The Ethics of Engineering Ethics Education: Curriculum Design, Ethics Pedagogies, and the Moral Responsibilities of Ethics Educators

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ABSTRACT: In this paper, we argue that engineering ethics education does have moral implications. More specifically, practices in engineering ethics education can lead to negative moral consequences if not conducted appropriately. Engineering ethics educators are often passionate about teaching students ways to examine the ethical implications of engineering and technology. However, ethics educators may overlook the moral significance of their instructional classroom practices. In this paper, we discuss two issues: First, we discuss the moral impacts of ethics curriculum and pedagogies on students' learning experiences. Then we discuss the professional responsibilities of educators who are involved in designing ethics learning experiences for engineering students. The reflections presented in this paper will serve as catalysts for more comprehensive discussions regarding the impact of engineering ethics education on the ethical development of engineering students.

KEYWORDS: Engineering Ethics Education, Ethics Curriculum, Ethics Pedagogies, Professional Ethics of Ethics Educators, Cultural Foundations of Engineering Ethics

Does Engineering Ethics Education Have Ethics?

IN HIS ARTICLE "Ethics of Doing Ethics of Technology," philosopher Sven Ove Hansson ~~notices~~ that ethicists who "analyze the ethical aspects of what other researchers do . . . seldom devote much effort to the ethics of [their] own activities" (Hasson 2017, 239). One of the most illuminating questions asked in that paper is whether "ethical research can have negative consequences" (Hasson 2017, 240). At a first glance, such a question may sound surprising. People may wonder if ethics research is intrinsically good: Isn't ~~that~~ a major goal of all ethics studies

~~is~~ to contribute to our knowledge of why people act morally or immorally, with the ultimate goal of designing educational interventions, programs, and policies to either prevent wrongdoings or invite good behaviors? ~~Ove~~ Hasson's (2017) work has shown that research in the ethics of technology can lead to negative consequences if studies are not designed or conducted appropriately.

In this paper, we ask a similar philosophical question while addressing the teaching not the research aspects of engineering ethics: what are the ethical aspects of teaching practices in engineering ethics education? Engineering ethics educators are passionate about teaching students ways to examine the ethical implications of engineering and technology. However, mostly we do not explicitly discuss whether we as ethics educators have any obligation to examine the moral significance of our own instructional practices. Can practices in engineering ethics education lead to negative moral consequences if not conducted appropriately? We believe the answer is yes.

Some engineering educators may find our response contradictory to their intuition. Isn't teaching some ethics to students at least *always better* than not teaching it? If this is not the case, how can one justify the critical value of teaching ethics in engineering and educational programs created to promote ethics education in engineering? Unfortunately, studies in moral psychology have shown that ethics education can sometimes have negative consequences if practiced inappropriately. For instance, two studies cited in Hansson's (2017) article show that teaching moral reasoning may invite immoral behavior by making rationalizations for immoral behavior that is more accessible to people (Valdesolo and DeSteno, 2008; Mercier, 2011).

In this paper, we first discuss the moral impacts of ethics curriculum and pedagogies on students. Then we discuss the accompanying professional responsibilities of educators who are involved in designing ethical learning experiences for engineering students.

The Moral Impacts of Ethics Curriculum and Pedagogies

A fundamental question for the moral impacts of ethics curriculum and pedagogies is whether teaching *some* ethics to students is *always better* than not teaching ethics at all regardless of what such ethics content might be (curriculum) or how it is taught (pedagogy). This question warrants a more thorough investigation as it can generate moral consequences for faculty and their students. For instance, any curricular approach to engineering ethics has its underlying values and assumptions. Instructing students in a legalistic approach to engineering ethics may inadvertently convey the notion that ethical engineering is solely centered around adhering to legal principles, rather than actively contributing to the advancement of human capabilities in underserved communities through innovative engineering solutions (Zhu et al. 2019). However, it is unclear whether most engineering educators are aware of the potential moral impact of their curriculum designs and pedagogies on students. Therefore, engineering educators need

to build habits of asking questions like, could there be any negative impacts or "side effects" of ethics curriculum designs and pedagogies if not designed carefully (Zhao 2018)? Can these curriculum designs and pedagogies lead to moral disengagement or even misconduct among students?

Before we address the moral impacts of curriculum designs and pedagogies, it is worth noting that curriculum and pedagogy are intertwined in educational practice and it is not always easy to separate them. More specifically, in engineering ethics education, the curriculum refers to the idea of *what to teach* or the key concepts, tools, and ways of thinking that are critical for understanding the ethical responsibilities of engineers and the ethical implications of their work (Herkert 2000). A curriculum reflects curricular priorities, but these *curricular priorities* do not simply implant themselves into students' minds automatically. Effective pedagogies are needed to deliver these curricular priorities to students successfully. Without effective pedagogies, it can be rather challenging for students to grasp the knowledge and skills that the curriculum is designed to cultivate. This is partly a reason why *intentional pedagogical designs* are often necessary to ensure effective learning among students. Therefore, in this section, when we discuss how curriculum design and pedagogical strategies affect engineering students' learning, we do not separate the two.

Also, in this paper, we use the term *curriculum* broadly to also include the informal elements of the curriculum such as co-curricular or extracurricular activities. Researchers such as Bielefeldt et al. (2021) and ~~**Blinded for Review (Year)**~~ have reported that engineering alumni did see the value of extracurricular activities in their ethical development, despite that alumni did not explain how and why these experiences helped further their ethical development. Bielefeldt et al. (2021) argue that extracurricular activities provided various ethical dilemmas for engineering students, although these activities seemed to contain little to no direct ethics instruction. In other words, extracurricular activities potentially have an impact on student's learning in the formal curriculum in ethics education, thus they can be considered as a part of curriculum. An example of such activities is the sports that students engage in. Depending on ther type of coaching, this activity may grow a team spirit, but it may also foster ruthless competition within teams.

Despite that extracurricular activities do not fall under direct ethics instruction, they do affect students' ethical development. We argue that such an observation is supported by our belief that *neither curriculum nor pedagogy are value neutral*. A similar argument could be found in other disciplines such as the philosophy of technology. There is a widely acknowledged view in the philosophy of technology that technology is not value neutral but value laden. We argue that such an argument also applies to engineering ethics education or education in general: All ethics curriculum designs and pedagogies are value laden. By choosing a specific curriculum design or ethics pedagogy, we are also choosing the values and assumptions underlying such a curriculum design or pedagogy

and the particular ways in which such curriculum design or pedagogy affects students' ethical development. Teaching itself is a value-laden, *communicative* process.

To further illustrate our position, we first showcase that ethics pedagogies are never value neutral. There is always a value-communication process in ethics pedagogies. For instance, a most typical ethics pedagogy in engineering education in the United States involves the use of case studies (Herkert 2000). Choosing which engineering ethics cases to include does communicate values to students. For instance, most engineering ethics textbooks tend to include prominent cases involving technical disasters, such as the well-known *Challenger Space Shuttle*, as primary examples (although we are aware that not all cases are about catastrophic cases in these textbooks). Teaching these catastrophic cases may potentially communicate a message to students that "preventative ethics" is crucial for engineering ethics and a major professional responsibility for engineers is to prevent engineering and technology from harming the public. Also, engineering ethics textbooks often include micro-level scenarios that highlight instances of misconduct by engineers, such as accepting bribes or cutting corners. This pattern conveys a message to students that engineering ethics is centered on "prohibitive ethics," emphasizing that their professional responsibility is to recognize and avoid specific misconduct behaviors that are strictly prohibited in engineering practice. Overall, emphasizing both preventative and prohibitive ethics communicates a message to students that engineering ethics is about "micro ethics" or professional obligations of *individual* engineers rather than "macro ethics" that refers to the collective responsibility of engineers or the social implications of technical decisions (Herkert 2005).

Value communication also exists in the design of engineering ethics curriculum (sometimes in implicit ways). By choosing not to include or discuss certain topics or themes either intentionally or unintentionally, instructors may also communicate certain values to students. Such implicit value communication also happens outside of engineering ethics classes, including a typical engineering class which may seem to be irrelevant to ethics. For instance, typical engineering problems students learn to solve in the engineering programs are often "decontextualized" or lacking social, environmental, or ethical dimensions. By not explicitly including these dimensions, engineering educators may communicate a value to students that the technical and the ethical *can* or *should* be separable or ethical issues will be left to other professionals such as human resources or legal experts in corporations to deal with.

Value communication takes places not only in the formal curriculum but also in extracurricular activities. In a research project that the lead author participated in, a story unfolded involving first-year engineering students who were given an opportunity to engage in an extracurricular ethics learning activity. This unique activity involved inviting the students to personally commit to the engineering code of ethics by signing their names on a displayed code of ethics

on the wall (**~~Blinded for Review~~**). After signing the code of ethics, students were invited to enjoy a treat of ice cream. The initial goal of the engineering program was providing an opportunity for students to commit themselves to ethical ideals. Nevertheless, the organization of the activity may inadvertently convey a message to students that ethics is not a serious matter, and that signing the code of ethics can be regarded as a lighthearted endeavor. As one student who participated in the code signing activity shared their experience,

> They gave me ice cream, in case I had any ethical qualms, just, 'here you go, Shhh.' . . . Hm. [[Laughs]] I remember signing it [code of ethics]? No, I remember they sat us down and read parts of it to us, we didn't actually have to read the whole thing, which was a little questionable. (**~~Blinded for Review~~**)

To further demonstrate the value communication mechanisms in ethics curriculum and pedagogy. we have drawn a four-quadrant map that outlines four distinct mechanisms through which the curriculum design (informal *vs.* formal curriculum) and the intentions (intentional *vs.* unintentional) of the instructor can intertwine. Each activity in the quadrant can further result in distinct consequential influences on the ethical development of students (see Figure 1).

As indicated in Figure 1, instructional activities can convey intentional or unintentional goals of instructors, whereas these activities can manifest within the structures of formal or informal curriculum. Quadrant I shows the most typical approach to engineering ethics through which instructors intentionally integrate learning objectives into the formal curriculum including stand-alone classes, ethics modules embedded in classes, and case studies. It communicates the message to students that ethics is central to their curriculum. Nevertheless, the selection of a particular form of the formal curriculum may also communicate certain values. Incorporating ethics modules into engineering courses might suggest to students that ethics is inherently intertwined with engineering, as compared to a distinct applied ethics class taught by philosophy faculty (the validity of this statement remains contingent on empirical research). Quadrant II illustrates that ethical learning can occur intentionally, albeit within a more informal curriculum framework. A coach may intentionally teach student athletes how to be a responsible and supportive team member. While this experience occurs outside of academic settings, it might be possible that its impact could extend to shaping students' understanding of ethical engineering and engineers. Sometimes such an informal ethics learning experience can be quite impactful especially if students find their life goals and values aligned with these extracurricular activities. Quadrant III shows a possibility that ethics learning can happen in the formal curriculum (e.g., classroom settings) but in a more unintentional way. The instructor may not have fully thought through the moral implications of their pedagogy for students. They may simply communicate a fact

about how ethical issues are handled in the workplace. However, the convenient and unintentional selection of a specific topic or story may potentially convey to students that in the workplace, engineers are anticipated to refrain from involvement in ethical matters and instead defer them to legal staff. Finally, Quadrant IV shows that ethics learning can occur in informal curricular settings and some moral consequences of ethics learning may be unexpected by activity organizers. As indicated earlier, providing ice cream as a reward after signing the code of ethics may inadvertently convey the message to students that ethics is merely a procedural checkbox or a matter of complying with rules.

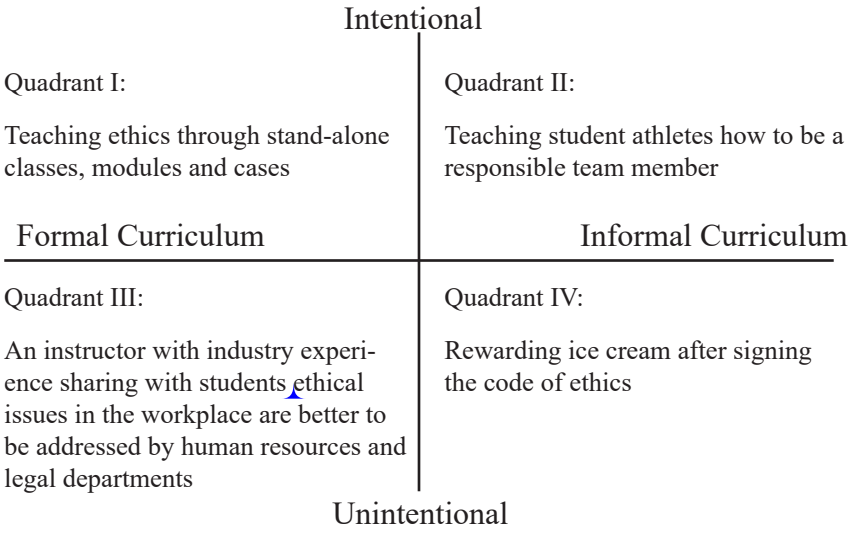

Figure 1. A Four-Quadrant Model for the Ethics of Ethics Education

Therefore, a major lesson that we can learn from discussing the moral implications of ethics curriculum and pedagogies is that educators need to take a holistic approach to examining the ways in which students learn about ethics and social responsibility (~~Blinded for Review~~), as the success of a particular ethics lesson, module, or class reported in an empirical paper may not necessarily lead to the cultivation of moral character among engineering students. This is not to say that such an ethics intervention is not successful. What matters here is that engineering students' ethical development is a rather *complex* and *dynamic* process. Therefore, the cultivation of engineering students' moral identity is significantly influenced by the intricate interplay between the formal, explicit elements and the informal, implicit components embedded within the ethics curriculum. The ways in which these curriculum elements are communicated to students including the character and intentions of instructors and the pedagogies they choose do matter.

Sociologist Erin Cech (2014) has discovered a phenomenon named *the culture of disengagement* which states that engineering students' interest in public

welfare declined following four years of studying in engineering programs. If most curricula and pedagogical interventions (at least those published in peer-reviewed venues) have been empirically proven to be effective, how do we appropriately understand the culture of disengagement phenomenon? We argue that the holistic approach to the ethics curriculum can be potentially helpful. There could be some chance that the positive effects generated by those formal, explicit elements of the ethics curriculum may be potentially neutralized by some informal, implicit elements of the ethics curriculum. These informal, implicit elements of the curriculum are aligned with the arguments made by other scholars, such as engineering ideologies (Cech 2014), educational cultures (Nieusma and Cieminski 2018), or hidden curriculum (Villanueva, et al. 2018). Furthermore, students' moral development can be influenced not only by the formal and hidden curricula but also by their life experiences beyond academic settings, such as interactions with others in both social and digital realms.

While engineering educators mainly design formal elements of the ethics curriculum such as ethics classes, modules, and cases, we cannot assume that students' formal learning takes place in a vacuum. Rather, it will be affected by various, broader cultural contexts. For instance, students may witness that their universities keep publishing anti-racism statements. However, they may also see very little effort taken by their universities to address racism on campus. Students' belief in the value of diversity and inclusion in engineering education acquired in the formal curriculum such as classes on campus may be potentially neutralized by these performative approaches to diversity and inclusion (Cox 2022). Therefore, it is crucial for engineering educators to develop a holistic understanding of the curriculum including the interactions between different curriculum components (both explicit/formal and implicit/informal) and the alignment between the designs of ethics learning activities and the levels of students' development in engineering expertise and moral skills.

Professional Responsibilities of Engineering Ethics Educators

If ethics curriculum and pedagogies have moral impacts as discussed in the previous section, what professional and moral roles should engineering ethics educators assume in their everyday practices? What are the professional responsibilities of engineering ethics educators?

Before delving into the professional responsibilities of ethics educators, it would be helpful to discuss the professional and ethical responsibilities of general educators first. American Association of University Professors (AAUP) ethics guidelines and Society for Teaching and Learning in Higher Education (STLHE) guidelines emphasize faculty members' primary responsibility is towards their students. Reflecting those guidelines, Svinicki and McKeachie (2014) pointed out six responsibilities faculty members have on their students:

- To encourage the free pursuit of learning
- To demonstrate respect for students
- To respect confidentiality
- To model the best scholarly and ethical standards
- To foster honest academic conduct and to ensure fair evaluation
- To avoid exploitation, harassment, or discrimination

It is relatively clear that nearly all the six responsibilities of faculty described by Svinicki and McKeachie (2014) can also be applied to engineering educators, especially those who are teaching engineering ethics to students, either explicitly or implicitly.

However, we argue that professional responsibilities for engineering ethics educators have unique characteristics, due to the complex, historical and cultural contexts of the engineering profession and the powerful impact of engineering expertise on society, the environment, and the human condition. For instance, the American Society for Engineering Education (ASEE) has developed a code of ethics for engineering educators (ASEE 2020). Besides ethical principles applicable to educators in general such as those included in Svinicki & McKeachie (2014)'s work, the code of ethics established by ASEE does incorporate certain ethical principles relevant to the field of engineering education. These engineering specific ethics principles suggest that engineering educators shall:

- work to cultivate students' abilities to recognize ethical and professional responsibilities in engineering situations and make informed judgments, including consideration of the impact of engineering solutions in global, economic, environmental, and societal contexts;
- encourage students to use their knowledge and skills for the betterment of human welfare;
- encourage students to be aware of the need for sustainable development and social justice and how engineers can contribute to both;
- maintain and improve their expertise by continuing professional development;
- recognize the limits of their knowledge and areas of competence and act with humility to engage others with complementary knowledge and competence when pursuing professional responsibilities.

In addition to these engineering specific ethics principles from ASEE's code of ethics, in the following paragraphs, we will now pose more specific questions directly tied to the daily decision-making processes of engineering faculty. These questions aim to elicit reflections from engineering faculty members concerning their professional responsibilities in teaching engineering ethics.

First, is it ethical for engineering faculty to design an ethics lesson or module in their classes without examining whether such ethics learning experience is aligned with technical learning outcomes of their own classes? A conscientious professor may think it is their obligation to incorporate some ethics in their

mechanics of materials class, but they may feel worried that they lack sufficient training in teaching ethics (Davis, 2014) or it is rather difficult for them to relate the class to ethics. They may think ethics is about humans but the class is about materials. In such a situation, one of the "natural" strategies the instructor may adopt is to invite a philosopher colleague to give a guest lecture on an ethics topic (such a topic could be either related or unrelated to the technical content of the class), perhaps on a day when the engineering instructor is on travel.

Imagine the following scenario: a petroleum engineering professor John[1] will be on his trip to a National Science Foundation review panel next week. He does not want students to waste time while he is away. He thought it would be good for students to learn *at least* some ethics while he is away. He has approached Jennifer[2] as he knows that Jennifer teaches in the philosophy department, although Jennifer's area of expertise in ethics does not cover technology or engineering. Jennifer feels concerned that she does not know anything about petroleum engineering or the ethics of petroleum engineering. But John keeps easing Jennifer's worry by saying: "Don't worry. You can teach *whatever* you want as long as it is related to *ethics*." Jennifer may listen to John and designs a lesson on political ethics based on her research or quickly prepare a lesson that applies her work to technology or engineering in general (without touching on the technical details of John's work) Despite that John has a good intent (it is valuable to teach his engineering students about ethics), can John be considered as a *truly* responsible engineering educator? John may feel satisfied as at least their class now has something to do with ethics. However, students in this class may feel disengaged from ethics learning as they do not see clear relevance of such an ethics lesson to their career goals or particular engineering practice in John's course.

Second, do engineering educators have the moral obligation to help students develop a critical attitude toward some philosophical ideals (e.g., safety, health, welfare, justice) in engineering professional norms? It is fairly common for engineering educators to teach students codes of ethics in their classes in the United States. However, how do we help students *critically* reflect on the practical challenges in the implementation of the codes of ethics into engineering practice? For instance, the first fundamental canon of the code of ethics of the National Society for Professional Engineers (NSPE) stipulates that engineers "shall hold paramount the safety, health, and welfare of the public." When we are teaching students NSPE's code, do we explain to students what the term public here refers to? Does it mean co-nationals or humanity in general? How do we as engineering educators help students relate these critical reflections to their own value systems and career goals? If engineering students are serious about protecting public health, safety, and welfare, should they work for companies that produce goods or services that may generate harm for the public? For instance, should they work for companies that contribute to the production of sugary beverages known for their association with diabetes? When students are grappling with the decision of whether to accept a job at a military contractor, despite the

allure of high salaries and potential career advancement, what advice should we as engineering educators give to them? At a more fundamental level, engineering educators should invite their students to reflect on the financial privilege inherent in the ability to choose employment with a company aligned with one's values (especially when these values may not necessarily be monetary values).

Third, do engineering ethics educators have a moral obligation to incorporate complex and yet controversial public debates on the social implications of engineering into classroom discussions? Or should we simply ignore the social controversies about engineering or separate engineering from politics? Engineering practice is a dynamic process that is always influenced by a multitude of interconnected factors, never occurring in isolation or disconnected from its surrounding context. So does engineering education. We argue that engineering should never be taught in isolation from its social and political contexts. Natascha Trellinger Buswell (2022) has pointed out that it is necessary and valuable to incorporate critical reflections on social and political issues such as gun violence into the engineering classroom. In her class, students were invited to discuss how students' learning about engineering problem-solving could be used to address gun violence issues. Students came up with diverse engineering solutions ranging from adding biometrics to guns to only allow registered people to use them to installing metal detectors and bulletproof glass in schools. Scholars may also argue here that in this case the instructor may potentially communicate a message to students that technology is *the* solution to social problems such as gun violence. We do believe that a more fundamental goal is to help students cultivate a critical perspective on the potential role of their engineering expertise in shaping society. Certainly it is worth acknowledging that the role of technology can also be limited and simply relying on technological fixes can lead to questionable outcomes. Overreliance on technological solutions may yield uncertain results and divert attention from tackling deeper societal issues, such as the pervasive culture of violence in this particular context. Once the technologies engineers create are in the hands of users, engineers lose control of how these technologies will affect society. Engineering educators who choose to disregard social and political issues must be held accountable for their failure to seize the opportunities available to foster an ethical sensitivity among aspiring engineers regarding the social implications of their work.

Fourth, what are the engineering educators' responsibilities in preventing academic misconduct in engineering curriculum? Engineering educators have the power to frame ideas and practices in engineering education in *authoritative* ways that our students would be convinced to adopt dominant ways of engineering thinking and associated values and ideologies. For instance, among engineering faculty, academic misconduct issues such as cheating are often framed as the most critical ethical challenges engineering students are facing. Some engineering educators have adopted medical or psychological metaphors to define and tackle cheating issues among engineering students. For example, in just one

example from the textbook *Teaching Engineering*, Wankat and Oreovicz (2015) stress that "the cure for cheating" is better approached through prevention rather than a more responsive approach of dealing with cheating after it has occurred. They call students who frequently cheat "chronic cheaters," indicating a persistent problem.

Nevertheless, research has shown that there are discrepancies between faculty and students in their perceptions of what counts as cheating. It is worth considering that factors originating from the faculty side may contribute to an environment that encourages student cheating. These factors encompass a lack of concern among faculty members for the well-being of students, a misalignment between the content taught and the material being tested, setting unrealistic expectations regarding what students can accomplish within the duration of a single course, inadequate course management, and an educational system based on competition. Simply framing cheating as a chronic disease can lead to questionable reactions and responses to student cheating while overlooking the unjust fundamental structure of engineering education.

A Tentative Conclusion

In this essay, we attempted to address the fundamental question whether engineering ethics education itself has moral implications? We believe that engineering ethics education as a professional practice is not value neutral. We discussed: (1) the moral impacts of ethics curriculum and pedagogies on students; and (2) the professional responsibilities of educators. With this short essay, our goal is to neither develop a systematic model for the ethics of engineering ethics education nor formulate effective strategies to address ethical issues in ethics teaching. Instead, our intention is that the initial reflections presented in this paper, along with other contributions in the special issue, will serve as catalysts for more comprehensive and inclusive discussions regarding the impact of engineering ethics education on the moral development of our engineering students. We aspire to stimulate a more systematic and expansive exploration of this topic within the academic community.

Notes

1. We intentionally chose a male name here to reflect the masculine culture within engineering.

2. Here we chose a female name to highlight the influence of socially constructed gender stereotypes associated with humanities faculty.

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