Learning to Link Micro, Meso, and Macro Ethical Concerns Through Role-Play Discussions

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***Abstract*—In this Research-to-Practice paper, we present findings from a study of role-play discussions for teaching technology ethics. In recent years there has been an increased emphasis on preparing students who are not only aware of micro-level aspects of ethics but are cognizant of broader ethical obligations at organizational and societal levels. In order to prepare engineers who can contribute towards addressing the grand challenges facing the world, such as sustainability, poverty, and social justice, among others, this approach is necessary. Students have to develop the ability to look beyond a narrow problem or issue, e.g., ethical design choice related to the use of a certain chemical compound and harms to users, to the larger environmental implications of this choice. Ethics is taught in a variety of ways in engineering, including diverse pedagogical approaches and topics, but one core technique is the use of case studies. Although case studies have been used by engineering ethics educators for decades, their efficacy for teaching issues beyond micro-ethics and linking different levels of ethical concerns is unclear. In this paper, we present a research study examining the efficacy of one genre of case studies, role-play discussion, in allowing participants to link ethical concerns at multiple levels. As exemplars, we discuss two cases we designed and used. We collected data from 20 groups of 4-6 students each that discussed a specific case and find evidence that when designed with appropriate roles and related narrative, role-play case studies can be an effective pedagogical intervention. This paper presents findings from qualitative analysis of student discussions and other pre/post assessment measures to show how students link micro, meso, and macro ethical concerns through role-play discussions.**

Keywords—engineering ethics, technology ethics, role-play case studies, engineering education research, qualitative assessment, ethics of algorithms

I. Introduction

The ethics of engineering continues to be a recurrent and important topic within engineering education. Engineering educators overwhelmingly agree that ethical understanding is a foundational skill for engineering practice across engineers' lifetime and essential institutionally for maintaining a responsible profession [1]-[3]. Yet, ethics is still largely a disempowered subject in most engineering programs [4]. For many engineering programs, the driver for ethical coursework is the accreditation of their programs. [2] found that in their study of 26 published engineering ethics interventions, the majority justified their study by referencing or acknowledging ABET accreditation. Even so, the catastrophic consequences of engineering failures are often a strong enough motivation for ethics to be taught across programs [5]. Yet, as many scholars have pointed out, large-scale events are an exception. The ordinary world of engineers is complex not because of the possibility of failures but because of the dynamic nature of their work context that requires decision-making under uncertainty [6]. Even in many seemingly mundane tasks, engineers are required to make judgements about right and wrong [7].

Consequently, there is a need to prepare future engineers and technologists for a range of thinking about ethical issues. It is important for them to understand the context around ethical decision-making, especially different actors or stakeholders or organizations and institutions interacting in situations where ethics are in play. In this paper, we present a study of the use of one ethical instruction methodology, role-play case studies, to examine their efficacy for ethics instructions that teach students how to think about ethical concerns across levels. In the rest of the paper, we first review the literature on the usefulness of linking ethical concerns at different levels, and the use of case studies and role-play case studies, particularly for teaching ethics. We then present the cases we have developed and implemented, followed by the findings of our study.

II. Literature Review

A. Linking Micro-Meso-Macro Level Ethical Concerns

Within ethics education literature, there has been a recent movement toward thinking of ethical concerns at multiple levels to accurately reflect the reality of ethical decision-making. In this vein, [8] integrated multiple perspectives advanced by engineering ethicists to illustrate that engineering ethics can be viewed from three frames of reference—individual, professional, and social. He further subdivided these into micro-ethics or ethics that focus on "decision making by individual engineers and the engineering profession's internal relationships" (pg. 374), and macro-ethics that refer to "the profession's collective social responsibility and to societal decisions about technology" (pg. 374). Furthermore, [8] distinguishes micro-ethical decisions as those related to the design of a product or individual-level corruption and macro-ethics considerations as those related to the social responsibilities of engineers and the engineering profession at

large, including concerns such as sustainable development. Based on his review, he argues that teaching in engineering ethics has focused largely on micro-ethics. This disconnect between the micro and the macro is problematic because "policies need to be ethical and ethical viewpoints need to be sensitive to social problems and issues" (pg. 375).

In terms of teaching practices, [8] recommends greater incorporation of macro-ethical issues and concerns through "broadening of the context of ethical decisions, including consideration of social values and multiple stakeholders" (pg. 380). He further argues that given the often ill-structured and controversial nature of macro-ethical problems, finding a solution requires considering different perspectives - including historical, political, and institutional. Engineering ethics instruction can achieve this by covering the broader social context of engineering in conjunction with approaches grounded in practical ethics.

Beyond the micro and macro issues related to ethics characterized in [8], scholars have recently argued that the intermediate, meso level of analysis is equally consequential. [9] argues that engineering is an extremely complicated phenomenon and that even the distinction between micro and macro, although necessary and important, is insufficient to capture the complexity of ethical decision-making. He proposed a *micro-meso-macro* distinction or framework. In addition to analytically differentiating between the three levels, [9] argues one has to look at the relational aspects of the levels and the integration across the levels. In his argument, [9] makes special references to economics and argues that engineering work and industry are set up similarly in terms of individuals and enterprises. Therefore, a better way to think about it is, "Engineering phenomena can be analyzed at three levels, micro level, meso level, and macro level. In philosophy of engineering, it is better to follow the example of economics and to regard the micro level as individuals and enterprises, the meso level as a region or an industry, and the macro level as a nation even the world. Philosophers of engineering should investigate not only micro engineering phenomena, such as individual conduct and production of enterprises, but also meso engineering phenomena, such as a kind of engineering as an industry, development in a region, and industrial clusters, and macro engineering phenomena, such as a state development and world development" (pg. 33).

[9] further argues that engineering practice can be seen as socially constructed as "engineering reality consists of a great number of aspects, technological construction of engineering reality, economic construction of engineering reality, societal construction of engineering reality, institutional construction of engineering reality, and so on" (pg. 34). Consequently, according to him, engineering reality is a multiple construction on different levels and, "the three levels, including a micro level, a meso level, and a macro level, have respectively three different time–space scales or measurements" (pg. 34). Following [9], in this study, we investigate the idea of the three levels as well as how they are related in relation to ethical concerns.

B. Case Studies for Teaching Ethics

One instructional method used commonly to teach ethics is case studies. Case studies are short narratives that encapsulate a real-world problem or dilemma. Case studies vary and in addition to ethics, are used commonly in business and law. Within engineering, case studies can be narrowly focused on a problem in the workplace or examine a large-scale project or disaster. They can be used as part of the curriculum to teach how to apply professional codes or even broader societal considerations of engineering. [10] reviewing prior work in the use of case studies in engineering ethics instruction, identify two key dimensions along which case study application in engineering varies: 1) analytical strategy or a deductive-inductive dimension; and 2) Level of analysis or a micro-macro dimension (pg. 149). In a deductive approach, instructors encourage students to apply a specific theory or viewpoint to the analysis of an event. In an inductive approach, students are asked to draw a wide range of ethical lessons from a given case. In terms of the level of analysis, cases can be used for micro-ethical scenarios that usually depict individual practitioners facing difficult situations or highlight socio-political consequences of engineering. The micro approach is a powerful pedagogical technique because it asks a learner to make a decision from the viewpoint of someone in that situation. The macro approach is useful as it forces learners to make connections across different stakeholders and larger organizational and societal concerns.

Micro-ethics cases are more accessible and relatable for students who often have limited work experience but at the same time, the decontextualized nature of such cases gives students a false sense of what real-world decision-making might entail [10]. Many such cases that are hypothetical and based in a work context also do not provide students the opportunity to bring their own life experiences to the case. In recent years, case studies in engineering ethics have seen a shift towards macro-ethical issues [11], and there is an increased vigor in both macro-ethics and in trying to forge a micro-macro connection (Martin, [12]-[13]. [13] argue that case studies need to be authentic, context-driven, complex, ambiguous, multidimensional and dynamic, to be effective. And ideally, they should bridge the micro-macro levels, especially through connecting micro-level decision-making with a grasp of macro-level consequences [10]. In spite of their long lineage in engineering ethics, case studies have been criticized for their inability to provide learners the affordance to *connect* micro and macro issues related to a problem and for their unbalanced focus on either one or the other. Invariably, case studies focus on the micro or decision-making aspect of a problem faced mostly by an individual and sometimes by a team or organization.

C. The Missing Meso in Case Studies

In addition to a disproportionate focus on a single level, one element that is missing or at least not explicitly called out in the use of case studies for ethics instruction is the in-between level of decision-making, the meso level. From an engineering perspective, between the individual engineer or even a team and the society-at-large, engineering wants to serve the engineering corporation and the industry that plays a critical role in determining the ethical aspects of engineers' work. For instance, regulations that engineers have to abide by are often targeted at the level of an industry or a profession. Many regulations are not just targeted at an industry but are further limited by a region of the country, e.g., emissions standards in California, USA, are different than the rest of the country but drive what automakers

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aim for. We also see this differentiation now in standards and regulations for autonomous vehicles across different regions. The meso level constraints, in other words, are significant drivers of decision-making and thus of ethical decisions or norms within organizations and ones that guide individual behavior. Thus, to better prepare engineers for the workforce it is important if within their ethical training they are also exposed to the meso level ethical concerns in addition to micro and macro level issues that are often the ones they are most familiarized with.

III. Design of Role-Plays to Incorporate Stakeholder and Organizational Affordances

Role-playing scenarios (RPSs) promote an active learning environment beyond what is possible in a traditional classroom and encourage students to contextualize the case or scenario they are working on [14]-[17] in a situated manner [18]-[20] and engage in sensemaking and perspectival thinking[21]. Role-play scenarios serve as an instrument to guide students to engage with, debate, and evaluate decisions from the perspective of different roles. By making students aware of other perspectives, they better understand pressures and influences that would otherwise have been hidden from view [22]. RPSs provide a collaborative learning pedagogical approach that is effective because 1) collaboration triggers cognitive processes associated with learning, including perspectival thinking; 2) collaborative activity allows learners to strengthen understanding of material they have already learned and repair mental models that maybe fragmented or incomplete [23]; and, 3) a cognitive-elaboration approach within collaborative learning requires actively processing information, and aims to elaborate basic information-processing activities such as encoding, activation of schemas, rehearsal, metacognition, perspective, and retrieval [24].

In a study [25] regarding role-play instruction for diverse student groups, it was noted that the role-plays were more successful with junior and senior students in engaging critical thought towards engineering ethics as compared to mature, foreign-trained professionals. Role-play scenarios have also been used beyond the field of engineering to enhance ethics instruction. In a study on students in pharmacy law in Saudi Arabia, the participants described role-playing engagement to facilitate a more real-world representative curriculum, which led to a positive learning experience for the students involved [26]. Overall, studies have begun to provide insight into the diversity of engineering ethics interventions in scholarly work. The complexity, opacity, and ambiguity of engineering decisions make it challenging to produce generalizable principles. Thus, role-playing scenarios and case studies play a substantial role in giving students experience with how principles can be applied in these complex, opaque, and ambiguous decision-making moments.

IV. Case Study Exemplars: Boeing and Facial Recognition

A. Facial Recognition Role-Play Design and Implementation

The role-play scenario we designed follows a fictional situation involving the stakeholder's decision on using facial recognition (FR) technology (FRT) for helping with monitoring COVID on a university campus. In this scenario, facial recognition is a method of identifying or verifying the identity of an individual using the features of their face. Facial recognition systems can identify people in photos, video, or in real-time. Prior work has shown that face recognition data can be prone to error, which can, for instance, implicate people for crimes they haven't committed. Brey examined ethical aspects of the use of facial recognition technology for surveillance purposes in public and semipublic areas, focusing particularly on the balance between security and privacy and civil liberties, and argues that most FRT systems face ethical problems of error, function creep and privacy, and that these problems outweigh the security value FRT in public places [27]. Recent research has also shown that facial recognition software is particularly bad at recognizing African Americans and other ethnic minorities, women, and young people, often misidentifying or failing to identify them, disparately impacting certain groups' outcomes [28]. Facial recognition works on the underlying data but also the algorithms that are trained using the data. Therefore, given the importance of FR technology and the role algorithms play in it we created this RPS to teach students ethics related to algorithms.

This scenario is set on a fictional university campus, Andrew Hamilton University (AHU), that is considering using FRT to monitor people on the campus for COVID symptoms. Currently, the university uses a mobile application that allows individuals to submit a report outlining their symptoms or diagnosis for COVID each day they are on campus. The mobile application is mandatory for all who need to be physically on campus. There is a proposal for cameras to be installed at AHU with the ability to match facial patterns and identify individuals on the campus grounds. The cameras would identify two sets of information: first, that an individual on the campus grounds has already filled out the mobile application with information regarding any current symptoms, and second, the technology would notify administrators of any person who has not submitted their daily report, and are present on campus. The technology also allows for temperature checks to occur through the technology itself. Once a vaccine is ready, the cameras could also check if individuals on campus grounds have submitted vaccination records prior to arriving.

Trisha Brown, Chief of Safety and Emergency Management (SEM) at the University has put together a cross-functional committee (played by participants of the role-play activity) to provide a recommendation on the use of the technology along with the pros and cons of adopting facial recognition technology or a different solution. The committee is charged with identifying barriers to the adoption of the technology that the campus would face. The composition of the committee is such that different stakeholders from the campus community can have a voice in a decision that will likely affect everyone. The roles are listed and described in Table I. The role-play scenario, as well as the script for discussion is available from the authors.

TABLE I. Roles and Descriptions for the Facial Recognition Role-Play Scenario

Role	Role Title	Role Description
A	Vice President of Information Technology	A is has recently moved to AHU after a successful career in the industry. He is an unabashed technology optimist who believes that IT can solve almost any organizational

	Software and Services	problem, and once a solution has been implemented problems can be addressed.
B	Undergrad in organizational psychology; vice-president of AHU student senate	B represents students' welfare on this taskforce. B is a frequent user of social media and has used it to drum up support for causes such as the safety of women on campus. She campaigned for the COVID app when it launched.
C	Professor of History and a member of the faculty senate	C represents faculty on this taskforce. As a historian, he often takes a long-term perspective and is circumspect of technology-based solutions. When the app for COVID was being rolled out, he pushed for self-reported data entry by the user rather than some form of automatic collection of information.
D	Associate vice-president in the Provost office at AHU	D looks at student admissions and retention and is worried that a perception that the university is not doing enough for student safety might impact admissions. D publicized the COVID app and reassured students and their parents that AHU was taking all the necessary steps. D thinks a FR software would put AHU at the forefront of technology use and safety.
E	Senior Director in the Office of Equity and Inclusiveness (OEI) at AHU	E manages a range of efforts that can assist with advancing AHU's mission to admit and support a broad range of students. E is skeptical of any effort that might undermine inclusiveness on campus and this includes technology-driven project.
F	Director, FaceAware, a non-profit consultancy in the field of FR	F is providing consulting for the taskforce pro bono. F is a renowned expert on FR and was responsible for creating one of the first deployable applications of facial recognition. F has been a proponent of facial recognition but is cognizant of problems with FR technology.

B. Boeing 737 Max Case Study

For this study, the role-play scenario assigned to students was based on recent Boeing 737 Max incidents in late 2018 and early 2019. The incidents involved two catastrophic crashes of the 737 Max passenger jet (Herkert et al. (2020). Many instructors use this incident as a case study for demonstrating real-life ethical dilemmas and incidents driven by software engineering. Students were given roles of various members of an "Aviation Transportation Investigative Committee" (ATIC), tasked by U.S. Congress to investigate the incident to better understand the lessons that could be learned from the Boeing 737 Max incident with the intent of ensuring future safety and to prevent future air transportation disasters. The members of ATIC were given two open-ended questions: 1) why the incident happened and 2) how it could have been prevented as a preparatory assignment to get the students ready for the role-play activity. They were also tasked with bringing potential recommendations by which Congress could ensure future safety and transparency and rebuild trust among consumers. Students were given a role to play during the activity. Students were provided with a detailed background and information regarding the alignment of the roles within the activity. The roles for the Boeing scenario were the following.

TABLE II. ROLES AND DESCRIPTIONS FOR BOEING ROLE-PLAY SCENARIO

Role	Role Title	Role Description
A	Aviation Consultant	A served as an expert witness on similar committees to ATIC; is always keen on expressing the viewpoint of pilots. A is concerned that authority for decisions during flights has shifted from pilots to technology and that decisions about pilot training have been determined by business interests rather than pilots' needs.
B	Professor of Aerospace Engineering	B is an expert on aeroelasticity, specifically nonlinear aeroelasticity flight dynamics of highly flexible wings. B provides insight regarding the change to the wing placement to incorporate the new, bigger, engine on the 737 Max. B does not have all the information needed to judge the decision and is a neutral participant.
C	Software Engineer	C is an expert on human-automation interaction and has designed written software for aerospace applications. C has seen the complexity of interdependent systems firsthand due to having designed software to manage it and to simulate outcomes.
D	Retired FAA Officer	D has knowledge and expertise on the role of Federal Aviation Agency (FAA). D is concerned with salvaging the reputation of the FAA as it has been affected by incident.
E	Boeing Representative	E has worked at Boeing for over 30 years and serves to bring the company's perspective to ATIC. E understands the impact of the incident on the company and wants to engage dialogue on what can be done now.
F	Family Lawyer	F represents passengers and their families. F wants to ensure passengers voices do not get stifled among the "experts" and that companies work towards safety rather than focusing on budgeted consequences.

C. Role-Play Implementation, Data Collection & Analysis

The findings in this paper come from a study conducted at a large public university in the United States with undergraduate students majoring in computing technology-related fields. Participants were provided the role-play outline a few weeks before the role-play activity and given specific roles ahead of time to allow for preparation. In addition, participants were also provided reading materials and articles (both peer-reviewed and news-focused) in the realm of ethical design to supplement their understanding of the scenarios [29]-[32].

All participants completed a pre-discussion assignment that focused on understanding students' individual perspectives on the case material presented. The pre-discussion assignment tasked students with outlining an individual recommendation to the committee lead based on their understanding of their role and the context of the scenario. Participants were also asked to identify any ethical issues and barriers that their role may be presented with while establishing their chosen recommendation. The role descriptions outlined ethical issues that each role could address, but also implied other ethical issues.

Next, the role-play activity was conducted online, where participants were asked to take the perspective of their assigned role and engage with the other role-play participants. The role-play discussion was facilitated by a moderator, who provided some initial questions to focus the conversation. Participants where then asked to explain their role-based recommendation, before leading into debating and negotiating with the other participants. Ultimately, participants were tasked with creating a group recommendation, reasoning for the recommendation, and the barriers they would face in adopting the

recommendation. Finally, a post-discussion assignment was conducted to capture the final consensus of the group and collect feedback regarding the participant's experience in the role-play scenario. Data were collected across multiple semesters in 2020-2021. Analysis was inductive to identify the presence of micro-meso-macro linkages. The study was approved by the Institutional Review Board (IRB) and only data from participants who consented was included in the analysis.

V. Findings and Discussion

Table III and IV present information on how the role-playing scenarios (RPSs) are connected to ethical concerns at different levels and also give examples of discussions that took place related to the different levels. In terms of linking the three levels through the role-plays, we can identify three primary ways this took place: 1) Developing Relational Awareness; 2) Gaining Transparency over Complexity; and 3) Building Situated Understanding.

TABLE III. FRT RPS ETHICAL CONCERNS AND EXAMPLES

	Role(s)	Background Resource	Ethical Concern	Discussion Examples
Micro-ethical Concerns Concerns or actions arising at the level of a single subject, individual, team, or a single institution.	A, B, C	Report - The use of cameras in classroom and university Marks - Can bias in facial recognition be fixed	Data and privacy Error due to the algorithm	With the use of that data like it's not that that is not being stored here at the school. It's going to be at base where or whatever company that is using the facial recognition technology so one of the students or faculty will know where that information is going to how that information will be used after it's collected. Most of our information is already in social media. So most people that do they have all their information all over. So it's not just that facial recognition is something new, like if they use Facebook in the past how our Facebook automatically tags near friends without… Knowing them so facial recognition is in the field before getting popular now.
Meso-ethical Concerns Concerns or actions at the interaction of multiple subjects, organizations, professions, or communities.	D, E	DeSalvo - TED talk - how tech companies can assist with COVID Facial recognition in schools prompts lawsuit	Perception of campus within academic community Different approaches towards FRT by organizational members	I think this would actually be a really good idea to use for the campus because it would help cut back and having to have a lot of manpower to try to like… Test everybody check them, make sure they fill out the app, I do hear the you know the feedback of, you know, the bias the creepiness. Which is why I say it has to be applied. If we have like one bad case of fake facial recognition on our campus. I mean that could just be way more harmful and bring down the reputation of pretty much the whole campus than the benefits of it.
Macro-ethical Concerns Concerns or actions at the societal, industry, country, or global level.	F	Crockford - TED Talk - What you need to know about face surveillance MIT Tech Review - Coronavirus apps tracking us Wrongful arrest of black man - facial recognition and race.	Bias and fairness in algorithmic decision-making Use of algorithms for surveillance	There are two big concerns that I personally have the first of which is it can we implement it without it being racially biased or Introducing false positives, because from what we have seen in previous studies and articles from other places in the United States and elsewhere, there has been a tendency or facial recognition technology to specifically discriminate against African Americans and Asians and…

1) Developing Relational Awareness

One of the primary outcomes of the RPS in terms of developing a micro-meso-macro understanding is the relational awareness it brings among participants to recognize aspects of cases that are interlinked. In particular, different actors – persons or organizations – are typically involved in any given engineering or technology development and implementation, and it is important to understand who they are and who holds power in any given context.

In the FRT RPS, different actors have different incentives and concerns for supporting the use of FRT or opposing it. These concerns come up in the discussion and set the stage in terms of the support that IT person has for the technology and the opposition from a faculty member and the DEI office in the university. It is also clear from the discussion that the power for decision-making is less for students and faculty as compared to the administrators in charge and the security people who are part of the taskforce.

> *"I agree that the software definitely needs to be tested more um. I don't think it should be implemented until there's at least like I'm not sure like… What the margin of like error is at the moment, but I think we'd first need to like set that. Like, what um, what is an acceptable amount of error that the software can have these like false encounters with certain demographics, because I feel… [the case] said that, like if the… If [the FRT system] catches someone who didn't… upload their COVID app data for that day that it could possibly send a notification or even like have Campus Security come and interact with them. And I feel like if it's just like… Primarily a certain demographic one it will just look bad for the campus overall that like securities constantly interacting with a certain groups of people." [F20DL2STU5. G2]*

In the Boeing RPS, for instance, the stakeholders who were involved included company engineers and managers, regulators, and pilots, among others. Invariably, in the case of Boeing, the managers or business leaders wielded the most power over the situation, leading to the implementation of the software and the decision not to inform the pilots about it. The regulators also failed to do their job as they were incorporated within Boeing and therefore lacked power over the company as it paid their

salaries. In this case, the least power for decision-making of any kind was with the passengers who flew as they did not decide which aircraft to fly in.

"I think that the problem was … Boeing was competing with Airbus and that they were saying that there was something there was not. And they were saying the pilots would need little training and they did training on an iPad… and you know simulation training which they needed. And so, Boeing pretty much just lied so that they could compete with Airbus and they were worried more about money than the safety of their own pilots. And they needed to communicate what software that their pilots were going to be working with because the pilot should be able to use the software as tools and not the software controlling the plane. They have no idea what's going on." [F20DL2STU4; G1]

2) Gaining Transparency over Complexity

One of the ways to understand the levels is to gain more insight or transparency into how different aspects of the scenario are linked to each other. The discussion breaks this complexity down, and different stakeholders bring different pieces to the table that are all part of a larger puzzle. This process is necessary to build on an understanding of the relational aspects as this transparency over the complexity in the situation allows participants to gain some understanding of chain of events and decision-making. Even if not fully causal, this process allows participants to at least get a sense or multiple perspectives on why decisions were made the way they were.

In the FRT RPS, there is complexity related to the FRT system's implementation and the relationship between that and COVID surveillance. As this relationship becomes clearer, many students suggested that technology does not need to be used for COVID and that physical testing and physical surveillance would also be viable options. By looking into why technology in the first place and how the technology connects to use at the micro level, concerns at the meso level within the university, and then societal problems with surveillance, discussants were able to develop a different and nuanced understanding of the issue.

"Right, so, um, my concern, you know, why do I… why I am I not advocating for implementation of facial recognition derives from the implementation perspective and the execution versus the fundamental technology itself because… I do believe I could be convinced that facial recognition is beneficial in terms of tracking the coronavirus. However, as I stated before the algorithm itself. You know, it takes time for the algorithms to mature and to build a sustainable, you know, outlook based on religion.… background facial features, etc. So my primary concern is, is you know it can be done, but at what cost is it going to take to get to the point where it's a sustainable system.… And including that like if the problem of facial recognition during the coronavirus particularly is the virus is transmitted via… I mean it's well documented. That's true, it's transmitted airborne and through the… Through exhaling of an infected member but the problem of facial recognition is you then have a scenario where you're instructing your, your student base to remove their facial coverings or their PPE.… So that you can scan their face to determine whether or not they have symptoms or not." [F20DL2STU2; G5]

In the Boeing RPS, there are layers of complexity as what initially appears to be a problem with the software is a lot more complex. The RPS discussion unearths this complexity as discussants hear why the software was needed in the first place, the decisions that were made to make do with the existing aircraft design for expediency, the role of regulators and why they failed and that pilots did not know about the system and therefore did not know what action to take or rather to not react. They are able to see the link between a micro issue, the software, and the reasons it was used and see a link.

"I mean it's no secret that it's been well documented that the MCAS system is largely the point of contingency within the investigation. But I also think it's point… It's a good point to make note of that as from the perspective of the FAA, you know, Boeing and the FAA have worked for have worked together in a joint venture for many, many years. And the problem here is… when you design an aircraft, especially in a in a commercial implementation you know there's so many regulations and certifications that you have to meet and the problem is when the 737 max program was launched." [F20DL2STU21; G5]

3) Building Situated Understanding

Finally, with a relational awareness in conjunction with transparency over the complexity at hand, students can build a reflective situated understanding of the concerns at different levels. They are able to connect the stakeholders with their actions across levels, and even though they might disagree with what unfolded, at least develop an understanding of what and how that happened.

In the FRT RPS, discussants develop a situated understanding of the micro (the technology and algorithmic aspects), meso (their university as well as reaction of other universities), and macro (use of algorithms across services) level ethical concerns and how they related. By considering different stakeholders and their positions and through insights into the workings of the technology and organizations, discussion participants were also able to come up with solutions that would work better in that specific situation or context (e.g., use of more physical checkpoints).

"So there are several known issues with this technology.… You know, we're trying to apply it to a university campus, which is a very diverse demographic and that's one of the main issues and concerns that you know we have obviously the safety.… Of the students is something that would be benefited from this technology, we could see the people who are coming in and leaving campus and making sure that everybody has submitted their information.… To the application, just so that we can track and monitor, you know, the overall health of the student body.… But there are privacy concerns and something like this would take several… Iterations of trying to implement them implement it and see how it works for us. And we really just don't have that time, I think there are several other things that we can implement quicker.… They may not be as effective, but I think, you know, if we all unite as a student body. We can we can definitely keep everybody safe." [F20DL2STU12; G3]

In the Boeing RPS, students were able to build an understanding how a complex aircraft and aviation industry functions and also how it is different from other industries. Even though, in this case, there were few other comparative incidents, and this was not something likely to take place with other forms of transportation, discussants were able to use this vantage point to understand how uniquely situated this industry is and this aircraft is within the larger ecosystem of air transportation.

"I came out from a very early on point that Boeing was holding information and basically lying and manipulating the FAA by keeping many factors secret. Which led to a lot of problems happening, not just the MCAS software but also a lot of parts were being improperly manufactured were susceptible to breaking and cracking. So from an early on point, it was clear that Boeing was trying to cut corners and to Basically meet their deadline and to save money and the FAA, unfortunately probably there was some collusion, probably with management. They were trying to meet Boeing halfway, be like, oh yeah, you guys have a deadline, you know, we'll try to help you out with try to rush through which should not have happened. There's also the issue that the FAA was not being properly funded. So, they were actually outsourcing and letting companies do their own safety tests. Which should never happen. So I'm really, in the end, there was problems, kind of on both ends." [F20DL1STU15; G4]

4) Ethical Literacy through Reflective Engagement

Overall, in addition to the three aspects discussed above, findings from our study show that through their participation in the RPS discussion students were able to develop an ethical literacy that included an awareness that ethical concerns work at different levels and how they are linked across levels. Furthermore, one of the common findings across all groups was a self-reflective component during the discussion in where students moved out of the role they were playing and discussed the issued from a personal viewpoint based on the value they held personally. They commented that before participating in the discussion they did not necessarily hold a personal opinion but after it, they had formulated one. This reflective aspect is important as reflection allows students to build a value system.

A final point that needs to be brought up in this discussion is that although for research purposes, we have made analytical distinctions between different aspects of ethical concerns, and to some extent even different levels, during the RPS they often appear in conjunction. In other words, discussants themselves would not distinguish between all different levels or aspects. For them many of these issues, and rightly so, are closely interlinked and all the perspectives are needed to make sense of a given

TABLE IV. BOEING RPS ETHICAL CONCERNS AND EXAMPLES

	Role (s)	Background Resource	Ethical Concern	Discussion Examples
Micro-ethical Concerns Concerns or actions arising at the level of a single subject, individual, team, or a single institution.	A, E	Vox Video, "The Real Reason Boeing's New Plane Crashed Twice" P. Johnston's blog on what software organizations can learn from the Boeing Saga Travis, G. (2019). How the Boeing Max 737 Disaster Looks to a Software Developer. IEEE Spectrum. Website with updates from Boeing	The performance of the software. The pilots not knowing how it works. Placement of the engine on the aircraft.	I think the biggest issue here is the placement of the engine. I don't know if there were many iterations, or if they considered, you know, changing something different. Physically to the airplanes. I know that obviously the decision to put the engine higher up on the wing was because of how short the landing gear was. However, the I just don't know whether enough testing really went into seeing how that affected you know the flight.
Meso-ethical Concerns Concerns or actions at the interaction of multiple subjects, organizations, professions, or communities.	B, C, D	Website with updates from FAA Update Seattle Times Boeing Coverage Johnston, P. & Harris, R. (2019). The Boeing 737 Max Saga: Lessons for Software Organizations. Safety & Automation, SQP, VOl. 21, No. 3.	Regulations responsibility of Boeing. Technological complexity leading to unintended results	I think the FAA should have had someone on hand to like instead of just believing what their engineers, tell them I think they should have someone go over there to like analyze the program to make sure it was safe to use to prevent the plane from, you know, going haywire and causing the plane, the nose to like dip down competitor and having the pilots fight against the also the idea that they didn't inform the pilots which is pretty bad because it's all about safety and regulation so Boeing was more focused on efficiency compared to stability and submit stability is like the main reason for Having a plane on you know for other companies to purchase and use.
Macro-ethical Concerns Concerns or actions at the societal, industry, country, or global level..	F	MacGillis, A. (2019). The Case Against Boeing. The New Yorker. Bloomberg Video, "How Boeing Lost Its Way?" Wall Street Journal Video, "Inside the Boeing 737 MAX Scandal That Rocked Aviation"	Competition with Airbus Effect of disaster on family.	This issue did arise from a design perspective but it's also from competition, where Airbus first implemented this new engine, but their aircraft was much better where it's higher from the ground it's properly built. So, they were able to fit this bigger engine. Boeing tried to do the exact same thing but they had to place the engine a little bit higher on the wings that caused the nose of the plane to point upward. I think the first thing that they need to do is like probably come out and apologize to the families that have lost their lives, actually. So, to, you know, admit that they have done some folks, especially when it comes to rushing the process of bringing out a new model of plane.

concern. As with any other interpretive research, this is a shortcoming where the meaning-making *in situ* is different than what a researcher has categorized it as.

VI. Conclusions

In this paper, we present a study of the use of role-plays for developing students' ethical understanding of micro, meso, and macro aspects of ethical concerns related to a given issue. We found that through their role-playing and discussions, students developed a robust understanding of ethical concerns at different levels and were able to make connections between them and across levels. We also found that the role-play discussions help them reflect on their personal values in relation to the case and the role, further cementing their understanding of technology ethics.

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