AC 2009-1384: PERCEPTIONS OF CHEATING BEHAVIORS BY FRESHMAN ENGINEERING STUDENTS

Angela Bielefeldt, University of Colorado, Boulder

Angela Bielefeldt is the Director of the Environmental Engineering Program at the University of Colorado at Boulder and an Associate Professor in the Department of Civil, Environmental, & Architectural Engineering.

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Abstract

Educating students on ethical issues is an important requirement of all engineering curricula. This is particularly essential for civil and environmental engineering, as human lives may be lost and significant environmental damage may occur as a result of unethical behavior. At the University of Colorado at Boulder (CU), the Civil (CVEN) and Environmental (EVEN) engineering curricula attempt to lay a strong foundation in ethics in the 1-credit Introduction to Engineering courses that first year students are required to take. It is hoped that drawing parallels between professional ethics and cheating behaviors among students will enhance the students' understanding of professional ethics. The perception of cheating behaviors by students in these courses was evaluated using the 18 questions from the PACES-1 survey[1]. Despite linking the survey with the student review of the Honor Code which clearly describes a variety of cheating behaviors, significant percentages of the students did not acknowledge some behaviors as cheating. For example, only 43% stated that working in groups on take-home exams was cheating. There were only minimal differences in the responses of the students in the CVEN and EVEN courses. Using a contingency table and chi-square test, only one question had significantly different responses among the CVEN versus EVEN students. A higher percentage of the CU students did generally report that activities were cheating than the engineering students who previously participated in the 2006 Carpenter et al.[1] and the 2008 Mattei[2] surveys. The largest exception was that only 36% of the CU students indicated that working in groups on web based quizzes or tests was cheating compared to 41% and 44% among the Carpenter et al. and Mattei engineering student respondents. Differences may be attributable to the demographics of the CU students compared to the larger number of participants in the Carpenter study (39% female, 84% freshmen, 97% raised in the US versus 19%, 23%, and 77%, respectively), but further data would be needed to test this hypothesis. The results indicate that discussing ethics may cause small changes in student views about cheating behaviors, but a significant percentage of the students still do not consider many behaviors as cheating despite explicit descriptions of those same behaviors as violations of the student honor code. Discussing specific survey questions with the students after they completed the survey did seem to change their impression of some activities; data to quantitatively test this assertion have not yet been collected. Qualitative data from the ethics homework and final reflective essay written by the students indicates that linking cheating behaviors to professional ethics may be an effective way to impact students' views on these matters.

Background

Educating students on ethical issues is an important aspect of all engineering curricula. It is required by ABET accreditation standards[3] and emphasized as an important part of the Body of knowledge for Civil Engineering and Environmental Engineering[4,5]. At the University of Colorado at Boulder (CU), students are exposed to ethics via modules in a variety of courses. This is particularly important for civil and environmental engineering, as human lives may be lost and significant environmental damage may result from unethical behavior. Media attention on the interstate bridge collapse in Minneapolis in 2007, levee failures in New Orleans during

hurricane Katrina in 2005, levee failures in the Midwest in 2008, and air pollution in China during the Olympics in 2008 relate to perceived engineering competence and ethics.

There are many corollaries between cheating behaviors in educational settings and unethical professional practice. Harding et al.[6] explicitly studied the self-reported cheating behaviors of undergraduate engineering students in high school, college, and their unethical behaviors at work. Their research found that these activities were correlated. In addition there were similarities in the criteria which impacted their decisions to cheat in a classroom setting and engage in dishonest and/or unethical behavior at work. A link between cheating in college and subsequent dishonest behavior in the workplace has also been reported for business majors[7,8].

Based on these findings, it is relevant to teach students about the ethical expectations for their behaviors in college as well as professional codes of ethics. While the students may view situations of professional ethical dilemmas as distant and unlikely, they are intimately familiar with cheating in an academic setting. Therefore, studying students' perceptions of and engagement in cheating in academia is important. A number of studies have explored these ideas. Hall[9] had senior civil engineering students review and write an essay on the ASCE code of ethics, followed by an assignment to develop a similar code for undergraduate students. He found that students' appreciation for ethics was improved by the exercise of linking future professional standards to current conduct expectations for students. Harding[10] found that cheating behavior was self-reported more frequently by engineering students than humanities students and noted: "Differences between engineering and humanities students may also be due to curricular differences in dealing with ethics education. In engineering ethics and ethical decision making are rarely discussed within the context of students' everyday lives. Instead most engineering ethics experiences focus on either prescriptive codes of conduct or engineering disasters, neither of which have a great deal of relevance to most engineering undergraduates, particularly within the context of cheating." Understanding of cheating may also evolve over time; Passow[11] reported that second-year students were significantly more likely to report cheating on homework than first-year students.

Based on the previous research reported above, it was of interest to measure how first year engineering students perceive various academic behaviors in regards to cheating. The typical professional ethics module presented in the first-year courses already asks students to draw parallels between the CU Honor Code and the professional codes of ethics for engineers. Given this context, would the students agree with stated expectations for ethical behavior at the University? More importantly, would the explicit discussion of various behaviors as cheating or unethical impact students' larger understanding of ethics? If so, the use of the PACES survey[1] could be a valuable instructional tool.

Methods

All freshmen entering the University of Colorado at Boulder (CU) are required to participate in an orientation module on cheating and the Honor Code the week before classes begin. The Honor Code was officially enacted as University policy in Fall 2002. It defines various specific activities as Honor Code violations and outlines the procedures by which these violations are

handled at the University and potential consequences. The Honor Code is published on-line and all students pledge to personally uphold the values of the honor code.

The Civil (CVEN) and Environmental (EVEN) engineering curricula at CU attempt to lay a strong foundation for student understanding of ethics by introducing this topic in the 1-credit Introduction to Engineering courses that first year students are required to take in fall semester (CVEN1317 and EVEN1000, respectively). There are two in-class lectures on ethics in the course (of 15 total lectures). The related homework assignment on ethics draws information from the Online Engineering Ethics website (http://www.onlineethics.org/) and accounts for 20% of the student's overall grade. The written assignment includes a question that requires the student to draw parallels between the engineering codes of ethics (from the American Society of Civil Engineers, ASCE, at http://www.asce.org/inside/codeofethics.cfm; or the National Society of Professional Engineers, NSPE, at http://www.nspe.org/Ethics/CodeofEthics/index.html) and the University Honor Code. This allows students to see that their ethical behavior as students has direct corollaries in the expectations for practicing engineers. There are additional questions based on the case studies and the engineering exemplars on the Online Ethics website. Ethics are also discussed in the context of the course projects such as the CVEN exploration of controversies and disasters and the EVEN drinking water evaluation project.

Student perceptions of cheating behaviors were indicated by their anonymous responses to 18 questions from the PACES-1 survey[1]. Students rated each behavior as either: cheating; unethical but not cheating; neither. The demographics of the students in the courses and the respondents, if known, are summarized in Table 1. Each course had about the same number of students, with a significantly higher percentage of female students in the EVEN course. Some non-first year students enroll in these courses, generally transfer students. In addition, not all of the students in the courses have declared the major of the course (CVEN or EVEN). Some of the students are in the so-called "open option" without a declared major within engineering while others are in the College of Arts & Sciences and considering changing their major into engineering.

Table 1. Students Participating in the First-Year Courses and PACES Evaluation Survey

Course	Total # students	# females	# 1st year	# declared majors	# students completing survey	# female	# 1st year
CVEN	56	10	48	45	35	8	32
EVEN	58	30	44	42	43	UNK	UNK

The survey was administered during the same time that ethics were being covered in the courses. The survey was administered via a web-site to the CVEN students, and 63% responded. The web portal indicates who has completed the survey, but does not link specific responses to specific students. A written survey was administered in class to the EVEN students, which 74% completed. In this hard-copy setting the students did not provide their name or any demographic information, so it is unclear exactly which students in the course completed the survey. A significantly higher percentage of the students responded when the survey was administered in-class, despite awarding 2-points of extra credit to students who completed the online survey versus no incentive when the survey was administered in-class. In the CVEN course a higher percentage of the female students, 80%, completed the survey compared to male students (59%).

There are significantly more females in the EVEN class, which may account for the higher response rate overall rather than the method of survey administration. The students participating in this survey were primarily first-year students majoring in either CVEN or EVEN. Both the online and in-class versions of the survey allowed students to select more than one response, if desired. This occurred in only a few cases; three CVEN students selected more than one response on one to three questions each.

In addition to the PACES survey results, other indications of how well the students learned about the importance of ethics were gleaned from the ethics homework assignment and a final reflective essay. One portion of the ethics homework assignment required students to draw parallels between the University Honor Code and the professional engineering codes of ethics. Better performance on this homework could indicate that the PACES survey and its discussion helped the students understand these similarities. In addition, there was a final reflective essay assignment at the end of each course. The requirements for these essay were fairly non-specific, instructing the students to "*reflect on your thoughts regarding Civil/Environmental Engineering"*. The students were asked how they define civil/environmental engineering, if their personal definition changed since the beginning of the semester, and how the content in the freshman course impacted their commitment to stay in the major. In some cases the students mentioned ethics in their discussion, and these instances were recorded.

Results and Discussion

PACES Survey Results

The CU student responses to the PACES questions are summarized below in Figure 1. Each of the 18 activities evaluated is listed on the vertical axis and the percentage of the students who rated each activity as cheating or unethical are shown as horizontal bars. The questions have been sorted to present those activities that the greatest percentage of the students classified as cheating at the top of the figure. The percentage of the students who indicated that an activity was neither cheating nor unethical can be determined by subtracting the cheating and unethical percentages shown from 100. Figure 1 shows that there were only minimal differences in the responses of the students in the CVEN and EVEN courses. Based on a contingency table and chi-square test, only one question had significantly different responses among the CVEN versus EVEN students: working in groups on take home exams.

Due to the similarities in the responses from the CU students in the CVEN and EVEN classes, these student responses have been pooled together. Despite linking the survey with the student review of the Honor Code which clearly describes a variety of cheating behaviors, significant percentages of the CU students did not acknowledge many important behaviors as cheating. For example, only 43% stated that working in groups on take-home exams was cheating. Overall, students seemed to discount cheating behaviors in contexts outside of class such as take-home and web based tests or quizzes. More students rated the same behavior as cheating when applied to exams or quizzes compared to homework, such as copying.

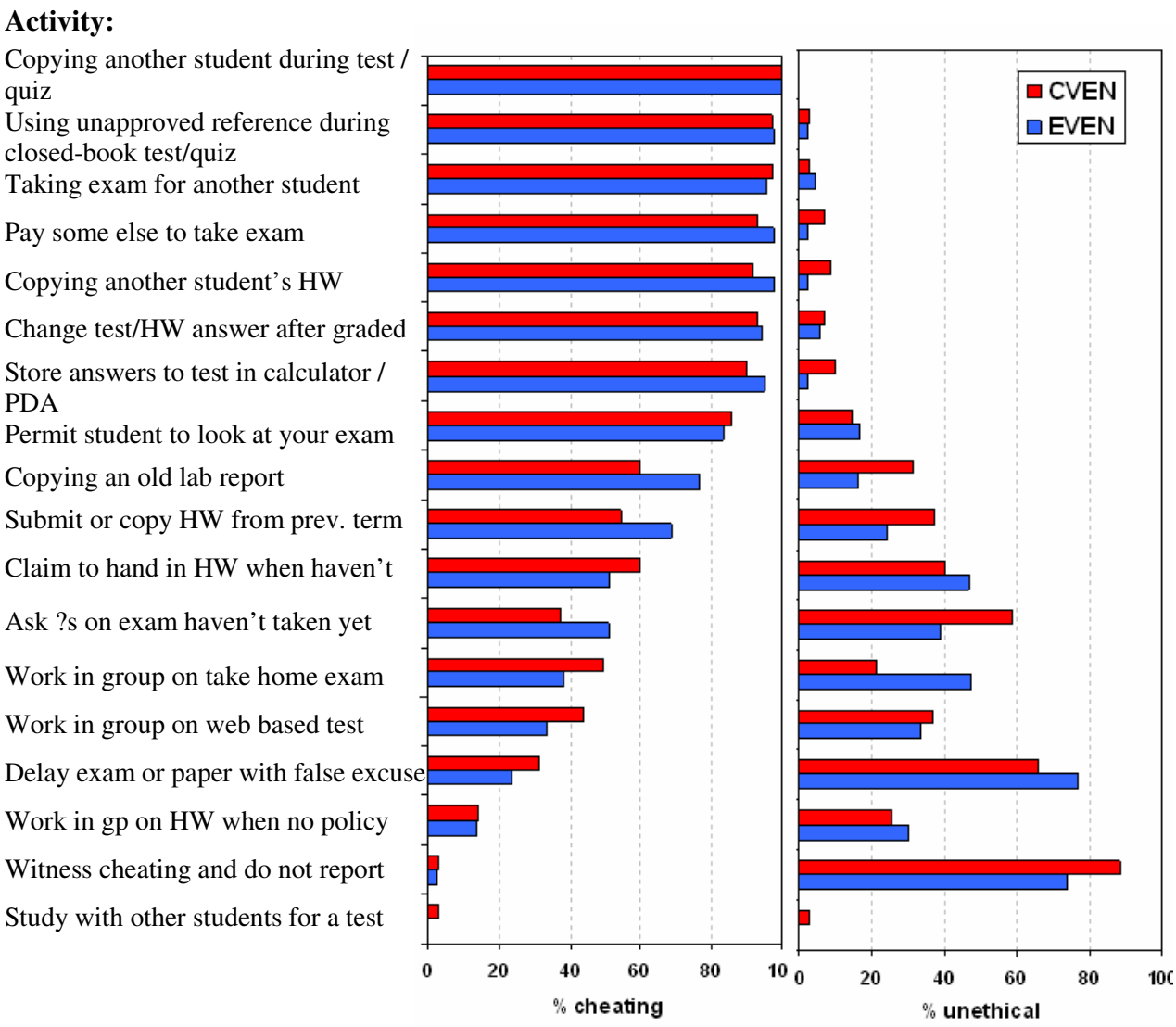

Figure 1. Percentage of CU students in CVEN and EVEN first year courses that rated various activities as cheating or unethical but not cheating. (The remainder of the students rated the activities as neither cheating nor unethical.)

The percentage of students who indicated that each activity was cheating were pooled from the two classes at CU and compared to engineering student responses in the Carpenter[1] and Mattei[2] surveys. The results are shown in Figure 2. In comparison to the results reported by Carpenter[1], five questions had a significantly different response among the CU students based on the chi-square test. A higher percentage of the CU students did generally report that activities were cheating than the engineering students who participated in the 2006 Carpenter et al.[1] and the 2008 Mattei[2] surveys. The largest exception was that only 36% of the CU students indicated that working in groups on web based quizzes or tests was cheating compared to 41% and 44% among the Carpenter et al. and Mattei engineering student respondents.

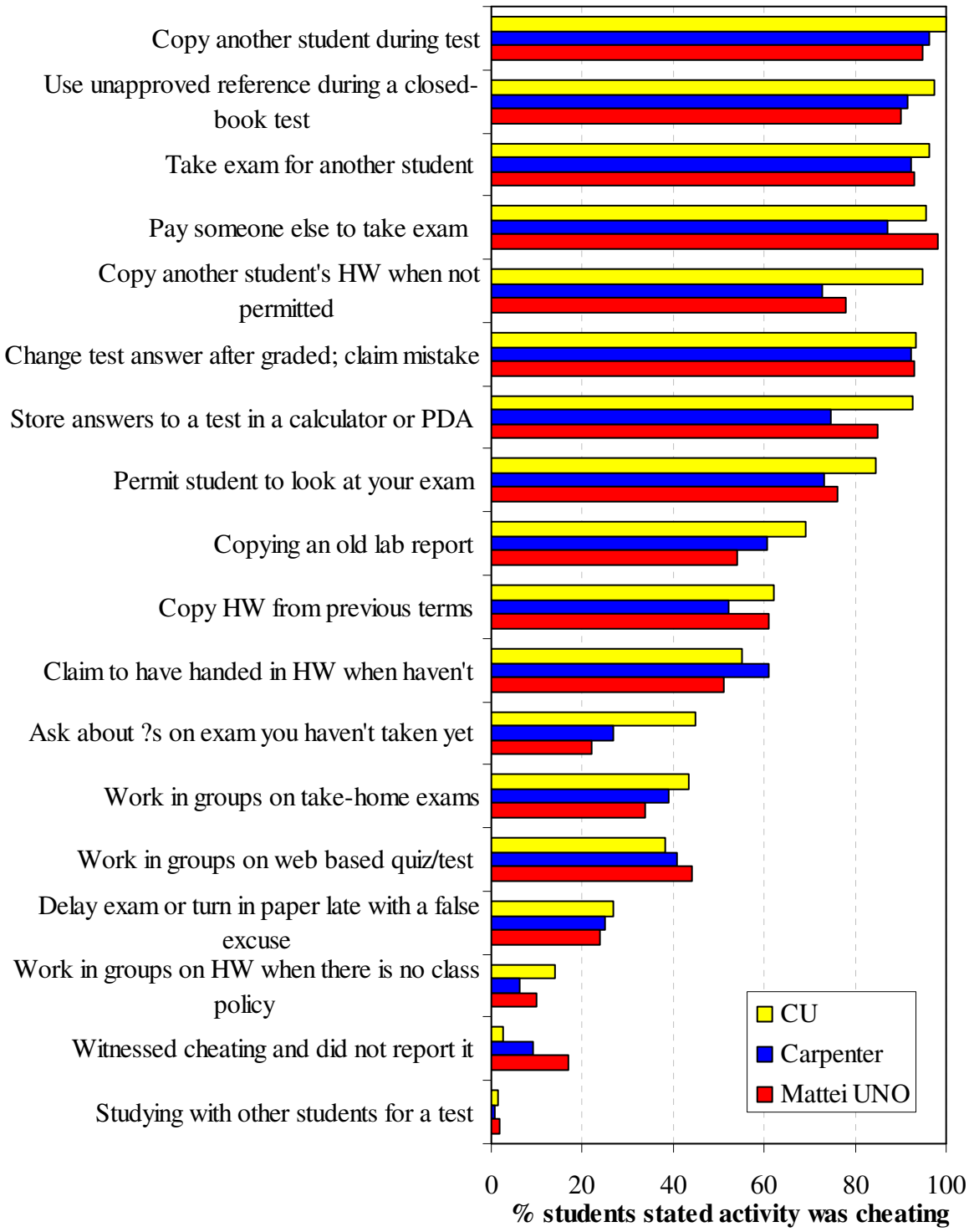

Figure 2. Summary of the percentage of students in different surveys who rated various activities from the PACES-1 survey as cheating. Questions sorted from high to low ratings by the CU students.

Differences in the responses of the CU students compared to the previous two studies may be due to administering the PACES-1 survey in the context of the course unit on ethics. This would

be a positive finding that at least students are aware of the university perspective on whether various behaviors are classified as cheating. However, differences could also be attributable to the demographics of the CU students (39% female, 84% freshmen, 97% raised in the US) compared to the 643 participants in the Carpenter study (19% female, 23% freshmen, and 77% raised in the US) and the 41 engineering participants across all years from the University of New Orleans who participated in Mattei's study (specific gender and class composition of the engineering students unknown). For example, Atakan[12] reported that female students majoring in Industrial Engineering and Business Administration in Turkey had higher standards for rating behaviors as ethical compared to their male peers. Rather than demographic differences, the difference may be due to the institutions. Burrus[13] found that students at institutions with well-publicized honor codes are more likely to consider a range of behaviors as cheating and admit to cheating compared with students at non honor code institutions. An abbreviated honor code statement is posted on a plaque in all classrooms at CU. The significance of a student honor code at the institutions in the Carpenter[1] and Mattei[2] studies is unclear.

Qualitative Information on Students' Ethical Understanding

There are indications that use of the PACES survey may have improved the students' learning of ethics. In the CVEN course, the average and median percentage scores on the ethics homework were 94 and 97, respectively, in 2008 when the PACES survey was used. This is higher than the average and median scores when the PACES survey was not used in 2006 of 88 and 91, respectively. (A different instructor taught the CVEN course in 2007, so the data cannot be compared.) More specifically, students who completed the PACES survey in the CVEN course earned an average score on the ethics homework of 95% compared to students who did not complete the survey with a score of 93%; this difference is not statistically significant based on a t-test. There was no difference in the average and median student grades on the ethics homework in the EVEN course; in both 2007 and 2008 these scores were 91 and 94, respectively. Thus, the evidence that use of the PACES survey improved students' understanding of ethics is inconclusive.

It does seem helpful to teach the professional engineering codes of ethics using a comparison to the student honor codes. When asked to draw specific comparisons between three parts of the CU honor code and the engineering codes of ethics, the students most commonly identified bribery, plagiarism, and fabrication/falsification as similarities. Example quotes from the student essays illustrate that they appreciate the direct parallels.

> "It is just as important to follow the Honor Code while you're in school as it is to follow the Code of Ethics when you're a professional engineer. Although it may not seem like a big deal when you're in college to cheat on just one test, this is a slippery slope that can lead to cheating again and again, and making it a habit that carries into your professional life. It is better to always hold yourself to the Honor Code and high moral standards. This way you will not have to make any adjustments when you get to the 'real world,' but instead you will be ready to abide by the Professional Code of Ethics."

> "I think that both the engineering codes of ethics and our own honor code boil down to living with integrity. The CU honor [code] is a set of guidelines, hoping to instill in us proper values that can be used later in life as well as in a professional setting."

"The CU honor code and the Engineer's code of ethics are very similar. The CU code could be applied to engineers because it addresses the community at large in regards to honor and integrity. Moral conduct is universal; it is not limited to a university nor is it limited to engineers. In that respect naturally we may find many crossovers between an honor code of one establishment (CU) and one of a profession. Thus we find that many infractions of the CU honor code are practically identical to infractions of engineering ethics."

In their final reflective essays on the course, 40 of 52 students in the CVEN course (77%) mentioned ethics. Of those 40, 25 (63%) had completed the PACES survey compared to only 10 (29%) who completes the PACES survey but did not mention ethics in their final essay. Some examples of students' comments include:

"To me, civil engineering is applying math, science, and ethics to create a better society. At the beginning of the class I did not think that civil engineering was publically oriented. However, the first cannon of the ASCE code of ethics is to 'hold paramount the safety and well being of the general public.' "

"Also I have learned, ethics and decision making play a huge role in civil engineers lives. It is important to be ethical and to make the right decisions as a civil engineer not only because the citizens put trust in you, but also because their safety is in your hands."

"Before taking this class, I had no idea about all of the ethics and moral responsibilities that must be upheld by civil engineers."

None of the CVEN students directly mentioned the PACES survey itself. A significantly lower percentage of the CVEN students (49%; 22 of 45) mentioned ethics in their final essays in 2006; a nearly identical ethics module was completed but without the PACES survey in the CVEN.

A similar comparison between students who did/did not take the PACES survey cannot be made for students in the first-year EVEN course, since it is unknown which students completed the PACES survey. However, the results from the PACES survey were presented and discussed in class, so that all students would be aware of how these behaviors would generally be interpreted by professors at CU. In 2008 when the PACES survey was included in the course, 39 of the 57 students (68%) who submitted a final essay mentioned ethics. This is higher than the number of students who mentioned ethics in their final essay in 2007 and 2006 at 20 of 43 students (47%) and 11 of 29 students (38%), respectively. As was true for the CVEN course, the other lecture, readings, and homework related to ethics in the course were the same in 2007 and 2008. Therefore, it appears that using the PACES survey raised students' awareness of ethics in the EVEN first-year course.

Summary

Selected questions from the PACES survey were administered to the students' in first year civil and environmental engineering courses via a web-based or in-class written survey, respectively. The survey results indicate that discussing ethics may cause small changes in the students' views

about cheating behaviors, but a significant number of the students still do not consider many behaviors as cheating despite explicit descriptions of those same behaviors as violations of the CU student honor code. It is important to share these results with colleagues, so that they explicitly describe their expectations with regards to working individually on take-home exams and web-based testing formats to students in their courses. Most colleagues that learned of these results were surprised at the high percentage of the students that did not consider these activities as cheating.

Discussing specific survey questions with the students after they completed the survey anecdotally seemed to change their impression of some activities. For example, the results from the survey were presented in-class during a discussion on the second day of the ethics module and students were asked after the discussion if they would change their answers to any of the questions. Only about 20% of the students raised their hands. Data to quantitatively determine if students' perceptions would change after in-class discussion have not yet been collected. This would require retesting the students. However, the "expected" response versus students' actual feelings may be reflected more strongly in a post-test environment.

In 2008 when the PACES survey was used, a higher percentage of both CVEN and EVEN students discussed ethics in their final reflective essay. CVEN students also performed somewhat better on the ethics homework. Thus, the use of the PACES survey may be a useful tool to raise students' awareness of the importance of ethics in civil and environmental engineering. Further data would be needed to determine if there are differences in the perceptions of cheating and engineering ethics based on gender or different engineering majors.

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