

Using the Boeing Max Air Disaster as A Role-play Scenario for Teaching Ethical Thinking

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Abstract

Algorithms are a central component of most services we use across a range of domains. These services, platforms, and devices rely on computing and technology professionals – who work as data scientists, programmers, or artificial intelligence (AI) experts – to meet their intended goals. How do we train future professionals to have an ethical mindset in their understanding, design, and implementation of algorithms? This was the question that prompted the use of a role-playing case study, which we designed, implemented, and studied in an undergraduate engineering course. We used the Boeing Max 8 flight disaster as the scenario for this case study as it encapsulates how a software algorithm shapes decision-making in a complex scenario. Theoretically, our work is guided by the situated learning paradigm, specifically the need to learn perspectival thinking for decision-making. The ability to make ethical decisions relies to a large extent on the ability of the decision-maker to take context into account – to understand not just the immediate technical need of the work but also larger implications that might even result from unanticipated consequences. Findings from the evaluation of the role-play scenario show that students reported a higher engagement with case study material and a better understanding of the scenario due to taking on a specific role related to the scenario. Analysis of pre-and post-discussion assignments shows a shift in their perspective of the case, further supporting the overall goal of developing a more situated understanding of ethical decision-making.

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Introduction

Algorithms and software now drive decision-making across a range of domains, and the impact of algorithms in the digital future is hard to escape (O'Neil, 2016; Pasquale, 2015). They not only shape individual actions but are increasingly embedded into the structure of our society, making decisions at scale about who gets a loan, who gets hired or fired from a job, who receives social services, who can vote, who goes to prison, for how long, and when they get parole (Brayne, 2017; Buolamwini & Gebu, 2018; Eubanks, 2018). For instance, a software system with COMPAS machine learning-based recidivism risk assessment tool assigns disproportionately higher risk to African-American defendants than to Caucasian defendants (Larson, Mattu, Kirchner & Angwin, 2016). New York City Department of Transportation (NYCDOT) has employed the Manhattan Traffic Model that fails to disaggregate transportation data by gender (Perez, 2019), thereby placing an extra burden on caregivers, predominantly female care workers, who must take multiple buses to navigate the city's periphery. Software systems used for policing that deploy predictive algorithms like Chicago's Strategic Subject List (SSL) disproportionately target African American individuals and neighborhoods for increased policing (Brayne 2017; Ferguson 2017; Karppi 2018; Sheehy 2018). The significance of systems that are engineered by technologists for society requires us to think seriously about preparing workers for a novel and uncertain future guided by software and algorithms (Stevens, Johri & O'Connor, 2014). Specifically, how do we prepare the future workforce to be consistently reflective so that their actions enable a better future with minimal or/and no harm? In other words, how do we help students develop an ethical mindset?

We believe that it is within their academic training that future technologists can be best prepared to develop an ethical mindset and can be equipped to respond to the challenging decisions they will have to make when they enter the workforce. The university is a critical site for this training because future workers will have little time to gain ethical training on the job in fast-paced technological work environments and, further, it might be in the best interest of companies to not provide such training or to 'do no harm' even when individual technologists might otherwise be so inclined. Even when industries are regulated, organizations often spend more resources trying to circumvent those regulations for profit-making than working within the regulations. This is true not just of companies that impact the environment but also new companies such as Uber or Airbnb (Nieuwland & van Melik 2018; Rauch & Schleicher 2015; Rosenblat 2018; Stone 2017). Given that in the digital era, laws and regulations far lag technological development, self-regulation in some form will be essential to our social well-being. It is also within their academic training, early in their professional socialization, that an ethical mindset can be best imparted to engineering students so that they have multiple opportunities to think through these complex issues and so that it becomes a part not just of their thinking but also their identity.

Engineering Ethics Education

The field of engineering ethics has a growing pool of scholarly work over the last decade. Much of the growth in published work can be attributed to maintaining accreditation with professional associations such as ABET (Accreditation Board for Engineering and Technology). A literary study of 26 published engineering ethics interventions in scholarly journals between 2000 and 2015 noted that "The majority of the 26 analyzed articles justified their study by referencing or acknowledging ABET accreditation" (Hess and Fore 2018). The guidelines presented in

Accreditation Criterion 3 address student learning outcomes towards ethical and professional responsibilities, although they do not define a framework or goals to achieve this outcome (ABET pg. 5). Thus, engineering programs have both the opportunity and responsibility to define their own goals towards establishing their ethics curriculum. Colby and Sullivan (2008) found a wide variety of techniques and granularity of engineering ethics content through an analysis of engineering courses.

Among engineering education researchers, there is a consensus that ethics coursework is vital to encouraging an identity of responsible engineering (Herkert 2000; Hess and Fore 2018). One reason for this is the impact of engineering decisions, which can result in catastrophic events (Boisjoly et al., 1989; Birsch & Fielder 1994; Herkert et al. 2020). However, this cannot be the only rationale for teaching engineering ethics. Harris (1996) argued that "Although [tragedies, disasters, and scandals] should be a matter of concern to all of us, and especially to engineering students, who can learn from past mistakes, they are exceptional rather than ordinary occurrences. Most engineers will never be involved in such newsworthy circumstances." However, for engineers in today's world, the context and pace with which engineering decision-making occurs have changed this dynamic. Engineering professionals, even those who are early in their careers, are tasked with applying technology, scientific understanding, and technical breakthroughs to solve, build, and create solutions that have a global impact. In doing so, they are faced with ethical dilemmas that they must bridge in order "to make judgments about what is right and what is wrong" (Heller 2012). These decisions are often not simple, straightforward and are faced with ambivalence towards whatever solution is chosen.

Engineering ethics interventions can take the form of several active learning techniques based on the institution's approach. The types of engineering ethics interventions include broad institutional college-led initiatives such as courses and programs but can also be implemented at a micro view through case studies and role-play scenarios (Hess and Fore 2018). In a study from Prince (2006) 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 (Al-Aqeel, 2013). 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 critical role in giving students experience with how principles can be applied in these complex, opaque, and ambiguous decision-making moments.

Situated Learning for Perspectival Thinking

The objective of the work we present in this paper was to bring a more nuanced and context-based understanding of how algorithms work in real-world applications, and one of the theories of learning that allow us to design and assess that goal is "situated learning" (Lave & Wenger, 1991; Greeno, 2011; Greeno & Nokes-Malach, 2016, Sawyer & Greeno, 2008; Johri & Olds, 2011; Johri, Olds & O'Connor, 2014). The focus of situated learning on the role of context and on taking

different perspectives guides us in thinking of pedagogical tools that support those activities. Of particular relevance to the proposed work is the idea within the situative perspective that what we learn and how we learn it are closely linked. This situation, or context, determines what people look for, how they get the information, and how they interpret the information. Knowledge arises dynamically and is constantly constructed and/or reinterpreted (Clancey, 2009). Within the situated learning tradition, Greeno and van de Sande (2007) and van de Sande and Greeno (2010, 2012) advance a perspectival view and argue that a person's or group's knowledge and understanding of any conception is "their ability to construct perspectival understandings that are situated in activity and that are organized according to principles that are taken as defining the conception (pg. 14)". This process of developing a perspectival understanding is a continuous process as long as the learner is engaged with the situation. Taking a holistic view, the analogy they provide in their paper is that of a painting or photograph where the focus of a perspective is on the different elements and their relational arrangements. Their formulation of perspectival learning is helpful in designing curriculum that is driven by the case or the situation.

Role-Plays for Engineering Ethics Education

Teaching engineering ethics using role-play activities or simulation has recently gained traction within engineering ethics education. Role-play scenarios are a popular engineering ethics intervention because they allow students to engage in empathy and perspective building exercises in the classroom. This participation is fundamental to early-career engineers, who Loui (2005) argues are likely to face ethical dilemmas that include conflicting viewpoints during their everyday work lives. It is important to recognize that "students come to a course with a variety of backgrounds and developmental stages, different students internalize different ideas" (pg. 383). As there is the certainty that students will face these ethical dilemmas but have different readiness levels, researchers argue that the focus is on readying students to empathize. Hess and Fila (2016) argue that empathy and perspective-taking exercises should be incorporated in the engineering curriculum and are fundamental to holistic engagement efforts. As Doorn and Otto (2013) describe, role-play scenarios serve as an instrument to guide students to engage with, debate, and evaluate decisions from the perspective of different roles. The authors also acknowledge that by making students aware of other perspectives, they better understand pressures and influences that would otherwise have been hidden from view.

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 (Shaw 2004; Loui 2000) and engage in sensemaking (Johri, 2009). RPSs provide a collaborative learning pedagogical approach that is effective because 1) collaboration triggers cognitive processes associated with learning, including perspectival thinking (Hmelo-Silver, Chinn, Chan & O'Donnell, 2013); 2) collaborative activity allows learners to strengthen understanding of material they have already learned and repair mental models that maybe fragmented or incomplete (Webb, 2013); 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 (O'Donnell & Hmelo-Silver, 2013; pg. 5).

In terms of how collaboration is structured within RPS, it assists with perspectival understanding and change in perspectives by several mechanisms: First, through the use of prompts or prior

information that is provided to participants to encourage high-level discussion, sharing of perspective, and construction and sharing of explanations; second, through the use of structured controversy whereby the topic presentation of views itself shapes discussion (Easton, 2006; Johnson, Johnson & Smith, 1996); and, finally, through cognitive role specialization where adoption of specific roles requires learners to carry out particular cognitive activities (Webb, 2013, p. 29-30). Role-playing provides an even closer approximation to experience than a case study, which is commonly used in ethics teaching, since "being" a character in a role-play introduces a social component that cannot be achieved with a case discussion (Hertel and Millis, 2002).

Proponents of role-playing argue that it supports learning across a range of areas, including perspective-taking (Pusateri, Halonen, Hill, & McCarthy, 2009), critical thinking (Poling & Hupp, 2009), and communication skills (Nestel & Tierney, 2007). In addition to these skills which are necessary regardless of the domain of learning, role-plays are also useful in teaching and consolidating student knowledge in a given subject area (DeNeve & Heppner, 1997; McCarthy & Anderson, 2000; Poling & Hupp, 2009; Poorman, 2002). In RPSs, students must not only apply their knowledge, but must also negotiate with another character with different information, perspectives, and motivations. As Brummel et al. have argued, this social component is important for students to experience, not only for developing communication and negotiation skills but also for cultivating a greater appreciation of the crucial role that social factors play in resolving an ethical issue. Prior research on the use of RPSs has shown that in their initial reactions to RPS, learners have reported finding the RPS uncomfortable. This discomfort is often due to the experience of "disjuncture" (Jarvis, 1987, pp. 79–84) between the experience of the RPS and the student's previous conceptualizations of a given topic. Studies have shown that these disjunctures can prime students to engage strongly in efforts to develop knowledge and skills to bring "equilibrium" back to their conceptualization (Jarvis, 1987, p. 80).

While researchers have argued that role-play scenarios are a viable means to engage students in engineering ethics topics, there is less evidence available on the extent to which the perspectival thinking among learners can change through role-play scenario participation, in addition to the students reported engagement with case materials.

RQ1: How well do RPSs work for furthering a situated understanding of ethical thinking related to algorithms among learners?

RQ2: What is the nature of perspectival thinking among learners, and how does it change through RPS participation, especially how does adopting different roles shape their thinking, and are students able to adopt a more responsible perspective?

Implementation of the Role-Play Activity

In this section, we discuss the class context in which the role-play activity was included, the role-play scenario, descriptions of the individual roles, and how the activity was conducted.

Course

The role-play was integrated into the curriculum for a university-level class for ethics in information technology. The course is a required core course and fulfills the undergraduate requirements towards various tracks within the IT major. The course is taught through both synchronous and asynchronous delivery in online format. The learning environment is discussion-

focused and uses case studies from different regions around the world. Course material is traditionally presented through a series of videos, readings, quizzes, discussions, and reflection assignments. The topics covered include, among others: global economic history; IT and global development; AI, algorithms, and fairness; and IT and ethics.

For this iteration of the course, role-playing elements were introduced to engage students in an online environment. The course is divided into four modules: 1) Societal Impacts of Technology, 2) Privacy and Surveillance, 3) Data & Algorithms, and 4) Ethics. This study focuses on the Societal Impacts of Technology and introduces Ethical decision-making concepts. The content assigned each week included assigned readings, including both journal and news articles, discussion posts, and homework assignments to scaffold learning, leading up to the goal of creating an individual concept map. Toward the end of the module, the group role-plays activity served as a culminating experience to synthesize all the material covered in the module and allow students to engage with several roles and the perspectives therein. Students were given several resources to allow for preparation for the role-play scenarios. The role-play was outlined in detail, describing the scenario and key individuals associated with each scenario.

Module Schedule

1 Introduction to module

2 Videos covering module material

3 Readings (scholarly and news articles) covering module material

4 Role-play pre-questions

5 Individual concept map

6 Role-play activity

7 Group concept map

8 Role-play post-questions

Role-Play Scenario details

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. As Herkert et al. (2020) describe the scenario:

“In October 2018 and March 2019, Boeing 737 MAX passenger jets crashed minutes after takeoff; these two accidents claimed nearly 350 lives. After the second incident, all 737 MAX planes were grounded worldwide. The 737 MAX was an updated version of the 737 workhorse that first began flying in the 1960s. The crashes were precipitated by a failure of an Angle of Attack (AOA) sensor and the subsequent activation of new flight control software, the Maneuvering Characteristics Augmentation System (MCAS). The MCAS software was intended to compensate for changes in the size and placement of the engines on the MAX as compared to prior versions of the 737. The existence of the software, designed to prevent a stall due to the reconfiguration of the engines, was not disclosed to pilots until after the first crash. Even after that tragic incident, pilots were not required to undergo simulation training on the 737 MAX.”

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 (see Appendix) were the following.

Role	Role Title	Role-Play Summary and Alignment
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.

Data Collection

This study was conducted at a large public university in the United States with undergraduate students in the engineering school who were majoring in technology-related areas, including IT and cybersecurity. The student population is highly diverse and includes many first-generation college students, first-generation immigrant students, Hispanic, and Black students. Data were collected from one semester from two different sections of the same course that covered topics related to technology and society and fulfilled the program's ethics requirements for accreditation purposes. Data were collected initially in the Fall 2020 semester through a written assignment, during the role-play scenario through an approach similar to a focus group (Krueger & Casey, 2014), and through a survey. The student responses were prompted by specific questions posted for them. The Institutional Review Board approved the research study of the institution, and only responses from students who consented to participate were included in the analysis. Fifty-one students took part in the role-play spread across twelve groups. There were 27 participants in one section and 24 participants in the second section. Students reported that they have never participated in a role-play scenario in the past.

Findings

We present findings related to students' reported learning experience and their shift in perspective due to participating in the role-play. There were three general themes among student responses to the role-play activity: students learned much regarding the details and complexity of the case, engaged in scenario-specific research beyond the resources provided, and demonstrated a change in their perspectival thinking.

The first common theme among the responses was that students were aware of the Boeing case, but did not realize the complexity or the different stakeholders. Overall, students reported that they learned new aspects of the Boeing case as a consequence of the role-play discussion. Almost all students either agree (25%) or strongly agree (71%) with this sentiment (Figure 1). Students also reported that their overall understanding of the scenario increased as a result of the role-play (Figure 2). By engaging with all the case materials, students demonstrated a more complete view of the events that led to the disaster and isolated several ethical dilemmas at play.

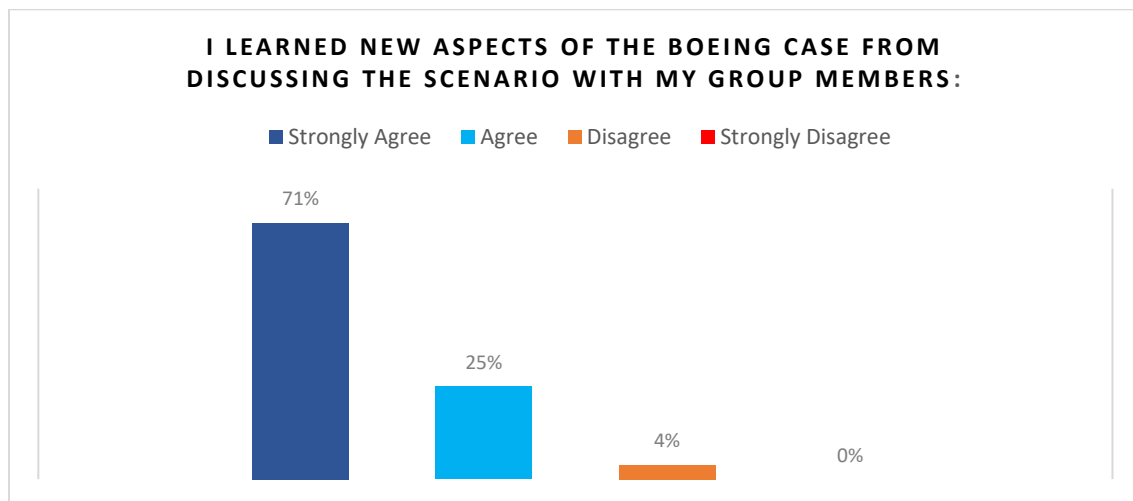


Figure 1: Student responses to the prompt, "I learned new aspects of the Boeing case from discussing the scenario with my group members." (n =51)

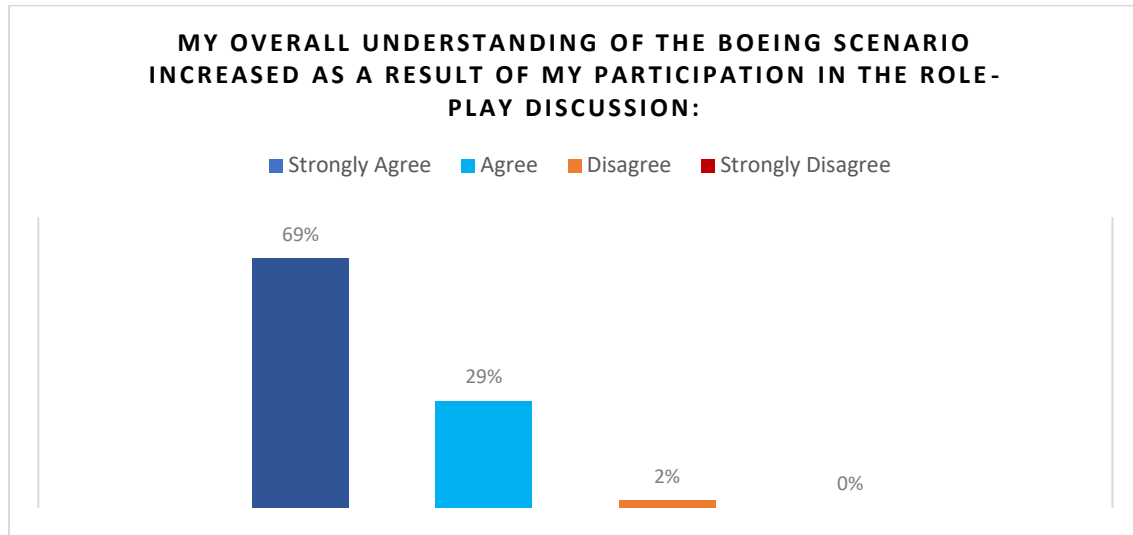


Figure 2: Student responses to the prompt, "My overall understanding of the Boeing scenario increased as a result of my participation in the role-play discussion." (n =51)

Throughout the discussion, different perspectives were expressed, and students reported that although beforehand they held a certain viewpoint, they were able to see things differently after participating in the role-play discussion. Some discourse related to this change can be seen below.

My role opened my eyes more to the situation. At first, I thought the MCAS system didn't work, or was badly designed, or implemented. But it was doing exactly what It was meant to do, which I didn't know at first. It seemed that the regulations and guidelines were what let the system down. If the sensor malfunctioned, MCAS would take over and that's what it was programmed to do. So, listening to others talk definitely made me see that perspective. - [Student 1]

A second theme among the responses was how students engaged with the resources provided and used this to springboard their curiosity to research their own role and the scenario in general. The learning they reported occurred not just through the discussion but as an outcome of preparing for the assigned role. This was partly attributed to the variety of materials used to engage students understanding within the module. Students were provided with academic readings, interviews, reports from different stakeholders, and a list of resources to prepare for the role-pla, along with the role description. Although these items were sufficient to conduct the outcomes of the role-play, each of these items gave direction to additional optional resources that students could use to do additional research. Even though all the information they found may not have been used in the actual discussion, they still reported it as a learning experience. Some discourse from this theme can be seen below.

My role's description said something about "human-automation interaction," and at first, I didn't know what that meant. But like I looked it up, and that really got me thinking

about how much software engineering must work to harmonize the pilot, plane, onboard systems with the software itself. - [Student 2]

During my preparation for my role (aviation/aerodynamics expert). I kind of over-prepared for the role-play... I researched so much about the case because I wanted to be the expert. While in the end we may not have gone into details about thrust or how the wings were shaped, I thought it was very interesting to be able to dive into those aspects of the case because of my role. I wouldn't have thought about it like that without my role. - [Student 3]

Given the centrality of the roles in the discussion, we asked students about their experience with the role and if they would have preferred to play a different role or learned more if they had a different role. Although a majority of the students (~75%) expressed that they were fine with the role they were assigned, a quarter noted a preference or expected learning gains if they had a different role (Figure 3).

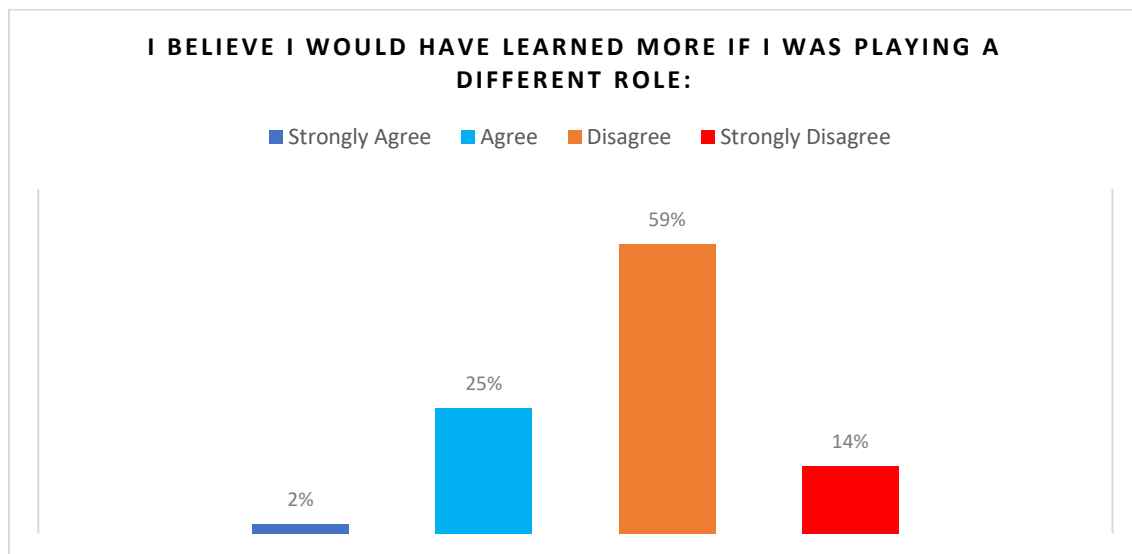


Figure 3: Student responses to the prompt, "I believe I would have learned more if I was playing a different role." (n =51)

We analyzed the data to understand better if this was role-specific, and students reported the least preference for the role of the family lawyer, Role F as that was a challenging perspective for the students to take (Figure 4). Many of the students were also not comfortable playing the role of the Boeing representative which is not surprising as students predominantly reported not agreeing with Boeing's viewpoint in general and the way the situation was handled.

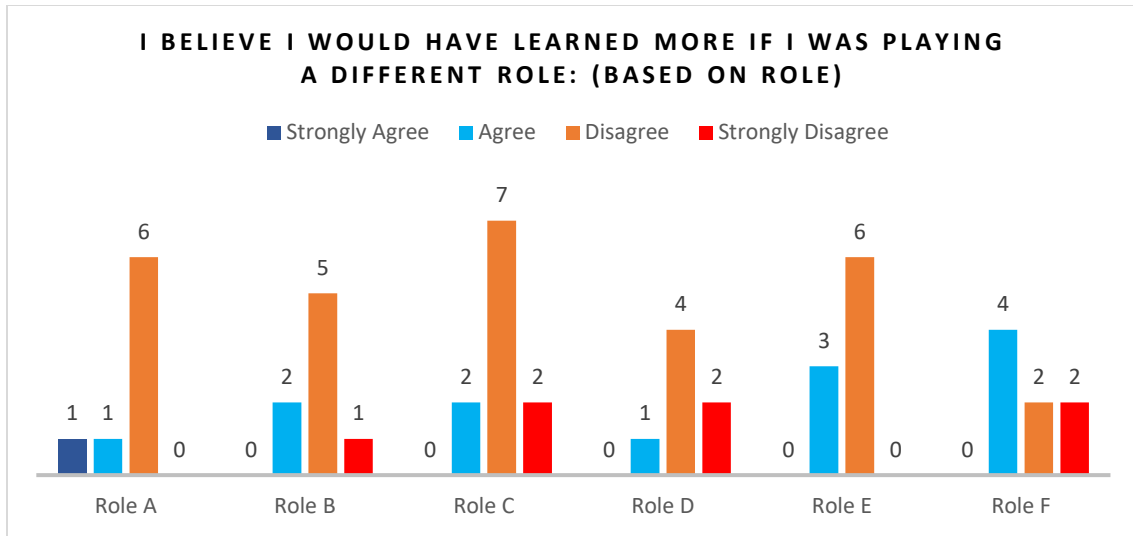


Figure 4: Student responses to the prompt, "I believe I would have learned more if I was playing a different role." based on the role they played. (n =51)

The third theme was the effect of role-playing on the student's perspective. Almost 80% of the students either agree or strongly agree that participating in the role-play activity had changed their perspective (Figure 5). The change in perspective resulted from students expressing different viewpoints and often resulted in a specific role having to change their opinion about what took place. The roles naturally encouraged collaboration and discussion, but since the role-play was focused getting students to form a recommendation, the discussions provided an opportunity for each participant to represent their role. Consensus-focused discussion also made them empathize with other roles and appreciate the overall complexity of the case.

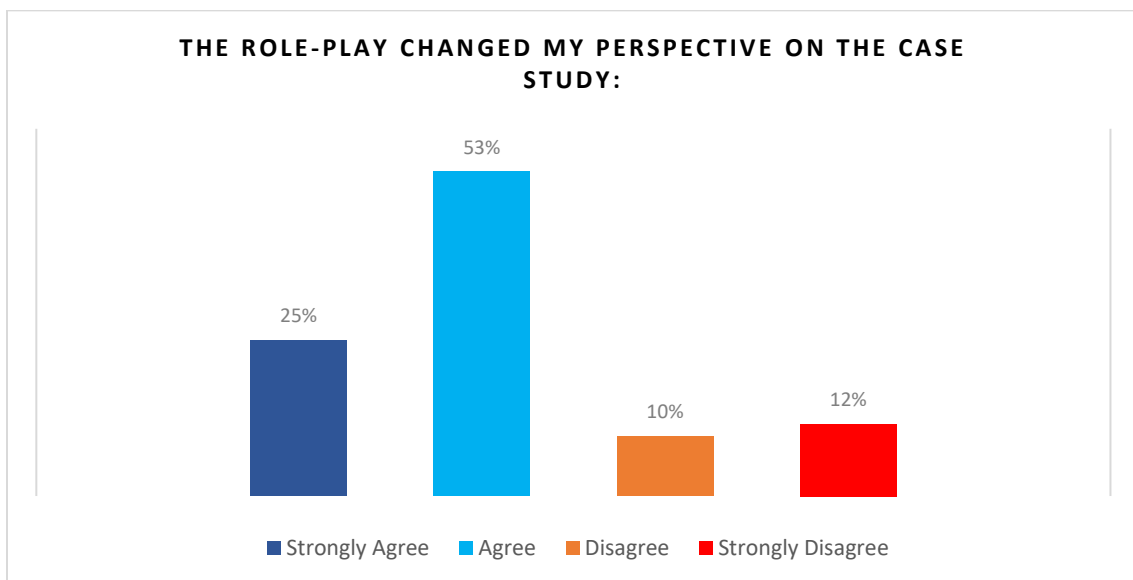


Figure 5: Student responses to the prompt, "The role-play changed my perspective on the case study." (n =51)

Some discourse associated with this theme can be seen below:

I think playing the role of the Boeing representative was really tough, but it was really interesting to gain a perspective for the people working at the company. I had to basically disagree with my personal opinion. I know it was tough on for that role, but their conversation showed that there are so many perspectives involved in this case. - [Student 4]

Coming into the role-play, I was pointing my finger at the FAA and Boeing, and I still do. But I am more sympathetic to the FAA because of what the retired FAA Officer said during the role-play. It made me realize that the FAA were essentially lied to. I agree there should have been more oversight, but the FAA trusted this company for so long. And, you know, that was wrong, but at the same time, it just made me a little bit more sympathetic towards someone in that position. - [Student 5]

I think taking on someone else's role and perspective lets you study more specific information of their area, and when we all come together, we all bring pieces to the puzzle, and we put them together. So, I got a good vision of the scenario and the different perspectives. I also think by doing this, I realized that there is a lot of complexity. It's great to break it off into smaller pieces, and everyone contributes. I enjoyed that. - [Student 6]

The role that I played definitely affected my stance and perspective. My role was less technical compared to some of the other roles, but I got to think like a businessperson. I feel like this role was perfect for me because it coincides with my personal perspective on the case. I had a lot of fun with it. - [Student 7]

Finally, students stated that they did not think that just reading the scenario and writing an essay would have been as effective as actually doing the role-play (Figure 6).

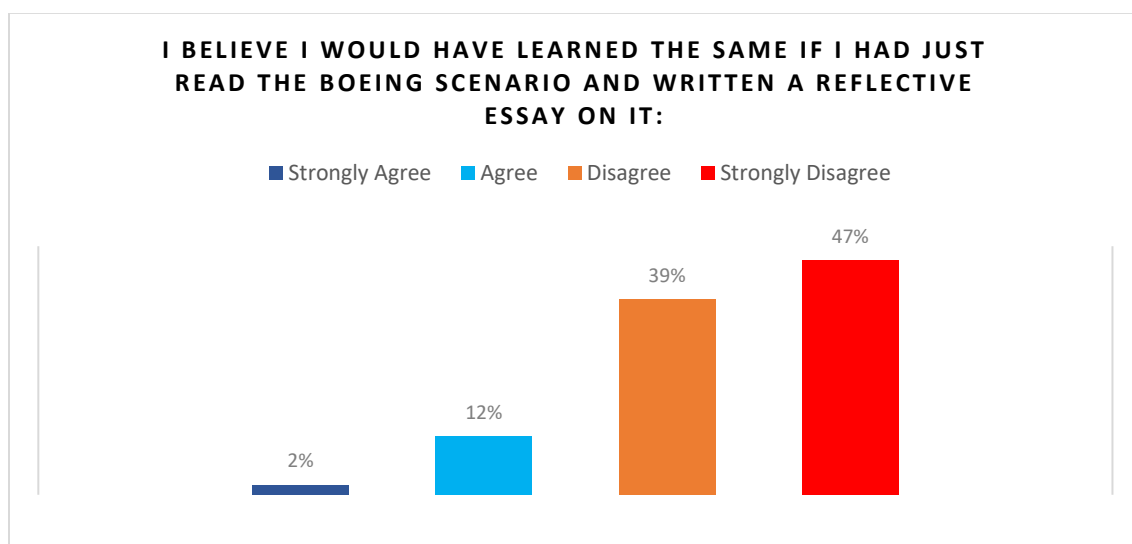


Figure 6: Student responses to the prompt, "I believe I would have learned the same if I had just read the Boeing scenario and written a reflective essay on it." (n =51)

Discussion and Conclusion

In this paper, we present a study of the use of role-play case studies for teaching perspectival thinking related to ethics. We designed and implemented a role-play in an undergraduate course and collected survey and focus group data related to the use of the role-play. We found that the role-play effectively provided students an understanding of how context shapes a situation and how different actors involved with a complex scenario interpret and approach it differently. Through active engagement with peers, schemas, which are the basic cognitive structures and shape perspectives, are enhanced and reshaped, thereby changing how learners view a concept or issue. Peer interaction leads to deeper engagement and also helps learners stay on task. Furthermore, feedback and discussion with peers ensure that learners understand the content they are trying to explain. For the overall success of role-play scenarios in the classroom, students should be both challenged and engaged by the content. There should be an interesting underlying problem that needs to be addressed or a contentious decision that needs to be made. Not all the information should be available in the given information; it should appeal to students' imaginations and encourage them to think beyond what is given.

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Appendix – Scenario

Aviation Transportation Investigative Committee (ATIC) 's Report on the Boeing 737 Max Crisis for U.S. Congress

To better understand the lessons that can be learned from the Boeing Max crisis in order to ensure future safety and to prevent future air transportation disasters the U.S. Congress formed an Aviation Transportation Investigative Committee (ATIC) and instructed it to understand the issues from all perspectives and report back to Congress with recommendations.

Brad Jorgensen and Kathy Schmidt, who had both worked in the aerospace industry at some point in their careers and were now staff members serving members of Congress were designated co-chairs of the committee. For assistance, they had assigned different members of their committee, including external experts, different issues to research and present their findings.

When Brad and Kathy took on this responsibility they thought it would be an easy task as the software was at fault but they soon recognized that the solution to the problem might be more complex. They were surprised to learn that competitive pressure from Airbus in terms of losing market share was one of the major reasons for the new model of the aircraft. They were amazed at how quickly decisions were made to be able to compete including changing the design of the aircraft to accommodate the new engine. As they dug in more into existing news coverage, reports, and testimonies they begun to feel the weight of the problem even more.

They were flying to Seattle to speak with Boeing representatives a few months after they started their work and when boarding the flight in Dulles they noticed that some passengers on their flight asked the desk personnel if the aircraft they were going on was a Boeing 737 Max and the one that had crashed. The desk personnel assured them that all Boeing 737 Max aircrafts were grounded. Trust was a key issue.

The initial time period to achieve this goal was set to be 6 months after the second crash but Brad and Kathy quickly realized that they would need more time to better understand the complex structure that makes up the overall ecosystem for the Boeing 737 Max aircraft. They realized that they would need more input in their report from additional external expert members and they reached out to folks from all different areas of concerns and added them to the committee. They are hoping to look towards the future and come up with guidelines that will be enforced not only through the regulatory agencies but also be made public so that there is more trust in the aircraft and the industry.

Today is the final meeting of the committee and five of the external members are scheduled to present their findings in brief and then discuss what they found to come up with a recommendation for the co-chairs to take to Congress.

The questions posed to the committee are:

- 1) Why did it happen and how it could have been prevented?
- 2) How can we ensure future safety and transparency and rebuild trust?