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Cultivating the Ethical Identities of STEM Students Through Enhanced Internships

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Cultivating the Ethical Identities of STEM Students Through Enhanced Internships

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Introduction

The oft-cited model of the engineer identity by Godwin [1] is comprised of three elements: interest, competence, and recognition. *Interest* refers to the desire of the individual to think about and engage in engineering. *Competence* refers to the belief in the individual's ability to perform engineering work and understand engineering concepts. *Recognition* refers to others' perceptions of the individual as a good engineer. A limited view of these three elements restricts their application to the realm of technical skills.

Adherents to this limited view might characterize an individual as a good engineer solely based on an observation that the individual enjoys math, science, and problem-solving (*interest*); is self-confident in their engineering ability or potential (*competence*); and is perceived by others as fitting the "engineering mold" (*recognition*). Further, it is arguable that these assessment criteria align well with four of the seven ABET student outcomes [2]. These are: i) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering science, and mathematics; ii) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors; iii) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and iv) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. However, these more technically oriented skills are, of practical necessity, supplemented with the equally important professional development skills encompassed by the remaining three ABET student learning outcomes that are focused on communication skills, ethical reasoning and decision-making, and interpersonal skills. Therefore, we argue, that the Godwin engineer identity model should be complexified and viewed as multidimensional (Figure 1). In our research, we are a particularly interested in the ethical skills dimension of the engineer identity and other STEM professional identities.

Contemporary issues such as the Volkswagen emissions scandal, the Surfside condominium collapse, and emergency vaccine development and distribution highlight the fact that mere technical ability is insufficient for engineers and other STEM professionals to fully live out their mandate to serve society in the practice of their craft—ethical reasoning, indeed, is an equally important component of STEM identities. The pedagogical challenge is to alter the aforementioned limited perception of such professionals and elevate the relative importance of ethical reasoning and decision-making so that it is on par with technical skills development and a core component of the STEM identity as well as to equip students with ethical competence.

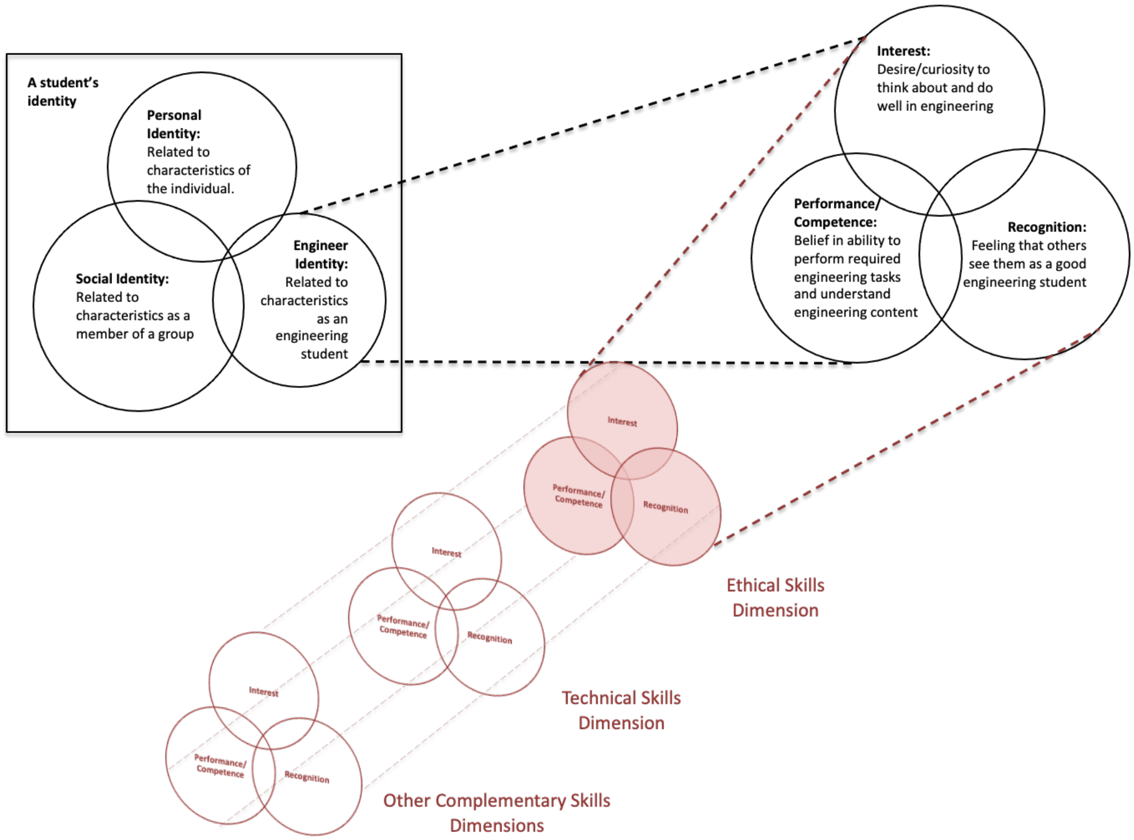

Figure 1: Framework for students' identification with engineering, adapted from Godwin [1]

Literature Review

Until rather late in the 20th century, the engineering[1] accreditation process gave little explicit attention to the ethical preparedness of engineering graduates for the work they were about to undertake [3]. Perhaps there was an assumption that the ethical background students brought with them from elsewhere would suffice, and not require any ethical instructional guidance. However, the number and severity of moral lapses in engineering practice that were brought to public attention raised serious doubts about the reliability of such assumptions [4, 5]. In response to this public outcry, ABET (formerly known as the Accreditation Board for Engineering and Technology) required engineering programs to incorporate an ethics curriculum. To comply with this requirement, engineering programs have developed stand-alone ethics courses—team-teaching environments where philosophers and engineers co-teach—and they have attempted embedding ethical concepts into additional courses in order to provide reinforcement and application [6]. In addition, academics have used case studies to simulate exposure of students to engineering work. The advantages to focusing on ethics education as a strategy include: instruction

[1] ABET accredits college and university programs in applied and natural science, engineering technology, and computing in addition to engineering. We believe that the fundamental argument we present regarding the engineering discipline more broadly applies to other STEM professions.

in ethics can increase awareness of responsibility [7], increase knowledge about how to handle difficult situations, and create confidence in taking action [7]. In addition, Canary et al. [8] found that ethics education can influence students' notions of their roles in and responsibilities to society. Much of this value is derived from discussions that increase awareness of issues or confront students with different points of view. Finally, Rulifson and Bielefeldt [9] indicate that ethics courses, among other things, can broaden or increase a student's sense of social responsibility as an engineer.

Interestingly, however, Rulifson and Bielefeldt [9] also discovered that some of the experiences students had in their technical courses and during engineering internships had the result of constricting this sense of social responsibility and, for some students, elevated the importance of company loyalty. Thus, we see the potential negative impact of engineering internships without an opportunity to reflect on engineering ethics as a component of those engineering practice experiences. We further see the positive potential of such reflection during internship experiences if it occurs in a nurturing environment that supports ethical development.

The potential of a pedagogical approach that includes reflection coupled with an internship experience is supported by the literature that indicates that case study analysis, reflective journaling, and subsequent reflective discourse can indeed impact beliefs and identity development [10-11]. Parsons et al. show that experiences like internships impact dimensions of the engineer identity, including experimental competence (i.e., the ability to conduct appropriate experiments and analyze and interpret the results). Experiential work experiences also enhance work self-efficacy, that is, "an individual's perceived level of competence or the degree to which she or he feels capable of completing a task" [12] (p. 602). Similarly, Ralph et al. [13] report one of the benefits of practicum-education is "developing confidence" as an engineer (p.125). Several studies also suggest that co-curricular practice impacts students' ethical skills and understandings. Guler and Mert [14] report that internship experiences contributed to students gaining awareness on acting ethically. University of California-Irvine noted that the workshops offered by practicing engineers resulted in a greater awareness among students of issues related to professional skills such as leadership and ethics [15]. In addition, Dukhan et al. [16] demonstrate that service-learning experiences, coupled with student reflection, resulted in students becoming more aware of their own attitudes and identities as engineers. Interestingly, a key finding of Meyers et al. [17] is that engineering internships could be either encouraging or discouraging of engineer identification development. More affirming experiences included internships characterized by challenging learning experiences. This highlights the need for additional formal assessment of internship experiences. To take advantage of this opportunity, our research proposes to make use of a feature of engineering programs that, as far as we have been able to discover, is largely overlooked in efforts to develop ethical engineers and meet the ABET ethics requirements: student internships. Our research builds on what little is known about the impact of ethics training on student development of a professional engineer identity by conceptualizing, measuring, and analyzing the development of an ethical dimension to this identity.

Enhanced Engineering Internships

We employ and assess a novel pedagogy that merges professional STEM ethics training with co-curricular STEM internships. Our pedagogical innovation, which we call an enhanced internship, includes the provision of ethics workshops for students immediately before they embark on their internships such that the ethics training becomes an interwoven component of the internships themselves. The initial ethics workshop and subsequent internship experienced is followed by another ethics workshop after the internships have concluded. The pre-internship workshop focuses on concepts, cases, and methods of critical analysis that can assist students in identifying and imaginatively think through ethical challenges in STEM practice. The internship itself can provide students with significant involvement in practice that should enable them to realistically reflect on ethical problems they encounter or observe in an actual STEM workplace. During the internship experience, students periodically journal about critical incidents they encountered as practicing STEM professionals.

We compare a group of students who, while embarking on internships, are not exposed to our enhanced internship to a treatment group who experience the full enhanced internship. In the initial trial of our developed survey instrument, we consider measures of engineering identity, such as competence, performance and recognition measures from Godwin [1] and centrality and regard questions from Chachra et al. [18]. We supplement these existing quantitative measures with qualitative measures adapted from such scholars as Rulifsen and Bielefeldt [10] regarding socially responsible engineering, and adding adapted measures from existing surveys, such as the Engineering Professional Responsibility Assessment (ERPA). The ERPA is intended to be used by educators to assess curricular interventions aimed at changing engineering students' views of social responsibility [19]. We have completed year one of our study and the purpose of this paper is to present the preliminary results of our pilot run, but we first describe some of the challenges we faced in our execution of the enhanced internships.

Challenges to the Fidelity of the Enhanced Internship Experience

History may one day separate time into a pre- and post-COVID eras. Such has been the impact of the pandemic. All sectors of society have seemingly been affected, including education. Our ability to deliver our educational innovation of an enhanced internship, too, was significantly impacted by the pandemic.

In our first year, travel restrictions and rescissions of internship offers led us to delay our initial pilot by a year. During this most recent summer of year two, we proceeded with delivery of our enhanced internships albeit with online delivery of the pre- and post-internship workshops instead of face-to-face delivery as originally planned. Despite some of the conveniences afforded by remote delivery, and the incentive of receiving $50 electronic Amazon gift card upon completion of the program, we were still only able to yield a net enrollment of 5 students who invested approximately 14 hours to complete all activities associated with the enhanced internship.

In addition to the significant impact of COVID, we encountered other challenges related to logistics that impacted study recruitment, retention, and engagement. In terms of recruitment, though the focal intuition has a compulsory internship course, as noted above, there were still challenges engaging the desired sample size in the treatment group. While the eligibility requirement of having a forthcoming summer internship limits the potential participant pool, we were hopeful that the incentives would attract the desired sample size for the treatment group. It is hypothesized that some students may have been dissuaded from participating due to the writing requirements despite the monetary incentives for completion of the various writing tasks. In terms of retention, we loss some willing participants due to workshop logistics. For example, though held after 5 PM on two consecutive weeknights, some employers prevented their interns from participating in the workshop due to other work obligations. In terms of engagement, only a minority of the participants completed all of the journaling and essay assignments. Such reflection is critical to the pedagogical approach. Further, students participating in the virtual workshops were potentially impacted by all of the distractions that oftentimes accompany that delivery modality. Again, active engagement in the workshop discourse is a theoretically critical component of the pedagogical approach. Lastly, not all students attended the final workshop. As a result, our final treatment group for this pilot launch totaled five participants. We are confident that we can address these challenges are optimistic that we will be able to attract the desired number of participants in the treatment group during the remaining years of our enhanced internship project.

Learning From Challenges

Despite the aforementioned challenges, the data collected from the pilot launch of our enhanced workshop, albeit limited, enabled us to learn a few lessons that we carry into our second iteration of enhanced internships. We sometimes learn more from our challenging experiences than we do when things go according to plan. While this seems to be an accepted truism in our everyday experiences in life, this method of learning is not reported much within the academy. What follows is our contribution to lessen the dearth of such literature.

In particular, we focus on a survey question regarding how important several characteristics are in order to be considered a STEM professional and a comparison of the pre- and post-internship workshop essays written by students. The specific survey question referenced required students to report on a 5-point Likert scale how important it was for the six characteristics listed to be associated with an individual in order to be considered a STEM professional. The survey was administered after the students completed their summer internships. Though our pilot sample is too small to make meaningful comparisons with the data from our comparison group, it is important to note a few findings from the comparison group, which was surveyed after they completed their internships. As a reminder, comparison group members did not participate in any of the enhanced internship activities. About 40% of the comparison group members were engineering students, with the remainder in other STEM programs. (This distribution is approximately the same as for the institution as a whole and for the participants in our enhanced internship.) Table 1 provides a further description of the comparison group. As Figure 2 below illustrates, the comparison group members had very similar responses for two items: "Making a positive social impact" and "Having technical knowledge in math and science." For both of these statements, in comparison to the other statements in the chart, only around 50% of respondents believed these items are very important, while around 80% found each of the other statements very important. This is somewhat striking for two reasons. First, none of the other ethical statements in the survey reflected the same degree of ambivalence as "Making a positive social impact," implying that this statement reflects perhaps a higher standard of expectation for STEM professionals related to their longer-term career goals, as opposed to items like "Accepting responsibility" or "Making ethical decisions." The differences among these three items will need further assessment. Second, the comparison group finding on technical knowledge is particularly intriguing, as 80% of the intervention group for both the pre and post survey marked that technical knowledge was very important to them. An analysis of our Year 2 data will perhaps shed additional light on this difference.

Demographic Composition of Comparison Group (N = 61)

Academic Major		
Business Analytics	3	5%
Computer Engineering	8	13%
Computer Science	30	49%
Data Science	1	2%
Electrical Engineering	4	7%
Environmental Engineering	2	3%
Mechanical Engineering	12	20%
Other	1	2%

Class Standing		
Junior (61-90 hours)	45	74%
Senior (91 or more hours)	16	26%

Gender		
Woman	12	20%
Man	49	80%

Race/Ethnicity		
African-American/Black	3	5%
Asian/Asian-American	3	5%
Multiracial/Mixed Race	1	2%
White	49	80%
Latino/a/x/e	5	8%

Table 1: Composition of Comparison Group

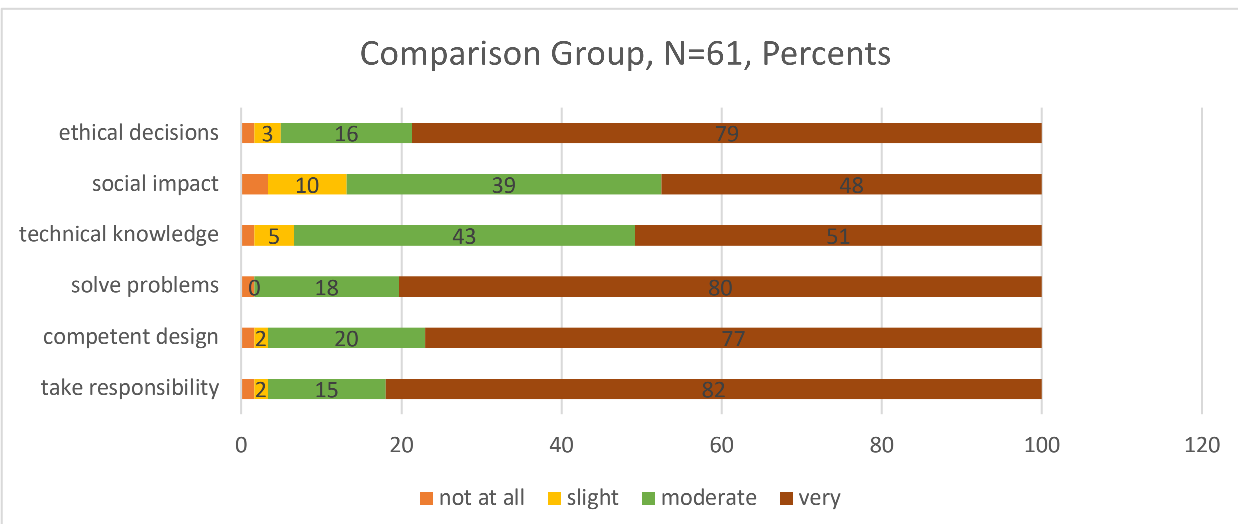

Figure 2: Comparison Groups' Reported Importance of Specific Characteristics of STEM Professional

A qualitative analysis of the pre-workshop and post-internship essays provides additional reason to look forward to year two with optimism. In the pre-workshop essay students were asked to write about the Volkswagen case, and discuss how they believe they would have acted if they had been employed by Volkswagen at the time. The discourse in student responses overwhelmingly focused on legalistic definitions of wrongdoing and ethics, with a very moralistic and narrow understanding of what was unethical. The terms 'punish' and 'deliberate' illustrate this emphasis, with students concerned that the appropriate individuals, those who were aware of the ethical breach, were punished because of their deliberate choices. In addition, students discussed management and organizational ethical failures. Students also demonstrated an awareness that there were consequences for ethical choices.

The Time 2 essays (Final reflections) were designed to have students reflect on their own internship experiences. Because a specific ethical dilemma was not given to the students, students needed to on their own consider how they witnessed or missed ethical actions and decision-making during their internship. Thus, student essays rarely touched on the moralistic, legalistic foundations of ethics that they had discussed in their pre-essays. Instead, a strong theme present in their final reflections focused on organizational actions and responsibility toward employees. The students spoke of how organizations symbolically and materially demonstrated their commitment to ethical behaviors. Students also placed themselves inside the workplace by discussing personal experiences that required ethical analysis associated with teamwork and especially how communication can be an ethical act.

To summarize, though the two sets of essays had very different intentional foci (the Volkswagen case versus their internships), by Time 2 students were thinking much more broadly about what could be considered ethical practice for organizations and individuals and had embraced a much more employee/team-centric (less client-centric) and a non-legalistic approach.

Conclusions

Though we have not yet yielded a sufficient sample size to draw meaningful conclusions regarding the efficacy of the intervention, we have learned from our efforts to date and look forward to using these insights to enhance the delivery of our pedagogical model of an enhanced internship going forward. First, there is evidence that our assumptions about the pervasiveness of a restricted view of the STEM professional identity that emphasizes the technical skills dimension of this identity are correct. This reinforces our need to promote a more equitable balance between the relative importance of technical and ethical skills as an important learning outcome of the enhanced internships. Second, based on students' essay responses, we have noted the potential need to expound upon the differences between violations of law and violations of ethics when discussing cases that make the former more explicit. Third, based on the number of participants in the pilot group, we are brainstorming ways to collect data from the study participants in a manner that may be perceived as less burdensome by them while still affording us the data richness required for our analysis. We are also altering our recruitment approach in an effort to dramatically increase participation in the study. Lastly, we have made some logistics changes to further lower some of the perceived barriers to participation including changing the timing, location, and delivery mode of the two workshops. We are also working on increasing the incentives related to completion of the enhanced internship, including academic recognition as an Ethics Fellow and increased monetary compensation. It is our hope that these changes will yield the sample size needed to truly assess the efficacy of our pedagogical innovation.

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