

## **A Graduate-level Engineering Ethics Course: An Initial Attempt to Provoke Moral Imagination**

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## **1. Introduction**

Most Western, Euro-centric educational systems under the dominant discourses of idealism have fostered a belief in ourselves as ethereal minds/souls who exist with the unfortunate circumstance that we are stuck with earthly bodies and that our true essential condition is to exist free of any pain, suffering, and misery. In other words, western discourses subtly – and not so subtly – undervalue the importance of pain and influence us with a belief that we deserve to be free of pain. On the contrary, many – if not most – ancient and contemporary cosmologies understand pain, misery, and suffering as a simple fact of human life. Life has labors. Life has pain. Life has miseries and struggles. Those facts can cloud our judgment when hidden or obscured, demonized, or misconstrued. Unless we accept life as laborious and sometimes painful, as *embodied* life, how can we ever hope to notice and trust when others say, “I suffer”? What happens to our relational, philosophical, and epistemological frameworks when pain is conceived of as an enemy of a life lived well? If we make ourselves labor-phobic or struggle-phobic, obsessed with living perpetually anesthetized and pain-free, how can we ever begin to imagine trusting when others say they suffer cruelties, and how can we begin work to end the cruelties?

To what extent does the dominant discourse within higher education treat the questions posed above as essential, marginal, or irrelevant? Changes can be made to foster understanding of the influence of suffering, the importance of pain in complex reasoning, and to expand reasoning practices in ways that complement and correct rational explanation and probabilistic predictions. Within the context of engineering education, specifically, we should show the implications of engineering as value-laden. Educators should emphasize the role of the public and social institutions, as well as the complexities embedded in how we think and how we relate to one another. Innovative curricular and pedagogical approaches in engineering ethics can provide a unique opportunity for students to stretch their imagination in dealing with the dynamics, complexities, and ambiguities involved in decision-making in practice, and to notice harm, suffering, and social injustice and treat their occurrences as urgent and pressing.

While pain and suffering experienced by someone else has a subjective character that is only truly perceivable by that person, the cultivation of internal imaginative deliberation can help us to approach the qualitative character of someone else's experience. With opportunities to *practice* at imagining how others experience the world, we can develop an ability to reason and make decisions with substantive moral insight. That is, exercising and practicing with one's moral imagination is vital to complex reasoning, since doing so places other forms of reasoning, such as quantitative and applied problem-solving, in a specific relational context. Engineers need to solve problems with robust insight into what it is people suffer, and what it means for them to know that engineers consider their pain and suffering when engaging in design and other technical tasks.

In 2019, we started developing teaching modules centered around moral imagination to cultivate sensitivity within reasoning and enhance the curriculum of a graduate-level engineering ethics course, *Engineering Ethics and the Public*, at Virginia Tech, a large land-grant, Research 1 university. The course is a three-credit elective course offered annually to engineering students. The overall course itself was originally co-conceived and co-developed by an engineer, one of the authors of this paper, and a medical ethnographer, with the support of the National Science Foundation (NSF) [1]. The learning objectives, topics, and assignments are presented in Table 1. The course aims to address relationships between engineering, science, and society by incorporating listening exercises, personal reflections, individual and group projects, and case studies within four major units of inquiry:

- 1) Learning to Listen,
- 2) Responsible Conduct of Research,
- 3) Responsible Conduct of Practice,
- 4) Witnessing Wrongdoing and the Obligation to Prevent Harm.

A major motivation in developing this course was to prioritize *listening* as a core component of engineering practice and to consider the perspectives of non-experts (i.e., non-engineers, non-scientists, non-architects, etc.) in conventional decision-making processes [1], [2]. The course provides practices in and reflection on *empathetic* and *in-depth* listening. Some of the major questions that guide the course are: Why does ethical conduct in engineering/science matter? Who is vulnerable to misconduct? Who is “the public,” whose safety, health, and welfare engineers/scientists hold paramount? And, what role does the public play in engineering/science research and practice?

Students are asked to complete a series of activities and assignments such as book review and presentation, simulated press conference, and final project centered around real-world controversies involving several stakeholders. In addition, several in-depth listening exercises have been integrated throughout the course. More details about the course are provided elsewhere [1], [2].

**Table 1.** List of learning objectives, topics, and assignments

Learning objectives	Topics	Assignments
<ul style="list-style-type: none"> <li>- Define unethical conduct in engineering and science</li> <li>- Discuss potential “costs” of misconduct and “benefits” of morally sound conduct</li> <li>- List personal, professional, or societal motives, other than profit, that can foster unethical behavior</li> <li>- Describe the code of ethics of at least one engineering or scientific society</li> <li>- Describe key moral theories relevant to ethical decision-making</li> <li>- Define “the public” and discuss its role in the production of technical knowledge</li> <li>- Identify skills, other than technical proficiency, that are necessary for competent practice in engineering and science</li> <li>- Describe the kind of engineer/scientist you aspire to become</li> <li>- Develop a comprehensive plan to identify ethical dilemmas in real-world cases as well as processes by which to determine preferable solutions to these dilemmas</li> </ul>	<ul style="list-style-type: none"> <li>- Learning to listen: Listening as a best practice in engineering and science</li> <li>- Unethical behavior in science</li> <li>- Whistleblowers and organizational power</li> <li>- Our inherent vulnerability to biased and unethical behavior</li> <li>- Witnessing wrongdoing and the obligation to prevent harm</li> <li>- Moral theory</li> <li>- Citizen science for good and bad</li> <li>- Responsible conduct of practice</li> <li>- Engineers and scientists informing public policy</li> <li>- Engineers and scientists under pressure to disclose and collaborate</li> </ul>	<ul style="list-style-type: none"> <li>- Book review and presentation</li> <li>- Weekly blogging</li> <li>- Press conference</li> <li>- Empathetic listening exercises</li> <li>- Ethics card-reflection</li> <li>- “Story of Self”-personal reflection</li> <li>- Final project</li> <li>- Reading quizzes</li> </ul>

Initially, the major instruction approach centered around the lead-in-water crisis in Washington, D.C. between 2001-2004, supplemented by moral theory and professional codes of ethics. Under the direction of one of the course co-founders, the model expanded to include the ever-evolving water crisis in Flint, Michigan.

The central method of instruction in the course that places emphasis on case-study or case-based discussion, is the predominant method of engineering ethics instruction [3], [4]. However, conventional approaches in integrating cases have been criticized due to isolation with real-world practices where the broader contexts of engineering practice, involving social, cultural, and political factors have been underemphasized [5]-[8]. Often, these case examples pose to the reader a given ethical quandary as an unusual mistake on the part of individual actors. That is, cases primarily and arbitrarily emphasize erroneous reasoning and subsequent faulty actions made by individual actors. The overly constrained task of moral reasoning, then, is narrowly to use fixed, presupposed rules as a formula to help search for certainty about a judgment and/or its resulting action. Among recent critiques of the narrowly-defined individual reasoner/actor case model, Bucciarelli [5] emphasizes the importance of collective response, reflecting on the nature of many problems engineers face in practice. The importance of collective response is even more evident when we think of “macroethical” problems involving the broader responsibility of engineering profession, for example, in connection with the role of technology or sustainable development [7], [9], [10]. In a similar vein, several studies specifically advocated engineering ethics centered around social justice [e.g., 11, 12].

As cases move to encompass the broader complex context, the value of considering different stakeholders, among them the public, and raising questions about power relations becomes more evident. What is unique about the curriculum used in the graduate-level engineering ethics course discussed in this paper is the attention to both interpersonal and broader relational contexts – the focus on what we call *comprehensive ethical cases*. It emphasizes the importance of the broader public, the relationships between engineers and the public, and helps students to see how judgments and decisions made by individuals and within the broader context of organizations can disrupt and even prevent resolution of problems. Case studies include examination of unethical behavior of engineers, as well as examples of citizen science misconduct from members of the public and activists. Students are prompted to reason through both technical and social facets of moral dilemmas.

The first author of this paper took the course in fall 2015 as taught by the engineer who co-founded the course. To briefly reflect on the experience, the course created a novel, authentic, and empowering learning experience in which we (students) listened, grappled, and reflected on first-hand stories about real-world cases and were encouraged to pay attention to different perspectives, in particular, the public. It helped us picture the interactions among different stakeholders, from scientists and engineers to governmental agencies to the public, and the different roles they may play in a given context. Furthermore, it provided different instances of unethical decisions made at both the individual and organizational levels. From the lens of a student, there was a meaningful engagement with the press conference assignment where each student was asked to perform as a representative/an agent from a particular stakeholders involved in the Washington D.C. drinking water crisis, 2001-2004, among them: Washington Aqueduct, D.C. Water and Sewer Authority, Environmental Protection Agency Mid-Atlantic Regional Office, and D.C. Department of Health. The semester-long activities, team exercise centered

around a book and individual project on a real-world ethical situation with the integration of listening exercises and ethical theory were among other influential components.

The course in fact provided and continues to provide various opportunities for emotional engagement and imaginative understanding of ethical reasoning even though developing imagination is not one of the major objectives of the course. As one of the students noted in the survey, we administered in 2020, “I think moral imagination is the unspoken ultimate objective of the class.”

Reimagining the experience as a student engaging with the details of various activities and exercises, integrating the modules could show the primacy of pain and suffering and help students acknowledge and engage with *ambiguity* involved in ethical decision-making and move beyond categorical ethical evaluation. Put it differently, there was a hope that students will benefit from explicit attention to our habits in making ethical decisions, the dynamics of interpersonal relationships, and the importance of power relations.

In what follows, we first provide an overview of the literature in engineering education and provide an account for the concept of imagination. Next, we discuss the modules and pedagogical methods used to facilitate the intervention. Finally, we report on the data collected from students' pre- and post-surveys in 2019 and 2020.

## **2. Understanding moral imagination**

Stimulating moral imagination as one of the primary goals of ethics instruction has been recognized within engineering education literature and beyond [4], [13], [14]. However, within engineering education literature, very few studies treat imagination as a major objective of ethics instruction and there is almost no relevant literature centering on pain and suffering.

Nevertheless, as Walling [15] argues, despite the dominant target of cognitive knowledge and skills, in isolation from emotion, in engineering ethics instruction, many innovative ethics curricula may in fact promote and foster imagination although it is not named as a specific objective. Imagination is there, it seems, and it plays some kind of role but it is not normally treated by instructors as a core faculty in moral reasoning.

In one of the earliest theoretical works in engineering education, centered around imagination, Pritchard [16] emphasizes the importance of seeing different alternatives and perception of consequences, both expected and unexpected, before decisions are made and in response to the problems that arise. There are several critical factors stressed in Pritchard's account of the process of ethical decision making: the role of our values, dispositions, and experiences in dealing with ethical situation, and importance of in seeing and constructing different alternatives, cares for others as well as moving from preventive rules and acting in a more positive mode. What is less clear is how emotion and rationality play a role in the imaginative process engineers need to engage. Newberry [17] reflects on the objectives of engineering ethics instruction and categorizes them into three broader groups: 1) Emotional engagement, 2) Intellectual engagement, 3) Particular knowledge.

Newberry describes emotional engagement in connection with students' affective level and their sensitivity about willingness to address ethical issues and argues that this objective is the most

important and at the same time most challenging to influence for educators. Similarly, Walling [15] emphasizes on engaging students' emotions. The study describes an assignment in an undergraduate course that puts students at the center of ethical decision-making working on a real-life ethical dilemma. The assignment designed to help students with personal awareness while engaging at affective level they encounter for the purpose of developing moral imagination and sensitivity that will eventually influence ethical behavior. Walling [15] criticizes the emphasis on intellectual and rationality in ethical reasoning and argues for approaches to teaching ethics with the primacy of emotion. Importantly, Walling argues for the linkage between cognition and feeling. This tendency to name the importance of affect/emotion while omitting a specific discussion of experiences such as pain and suffering is a common limit of literature in engineering education. Within engineering education literature, the emphasis on imagination as a central constituent of moral reasoning has often been informed theoretically by pragmatism and liberation theory and praxis [e.g., 18-21]. Yet, the specific and deep importance of applying moral imagination to consider pain and suffering remains under-theorized.

### **Framing: Imagination and relational reasoning**

The integration of the modules aimed to stretch imagination to foster sensitivity towards others' experiences, mainly pain, and suffering – to give them opportunities to practice the imaginal components of moral reasoning that are tied to broader relational practices. Imagination was treated as an essential character of thinking and understanding, urging us to pay attention to otherwise obscured patterns of human suffering. Johnson [22] argues that by means of “imaginative rationality”, we can empathetically participate in other's experiences.

It is not sufficient merely to manipulate a cool, detached ‘objective’ reason toward the situation of others. We must, instead, go out toward people to inhabit their worlds, not just by rational calculations, but also in imagination, feeling, and expression. Reflecting in this way involves an *imaginative rationality* through which we can participate empathetically in another's experience: their suffering, pain, humiliation, and frustrations, as well as their joy, fulfillment, plans, and hopes [20, p. 200].

The concept of imagination addressed in our study is theoretically akin to what Josiah Royce [23] describes as “moral insight,” a qualitative process of the complete realization of another person (“neighbor”), treating them unselfishly, with genuine respect for their inner life and experiences: “This insight is not the mere emotion of pity nor yet sympathy, but something different from these, namely, something that involves the realization, and therefore the reproduction in us, of the opposing will of the neighbor” [23, p. 148]. One who engages in this process possesses the ability to see and reason for different aims Royce's theory places moral sympathy – simply knowing others can and do sometime suffer – on a lower tier of reasoning, one which different orders of animals express. Moral insight, however, requires one to consider the sheer logic involved in treating ourselves as morally real. *I imagine myself as real now and in the future, even though my future self is not yet a material fact. If I can justify treating my future self as materially real then I ought to treat other persons who are present, immediately, as no more or less morally real than I treat myself.*

Similar to Royce, Martin Buber's intersubjective theory emphasizes the importance of inner aspects in fostering relation considering the "whole being", in which *both* observable features and imagined complexities of another person will be taken into account. According to Buber [24], we tend to conceive of one another in terms of either "I-It" or "I-Thou" relations. I-It relations occur when persons interact with one another primarily as a set of categories, or parts, such as race, gender, religion, disability, etc. I-It is a misnomer, he explains, since once a person treats another as an "It" the result is to only conceive oneself as an It, or a collection of parts. I-It relations are always It-It relations in which a person objectifies and dehumanizes oneself by objectifying and dehumanizing another. One can never be an I while treating others as an It. Conversely, I-Thou relations refer to the treatment of one another as complex, indeed far more complex than our respective categorical parts or features. Only someone who treats another as a Thou, as a person with more complexities than simply a collection of parts, can count as an I. In other words, relating to another as a Thou reinforces my own personhood as a complex I. The options are either It-It / dehumanized or I-Thou / humanized relations.

When Thou is spoken, the speaker has no thing; he has indeed nothing. But he takes his stand in relation. For where there is a thing there is another thing. Every it is bounded by others... When thou is spoken, the speaker has no thing; he has indeed nothing. But he takes his stand in relation [24, p.4].

Imagine shifting the scope of our understanding to a more practical context and taking into account a sinister side of the world beyond the bubble in which we may presently live, mentally and physically. People are faced with institutionalized cruelty [25] and dominance; their needs and desires are systematically ignored and suppressed. The ways we see and imagine one another can be expanded to the broader institutional level; and as argued by Roberts [26] Buber's I-It relations can explain the very possibility of oppression.

### **3. Setting: Revising engineering ethics course**

#### **Background**

As described in the Introduction section, the original course materials were supplemented with two learning modules. One of the authors of this paper facilitated both sessions, each for two and half hours, where 14 and 10 students were enrolled in the class, in 2019 and 2020, respectively. The major difference between the two years was the mode of instruction, face-to-face in 2019 and online in 2020 during the COVID-19 epidemic. We intentionally integrated the modules at two different points during the semester, one during the first few weeks and the other during the last few weeks of the semester, at the point that students discussed different ethical theories and got exposure to the role of broader institutional, social, and political factors in dealing with ethical situations.

Two readings were considered for the first module: "Moral Insight" by Josiah Royce [23] and an excerpt from "I and Thou" by Martin Buber [24], and two readings were chosen for the second module: "From Cruelty to Goodness" by Philip Hallie [25] and "The Ones Who Walk Away from Omelas" by Ursula Le Guin [27]. The readings were included on the course syllabus and students were provided with the access to the texts and requested to read each before the class.

Table 2 provides a summary of the core concepts and ideas – that were emphasized in the intervention – in connection with the authors whose work was integrated.

**Table 2.** A summary of the core concepts and ideas

<b>Author</b>	<b>Core concepts and ideas</b>
Royce	Moral Insight defined
Buber	I-It and I-Thou relations defined
Hallie	Negative Ethic and Positive Ethic defined Cruelty/Harm and Hospitality/Healing defined
Le Guin	Personal pleasure as the highest utilitarian virtue vs. justice, liberation, hospitality, etc. as the highest moral virtue

The first session of each year focused on thinking processes and how we reason, briefly addressed major flaws such as appeal to authority and ignorance, and highlighted the importance of imagination in seeing different perspectives. The second session highlighted institutional culture and systematic oppression. This module made a major shift from negative ethic – passive role/do not harm – to a more positive ethic to notice and diminish and/or prevent pain and suffering – active role/add good, and emphasizes the importance of power relations and collective responsibility.

### **Topics and methods of instruction**

The topics discussed and our aim for facilitating imaginative understanding demanded engagement with the materials with high intensity. Several formats were used to create interactive and engaging sessions: 1) small-group discussion, 2) free write-up and reflection, and 3) in-class discussion. In addition, during the presentation and building on different topics, questions were posed to help with the active participation of the students. Furthermore, intentional pauses were made to check and recap, especially because some of the readings were dense and complex. In 2020, we used the Zoom video communication platform as the medium of instruction (<https://zoom.us/>), and took advantage of the “breakout rooms” feature to facilitate small-group discussions.

The first major part was a discussion on ways to make moral judgments and reflection on thought processes in ethical decision-making. Students were asked to reflect on their own moral judgment and the extent to which they see the influence of intuition and emotion or rationality. Students were asked to think about examples of their thought processes and decision-making that could be subject to biases and how they could rationalize their decisions as students and as professionals. The goal of these exercises was to provide an opportunity for *personal awareness* and *sensitivity* towards assumptions and preferences. In particular, as discussion and case examples around biases often include topics such as race, gender, nationality, religion, the facilitator tried to create a bridge with the next major part of the modules centered around Royce and Buber. The discussion about biases then expanded with interpretations of stereotypes, discrimination, and prejudice to help with reflecting on ways we see and imagine others and reimagine our interpersonal relationships. Such discussion, by its nature, promotes inclusivity of perspectives and care towards what other persons/groups/societies may experience.



Royce's moral insight was the next major part of the first session. The "Revenge Test" developed by Christian Matheis was facilitated before providing detailed background about the readings and posing questions about the nature of moral insight, interceptions, and examples; the test asks students about why we take revenge [28]. The facilitator pushes the discussion and asks about the basis of revenge and how we can be sure that it is working. As students explain the reasoning behind revenge they are shown dialogically how revenge requires imaginal insight into another person, otherwise there would be no justified rationale for enacting vengeful strategies. Conversely, it is explained, if imagination works so automatically in reasoning about revenge then it can and should work just as automatically for making positive, humanizing strategies. That is, the imagination gives us clear reasons to conceive another person as complex, plan for how our actions will make them feel and/or influence them, and then take more seriously the emotional insight involved in moral deliberation. Then to connect with Royce's major argument, the distance between ways we could imagine someone else's present and future experience in a negative manner and how we show insight into ourselves was emphasized. We discussed the conflict between selfishness and unselfishness, and students were asked to reflect on examples and reasons they can think of to pick selfishness. The ultimate question came up from this discussion was about ways we can imagine the harm and pain as real when we think about what someone else experiences or may experience as a consequence of an action. The recognition and realization of someone's else was also stressed upon in the session by incorporating Buber's relational philosophy. Students were asked to think about how I-It and I-Thou relation can be manifested in the world.

The second session started with a brief overview of the topics discussed in the first meeting, bridged from interpersonal contexts to a broader social context, and moved towards the concepts of *power relations* and *moral courage*. First, to connect with real-world practices, students were asked to think and reflect on the examples from the course or their own personal experiences that can be considered as instances of positive and negative ethics. We then discussed Phillip Hallie's [25] illustration of cruelty, healing, and hospitality. In addition, Physical power and verbal power were emphasized through Hallie's description of the Nazi's persistent and institutionalized cruelty.

The last major part of the second meeting was the short fiction, "The Ones Who Walk Away From Omelas" [27]. The story illustrated by Ursula Le Guin presents the utopian city, Omelas, and the apparent joyful experience of its people, whose joy depends on the misery and suffering a child kept in a basement. Students were asked to describe Omelas and imagine themselves as people who made different decisions and thought about real-world examples and implications. The session was ended with a write-up and reflection exercise in which students asked about the role they think they can play in diminishing human suffering?

#### **4. Data collection**

Students were requested to complete a pre-survey within the first week of the semester and a post-survey at the end of semester. Initially, the goal was to understand students' expectations, explore their notions of ethical reasoning, and to gauge what they value in ethical decision-making before and after the course as a whole. The survey questions included 7 open-ended, 1 Likert scale, and 1 ranking question. Sample questions are included in Table 3.

After reviewing the data in 2019, we decided to revise the post-survey and add 10 more questions for the year 2020, including 1 question on demographic information and 9 questions about students' experiences with moral imagination modules and ways they reflect about the importance of imagination and its role in ethical judgment. Sample questions include: How have the modules focused on moral imagination influenced your thoughts about moral reasoning and ethical decision-making? and, To what extent do you consider discussions of moral imagination to be important parts of ethical reasoning and/or ethical decision-making? Please explain.

**Table 3.** Pre- and post-survey sample questions

Type	Sample question
Open-ended	If you were to describe your own ethical reasoning to someone else, what would you say? How would you describe your reasoning about ethics?  What do you think scientists and engineers should consider when trying to make ethical judgments?
Ranking	Based on your understanding of ethics, how would you rank the importance of each of the concepts below? In other words, how important or unimportant is each idea when it comes to ethical reasoning and ethical decision-making?
Likert scale	Please indicate how satisfied or dissatisfied you are with the quality of each of the following components of the class?

## 5. Data analysis and results

Considering the focus of this paper, we concentrate on students' overall satisfaction with different components of the course in 2019 and 2020, and students' experiences with imagination module in 2020. In 2019, 13 students (93%) responded to the pre-survey and 7 (50%) to the post-survey. In 2020, 8 (80%) responded to the pre-survey and 9 (90%) to the post-survey. Most students were in environmental engineering and civil engineering. The other disciplines they represented are: biomedical engineering, electrical engineering, and engineering education. Among the post-survey participants in 2020, four students were female, and four were male. In addition, four students identified their racial/ethnic background as White or Caucasian, two students identified as Africa American or Black, and two students identified as Asian. One student did not disclose their gender and racial/ethnic background.

One of the important findings was how students prioritize different concepts and ideas in connection to ethical reasoning. Students were given 15 different concepts to respond to the ranking question presented in Table 3. The randomization feature in Qualtrics survey was used to randomize answer choice. Importantly, most students' top selected three choices on pre- and post-surveys in both years were: Harm, Consequences, and Suffering. While each student may have different explanations about various terms, prioritizing these three over other concepts such as character and duties may need more in-depth analysis of students' thought processes and whether there were any influences resulted from the class. We also asked students about different components of the course. We intentionally added bias, thinking and imagination, and injustice and systematic oppression that were the main focus of imagination modules to the course existing major elements. On a Likert scale ranging from "Very satisfied" to "Very dissatisfied," students evaluated different elements of the course. The summary results for 2019 and 2020 are

provided in Table 4 and Table 5, respectively. The majority of respondents were either satisfied or somewhat satisfied with different elements.

**Table 4.** Students’ evaluation of the quality of different components (2019, n=7)

<b>Components of Class</b>	<b>Very satisfied</b>	<b>Somewhat satisfied</b>	<b>Neither satisfied nor dissatisfied</b>	<b>Somewhat dissatisfied</b>	<b>Very dissatisfied</b>
Bias	2	4	1		
Codes of ethics	4	2	1		
Injustice and systematic oppression	5	1		1	
Institutional culture	4	3			
Listening as practice	3	4			
Moral theory	3	3	1		
Responsible conduct of practice	4	2	1		
Responsible conduct of research	4	3			
Thinking and imagination	2	2	3		

**Table 5.** Students’ evaluation of the quality of different components (2020, n=9)

<b>Components of Class</b>	<b>Very satisfied</b>	<b>Somewhat satisfied</b>	<b>Neither satisfied nor dissatisfied</b>	<b>Somewhat dissatisfied</b>	<b>Very dissatisfied</b>
Bias	4	5			
Codes of ethics	5	4			
Injustice and systematic oppression	2	4	1	2	
Institutional culture	6	2	1		
Listening as practice	9				
Moral theory	5	4			
Responsible conduct of practice	9				
Responsible conduct of research	8			1	
Thinking and imagination	3	4	2		

Students’ responses on what scientists and engineers should consider in making ethical judgments were coded to examine major themes and potential changes. Although students overall used similar themes on the surveys, the majority of themes in the pre-survey were safety, health, and well-being, which are the common terms that are often emphasized in engineering curricula. The post-survey responses overall presented a broader vision towards ethical decision making. The most common theme was *impact* (consequences, effects, impact), with more emphasis on *relation with the public*. Table 6 presents pre- and post-responses for two students.

**Table 6.** Sample pre- and post-responses (What do you think scientists and engineers should consider when trying to make ethical judgments?)

Student response (pre-survey)	Student response (post-survey)
“Stakeholders, environmental effects, personal conscious.”	“Who gets harmed/who gets benefitted? In these situations who has the power and what are they trying to accomplish with it? Is my work negatively impacting people? Are there populations affected by my decisions that are not being involved in this design process?”
“Scientists and engineers need to realize that as specialists in commonly misunderstood fields, they bear a great responsibility for ensuring public safety. It is often difficult for "normal people" to tell if a scientist/engineer has done anything wrong until it is too late.”	“They should consider the impact of their decisions on those who do not have a say. Engineers and scientists have a say, but the poor downstream community might not. They should make sure not to exploit vulnerable people.”

### Imagination modules

As mentioned in the Data Collection section, several questions were included in the post-survey in 2020 to capture students’ thoughts and experience with regards to imagination modules. To capture an illustration of the influence of the class, we included an explicit question: How has the modules focused on moral imagination influenced your thoughts about moral reasoning and ethical decision-making? Students described rather more holistic views of moral reasoning expressing *relational* components of thinking, emphasizing cautious and inner *reflection* in decision making, and acknowledging *ambiguous* nature of ethical judgment beyond narrow search for categories, principles, or standards. Sample responses are presented in Table 7.

**Table 7.** Sample post-survey responses about the influence of imagination modules

Question	Student response
How have the modules focused on moral imagination influenced your thoughts about moral reasoning and ethical decision-making?	<p>“I was pretty moved by “The Ones Who Walk Away from Omelas.” It was a powerful story and one that influenced how I perceive utilitarianism and other philosophies.”</p> <p>“They reminded me to continually check how I view people to make sure I value their humanity. They also allowed me to somewhat connect the ideal to reality particularly in the story of the people of Le Chambon. They show that while ethical ideals may seem like a long shot, they are still worth aiming for.”</p> <p>“They showed me that there is more than one way to solve an ethical dilemma.”</p>

When asked about their level of satisfaction with instructional approaches, a majority of students responded positively. Sample responses are presented in Table 8. Finally, students' responses to the questions about the modules explored to see whether there are indicators of pain and suffering. Students did not explicitly discuss the primacy of harm, pain and suffering, nevertheless *appreciation of diversity of perspectives* was one major theme that identified in students' responses. It demonstrated through consideration of broader perspectives and/or cultivation of sensitivity and understanding towards others' perspectives. For example, one student noted:

“They made me think outside of ethics in science but in a broader perspective... I may think something may be okay with my moral imagination, but it may not be. I would have to think more broadly than its immediate impacts and personal impacts... It gets science minded and engineering minded people to think outside their immediate realm of thinking about ethics.”

Another student said:

“I do not think they have influenced my moral reasoning, but they served as useful tools to return in the future... While I disagree with some perspectives in our moral imagination discussions, it is good to understand perspectives others may have in their ethical reasoning. I did not realize there could be a diversity with ethical reasoning, but now I realize that I will have to be aware that others in my teams may not share the same moral imagination of a situation as myself.”

It is worth noting that there were also a few students who clearly highlighted the primacy of “human element” within their responses. One student said:

“It can be easy to forget that the work of scientists or engineers has severe impact on the lives of individuals. When a task becomes routine, the human element can be lost. For example, analyzing water samples from a community is not simply about research discoveries. It is meant to help support the community.”

However, the data we collected provides a limited picture of the benefits of this intervention. To have a better understanding of such attempt, there is a need to incorporate a more robust data collection and analysis mechanisms. In particular, to understand students' rational and emotional perspectives and how they situate imaginative deliberation; the improvements can be made with including interviews and journal entries at various points during the semester.

**Table 8.** Sample post-survey responses about the instructional approaches

Question	Student response
<p>To what extent are you satisfied or dissatisfied with the instructional approaches used by the facilitator? Please explain.</p>	<p>“Very satisfied. The discussions were great and helped me better understand the main points of our ethical readings. Like I said before, some of them were especially dense, and without the instructor, I may not have been able to understand the concept or application of a particular ethical philosophy discussed in a reading.”</p> <p>“I enjoyed that we started with a summary of what the text was about because in some cases I had trouble understanding the main point that the author was trying to convey. I also liked the idea of the breakout sessions, but at times they were not productive. This may have been because we didn't understand the question or did not have time to process before answering. The cases when we had time to think on our own before the breakout were the most beneficial I believe.”</p> <p>“I am satisfied with the approaches. These lectures were very fun and stimulating.”</p>

## 6. Discussion

Previous empirical studies and theoretical accounts of imagination within engineering education literature mostly focused merely on the role of emotion, feeling, and/or descriptive analysis of the use of imaginal capacity in envisioning different possibilities. We posit that by revising conventional engineering ethics courses (and case studies) that are *unembodied-technical* with those based in *moral-technical reasoning*, there is a stronger chance of moral reasoning that will render robust ethical judgments. Here, we use moral-technical reasoning to refer to the kinds of complex cognitive and emotional labor a well-educated engineer demonstrates when engaging in both moral insight and design and problem-solving as inextricably linked and co-constitutive of one another. *Such pedagogical and curricular methods value the bridge between mind and body, the importance of individuals and communities' backgrounds and experiences, and the connection with broader macro-ethical problems such as poverty, racism, sexism, etc.*

Perhaps the most important finding of our study was that imaginative moral deliberation is not something uncommon for students. They do use the moral imagination but it is usually in unguided ways, leaving the role of the imagination largely in the background as an under-utilized and vague cog. We mean to show that the role of the imagination must be foregrounded, engaged, and practiced if engineers are going to effectively reason through the intersections of technical and moral dilemmas. The use of imagination either demonstrated as a tool in the process of deliberation or presented as a form of moral reasoning, that in turn could help them to have a *self-awareness* of their values and *envision* different possibilities. Put it differently, students can relate to the models based on *moral-technical reasoning where pain and suffering*

*are key pieces.* But imagination takes labor; it requires a thinker to put in the work, and for most of us, *it needs to be practiced.* Such quality is crucial to the understanding and altering human suffering.

Phillip Hallie [25] describes a story of the village of Le Chambon, whose people saved the lives of about 6000, mostly Jewish children, under the Nazi's persistent and institutionalized cruelty. Hallie describes the people of Le Chambon:

The people of Le Chambon are poor, and the Huguenot faith to which they belong is a diminishing faith in Catholic and atheist France; but their spiritual power, their capacity to act in union against the victimizers who surrounded them, was immense, and more than a match for military power of those victimizers [25, p. 26].

In the response to institutional and substantial cruelty, Hallie distinguishes between the absence of harm and *hospitality*. Hallie argues that the opposite of cruelty is neither the absence of it nor kindness--- "kindness could be the ultimate cruelty." The opposite of cruelty is hospitality; the people of Le Chambon possessed the spiritual power, the capacity to respond and act urgently. Such power has healing impact: "...the people who I have talked to who were once children in Le Chambon have more hope for their species and more respect for themselves as human beings as most other survivors I have met" [25, p. 27].

Beneath this spiritual power is the laborious effort of imagination, reflection, and action. It may become a virtue as it is practiced. The account is relational – though it begins with us, it is not only about us. Those who practice such deliberation and use the potential of imagination, they are in the ever-evolving process and dedication to ameliorating pain and suffering.

## **7. Conclusion**

We developed imagination modules and created a learning environment where students can exercise their capacity to envision different possibilities in relational contexts centered around pain and suffering. Our goal is to expand the modules by providing more opportunities for reflection and practice in connection with engineering and professional settings. We also plan to enhance data collection mechanisms to better capture the modules' influence, via incorporating individual interviews. This work emphasized the explicit attention to pain and suffering in developing an ethics curriculum and the primacy of the imaginative nature of moral reasoning. We suggest that engineering ethics instruction should go beyond reliance on principles, rules, and logic-oriented rationality in dealing with complex real-world situations. It should create opportunities for reflection on imaginative resources we rely on within our thought processes.

## **Acknowledgments**

We would like to thank the anonymous reviewer for their thorough review and constructive feedback on the paper.

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