AC 2011-1375: OUTCOMES OF ENGAGING ENGINEERING UNDERGRADUATES IN CO-CURRICULAR EXPERIENCES

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Outcomes of engaging engineering undergraduates in co-curricular experiences

ABSTRACT

The effects of involvement in co-curricular experiences (i.e. internships, co-ops, service projects, and clubs and organizations) on student persistence in college is well documented in the education literature. What remains unclear are the specific ways that involvement influences the development of engineering undergraduate students. We found that when engineering students are involved in co-curricular experiences they exhibit greater leadership skills, are more thoughtful about their ethical decisions, and can articulate how involvement influences their ethical development. In this paper, we explore outcomes of participating in co-curricular experiences for engineering students at four undergraduate focused institutions.

INTRODUCTION

The effects of involvement in co-curricular experiences (i.e. internships, co-ops, service projects, and clubs and organizations) on student persistence in college are well documented in the education literature[1, 2, 3, 4]. These effects include persistence from year to year, broadening of career choices, graduation, and having an improved holistic educational experience[5, 6, 7]. Despite the growing research on the educational experience of engineering students[8, 9, 10], less is known about the specific ways that involvement influences the ethical development of engineering undergraduates. We found that when engineering students are involved in co-curricular experiences, they exhibit greater leadership skills, are more thoughtful about their ethical decisions, and can articulate how involvement influences their ethical development. In this paper, we explore the outcomes of participation in co-curricular experiences for engineering students at four undergraduate focused institutions.

LITERATURE REVIEW

Student involvement has been widely researched and has been linked to college retention and graduation[1, 2, 3, 4]. The earliest findings using national data found that students who are connected to the fabric of the institution through involvement with peers and faculty are more likely to be retained than students who are not involved. Despite these findings, it was unclear in the literature as to which specific co-curricular experiences were beneficial to students. As a result, some scholars reconceptualized the term "involvement" to include any purposeful educational activities, sponsored and/or supported by the institution in which students devote their time and energy[5, 6, 11, 12,] . Thus, an institution can facilitate high or low levels of student involvement by supporting (or discouraging) student involvement.

Scholars[2, 12, 13] assert that the collegiate experience of students is at stake, warranting the need to study student involvement. Evaluating student involvement can help administrators, faculty, and staff better understand how campus programs and classroom pedagogy influence student development [9, 14, 15]. There remain limitations to the research on student involvement. We know that involvement is related to several outcomes[1, 2,3,4,5,6], however, less is known of which types of involvement are most significant, especially for diverse student populations[11]. In addition, we do not know which co-curricular experiences benefit students by academic discipline (i.e. does involvement in Greek life have a positive or negative impact on students in engineering majors). This paper adds to the existing research on student involvement by

exploring how involvement (as defined in the extant literature) impacts engineering students. Thus, this qualitative study will address the following question: What outcomes are produced when engineering undergraduates are involved in co-curricular experiences?

CONCEPTUAL FRAMEWORK

Our conceptual model of a student's ethical development during college draws from the work of Astin's[1] Inputs-Environments-Outputs, or I-E-O, model, and that of Terenzini and Reason[16]. Our model conceives of several distinct, yet interconnected, domains affecting a student's ethical development: student characteristics, institutional culture (comprising both organization context and peer environment), and individual student experiences (including formal curricular experiences and co-curricular experiences).

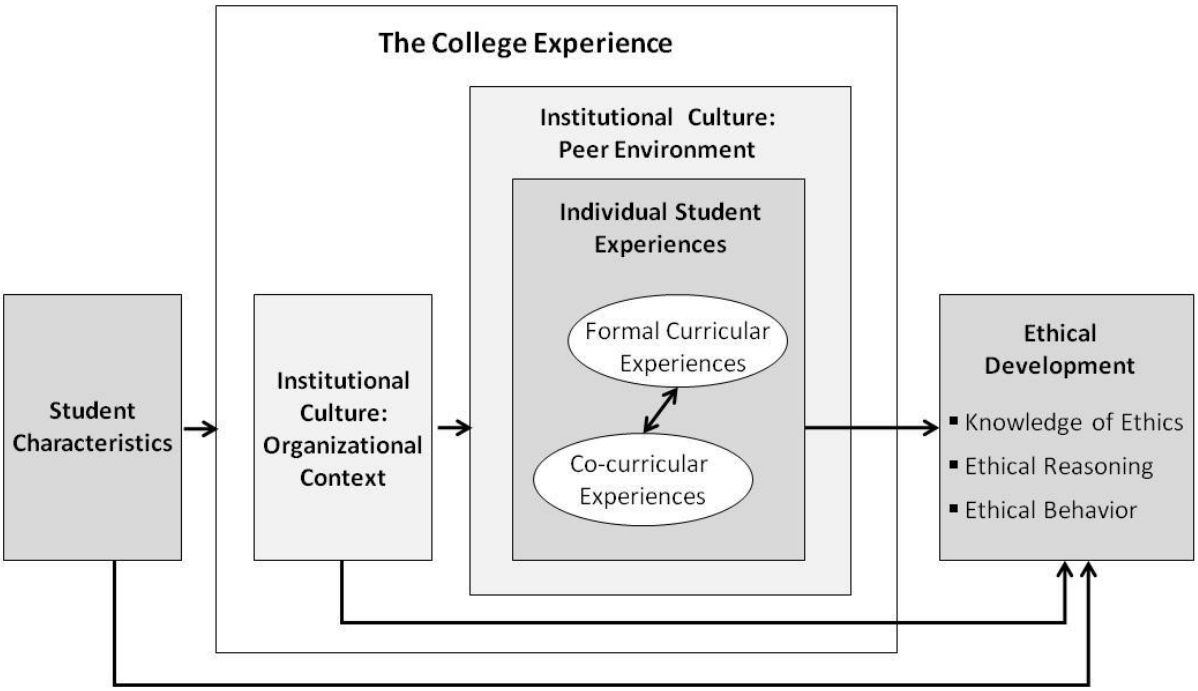

Figure 1. Conceptual Model of a Student's Ethical Development During College

Institutional culture, shown in the center of the model, influences the experiences a student has while attending college. Institutional culture refers to the culture of the engineering school or department within the context of the institution as a whole, both of which influence student outcomes.[1, 12]. Institutional culture is parsed into two constructs: organizational context and the peer environment. The organizational context comprises the formal structure of the organization, the informal structure of the organization (i.e. the balance in priority between teaching and research, and faculty composition), and academic policies and priorities (i.e. the presence of an honor code, or lack thereof). The peer environment represents the environment created by the student body at an institution and within the engineering school or department. This peer environment includes the socio-demographic composition and other characteristics of the student body, as well as understood norms, dominant values, and attitudes (i.e. the prevalence of cheating, a student's opinion of cheating behavior). As a result of the student's college

experiences, shaped by the institutional culture, ethical development (as defined by their knowledge of ethics, ethical reasoning, and ethical behavior) is directly affected.

METHODOLODGY

Data Collection

We visited 18 institutions over a three-year period. The collection of institutions was divided to encompass multiple institutions from each Carnegie classification. The purpose of the study, funded by the National Science Foundation (NSF), was to understand how institutional culture and educational practices affect the ethical development of undergraduate engineering students.

We conducted two 90-minute focus groups at each institution: one with engineering undergraduates and one with engineering faculty members (both students and faculty members represented diverse engineering disciplines). Students were randomly selected to participate in the focus group and recruited via email; faculty were invited to participate based on their knowledge and/or involvement in the teaching of ethics in their programs. Each campus visit also included two 60-minute individual interviews: one with an academic administrator and on with a student services administrator.

Finally, the information gained through the campus visits were used to develop the Survey of Engineering Ethical Development (SEED) instrument administered to approximately 4,000 undergraduate engineering students in Spring 2010, which is part of a broader research effort.

Sample

For this paper, we examine the experiences of students attending four institutions from our sample. These four institutions were selected because they were all classified as baccalaureate and specialty-focused institutions by Carnegie. Faculty data were included in this analysis to better understand the experiences of students, that is, students' experiences were cross-referenced with that of faculty members. In addition, faculty members often provided background information that helped clarify policies, institutional culture, and experiences that students discussed. Two of the institutions in this sample were located in the Midwest and two on the East Coast. Each institution is routinely regarded by national rankings as leaders in training engineering undergraduates. They all have rich histories in American higher education, each institution having surpassed 100 years since being founded. Finally, the student populations at these four institutions range from 1,000 to 4,000. For the purposes of this paper, the institutions were given the pseudonyms Alpha University, Bravo College, Charlie University, and Foxtrot Institute

Data were analyzed from a total of eight focus groups: four engineering faculty focus groups (N= 23) and four undergraduate engineering student focus groups (N=31). Males (20 students and 19 faculty) outnumbered females (12 students; 6 faculty) at both the student and faculty levels. In addition, a majority of focus group participants were White, with a relatively small number of Asians and Hispanics comprising the faculty focus group participants. Finally, approximately half the faculty members were tenured (N=12).

Procedures

Because we have a broad understanding of what the literature says about student involvement, yet we do not know as much about how involvement influences engineering undergraduates, grounded theory was the methodological approach selected to analyze the data. In grounded theory, the goal is to gain an understanding of the phenomenon from the data, compared to using a theoretical framework to guide the analysis (Creswell, 1998). Accordingly, the steps to data analysis include an iterative process in which the data help elucidate a cohesive story.

It should be noted that our conceptual model of a student's ethical development during college was used to guide the larger research project (including developing the semi-structured questions used during focus groups and the creation of the survey instrument). However, our conceptual framework does not restrict the analysis of data when using the grounded method approach. First, the transcribed interviews were read to identify possible explanations about the significance of student involvement at each of the four institutions (open coding). Second, open-codes were fit across the four institutions by grouping sections of data that were related (axial coding). Next, emergent themes were identified from the axial codes with discrepant evidence noted whenever students at the same or different institutions articulated disparate experiences. Finally, we constructed categories of patterns in our sample of four institutions.

FINDINGS

Student Populations

At each of the four institutions, students were described as being hard-working, focused, and high-achieving by faculty members. The students differed, however, in their levels of involvement in co-curricular experiences. The faculty members at Alpha University described their students as primarily focused on academics, "Our students really do nothing but school, uh, you know, are not involved in extracurricular activities in any meaningful way, do not have big lives outside of school, they just do this." At Alpha University, students stay in the engineering building to take classes and work with peers to complete assignments, without much involvement in co-curricular activities outside of the classroom.

Students at Bravo College, Charlie University, and Foxtrot Institute, on the other hand, were extremely involved in co-curricular experiences. One junior described Charlie University as a vibrant campus where students balance myriad of activities with their rigorous academic load, "We also have a really active campus, if you think about it. Like how many of us are either athletes or like intramural athletes or… like we all… no one has…is, you know, lacking for stuff to put on their resume, let's put it that way. Like we all are really intense with campus life and extracurriculars." One veteran faculty member at Bravo College described the students in engineering as "super students":

> The culture you were asking about our students is that they look at themselves, and I think for a good reason, as kind of the super-students on campus because they live in our building. You know, they…they spend more time here than, you know, in their dorms because they're always working here, they're up late, they sleep on the couches and they're doing all the stuff, whereas their counterparts in the other side of the university, you know, can get in and out in thirty-five hours a week. And I think that that…I'm not

> sure how that plays into the ethical development but that's…I think at least partly culture that I see.

At these three institutions, unlike at Alpha University, students were encouraged to be involved and responsible for their balancing-act of coursework and co-curricular involvement. Thus, according to the research on involvement, students at Bravo College, Charlie University, and Foxtrot Institute are the types of students engaged in meaningful experiences because their institutions supported student involvement[8, 10, 15].

Benefits of Co-Curricular Involvement

Involvement Promoted Leadership Development

According to the students at Bravo College, Charlie University, and Foxtrot Institute, involvement in co-curricular experiences provided them with opportunities to develop their leadership skills. In separate accounts, engineering students suggested that being involved on campus provided opportunities to model positive behavior to student peers. One senior at Bravo College stated:

> I just think one of the big learning experiences for college students isn't necessarily in the classroom, [as another participant said], but outside of it and I know, for me, having a large leadership role in a large organization has really helped me see that whole side of things. And having to make really tough decisions that affect other people, for me, has been probably the thing that has like…will affect me the most. And a lot of us have those similar experiences in different groups and I think those are the things that…I mean, mine has nothing to do with engineering at all, but it's still at Bravo College and so I think that that has been the biggest.

Another engineering student leader at Charlie University described how his participation in Greek Life provide him greater leadership training:

> I learned about it [leadership] from my fraternity so, yes, it was here, though, at Charlie. Definitely…we have regional leadership academies, leadership institutes over the summer that you go on and you learn how to better use your skills to become a better leader or what are some of the characteristics that you wanna build upon, where your weaknesses and strengths are and how you could use it…what your abilities are to be the most ideal leader for yourself and, then, the big thing is, you know, leadership can be learned; it's not something you're born with and anybody can improve upon it.

In both the previous examples, students articulated how holding leadership positions at their institutions helped develop their leadership skills. The instances in which they described modeling positive behaviors to peers, decision-making, and recognizing one's strengths and challenges illustrate transferable skills that students need to exercise in the professional world. As a result of their participation in co-curricular experiences, they became equipped with skills that would benefit them upon graduating from their respective institutions. Unfortunately, when students do not have opportunities to participate in co-curricular experiences they are responsible for learning these skills in the classroom and/or at the site of their first job.

Involvement Exposed Students to Ethical Decision-Making

Participation in co-curricular experiences exposed students to ethical decision-making in ways that the classroom experience did not provide for students. For instance, leadership skills were not only discussed in terms of how students behave in their respective organizations, students discussed how participation in co-curricular experiences empowered them to stand up to unethical behavior exhibited by their peers. This empowerment to address cheating behavior of peers was a result of developing their leadership skills through co-curricular involvement. One junior at Bravo College suggested that unethical behavior impacted more than the individual engaging in the behavior; it negatively impacted everyone in the classroom. Students felt an obligation to address unethical behavior among peers, "I feel like there is that atmosphere where it's like…when people cheat, they're not only like cheating themselves of the material, they're like cheating other students and like since you are so close to everyone, like there is just like this sense of obligation where you shouldn't do that."

In a similar account, a senior student leader from Charlie University discussed the challenges of addressing the unethical behaviors of peers. This student described how decisions have to be processed and the impacts of one decision over another need to be considered:

> The biggest things is like, motivation-wise, if you're dealing with peers and everything, 'cause, you know, they might not have the same priorities as you do and, you know, you may think your group is the most important and everybody should hold that as the most important but you gotta look at their lives. It's…I mean, being in a leadership role, having all these responsibilities, you can't lose the feeling of the people that are involved in the organization and that's the big thing, you know. These are the rules, OK, you did something wrong but I still have to look at what you're doing and, you know, how this would affect you if I just punish you without even considering your actions, you know?

In each previous example, students described engaging in ethical decision-making with peers in their organization and classes. It was rare for students to discuss with faculty members the ethical scenarios they faced. What was more common was for students to talk about ethics with people they considered experts, mentors working in the field of engineering. One student described the relationship with his co-op mentor, "I know on a co-op, like you usually have a mentor [at the site] or like someone you're assigned to who you can, you know, go to and ask like any question, whether it's like how do I do this problem or like what do I do with this situation. So that's helpful to learn from experienced engineers."

According to the students, the types of experiences they gained from participating in co-curricular activities were not provided in the classroom. In fact, a trend among students across the three engaged institutions were that students described an absence of classroom discussion on ethics. For some students they were able to juxtapose their experiences with peers in other academic programs that discuss ethics in more consistent ways. Students in this study commonly took an ethics workshop, freshman course, or senior professional series in which ethics was briefly addressed. Nonetheless, as one Foxtrot Institute senior suggested, "If you're not in the ethics course and you're not maybe in one of your freshman engineering courses, the word ethics doesn't even come up." Another student at Foxtrot Institute agreed that the discussion of ethics was scarce in the engineering curriculum, "This far, up to my sophomore year, we haven't had much even chance to apply ethics. It's just kinda grind out solutions and stuff like that so

there's…it's not even really pertinent." When the curriculum lacked discussions of ethics, students were able to recognize these gaps. They used their involvement in co-curricular experiences to supplement what skills and lessons in ethics were lacking in the classroom.

Involvement Influenced Students' Abilities to Articulate Ethical Development

The students who attended the engaged institutions often articulated their ethical development by demonstrating how they process various scenarios. As students reflected on ethical decision-making, common elements emerged: acknowledging an ethical dilemma, processing how to respond, and finally, identifying where they are in the decision making process. One senior at Charlie University offered a reflection on the ethical decision-making process:

> I feel like I'm often surprised at our school. Like I think they teach us to be very ethical engineers but I'm often surprised by how unethical some people's behavior is, like not as an engineer but as a student. And like, especially recently, like people like telling each other like what material is on exams and things like that…And, so that always surprises me like because…it's a very compromising position to be put in sometimes, I think, and that, like being forced to make that ethical choice can be very hard.

Another student discussed ethical development in terms of personal growth. This student at Bravo College stated:

> I think a lot of it is just personal growth…Every single time that I take a test and I could look at someone's paper and I don't, like, yay, me. And so like that, to me, is like me doing ethical behavior…I think part of it is just me getting older and having more opportunities to do something unethical and not taking them. It's a lot…probably something that all college students are going through; it's a very like pivotal age for us.

In the examples provided above, students acknowledged that they are routinely faced with ethical decisions. The most important aspects were their abilities to recognize these incidents and process the choices they made. Some faculty members suggested that the decisions students faced in the classroom were exacerbated because all of the students wanted to be the best, they were used to being high-achievers. As a result, faculty members felt as though students considered whether or not to cheat themselves, before considering telling on their peers. Nonetheless, the ability for students to identify unethical behavior, process their choices, and then reflect on the incident illustrated their ethical development.

Because the students at Alpha University primarily focused on their academic requirements, it was rare for students to engage in co-ops, internships, or other co-curricular experiences. Interestingly, faculty at Alpha University agreed that when their students participated in these experiences, they added depth to class discussions; students were able to draw upon their co-curricular experiences to help make discussions more practical for their peers. One student from Alpha University described how the ethical decision-making process was shaped as a result of participating in two internship experiences:

> I would say that looking at them [the internship company] and having that experience, whether or not it was they practice good engineering ethics or bad engineering ethics, I think reflecting on that helped me decide for myself what is good or bad engineering

ethics and what's important. At the one place I had, it wasn't necessarily the best engineering ethics probably, but looking back on that I say whoa, that isn't good. I need to make a point of avoiding that in the future focusing on that sort of stuff, too.

When ethics was not consistently woven into the curriculum, students lacked opportunities to engage in discussions of ethics in the academic setting. The exception however was for students who were engaged in co-curricular experiences that exposed them to ethical dilemmas in which they had to make decisions. Participating in co-curricular experiences improved their abilities to articulate the complexities of ethics. These varied accounts from students at different institutions illustrated how participation in co-curricular experiences influenced students' abilities to articulate ethical development.

DISCUSSION

The outcomes presented in the findings are salient because they primarily emerged in dialogues from students who attended the three institutions where students were involved in co-curricular experiences. By juxtaposing the lack of involvement of students who attended Alpha University, it becomes apparent that the students who attended Bravo College, Charlie University, and Foxtrot Institute benefited from their engagement. Faculty at all of the institutions included in this sample realized that students who were involved had enhanced opportunities to put into practice things they have learned in the classroom (e.g. seeing how ethics is practiced in other environments, and developing personal ethical standards). At the three institutions where students were more involved, faculty members, as agents of their respective institutions, influenced student involvement[5, 6].

Students at three of the schools in our sample described outcomes that resulted from participating in co-curricular experiences. Some of the lessons they learned in their various experiences complemented (or supplemented) what was taught in the classroom. The dialogues that comprised the benefits of involvement were drastically different for students who attended institutions where involvement in co-curricular experiences was scarce and not emphasized by faculty and administrators. The findings from this study suggest that there is a relationship between engineering students' involvement and the development of leadership skills, exposure to ethical decision-making, and the ability to articulate ethical development.

This paper focused on the benefits of engineering students being involved in co-curricular experiences. There is evidence of consequences for engineering students who are overly involved in co-curricular experiences, namely, increased pressure to perform well academically and increased need to manage time effectively, both which can lead to unethical behavior. There is also evidence that suggests that lack of involvement, may lead to unethical behavior. These findings add to the growing line of research on engineering students' ethical behavior[17, 18, 19, 20]. Further analysis is being done to explore the negative relationships that involvement in co-curricular experiences may have on engineering students.

CONCLUSIONS

Engineering students from the four institutions analyzed in this investigation are similar in many regards; they have small class sizes, greater interaction with faculty members than students who attend larger engineering programs, and they all attend institutions with reputable engineering programs. However, for four institutions that may seem similar based on size or

other Carnegie classification measures, the level of involvement in co-curricular experiences distinguishes these institutions.

Student involvement is an important component of the college experience. Repeatedly faculty hear from employers that they are looking for students who are engaged in out of class experiences because they are better prepared for the work force. One way to influence students to get involved is for faculty members to participate in behaviors they want students to emulate. Faculty volunteering in outreach and professional service events could positively influence students to get involved in meaningful experiences. Faculty members could also serve as faculty advisors for out of class projects and engage students in that way.

Creating the space in the classroom to discuss everyday ethical scenarios will benefit students who are involved in co-curricular experiences as well as students who are not involved. When faculty, staff, and administrators create opportunities for reflection, opportunities that link the out-of-classroom experience to the ethical lessons taught in the curriculum, we begin to engage engineers and create more robust learning experiences. Engaging students on the practical decisions they face in their organizations could positively influence how students view ethics in all situations they encounter. In addition to relating out-of-class experiences to in-class discussions on ethical development, institutions should create a culture that promotes student engagement with an understanding that there may be risks to students when they are over committed.

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