positive attitudes toward CS. This is the result that would be expected – more positive attitudes toward CS in general and in particular step 4, where the person actually acts, for those who do participate in CS more frequently.

It was of interest to determine if there would be significantly different attitudes of the students based on their major. There were minimal differences in the attitudes of the engineering students versus the non-engineering majors. Of the 61 scaled-response questions, 1 had a significant difference and 2 a probable difference. These 3 questions were all confidence in skills questions, with higher confidence by the non-engineers. However, none of the phases or factor scores were significantly different between the engineers and non-engineering majors ($p>0.40$). Engineers had slightly higher scores on all but 2 of the phases/subphases and 6 of the 8 factors.

Potential response differences based on race (White non-Hispanic n=23 versus others n=5) were also explored. Of the 61 scaled-response questions, only 1 was significantly different and 2 were probably different. However, none of the scores for the phases/subphases or factors were different (p values ≥ 0.23). Comparisons of responses based on gender are discussed below in combination with the results from the other courses.

The CS attitudes of the engineering students in the EVEN 1000 course are compared with results reported from the Bauer et al.[4] study in Figure 1. While the EVEN 1000 students are primarily first year students majoring in environmental engineering (n=17; 88% first year, 76% EVEN), the students who participated in the Bauer et al. study[4] were first and second year students from all engineering majors (n=78, including civil, environmental, mechanical, electrical).

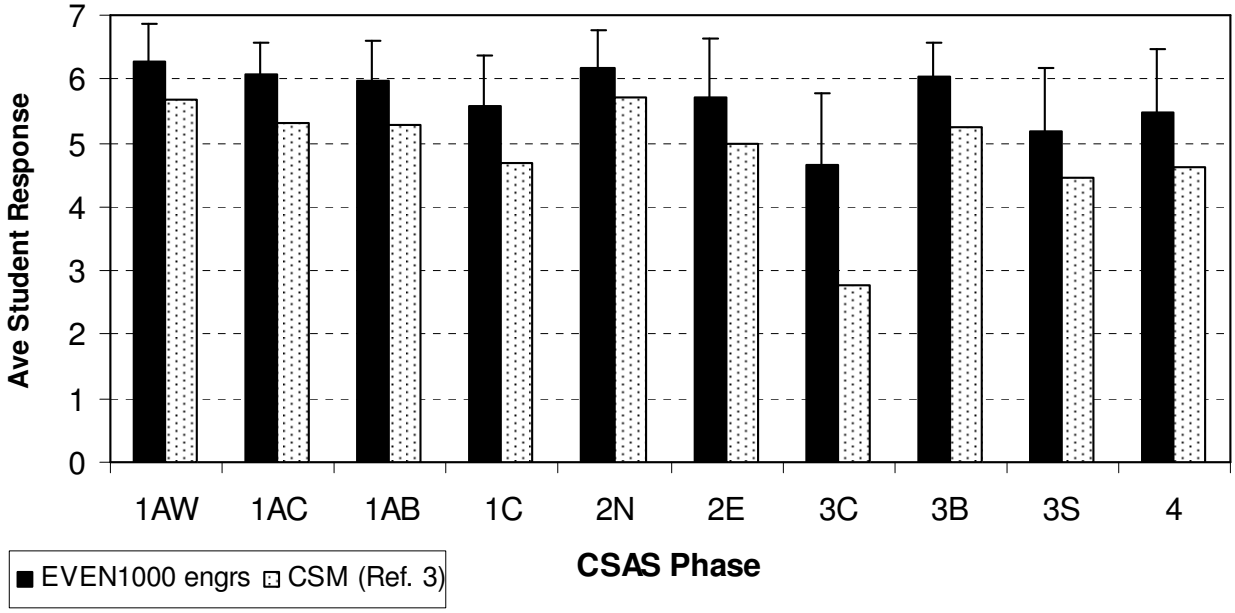

Figure 1. Comparison of engineering students in EVEN 1000 versus Bauer et al. study[4]

Although statistically valid comparisons cannot be made (due to lack of raw data from the Bauer et al. study), the attitudes of the EVEN 1000 engineering students appear more positive towards community service, although with a higher recognition of the costs. This may be due to a more altruistic attitude among students interested in environmental engineering versus other engineering majors represented and perhaps predominating in the Bauer et al.[4] data set. Further studies would be needed with students of known majors and a larger sample set to determine if this is the case.

Comparison Among Different Classes

The initial set of questions shows that a similar percentage of students in each class indicated that they have participated in unpaid community service. A much higher percentage of the senior/graduate students are working, have participated in service learning in a course, and participate in EWB activities than students in the first year course. The fairly high percentage of freshman students who report that they have already participated in service learning in a college course is likely because the students are enrolled in the First-Year Engineering Projects course, which often includes service projects for mobility-impaired people and interactive museum displays (http://itll.colorado.edu/geen1400/).

Table 5. Summary of Student Responses to Preliminary CSAS Questions

Class:	EVEN 1000	EVEN Design	EDW F07
% who have participated in CS	89	88	100
Frequency of CS, median # of times/yr	2-4	2-4	2-4
% working while attending school	36	76	73
% who have participated in service learning project in a College course	21	71	73
% who have participated in an EWB project	4	29	45

Comparisons in the responses to the attitude questions were made between the 17 engineering students in EVEN 1000 and the students in the EVEN design and EDW courses. The average student attitudes from the different CS phases and factors are shown in Figures 2 and 3, respectively, with error bars representing the standard deviation. Note that the y-axis of the figures only shows the 4 (neutral) to 7 (strongly agree/extremely likely) range of the 7-point Likert scale to make differences more visible.

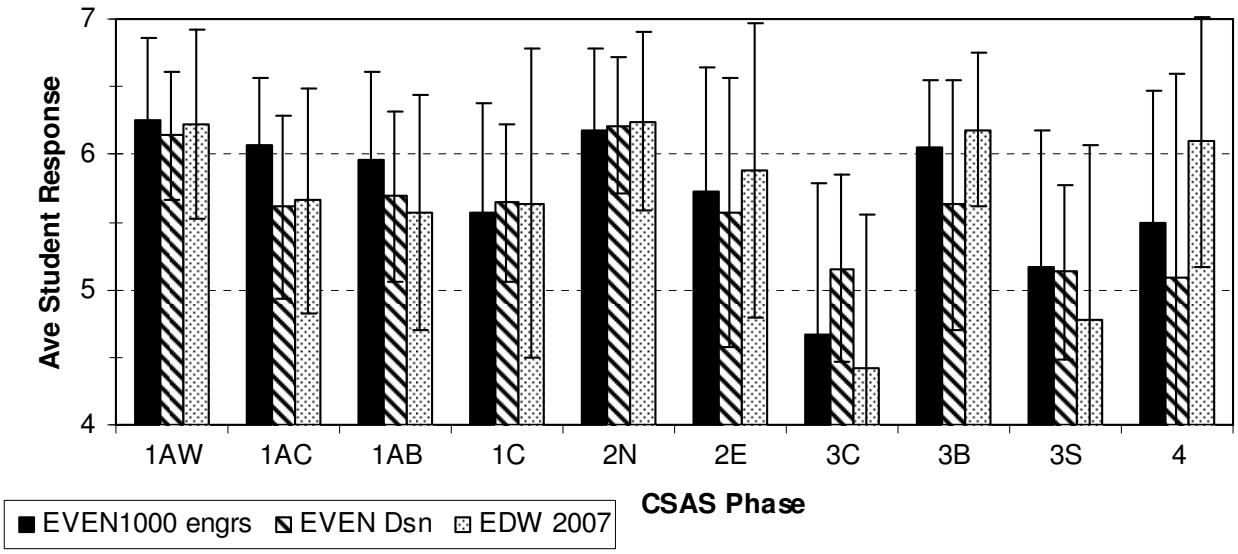

Figure 2. Average CS attitudes of engineering students based on phases of helping behavior

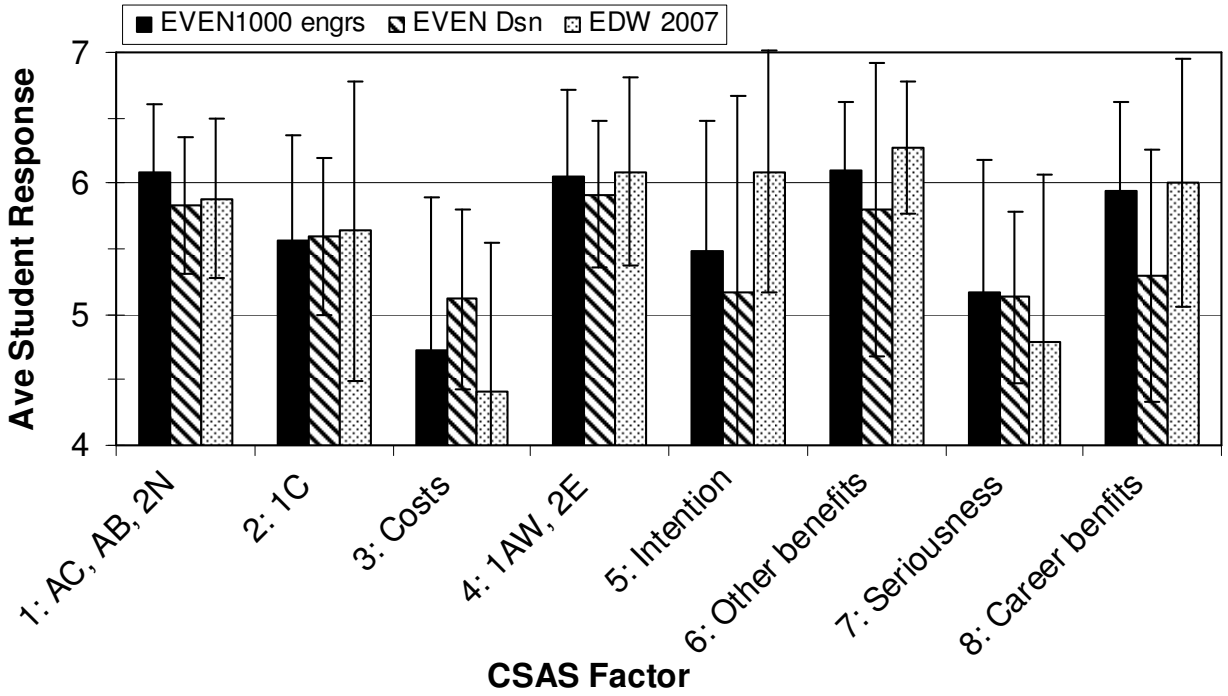

Figure 3. Average attitudes of engineering students toward different factors related to CS

The few significant differences found based on statistical evaluation are summarized in Table 6. The largest differences are in Phase 3 answers, with EVEN design students stating that the costs of community service are higher than the other students. It is logical that students in the EDW course have the highest responses to Phase 4 (and Factor 5 intention), given that they voluntarily enrolled in this elective course where service learning projects are the major component. Students in the EVEN design course had less belief that engaging in community service activities would be beneficial to their career (Factor 8).

Table 6. Differences in Responses of Students from Various Classes

Comparison Groups:		EVEN 1000 ENG majors vs. EVEN Dsn	EVEN 1000 ENG majors vs. EDW 07	EVEN Dsn vs. EDW F07
n for surveyed groups		17 vs. 17	17 vs. 11	17 vs. 11
# of 61 ?s with:	Significant Differences	4	2	5
	Possible Differences	2	3	3
Phases & sub-phases with:	Significant Differences	1AC	none	Phase 4
	Possible Differences	Phase 3	none	3B; 3C; Phase 3
Factors with:	Significant Differences	8 career benefit	none	8 career benefit, 5 intention
	Possible Differences	none	none	3 costs

Gender Effects

There were few if any significant differences in the community service attitudes of the students based on gender, as summarized in Table 7. In the freshman class there was a significant difference in the total Phase 3 Defense scores, with a higher response from female students. This generally agrees with the results from the Bauer et al. study[4] that found minimal differences in attitudes due to gender. In their study, the only significant difference was that females had a higher awareness (1AW) than males, although they pooled the student and faculty data for this comparison. Similar to the Bauer study, females in EVEN 1000 (n=14) had a more favorable attitude toward community service than males (n=14) on all aspects except 1AB; however, these differences were not large enough to be statistically significant. In the EVEN Design and EDW classes, there were no significant differences in the CS attitudes of female versus male students, possibly due to the small numbers of student participating in the survey. The results from the 2004 and 2005 National Survey of Student Engagement (NSSE) of 129,597 first-year students found that female students are more likely to volunteer and plan to volunteer than male students.[2]

Table 7. Differences in CSAS Survey Responses Based on Gender

Course:		EVEN1000	EVEN Design	EDW F07
Number of 61 questions with:	Significant Differences	3	3	0
	Possible Differences	3	3	5
Phases and subphases with:	Significant Differences	Phase 3	none	none
	Possible Differences	none	none	none
Factors with:	Significant Differences	none	none	none
	Possible Differences	none	none	none

Effects of Participation in EWB

One might expect somewhat different attitudes toward community service in the students that voluntarily participate in Engineers Without Borders (EWB) versus those that do not. Results of this comparison are presented in Table 8. Unfortunately, the small number of students in these courses who were EWB participants makes statistically valid comparisons difficult. In the

EVEN 1000 course, only 1 student self-reported participation in EWB so no comparisons could be made. In the senior/graduate project courses, the results of the t-test comparing EWB participation were different. In the EVEN design course, which most students were taking due to curriculum requirements, EWB participants did have significantly different attitudes than the non-EWB participants. Specifically, in Phase 4 Response and Factor 5 Intention to help, EWB participants averaged 6.3 compared to 4.7 for non-EWB participants on the 7-point Likert scale. EWB participants also had somewhat higher scores for phase 2E Empathy and factor 2 Connectedness.

Table 8. Differences in CSAS Survey Responses Based on EWB Participation

	Course:	EVEN Design	EDW F07
	Number of EWB Participants	5	5
Number of 61 questions with:	Significant Differences	10	1
	Possible Differences	4	1
Phases and subphases with:	Significant Differences	Phase 4	none
	Possible Differences	2E	none
Factors with:	Significant Differences	5 Intention	none
	Possible Differences	2 Connectedness	none

In contrast, in the EDW course there were no significant differences in the attitudes of EWB participants versus non-participants in any of the phases or factors. One key difference is that the students in the EDW course all self-selected to participate in this course as an elective. Therefore, these students may have had higher overall positive attitudes to community service, as a service learning project was known in advance to be the major activity in the course. For example, the average overall CS score from the EVEN design course was 238 in the design course (5.2 on Likert scale) versus 248 in the EDW course (5.4 on Likert scale), out of a maximum possible score of 322. Thus, similar personal attitudes might be generally present in the EDW students but other factors simply prevented their participation in EWB.

Conclusions

The results indicate that the attitudes of students who are primarily first year college students interested in environmental engineering do not vary based on readily identifiable factors such as declared major in college, race, or gender. The engineering students in freshman EVEN 1000 course had generally stronger positive attitudes toward community service than freshman and sophomore students from all engineering majors at the Colorado School of Mines (CSM). Perhaps students with positive attitudes toward community service and an interest in engineering tend to self-select into environmental engineering as a major. Environmental engineering might be perceived as more service-oriented than other engineering disciplines. Further data is needed to confirm or refute this hypothesis. Senior engineering students in the EVEN design course who participated in EWB had stronger positive attitudes toward community service than non-EWB participants. It is likely that students with more positive attitudes toward community service choose to participate in EWB, as opposed to the EWB experience increasing community service attitudes. This is supported by the lack of difference in the CS attitudes of EWB participants versus non-participants in the EDW course.

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