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Senior Engineering Students' Reflection on Their Learning of Ethics and Morality: A Qualitative Investigation of Influences and Lessons Learned

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Abstract

Informed by ABET accreditation criteria and broader societal needs, ethics has been emphasized as important for engineering professionals. Engineering students are thus exposed to professional ethics and related concerns throughout their college experiences both within and beyond the formal engineering curriculum, but little is known about what learning experiences and lessons engineering students view as most memorable and salient as they approach graduation. Therefore, this paper answers the following research questions: RQ1) What types of experiences do senior engineering students report as salient learning experiences for their ethical and moral formation as they approach graduation? and RQ2) What do students learn from the most commonly discussed types of experiences? To address these questions, we conducted semi-structured interviews with senior engineering students (n=33) and performed inductive thematic analysis on the resulting transcripts. Among various types of experiences that students reported as influencing their ethical and moral perspectives, this paper highlights work experiences, formal education, and family environment as the most frequently mentioned. Our results suggest that work experiences were especially significant for students' learning of engineering ethics in a professional context, followed by academic experiences as a source of both professional/ethical and more general moral lessons. Many students also described family and friends as influential, especially as related to their general perceptions of morality. Based on these findings, a variety of educational implications are discussed.

Keywords Engineering ethics · Ethics education · Internship · Co-op · Family · Morality

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Introduction

Ethics has been explicitly emphasized as a required student outcome in undergraduate engineering degree programs since the implementation of Engineering Criteria 2000 (EC 2000; ABET 2006). Current ABET accreditation criteria more specifically mandate that engineering graduates should have "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments" (ABET 2019). Most professional associations for engineers also have ethical codes for their members, and many companies maintain their own ethical standards which apply to engineers and other employees. Engineering ethics is thus typically treated as a kind of professional ethics, which Davis (2006) describes as "special, morally permissible standards of conduct every member of a group wants every other member of that group to follow even if that would mean having to do the same" (p. 728).

In contrast, Davis defines morality as "standards of conduct [that] everyone […] wants every other to follow" (p. 728). Thus, morality is equally applicable to everyone, whereas professional ethics applies only to members of a specific group. Nonetheless, the boundaries between personal and professional values and behaviors are often unclear (Pipes et al. 2005), and personal moral values can play a role in professional practice (Green 1997; Hazard 1992). In the engineering ethics field, Martin (2002) further argued that professional ethics are not reducible only to obligations shared by all members of the profession, highlighting "the relevance of personal commitments to professional life" (p. 547). He additionally noted that personal moral commitments often influence an individual's career pathway as an engineer, from decisions about which job to take to preferences for specific work assignments. Many engineering students are likewise exposed to many experiences outside of formal courses and curricula which might reflect and/or shape their broader personal commitments, such as volunteer activities within their local communities.

Engineering students thus have varying levels of exposure to concerns related to ethics and morality, and their experiences may in turn influence their ethical formation as engineers (Finelli et al. 2012). However, in-depth understanding of the specific lessons they learn about ethics and morality, both within and beyond the formal engineering curriculum, is lacking. For example, Hess and Fore (2018)'s systematic literature review of U.S.-based engineering ethics interventions showed that while more than half (16 out of 26) of the analyzed articles reported qualitative evaluation results of their ethics interventions, only four of them systematically evaluated students' narrative accounts of their learning or reasoning through interviews or focus groups. Also, among their analyzed articles, only three of the identified interventions were extracurricular activities, suggesting that engineering students' learning of ethics and morality outside of formal ethics education settings has not been deeply explored or understood, although educators have anecdotally noted such impacts (Burt et al. 2013).

Also, while engineering students undergo various experiences throughout their college years, it is not known what learning experiences and lessons engineering

students view as most memorable and salient as they approach graduation and the beginning of their careers. A better understanding of such experiences can help educators facilitate engineering students' ethical formation, even if the experiences themselves are not specifically related to engineering. Therefore, in this paper, we address the following research questions: *RQ1) What types of experiences do senior engineering students report as salient learning experiences for their ethical and moral formation as they approach graduation?* and *RQ2) What do students learn from the most commonly discussed types of experiences?*

Literature Review

Previous literature has reported various types of experiences that impact engineering students' learning of ethics and morality. In this section, we report what such studies have discussed in three main categories: formal coursework, extracurricular/cocurricular experiences, and non-academic experiences.

Formal Coursework

Formal coursework, including stand-alone ethics courses and modules in other engineering courses like capstone design, remains the most extensively documented experience type for ethics learning. One of the most popular learning objectives of formal ethics education is developing ethical reasoning skills (Beever and Brightman 2016; Clancy 2021; Finelli et al. 2012), and evidence suggests that ethics coursework can lead to development of such skills (Loui 2006; Self and Ellison 1998; Willson 2013). For example, Mayhew and King (2008) studied students in five undergraduate courses with ethics components and found that students in courses with explicit moral content experienced larger gains in their reasoning skills. While many studies report positive gains from formal ethics coursework, other studies have reported more variable results. For example, another study of undergraduates who completed a formal engineering ethics course found that students still struggled to effectively identify nuanced ethical situations (Shuman et al. 2004). Similarly, Rulifson and Bielefeldt (2019) noted that the effect of specific courses may be rather transient. In their longitudinal study, 8 of 21 students interviewed in their senior year did not cite any particular course, at any point in their undergraduate education, as being meaningful in developing their understanding of social responsibility.

In terms of specific coursework in typical engineering curricula, the senior design/capstone experience has been often discussed (Catalano 2004). In fact, a large-scale survey of upper-division engineering students found that 29% of students stated they learned about ethics in a capstone/design course and 11% of students identified the capstone/design course as the most influential setting where they learned about ethics (n=3914; Finelli et al. 2012). Another longitudinal study found that 4 of 21 interviewed students stated that a design course (senior design or capstone) was influential in their perception of the importance of social responsibility (Rulifson and Bielefeldt 2019). Engineering capstone courses also provide

opportunities for students to face ethical issues as they work in teams. While engineering students have observed that working in teams can help them learn to take responsibility and support one another, collaboration can also introduce new ethical issues such as inconsistency in the completion of work tasks and distribution of credit for that work (Solnosky and Fairchild 2017).

Students also often encounter issues of academic integrity in their coursework (Harding et al. 2004), which may provide them with opportunities to view such experiences as moral or ethical concerns. Despite the majority of students (95.4%; VanDeGrift et al. 2017) reporting that they feel it is important to earn their degree without cheating, many engineering students report that they cheat due to the various pressures they experience in the academic setting (e.g., lack of time) (Harding et al. 2004). Another study of college students more generally observed that many relaxed their attitudes toward cheating during their time in college, saying that sharing answers is an acceptable way to support other struggling students (Robinson and Glanzer 2017). Harding et al. (2013) also reported that engineering students' willingness to engage in academic dishonesty increases as they progress toward upper-level classes, along with evidence of correlations of self-reported unethical conduct in both academic and workplace settings.

Extracurricular or Cocurricular Experiences

Extracurricular or cocurricular experiences have has also been discussed as influential for the ethical and moral development of students. For example, Bielefeldt and Canney (2014) showed that engineering students' participation in service-learning activities positively correlated with higher social responsibility scores. Aligned with this finding, Huff et al. (2016)'s survey study of engineering alumni showed that 66.5% of respondents reported that EPICS (a service learning program at Purdue University) contributed to their ability to recognize ethical issues at work and 61.7% of them reported that EPICS contributed to their ability to resolve ethical issues at work.

Cocurricular activities like internships and co-ops have also been discussed as having the potential to significantly contribute to engineering students' learning of ethics (Bielefeldt et al. 2020; Finelli et al. 2012). Internships and co-op experiences are an integral part of many engineering students' college experiences (Bielefeldt et al. 2020), and students often report such experiential opportunities as the source of more learning than their classes (Eyler 1993). As Eyler notes, workplace settings allow students to be "surprised by exposure to situations and information that conflicts with their assumptions about the world and that they will be challenged to explore further" (2002 p. 524). Although it was not specifically about engineering students, San-Martin et al. (2016) discussed the positive impact of the rotational internship on development of medical students' professionalism. Therefore, we might expect that engineering students' internship or co-op experiences would also have similar positive impact on their professionalism.

While few studies have more specifically focused on how work experiences influence ethics learning among engineering students, a handful of prior studies

offer mixed results. For instance, Burt et al.'s (2013) study of how out-of-classroom experiences influence engineering students' ethical formation reported frequent observations among faculty members about the positive influence of students' co-op and internship experiences on their ethics learning. The authors propose that internship and co-op experiences complemented classroom instruction on ethics by helping students connect ethics learning to engineering practice. Rulifson and Bielefeldt (2018) also reported that 7 of 15 students who participated in their longitudinal study explicitly linked their internship experiences to learning about socially responsible engineering, more specifically, but only four of these students reported expanded understanding over time.

Other Non-Academic Experiences

Experiences outside of university have also been often documented as influential to one's learning of ethics and morality. For example, religion has been reported as an influential factor on engineering students' attitude towards social responsibility. Bielefeldt and Canney (2016a, b) showed that engineering students' religious beliefs and the religious affiliation of their institution influenced their social responsibility attitudes. Travel abroad is also known to provide an opportunity for students to begin to consider the impact of their work and to be more aware of the needs of the public. Berdanier et al. (2018) studied the effects of a two-week long international experience for nine engineering students through a qualitative photoelicitation interview. These students faced ethical dilemmas in their work abroad and reported a greater awareness of the implications of engineering on a larger scale (notably considerations about regulations, gender roles, and sustainability) and the effects of design on "invisible stakeholders" (p. 253).

While not directly related to engineering ethics, studies in moral psychology have also highlighted the importance of familial influence on individuals' moral formation. As Mones and Haswell (1998) suggest, the family system works as "a funnel and filter from culture to family members and back again to culture in an ongoing feedback loop" (p. 98). They also argued that family culture is the most powerful influence on individuals' moral learning. Other studies have focused on various dimensions of morality as they relate to familial influence. For example, researchers have explored familial influences on individuals' moral judgment (Powers 1988; Speicher 1992; Speicher 1994; Walker and Taylor 1991) and moral identity (Hardy et al. 2010; Reimer and Wade-Stein 2004; Weeks and Pasupathi 2009), as well as specific virtues like honesty (Ma et al. 2015; Talwar and Lee 2011) and caring (Chase-Lansdale et al. 1995). Berkowitz and Grych (1998) additionally explored how parents' positive or negative behaviors related to moral issues serve as a model for their children. For example, children exposed to altruistic models often tend to be more altruistic (Bryan and London 1970), whereas families with interparental conflict tend to have more aggressive children (Grych and Fincham 1990).

Methods

Data Collection

This study is a part of a larger longitudinal, mixed-methods project that explores perceptions of ethics and social responsibility among undergraduate engineering students during their time in college (Zoltowski et al. 2016). Figure 1 summarizes the overall study design, which involved collecting data from students at four universities: Arizona State University, a public research-intensive university in the Southwest; Brigham Young University, a private, religiously affiliated, research-intensive university in the Mountain West; Colorado School of Mines, a public, primarily undergraduate-serving university in the Mountain West; and Purdue University, a public research-intensive university in the Midwest. Initial data collection for the study involved a survey on ethics, social responsibility, and related topics administered to 757 first-year students. Semi-structured interviews, typically up to about 60-minutes in length, were in turn conducted with 111 students who were recruited from this same pool of survey respondents.

The data analyzed for this paper are exclusively based on the follow-up interviews conducted with 33 of the original 111 interviewees during their fourth (typically senior) year of study. We focused on senior engineering students' data to better understand engineering students' perception of their learning as they approached graduation. Among these participants, 8 students were from Brigham Young University, 12 were from Colorado School of Mines, and 13 were from Purdue University. No interview data was included from Arizona State University due to participant attrition from the first to fourth year of the project. Also, 20 of the interviewees identified as male and 13 students as female. Of the interviewees, 27 identified as White, 5 students as Asian, and 1 student as mixed-race.

During the semi-structured interviews, we asked questions about students' own experiences related to ethics, how they understood ethics and related concepts, activities that might have shaped their ethical perspectives, etc. Our interview protocol is included in an Appendix to this paper. Additionally, it is worth noting that we intentionally did not pre-define "ethics" for this study, and instead asked students to define ethics during the interviews. As a result, students often described learning lessons about both

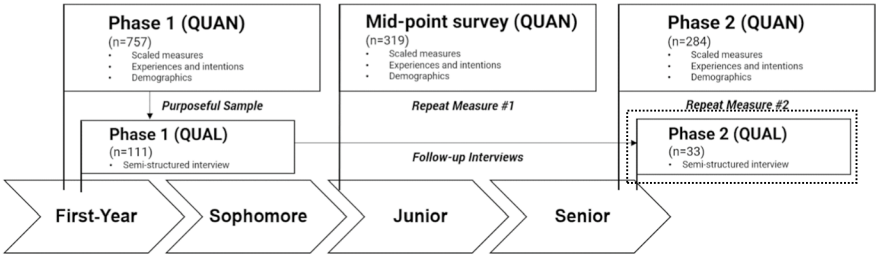

Fig. 1. Study design of a larger longitudinal mixed-methods study. This study focuses on the Phase 2 (QUAL) in the dotted line.

morality in general and professional ethics in particular, although we mostly used the term "ethics" during the interview. The interview protocol was designed for the entire project, and we used very similar interview protocols for the first-year and senior interviews. Not surprisingly, in the second interview students tended to share more experiences that they had in their college years compared to the first-year interview.

Interviews were conducted by three researchers affiliated with BYU, Mines, and Purdue respectively. All data collection was carried out under appropriate IRB approvals from each university. All names included in this manuscript are pseudonyms (Students with pseudonyms beginning with B are from BYU, pseudonyms beginning with C are from Mines, and pseudonyms beginning with P are from Purdue).

Data Analysis

The data analysis was a three-step procedure: First, we read through each of the 33 interview transcripts and coded any situation that students described as influential to shaping their ethical or moral perspective as *learning experience*. Such data was often elicited when students were asked to describe experiences, which influenced their ethical perspectives, and examples, which helped illustrate their definition and understanding of ethics. In this first step, we block-coded the data, which means when we found an example of learning experience from a paragraph, we coded the entire paragraph. Second, after performing this high-level coding, we clustered the learning experiences that students reported as influential to their perspective into categories (e.g., work experience, academic experience). Then we counted the frequency of each experience type. This step contributed to answering the RQ1 of this study. Third, we conducted inductive thematic analysis (Merriam and Tisdell 2016) within each category for the three most frequently discussed experience type. This step contributed to answering the RQ2 of this study.

As we discussed, we intentionally did not pre-define "ethics" for this study, and as a result, students described their learning about both morality in general and professional ethics in particular. Since our goal is to develop a foundational understanding of engineering students' learning of engineering ethics throughout college, we distinguished general morality and engineering ethics at the analysis stage. However, we include both types of examples because they were both frequently mentioned.

Results

In the second step of the data analysis procedure, we identified eleven categories of experiences: 1) internships/co-op, 2) academic coursework (including senior design), 3) family, 4) religion, 5) social (including friends), 6) travel/study abroad, 7) engineering professional societies and other engineering-related events, 8) undergraduate research, 9) volunteering, 10) honors programs, and 11) all other extracurricular activities. We grouped any experience types that had three or fewer respondents including student government, fraternities/sororities, participation in music or military groups, clubs, or residence life, in the "all other extracurricular activities"

category. These categories are well aligned with our previous report of types of experiences that seem to impact first-year engineering students' perceptions of ethics and morality (Nittala et al. 2018). In that prior paper we discussed academic, extracurricular, family, international, professional/work, religion, service/volunteer, and social/friends as influential experiences among the students in our study.

After identifying the eleven categories of experiences, we also counted the frequency of each category, as shown in Table 1. Here, frequency represents the number of participants who explicitly discussed the type of experience during their interview with us.

As Table 1 shows, the three most prevalent learning experiences were: 1) internships/co-op, 2) academic coursework, and 3) family. More specifically, 26 of 33 students mentioned the influence of work experiences such as internships or co-ops, while 24 discussed the influence of academic experiences and 22 referred to family experiences. Since each of these three experience types were mentioned by a strong majority (two thirds or more) of the interviewees in our study, in this manuscript we especially focus on these three experience types, including by presenting subthemes obtained from the inductive thematic analysis of data coded for each experience type.

Internships/Co-op

Findings relevant to ethics learning in workplace settings fall into four subthemes: 1) broader social and ethical considerations, 2) how different organizations and industry sectors approach ethics, 3) exposure to real ethical issues, and 4) specific learning outcomes.

To begin, a number of students discussed how their work in certain industries spurred their thinking about *broader social and ethical considerations*. For example, Christopher said that his internship in a military research lab was "the first time I'd

Table 1. Experience type and number of students who mentioned each

Experience	No. of Students
Internships/co-op	26
Academic coursework, including senior design	24
Family	22
Religion, including mission trips	11
Social, including friends	10
Travel and study abroad	8
Engineering professional societies (including their codes of ethics) and other engineering-related events (including Grand Challenges)	7
Undergraduate research	6
Volunteering	4
Honors	4
All other extracurricular activities	12

been approached or directly faced with something that I could see my action would cause some kind of chain to occur, and then I don't know where it could've gone," adding that engaging in this type of work helped him appreciate "that life's a little more complex; it's not black and white." Petunia, who completed multiple summer internships in industry, noted her growing awareness for the possible impacts of her process improvement work in a production facility: "you're still wanting to think about the people involved in the process and how your changes will affect them because if you make a change and you leave, it doesn't really affect you. Like, I'm gone … but any change that I helped implement would affect the people, the workers who worked there 40 hours a week."

Broadened awareness of the social and ethical impact of their work also influenced students' career plans. Corvin initially thought that "I'll be able to work in any industry, as long as I'm able to make money and I'm enjoying the work that I'm doing." Yet after an oil industry internship, he came to realize that "it does [matter] more than I expected it to, mostly because of that social responsibility aspect of it." He went on to acknowledge that while oil remains a necessity, his sense of responsibility toward climate change meant that he "didn't want to be a part of it [i.e., the oil industry], per se." Conversely, Padme described how multiple co-op rotations in a biomedical device company reinforced her career goals. After learning about how her company's role in providing orthopedic surgeries to individuals in need, she said it "made me sort of realize that's the kind of company I want to work for." She went on to explain: "I'm not sure if it majorly shook my ethical beliefs, but it definitely helped me fine-tune what sort of other ethical beliefs I want to align myself with."

Other students reported more specific learning about *how different organizations and industry sectors approach ethics*. Paulina's co-op experiences in an aviation company gave her a favorable view of "how the company presents themselves and how they set the example or lead by example for their employees to follow through with." Still others were impacted by their exposure to norms prevalent in specific firms and industries. Reflecting on how multiple internships in utility companies had shaped her views, Penny explained how "the number one top priority concern was always safety, safety for the employees and safety for the users." Exposure to the military/defense sector also seemed to have memorable impacts on multiple students. For instance, Beverly described how her internships with a defense contractor introduced her to stringent rules associated with work on restricted projects. As she explained, "BYU has set us up to a high standard, but working for this company has set me to an even higher standard."

Another group of students discussed insights gained through *exposure to real ethical issues* in their technical roles. Phineas, who completed multiple co-op rotations in a manufacturing firm, pointed to multiple avenues for learning. He spoke at length about day-to-day encounters with ethical issues, noting how such experiences "gave me a very practical experience on what ethics as an engineer looks like… It was real-life ethical choices, probably weekly." He went on to describe how he encountered "little decisions that were ethical that you can't be trained on in a class, so the experience was very good for hands-on ethical learning." Phineas additionally described specific situation that involved some degree of ethical ambiguity. During analysis of failure rates for a certain part, for instance, Phineas realized the company

often had to accept a small amount of error, as well as the uncomfortable reality of "putting a number to your ethics."

Many students commented on similar tensions in their work. Benson noted that his chemical engineering internship gave him a more realistic view of ethics in industry. He described how risk analysis work made him "uncomfortable at times," including when coworkers seemed to "brush off risk in terms of cost." As he summarized: "what I learned is you're not always going to see a perfect commitment to ethics in industry." Paulina explained how her work experiences in the aviation industry challenged her assumption that "when you think planes, you think everything has to be perfect." Describing how the company was forced to prioritize maintenance tasks, she explained: "We can be proactive about it [maintenance tasks] … but it's going to take some resources that are better spent or allocated somewhere else. So surprising [as] it was for me initially, … it makes sense that you have to prioritize and you have to be understanding of, like, there's something more important that needs to be taken care of right now."

Other students seemed to have more difficulty reconciling gaps between ethical ideals and pragmatic realities. Carlos expressed uncertainties about whether an equipment safety concern had been appropriately resolved at the national laboratory where he interned. For Carlos, exposure to this situation led to a bigger realization: "I learned that even small things like this are going to be ethical dilemmas. It doesn't have to be life-or-death kind of situation. It can just be, should we cut this red tape or should we follow the red tape kind of thing. … It taught me that I've got a long road ahead of me in terms of decisions, especially if I'm going to be a professional engineer and actually making the decisions."

A final cluster of results center on *specific learning outcomes* associated with student work experiences. Especially notable is evidence of increased confidence and moral fortitude among students facing ethical situations. For example, Phineas noted how he became more proactive in holding teammates accountable. Patricia, who had done multiple internships in a manufacturing setting, likewise described how quality control issues helped her see the difficulty of certain situations and need for moral fortitude. Reflecting on a disagreement with a machinist over the quality of a manufactured part, she explained that such experiences have "done a lot when it comes to me understanding … really just the pressure from all sides and why decisions can be so hard to make. Very few things are cut and dry." Asked to describe what she learned from such incidents, she added: "I would say the only thing would be maybe I had more confidence to stand up if I knew that what I was measuring was correct and that the parts were wrong."

Still other interviewees noted the importance of establishing firm commitments before facing ethical challenges. Reflecting on his work for a software firm, for example, Brody explained: "If you define your parameters beforehand, and the boundaries for yourself and for your company, whatever it is, it's a lot easier to stay within them and be confident in that."

While other types of workplace learning were mentioned less frequently by students, some are worth noting. Based on multiple internships doing testing work at an engineering company, Chad highlighted the importance of being transparent and truthful: "Transparency is what I really learned from the workplace… No matter

what you do, whether it's right or wrong, whether it's good or bad work, don't lie about it. Be completely honest because it could end up [pause] like if you fudge one little thing during a test, and then they go and launch the thing and it fails because you didn't account for it, that should fall on you because you weren't being transparent about something." Expanding on similar themes, Brody added: "If something goes wrong, you have to report it immediately… That was a big exposure, although it wasn't directly related to engineering or necessarily ethics. It was just one of those things where it was day in day out, making sure you're doing the right thing." As such passages suggest, workplace environments offer rich opportunities for ethics learning.

Academic

Students also discussed the influence of specific courses on the shaping of their ethical perspectives. Three subthemes were identified: 1) working fairly with others 2) understanding of the broader implications of engineering, and 3) academic integrity.

Senior capstone/design courses were mentioned by several students in relation to their attempts to *work fairly with others*. One area of particular concern was who is assigned credit for their work. Students noted the difficulty of working in a design course with other students who were not making adequate contributions, and were concerned about the potential consequences on the grades of students making lesser contributions. For example, Penny felt at peace with her decision to not report a non-participating team member to her professor: "If we had reported her for not doing anything, she would have probably not have been able to graduate." Petunia experienced a similar situation and likewise advocated for including a non-contributing student's name on a project: "I think I really couldn't think of a situation ever where I would, if they were a part of the team, even if they did nothing, like want to take their name off because that would be a major consequence to them." In contrast, Parson commented that one of his teammates had played a significant role behind-the-scenes and he made it a priority to make sure others were aware of these contributions: "I kinda felt bad that people would sometimes wonder what he was doing or what has he really done. And it's like actually he's been doing a lot, just not with us all there. So if there was ever anyone trying to allude at that, I would make sure that he knew that someone noticed." These students have an awareness, likely gained by working on other group projects, that not participating can seriously impact a student's grades if reported to instructors. These students are facing an ethical dilemma of giving credit where it is potentially not deserved, to the benefit of their peers and to the detriment of instructors who assign grades.

Additionally, some interviewees mentioned challenges associated with working fairly with users or stakeholders as part of their capstone/design courses. For example, Calvin's team struggled to inform the stakeholders about the constraints of engineering, observing a "rift" between what the stakeholders envisioned for the project and what his team could safely provide in a short timeframe: "There's a very different mindset than us engineers. Trying to explain that we need a little bit more safety or understanding what they even want sometimes is tough." From Calvin's

comments, and the aforementioned experiences of the three Purdue University students, we can see that these future engineers are grappling not just with the technical requirements of their design courses, but with a growing awareness about their responsibility to cooperate and communicate within their design teams and with other stakeholders.

Second, some students also mentioned how they gained *an understanding of the broader implications of engineering* in their coursework. The potential consequences of design were emphasized so frequently in Calvin's coursework that he felt that anticipating those consequences was automatic, stating that considerations for the "greater good that will just be installed in the back of our head for when we go into work. It's just the first thing we do on a project. We don't have to think about it as much because we've done it so much." Phoebe made a similar observation based on discussions from an engineering course which "really emphasized thinking about the life cycle of your product. So it starts when you make it, and then it goes out, and people buy it, and they use it, but what happens when it breaks?" The students' insights suggest that their coursework emphasized the need to anticipate design issues and impacts beyond the initial engineering problem to be solved. Beyond that, these courses gave them adequate opportunities to apply their knowledge so that such considerations became ingrained in their design process.

Though several students in this study had taken a formal ethics course (e.g., Nature and Human Values is a required course at Colorado School of Mines), their statements about what they learned in those courses were somewhat nebulous. Nonetheless, some did recall specific case studies. For instance, two University Mines students cited structural engineer William LeMessurier when asked to name a moral exemplar, remembered details from a case study about the weakness of the Citicorp building's structure in the face of quartering winds, and LeMessurier's actions to correct the problem. As Charlie stated "he [LeMessurier] was wrong, took the hit, and now, he's pretty revered heavily for his ethical decision to basically go back and fix his mistake because he knew the potential hazards instead of just ignoring it and waiting for something bad to happen." Cody similarly commented: "that entire thing could have cost this engineer his entire career, but he did the right thing." Both clearly recalled an engineer facing an ethical dilemma and then acting to ensure the safety of others, even at potential personal cost.

Third and finally, *academic integrity* issues were mentioned as a concern, particularly in engineering courses. However, these concerns were not always what one might expect. Students in this study were not always concerned about other students cheating, and in some cases even actively chose to support cheating. Answers to homework assignments were sometimes asked for and exchanged between students and accessed through other means, seemingly with tacit approval from the students we interviewed. For instance, Paula discussed at length how students in her engineering classes were initially reluctant to share answers to certain assignments, yet "as the semester continued, life got more hectic and people got more relaxed with it [sharing answers]." When a friend forgot an assignment, Paula offered to share her answers, which the friend turned down, saying "No, no, it's fine because I didn't have time to do it so I shouldn't be able to do that." As Paula reflected on that conversation:

> That stuck with me and so after that point, I interacted much less frequently in giving and receiving these answers. I think that there was one other person over the course of the semester who refused answers. They didn't ask, someone offered to them and they refused it because they didn't think that they deserved that because they didn't put in the work.

There is an interesting social dimension to this cheating. Paula willingly engaged in the sharing of answers and even volunteered her assignment to her friend. When asked about this further, she mentioned more about this social aspect: "I think there'd be times where other people would ask for those answers and they would not be given those answers because they weren't part of our group, I guess."

Chad, on the other hand, justified his use of an online resource to get answers as "learning from someone else who's already done it rather than sacrificing your own time, your own mental health, your own personal time and sanity," adding that doing so was actually the "right way" to get help. Similar to Paula's story above, Chad chose to justify his cheating as a way to accomplish a goal of getting his work done. Carlos, on the other hand, did express concern about the long-term effects of students cheating. He distinguished how he viewed the use of solution manuals as compared to others: "…in my mind, it's cheating. But in their mind, it's using a tool to get their homework done." As he went on to state, "But yeah, I think people do bend the rules and it scares me that these are the people that are going to be building my airplanes and building my cars and building my bridges." Unlike Penny and Petunia, who gave their classmates credit with no apparent concern about these classmates failing to master the material, Carlos shows an awareness that there are consequences to this type of cheating that extends beyond this particular class. Despite this, he did not report what he knew about this cheating to his professors.

As such passages suggest, throughout academic experiences, students learn specific lessons like how to work with others and broader implications of engineering, and are exposed to situations including moral dilemmas, including as related to academic integrity. Yet what they learn through these experiences may not be what is desired, especially as it relates to cheating.

Family

While not specifically probed in our interview protocol, many students discussed influences from their family members and family life. Unsurprisingly, most reports centered on general rather than engineering-specific lessons. Compared to evidence of learning in the Internships/Co-op and Academic categories, lessons from family experiences varied widely. Through the coding process, the lessons were grouped into three broad themes: 1) behavioral/dispositional lessons, 2) moral principles/perspectives, and 3) professionalism.

First, students discussed various *behavioral/dispositional lessons* they learned from their family experiences. For example, Beverly shared such lessons learned from her father:

> He [father] always taught me growing up that… to *think about the decisions we make before we make them*… Obviously he, my dad is a police officer for the police department. He's *held to a very high standard of honesty and ethics* every day… in split second decisions he has to make that regard his safety and the safety of others and people he doesn't know. People he worked with… they're good people down to their core, but they don't always make the best decisions. That makes life hard for everybody else, but he just tries to help others see that and just be honest in everything. He says that *honesty will never hurt*. I mean it's not always easy to tell the truth, but in the end the truth will come out… He works very close with his superiors, and that's key for him. It's honesty.

In this quote, Beverly describes that she learned from her father the importance of thinking about her decisions before she makes them and being honest. Braxton also shared what he learned from his father, although the specific lesson was different. Braxton said his father turned down his job because he disagreed with the employers' attitudes towards their employees. He said, "the degradation that they were putting onto others […] they overworked or didn't value employees […] my dad puts a lot of value into people, and so, for him that was something that was not morally right […] So he turned it down and moved somewhere else." Later in the interview, regarding a specific lesson he learned from his father's behavior, Braxton said, "That's always been a good example to me of like *just standing up for what you know is right*."

As another related example, Paula shared how her parents handled differences and what she learned from that. As she explained, "My mother is very democratic and my father is very republican and so anytime elections come around it's a bit heated but the way that they continue to respect each other […] They both have very strong moral compasses but they're also open to hearing all sides of arguments." Further reflecting on her parents' behavior, she said she learned "*[how to] figure out why or to try to understand why […] they [people who have different perspectives] believe that that's the right way to go about* […] I think growing up like that has also been very helpful and I definitely see it more now that I'm older."

Still other students discussed how their family history influenced their moral character, especially their *willingness to care for and help others*. For example, Carlos said he became interested in helping homeless people since he understands that his parents also came out of poverty. Additionally, Christiano stated: "Like my mom and dad, they come from Vietnam, and they always wanted their kids to be doctors because doctors have the most potential of helping people […] So I always came up with that mindset of I don't wanna be a doctor, but I do wanna help people […] my parents always wanted a profession for all their kids to help people."

Second, students discussed *moral principles/perspectives* they learned from, or that were shaped by, family experiences. As an example, Pete said his moral code and ethics came from being raised in a Presbyterian family. He described that alongside of many traditional Christian values, Presbyterian church also importantly considers "democratic value," in his words. He said, "It's like the principal that, in keeping true to *all people are created equal* in the structure of the church... So I think

that definitely has influenced how I view politics, definitely." Similarly, Bagheera described how growing up in a family with active membership in the Church of Jesus Christ of Latter-day Saints shaped his moral perspectives and taught moral principles that inform her decisions. As he said,

> I guess the biggest effect that that's had on my moral compass is the *understanding of absolute truth*. There seems to be a whole lot of gray area in the world, and when people experience ethical or moral dilemmas, they fail to recognize the principles on which the ethical dilemma is based… if you don't believe it's wrong to kill, then it's a gray area whether you should be making something that may or may not kill someone, depending on how it's used. So, that's an extreme example but it does [pause] *my view is perhaps more absolute in some ways because of the grounding principles which I try to let inform my decisions*.

Another example for this theme comes from Calvin, who shared how a discussion with his brother influenced his moral perspective: "He's working up at Company X headquarters. We have a lot, we definitely have a lot of ethical talks of like what they're doing… *That's where I get a lot of my ethical, moral decision making* is watching him and seeing what he does, and listening to him, and discussions we have with like how he views things and what he does with that."

While not as common as the previous two themes, students also discussed that they learned *professionalism* from their parents. For example, Cody said he learned professional integrity from his father, as his dad always tries his best for his company. As Cody states, "He [my father] doesn't really have to run into a lot of super difficult moral problems, because he's a programmer… But he just *tries to do the best for his company*." Christopher also noted that he learned the importance of being dutiful from his mother, explaining: "You need to put bread on the table somehow. That's kind of a duty to yourself. *To employers, engineers have a duty to deliver the best performance of whatever technology endeavor, objective, product they can, but also to have the interest of the user and the public in mind*, and if there's a direct conflict, then to bring that up in the structure of the company or organization they work for… That's the duty you have as an engineer."

Findings from this category suggest that many students perceive their parents, as well as other family members, as very influential for their moral formation. Yet as the preceding overview suggests, the specific lessons they reported learning varied significantly.

Discussion

We approached this study with broad research questions about what experiences engineering students reported as vehicles for learning about ethics and morality, and what specific lessons they learned from those experiences. And while our participants were undergraduate engineering students, the focus of our data collection efforts was not solely on "engineering ethics." Instead, we sought to explore how a wider range of experiences and associated lessons learned could have implications

for how these students think about engineering ethics. In the following, we discuss findings from each of the three types of experiences, including what students learned, how the students learned and in what context, and then discuss potential educational implications of what and how they learned.

Internships/Co-op

As described above, the present analysis found that fourth-year engineering students discussed work experiences, including co-op and internship roles, most frequently. We were struck by how often students discussed the influence of professional/work experiences, as well as by the amount of detail they shared about specific situations and learned outcomes.

Our results are aligned with the work of Burt et al. (2013), who noted faculty members' frequent observations about the positive influence of co-op and internship experiences on students' ethics learning. However, as mentioned in our literature review, Rulifson and Bielefeldt (2018) reported mixed results about the positive impact of internship experiences, which is not necessarily aligned with our results. Naturally, caution is required when directly comparing their results with our study, as ethics and social responsibility are not synonymous, and we focused on students' perceptions of influence whereas Rulifson and Bielefeldt (2018) compared students' comments longitudinally. However, it is interesting to note that while they suggested that the impact of internships may have faded from students' memory because interviews were typically conducted somewhat after their internships, workplace experiences seemed very salient for our participants even though our interviews were conducted after about the same amount of time.

Further, immersion in workplace environments most often seemed to involve spontaneous, informal learning among many of our interviewees. More directive or planned educational interventions, such as formal ethics training sessions or workshops offered by employers or universities, were mentioned less often. The informal learning students reported in their co-op and intern roles in turn often fell into two main categories. Through specific incidents or dilemmas that were usually relatively short in duration, many students reported increased awareness of – and in some cases an improved ability to navigate – typical workplace situations involving ethical considerations. Over longer spans of times (i.e., from weeks to months and even across multiple years and positions), many students also described how they gained deeper insights about the job roles, companies, and/or industry sectors they preferred, often aligned with an evolving sense of their own social and ethical commitments, as well as a larger sense of their identity as an engineer, professional, and/or member of society.

Academic

Looking beyond work experiences, we found students also commonly discussed the influence of academic experiences, yet what the students learned in their coursework went well beyond just the intended academic learning outcomes. Several students

brought up issues of fairness and were specifically concerned about their fellow students being recognized for work they did (Parson) and even for work they did not do (Penny and Petunia). Though none of these students explicitly state that they made decisions about attributing credit for work because of previous experiences, one can infer that they are reacting to previous group work experiences and their concepts about the consequences of not participating. The repercussions of formally documenting that a fellow student did not participate are perceived as so severe that Penny and Petunia were willing to forego such reporting, despite the fact that they felt their teammates did not deserve equal credit for the work of their groups. Parson also shows an awareness for the potential consequences to his teammate if others in the group report that teammate as inadequately participating. In fact, Parson makes a concerted effort to assure that this teammate is given credit though he never explicitly states what has prompted him to be so concerned for the teammate.

As students reflected on what they had learned about ethics in their coursework, formal ethics courses were rarely cited as settings where they learned about ethics, although eleven of these thirty-three interviewees reported that they had taken a formal ethics course within the last two years. This aligns with Rulifson and Bielefeldt's (2019) evaluation which suggests the effect of specific courses may be limited and transient. However, the fact that two Mines students in our study were able to independently recall a specific case study example from formal ethics instruction (e.g., the case study of LeMessurier and the Citicorp building) suggests that case studies may be especially persistent in students' memories, as compared to other types of instruction. Given the prevalence of case studies in ethics courses (Bielefeldt et al. 2017; Clancy 2021; Hess and Fore 2018), our findings provide continued support for the use of case-based methods. LeMessurier's example of moral fortitude, and others like him, could provide a template for these students to consider how might aspire to act when faced with ethical situations in their future employment.

When the students we interviewed discussed what they had learned through coursework, they rarely addressed the actual engineering content objectives of the course (with the exception of the Citicorp case study) but instead described how they learned from unauthorized online resources (e.g., Chad) and from each other (e.g., Paula). One example was students' experiences related to academic integrity. As discussed above, concerns about academic integrity and its prevalence in engineering courses have been extensively documented (Bertram Gallant et al. 2014); Harding et al. 2004; Robinson and Glanzer 2017; VanDeGrift et al. 2017). Our findings reflect similar themes, especially regarding the social aspects of student encounters with academic integrity issues (*i.e.,* a willingness to share with only one's friends or a desire to help someone out), such as reported in Robinson and Glanzer (2017). Our study participants seemed to be acting on accumulated knowledge about how to earn good grades and how to work with each other to reach that goal.

Family

Another important finding from our study was that students shared their learning about both general moral lessons and more specific engineering ethics lessons

during their interviews. While we did not pre-define "ethics" in the context of our interview protocol, for this study we acknowledge distinctions between the two domains considering the overall purpose of this project and following Davis' (2006) suggestion. Our results suggest that while work experiences were the most salient contributor to students' learning of engineering ethics, students' discussion about family influences mostly centered on general moral lessons. Academic experience reflected a mix of general and professional learning. This may be because students interact with their family mainly outside of professional contexts throughout their entire life. In contrast, academic experiences bridge students' personal and professional life while facilitating professional socialization, while the workplace allows students to perform as novice professionals, including through encounters with real-world ethical issues.

Although family influence was not cited by our participants as a source of learning about engineering ethics, it nonetheless represented a considerable portion of our data. This aligns with the claim that parents strongly influence their children's moral formation (Berkowitz and Grych 1998). It is also noteworthy that behavioral/dispositional lessons (e.g., thinking deeply before making any decision; standing up for what they know is right) emerged as an important theme out of the family influence, while such kinds of lessons were not evident in the workplace and academic experiences that students shared. A potential explanation for this difference is that students have been exposed to their family environment much longer than academic and internship/co-op environments. Also, as discussed, most of the lessons that students discussed were general moral lessons rather than engineering specific lessons. To sum, students learn general behavioral/dispositional lessons through the long-term interactions with their family.

Therefore, we would cautiously argue that the family environment functions as a grounding for students' further learning of ethics before their entrance to formal engineering education and future career as engineering professionals. This can be more evident when we consider that the third theme of the family influence was professionalism. However, this idea should be tested further to draw any educational implications, as there have been few empirical studies on the relationship between an engineer's general morality and their commitment to professional ethics. As some examples that explored engineering students' general morality for engineering ethics education, Beever and Pinkert (2019) and Clancy and Hohberger (2019) studied engineering students' moral foundations (Graham et al. 2013). However, none explored the relationship between the students' moral foundations and their ethical commitments. Considering the prevalence of family influence in students' reports, further research on such relationships and how to leverage them would be helpful for further exploring specific educational implications.

While delving into how students learned such lessons was out of scope of this paper, we found that many students described their parents as their moral exemplars. Also, we found that they likely learned the lessons through observation of their parents' behaviors mixed with their parents' direct guidance. For example, Beverly discussed how her father applied high standards of ethics, such as honesty as a police officer and taught her its importance. Also, Paula discussed how her parents respected each other's political perspectives which are different from their own. If

we acknowledge that it takes time to make behavioral/dispositional changes and that modeling with direct guidance is one mechanism that can make the change, educators may consider how to help students be exposed to good models for ethical engineering practice, and how to make such an exposure be more long-term. This aligns with previous efforts in engineering ethics education, such as Pritchard (1998)'s introduction of positive role models for ethical engineers and Davis (2006)'s micro-insertion approach.

Implications

While there is no singular definition of what constitutes engineering ethics, professional codes are especially prominent in engineering education and practice (Hess & Fore 2018). Our own results suggest many learned outcomes that are closely aligned with many of the precepts commonly found in such codes. For example, across all three settings (workplace, academic, family) we can find evidence of students learning about the importance of individual honesty and trustworthiness, or "doing the right thing" in more colloquial terms. In all three settings, students also reported engaging with questions about the responsibilities of engineers vis-à-vis society more generally, suggesting intersections with the "paramountcy" clauses typically found in engineering ethics codes, e.g., *Engineers shall hold paramount the safety, health, and welfare of the public* (NSPE 2019). In the workplace setting more specifically, attention to more localized kinds of quality and safety issues were also prominent, along with reflection on both the necessity and difficulty of engineers and their employers trying to balance risk versus cost. And in the academic setting, students grappled with conflicts of interest and attributing credit for work done – both of which are issues commonly mentioned in ethics codes, e.g., *We… commit ourselves…to credit properly the contributions of others* (IEEE 2020).

Further, we found little evidence that these kinds of informal learning were formalized or scaffolded by educators or employers, e.g., through structured reflection activities, focused discussions with assigned mentors, etc. This begs the question of whether more intentional interventions – including before, during, and/or after various kinds of experiences – could further enhance ethics learning among participating students. These proposed ideas could be implemented in both work and academic experiences as the issues the students face in those contexts are similar. Doing so could demonstrate to students the applicability of what they are learning in one context extends to other contexts.

Both academic and workplace experiences provide students with ample opportunities to consider issues of fairness. Educators and employers should consider leveraging such experiences to teach related concepts such as distributive justice, academic integrity, and honesty – ideas that are enshrined in various engineering codes of ethics (e.g., *Engineers shall… Conduct themselves honorably, responsibly, ethically, and lawfully;* NSPE 2019). For instance, students like Penny and Petunia could be encouraged to reflect on how they might approach a situation at work where they need to act as whistleblowers. Would they protect co-workers who were acting unethically, just as they protected their classmates from the potential consequences

of not contributing to team projects? Students often spoke of wanting to stay in good favor with their classmates, without noting that this is a potential conflict of interest between the expectations of their professors and their classmates. Would these students make a similar choice if they were faced with a choice between maintaining a relationship with their co-workers at the expense of their duty to their employer, relevant regulatory bodies, or even society more generally? Several students in our study reported using unauthorized resources (or at least being aware of others using those resources). How might these future professionals react to being aware of a co-worker misusing proprietary information at work? We propose that students should be made explicitly aware that they will likely encounter and need to decide how to act in future ethical situations.

Across settings students acknowledged other outcomes and characteristics, such as moral fortitude, which are not explicit in most ethics codes but nonetheless can be viewed as enabling or supporting ethical professional behavior. Students spoke of moral exemplars they had encountered in their own families or from case studies (i.e., LeMessurier). These examples could provide a template for students to consider how they might aspire to act when faced with ethical situations and show them ways to *commit [them]selves to the highest ethical and professional conduct* (IEEE 2020).

Finally, it is worth noting a lack of attention to some other themes commonly found in codes of ethics. For example, rarely mentioned in our data set were topics such as: improving the public understanding of engineering and technology; avoiding unlawful conduct, including bribery; not working outside of one's own domain of competence; not maligning other professionals; and encouraging mutual accountability in upholding the ethics code in specific fields. While further research is needed to explore these gaps, these may be areas where ethics training could be enhanced, namely by increasing attention to topics which are often neglected or overlooked.

Conclusion

In this paper, we found that senior engineering students report work, academic, and family experiences most frequently as contributors to their learning of ethics and morality. Students' learning spanned a wide range of lessons/outcomes, including micro-ethical considerations, macro-ethical considerations, and enabling or complementary characteristics such as moral fortitude.

Students' frequent references to work experiences is noteworthy, in that this learning occurs outside of the formal engineering curriculum. This finding corroborates the work cited earlier (Burt et al. 2013; Finelli et al. 2012). Considering the potential impact of work experiences, engineering educators may consider how to more effectively utilize students' out-of-classroom experiences to support ethics learning. For example, engineering educators may encourage students' involvement in professional experiences (e.g., co-op, internship) where they can develop a more nuanced understanding of engineering ethics. Then, educators may consider teaching ethics more in the context of professionalism by situating ethics course content

within engineers' daily work. At a minimum, educators, administrators, and even employers should consider providing students with more opportunities to reflect on their experiences outside of the classroom (e.g., extracurricular activities, volunteering, in the workplace) and connect these with engineering ethics to make meaning out of their experiences. This aligns with findings of Kim et al. (2020), which suggested that reflecting on previous experiences and making novel associations with engineering ethics can help expand engineering students' understanding of ethics.

We found that academic experiences, such as formal classes with and without a focus on ethics, provide students with opportunities to decide how they want to respond to ethical situations regarding academic honesty and fairness in teamwork. The case studies presented to students in engineering classes also seem to provide memorable examples of ethical situations and moral conduct. This finding supports the wide use of case studies in engineering ethics education (Hess and Fore 2018), as well as related efforts to introduce positive role models of ethical engineers (Pritchard 1998). Educators may also focus on the fact that students explicitly discussed behavioral/dispositional lessons with specific virtues as learning outcomes (*e.g.*, honesty) when they talked about family influences. Engineering ethics education has advocated teaching virtues (Frey 2010; Han 2015; Harris 2008), but most such approaches have been theoretical/conceptual rather than based on empirical findings. This could partly be due to the difficulty in teaching and evaluating virtues compared to knowledge and skills, e.g., as related to ethical reasoning. But given that our study participants often referenced virtues as outcomes of family influence, educators may want to think about how to leverage students' family experiences, or their pre-established value systems more generally, to help facilitate engineering ethics learning.

In summary, our findings suggest that engineering ethics education will likely be more effective when educators consider students' experiences both within and beyond the classroom, as well as their past family experiences.

Appendix - Interview protocol

CCE STEM Project - Final Interview Protocol - Spring 2019

Suggested interviewer script: *The interview protocol is essentially broken down into four sequential parts:*

1. *Experience with Ethics*
2. *General definitions (including macro-ethics)*
3. *Experiences past, present, and future (including justice)*
4. *Ethical climate*
5. *Ethical scenarios*

Introduction

To begin, please tell me a little bit about yourself, a 30-second elevator speech about who you are.

1. Would you say you identify as an engineer? Why or why not?
2. What are your main goals as a future engineer/professional?
3. What do you hope to achieve personally and/or professionally over the next 4-5 years?
4. In what ways have your goals been influenced by your experiences here at [student's university]?

Experience with Ethical and Social Responsibility (Phenomenography)

1. Can you describe an experience you have had with an ethical situation as an individual, student, and/or an aspiring professional?
    a. What was your role in the situation?
    b. Who else was involved in this situation? What were their roles?
    c. How did you approach the situation? Please walk me through the experience.
        1. Why did you take that approach?
        2. What led you to do things in that way? -OR- How did you decide to do these things?
    d. What feelings did you experience during this situation? -OR- How did you feel during this situation?
    e. How did the situation end? Were there any repercussions or long-term implications of the situation? If so, what were they?
2. Have you ever experienced any ethical situation related to engineering?
    a. Can you briefly describe the situation, including who was involved?
    b. How does it connect to ethics in engineering? (How is this an example of ethics in engineering?)
    c. How did you handle the situation?
    d. Why did you handle it this way?
    e. What was the outcome?
    f. What did you learn from this experience/incident?
    g. Do any other situations come to mind?

General Definition Questions

1. How would you define ethical or moral character?
2. Please identify and describe a person (e.g. someone you know, a historical figure, a famous person, etc.) who you think exemplifies moral character, personal or professional integrity, and/or social responsibility.

a. Why did you choose that person?
b. How would you describe their moral character?
c. How is their character exemplified?

3. What do you think it means for engineers to be ethical or to have high levels of professional integrity?
   a. What kinds of considerations, behaviors, attitudes, etc. are most important for ethical engineers to possess?
   b. What are some examples of situations where engineers face ethical situations in their work?
4. Explore relationship(s) between views on ethics and engineering ethics:
   a. How do ethics, generally, and engineering ethics relate?
   b. You just said XX about ethics and moral character. How does this view impact your beliefs about engineering ethics? *Possibly point out when they are inconsistent, and ask them to explain why.*

Macro-ethics

1. What professional responsibilities and obligations do you think engineers have to society?
2. What responsibilities do engineers have for the technologies they create?
   a. For example, can you talk about how and why you would/did respond to the following question: Surprising and risky uses or new technologies, such as social networking websites, are completely the responsibility of people who use them.
      A. Strongly Disagree
      B. Disagree
      C. Neither Agree nor Disagree
      D. Agree
      E. Strongly Agree
3. What duties do engineers have to their employers? (Refer back to the survey items 10.9 and 10.10 and ask the following questions)
   a. Before you talked about the duties engineers have to public. What should an engineer do if their duties to the public and their employer conflict?

Experiences, Prior and Future

1. You have indicated that you participated in [xxxx] activities.

(Interviewer note and script: List down all activities that the interviewee has participated in. See responses from *Experiences and Demographics" Item #1 and from the interviews*. Ask students to select specific activities that they think have shaped their ethical perspectives and explore the following prompts. Repeat as necessary for the other activities)

a. What motivated you to participate in that activity?
b. What is it about that activity that you think has shaped your ethical perspective?

2. Are there any other kinds of experiences that have shaped how you think about ethics and social responsibility—both in general and more specifically in relation to engineering practice? (***Interviewer note and script:*** *Additional prompt as needed: Have you participated in any volunteer activities, church programs, travel, special coursework, encounters with family or friends, student clubs, places you've lived, places you've worked, etc.?)*

a. Why did you choose to participate in this program or have these experiences?
b. What is it about that activity/experience that you think has shaped or may shape your ethical perspective?
c. Are there any activities that you wanted to participate in but were unable?
d. What prohibited you from participating?

Justice

1. Tell me about a time when you felt that you or someone you know did not receive a fair response/reward for your/their efforts.

a. Why did you think it wasn't fair?
b. How did you respond?
c. Why did you respond that way?

Ethical Climate

1. Thinking about the ethical climate of your university:

a. Would you describe the ethical climate at [Student's University] as cooperative or is there is a sense that everyone is out for themselves? Can you provide examples?
b. Do you get a sense that students here are working towards a greater purpose? Can you provide examples?
c. Do you think students behave according to the code of conduct or do you feel there are certain situations where you feel students are more willing to bend the rules? If so, when? And what makes you feel this way?
d. Has your perception of the ethical climate at your university changed over the last 3-4 years? If so, how and why?

Moral Disengagement

1. The following items come from the survey you recently took. We'll review some of these items and talk about why you either agreed or disagreed with the statements. All items range from Strongly Disagree to Strongly Agree. We will also talk about your responses from your previous interviews. [Q 49]:

a. It's alright to fight to protect your friends.
b. It's ok to steal to take care of your family's needs.
c. If a group decides together to do something harmful, it is unfair to blame any one member of the group for it.
d. If someone leaves something lying around, it's their own fault if it gets stolen.

Why did you choose this response? (Probe further)

Ethical Scenarios

When Andrew, a professional engineer, discovers evidence that leads him to strongly believe his supervising engineer is attempting to injure the reputation of a competing firm, what should Andrew do?

· Andrew should focus on doing his own work not on criticizing others.
· Andrew should inform the NCEES (National Council of Examiners For Engineering and Surveying) Licensing Board of his evidence and assist it in determining the truth of the matter.
· Andrew should resign from his job.
· Andrew should speak to the supervising engineer in order to determine the rationale for his actions.

1. In this scenario, you indicated that you would [xxxxx]. What factors influenced your choice?

Langdon, a consulting electrical engineer, is hired by PixDream, a major motion picture company, to design and oversee the construction of the power distribution system at the company's new film studio. Once the system is in place, PixDream asks Langdon to accept a nine-month contract extension, and to monitor the power system during the filming of Monster Mountain. He accepts the contract extension. Three weeks into the shoot, with the power system operating well within acceptable parameters, Langdon is asked by PixDream to give his opinion on a pyrotechnic specialist's plan for detonating a series of explosive charges. The charges are triggered electrically, but their chemistry does not fall within Langdon's expertise. PixDream is confident Langdon can become familiar enough with the charges to give them a professional and competent opinion. Langdon wants to continue working for PixDream, but is uncomfortable with the idea of giving his professional opinion on matters beyond his area of expertise.

Of the following, which is Langdon's best option?

· Since he enjoys the work, Langdon can learn about a charge's chemistry and give PixDream his opinion on the pyrotechnic specialist's plan.
· Langdon can trust that the pyrotechnics specialist is knowledgeable and trustworthy, and give PixDream a favorable assessment of the plan.
· Langdon should contact some of the specialist's previous clients and base his analysis on their degree of satisfaction or dissatisfaction with the specialist's work.

· Langdon should decline to accept the contract extension on grounds that explosives chemistry is beyond both his engineering education and subsequent work experience.

2. In this scenario, you indicated that you would [xxxxx]. What factors influenced your choice?

Muriel, a consulting computer engineer, is hired to review her client's plans to expand its existing computer network. In the course of completing her examination of the client's internal communication capacities and requirements, Muriel discovers that the client is using an unlicensed version of a popular proprietary software package to manage its financial accounts. Since her finding is only indirectly related to her work, Muriel is not sure what she should do.

Of the following options, which one should Muriel ***not*** choose?

- Since the unlicensed software is not directly related to her work, Muriel should ignore it and complete her assignment.
- Muriel should bring the matter to the attention of her client's executive officer and terminate her contract.
- Muriel should refuse to continue her work for the client unless the unlicensed software is immediately replaced with a properly licensed version.
- Muriel should not allow the client to use her name in advertising materials.

3. In this scenario, you indicated that you would [xxxxx]. What factors influenced your choice?

Conclusion *(Can be inserted at any point as needed.)*

Is there anything you believe is unique about your experiences that you would like to share?

1. Is there anything else that has shaped your ethical perspectives that we haven't spoken about?
2. Is there anything additional you would like to share?

Code availability Not applicable.

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Declarations

Conflicts of interest/Competing interests The authors have no relevant financial or non-financial interests to disclose.

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