Role-Play Case Studies to Teach Computing Ethics: Theoretical Foundations and Practical Guidelines

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Abstract

The use of computing shapes all aspects of life and society. Consequently, the future computing workforce must be trained to design and implement computing technology ethically and responsibly. Specifically, the design and use of algorithms require closer attention given their increased use across applications and systems. In this paper, we report on the effectiveness of role-play case studies, an innovative pedagogical method, to teach the ethics of algorithms to technology and computing students. We present findings from a three-year design and implementation effort. Rooted in theoretical research on situated learning, role-play case studies provided students the capability to employ perspectival thinking, link micro, meso, and macro level concerns, and use an ethical mindset to examine a case. In practical lessons from our work, we discuss the importance of collaborative learning, designing interest-based situations, and role preparation. Finally, we outline different methods for assessing student learning.

Keywords: Computing ethics, perspective-taking, role-play, case studies, situated learning.

1. Introduction

The importance of research on computing education has increased as computing becomes part of everyday life and society. The influx of data, the development of new algorithms, and the capability to bring the two together with improved hardware - storage and processing - have portended a new era for computing. As new platforms, services, and applications get developed and deployed across devices, it has also become fundamental to explore how they shape society, particularly how to design and implement computing technology ethically and responsibly (Borenstein and Howard, 2021; Smith et al., 2023). The two largest professional societies serving computing - ACM and IEEE - have released ethical guidelines, and accreditation bodies such as ABET require that students be taught ethical principles and frameworks.

This paper presents findings from a three-year design and implementation effort on teaching computing ethics to undergraduate students pursuing technology degrees. The project focused on the ethics of algorithms, as algorithms are pervasive and affect almost all modern societal functions. From life-altering decisions, such as who gets a loan or evaluating parole decisions, to more mundane ones, such as what video is recommended to watch or items to purchase, algorithms, big and small, play a significant role. Therefore, it is necessary for computing students to understand the role of algorithms holistically, beyond the functional, technical, and mathematical foundations (Mittelstadt et al., 2016).

To teach students about the ethics of algorithms, we created a series of case studies designed for roles-based discussions. This approach has some support in the literature, and through our research, we want to understand its efficacy further. In the rest of the paper, we first discuss the prior work that motivated our effort, followed by a discussion of our design and implementation efforts. Finally, we report our findings, both theoretically motivated and practical, on the effectiveness of our efforts. The curriculum and course material we have created are publicly available for others to use in their teaching.

2. Theoretical and Practical Foundations for Ethics Education

2.1. Situated Learning

Teaching ethics in technology disciplines, such as engineering and computing, has a long lineage (Loui and Miller, 2008). In engineering, ethical concerns have been part of professional preparation for over a century (formally established by ASCE in 1914). Although relatively recent, computing has had professional codes of ethics since the 1960s. Even though codes of ethics exist, inculcating them as desirable values among students requires significant effort. The objective of

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our project was not only to tell students that ethical concerns exist but also to teach a more nuanced and context-based understanding of how ethics and related principles emerge in applied computing. One of the theories of learning that allows us to design and assess that goal is situated learning (Greeno et al., 1996; Greeno, 1998; Lave and Wenger, 1991; Johri et al., 2014). The situative perspective emphasizes the role of the context on an individual's conception of knowing and how they learn – knowledge is not something that an individual possesses or stores in the brain but is present in all that they do. The idea within the situative perspective is particularly relevant to the proposed work, emphasizing that what we learn and how we learn it is closely linked. This situation, or context, determines what people look for, how they get the information, and how they interpret it. Knowledge arises dynamically and is constantly constructed and reinterpreted. As we discuss later, this motivated the use of case studies and, specifically, role-plays.

Within the situated learning paradigm, Greeno and van de Sande (Greeno and Van De Sande, 2007; van de Sande and Greeno, 2012) further advance a perspectival view which argues 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)". Situated learning's focus on the role of context and different perspectives guides us in thinking of pedagogical tools that can support ethical thinking among students (Greeno et al., 1996; Hess et al., 2017). Specifically, one commonly used teaching technique is the use of case studies (Herkert, 2000).

2.2. Case studies based instruction

Case studies are short narratives that encapsulate a real-world problem or dilemma. Case studies vary and, in addition to ethics, are commonly used in business and law. Within computing, case studies can be narrowly focused on a problem in the workplace or examine a large-scale project or disaster (Hess and Fore, 2018). They can be used as part of the curriculum to teach how to apply professional codes or even broader societal considerations of engineering. Rottmann et al. (Rottmann and Reeve, 2020) identify two critical dimensions along which case study application 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 analyze an event. In an inductive approach, students are asked to draw various ethical lessons from a given case.

Regarding the level of analysis, cases can be used for scenarios that usually depict individual practitioners facing difficult situations or highlight more considerable socio-political consequences. The micro approach is a powerful pedagogical technique because it asks a learner to decide on the viewpoint of someone in that situation. The macro approach is helpful as it encourages learners to make connections across different stakeholders and more significant organizational and societal concerns. Overall, case studies provide considerable flexibility for teaching ethics in a situated manner.

2.3. Role-play-based case studies

Role-playing involves using cases or scenarios to discuss a problem or an issue where each participant is assigned a specific role. In broader terms, role-plays are a kind of simulation-based learning exercise (Hertel and Millis, 2002). In a role-play case study discussion, students take on the role of a person who is involved with or impacted by the problem outlined in the case, and they have to respond to questions and take part in a discussion in a manner that reflects the viewpoint or perspective of the role they are assigned. Role-playing is used in teaching to make a topic more interesting for the students by emphasizing the real world and allowing students to engage deeply with the issue by personalizing it for them (Hertel and Millis, 2002). Role-play supports learning across a range of areas, including perspective-taking, critical thinking (Poling and Hupp, 2009), and communication skills (Nestel and Tierney, 2007). Role-plays are also helpful in teaching and consolidating student knowledge in a given subject area (DeNeve and Heppner, 1997; McCarthy and Anderson, 2000; Poling and Hupp, 2009).

Case studies and, in particular, role-play-based discussions are effective because, as prior research on situated learning has demonstrated, there is value in inculcating perspectival thinking and that case studies and collaborative discussions are effective in achieving this learning outcome. Furthermore, a role-play-based approach lends itself to a broader discussion around the role of technology from multiple perspectives.

3. Design and Implementation of Role-Play Cases

3.1. Design of role-play case studies

We leveraged prior work on the design of role-play case studies to create six fictional cases. Each case included a real-life inspired scenario encapsulating an algorithm-driven concern or problem within a larger

context. For some themes, a specific algorithm was defined and detailed; for others, the algorithm was embedded within the decision-making system. The brief case description and algorithms used are:

1. Boeing Case - After the Boeing 737 Max crashes, this case asks students to discuss engineering responsibility and trust. Case Algorithm: Maneuvering CharacteristicsAugmentation System (MCAS).
2. Facial Recognition Case - To bring students back to campus post-COVID, a college is asking for feedback on using facial recognition cameras to monitor the community. Case Algorithm: Biometrics that detect and authenticate students and symptoms.
3. Lending Risk Case - A bank wants to use data models to decide who should be awarded loans. Case Algorithm: Classification model using demographic and past financial data to define creditworthiness.
4. Volkswagen Emissions Case - After the Volkswagen emissions scandal, a rental company wants to know if brand trust can be earned again. Case Algorithm: systems used to cheat emissions tests and whether an algorithm can be used to determine consumer trust.
5. E-Scooter Case - A college probes public sentiment on e-scooters and if regulations are needed. Case Algorithm: Cost-impact models for e-scooter developers and service providers.
6. Agriculture Case - A rural farming community discusses the impact of larger technology organizations "revolutionizing agriculture." Case Algorithm: Automation of farming procedures, software (ML models), and hardware (drones).

Furthermore, we created 6-8 different roles for each scenario to participate in the discussion, including a moderator role - a stakeholder who would lead the discussion and engage all the other participants. Each case also included readings and video resources for teaching purposes that students could use to understand the context and prepare for their role. Table 1 highlights the case descriptions, participant roles, and reading/video resources provided to participants to prepare for their roles. Students were encouraged to undertake additional research, especially for role preparation, and most reported doing so.

3.2. Implementation context

The course, consistent across the three years of this work, was an undergraduate offering in IT to teach students about the role of technology in society. The course fulfills the ABET accreditation related to ethical and professional responsibilities for students in degree programs, including cybersecurity, information technology, and data analytics (broadly described as technology students). The student population is highly diverse and includes many first-generation college students, first-generation immigrant students, and Hispanic and Black students. About 25% of the students are women. We implemented the cases across seven class sections with 30-40 students each between fall 2020 and 2022. The students were divided into groups of 5-7 for the role-play discussions, and these groups remained largely consistent.

In each course, four cases were implemented out of six designed cases. We used a design-based research approach to understand the implementation outcome and evaluate the intervention (Anderson and Shattuck, 2012). Based on student feedback and our observations, we systematically revised aspects of the cases and their implementation in different iterations. For instance, we added more background reading about technical concepts across all the cases, created more roles for larger sections, and recorded a mock video demonstrating how to run a role-play.

The course was divided into 3-week long modules. In the first week, students were introduced to a topic through papers and videos and provided the case study and assigned roles. In the second week, students were given pre-role-play assignments, which included answering a set of questions from the perspective of their role and drawing a concept map on their recognition of broader concepts. In the third week, students would participate in the role-play discussion activity during the class session. After the session, students would complete a post-role-play assignment and a collaborative group concept map.

3.3. Assessment and Evaluation

We created and used various methods and modalities of assessments to assess student learning and evaluate the use of role-plays and case studies, including open-ended questions given to students through pre-and-post assignments (Hingle et al., 2021; Hingle and Johri, 2023) and concept maps to map the expansion of student concept recognition (Hingle and Johri, 2022). In conjunction with short focus groups and feedback on teaching evaluation, the assessment data were used to evaluate the implementation. This was the research aspect of the work, and we received approval from the institution's Institutional Review Board (IRB). No data were collected from the system or analyzed before the

#	Case Study Description	Roles	Resources (Frameworks, Articles, & Videos)
		Responding to the Boeing Max 737 Crisis (aka Boeing Case)	
1	As a member of the Aviation Transportation Investigative Committee (ATIC), participants are tasked with discussing how systematic (technical and social) issues in aviation can be mitigated.	• Aviation Consultant • Aerospace Eng. Professor • Software Eng. • Retired FAA Officer • Boeing Representative • Family Lawyer	• (Framework) Brey, P. (2018). The strategic role of technology in a good society. Technology in Society. • (Article) Johnson, B. (2015). Doing good tech versus doing good with tech. Medium, TechCrunch. • (Video) Wall Street Journal, "Inside the Boeing 737 MAX Scandal That Rocked Aviation." YouTube.
		Facial Recognition Technology (FRT) on a College Campus	
2	In response to the global pandemic, Andrew Hamilton University administrators have established a task force to discuss if facial recognition technology will ensure students' safe return on campus.	• V.P. of Campus IT • V.P. of Student Government • History Professor • A.V.P. in Provost's Office • Equity and Inclusion Director • FRT Non-Profit Director	• (Framework) Tzafestas, S. G. (2016). Chapter 2. Ethics: Fundamental Elements. In, Roboethics, Intelligent Systems, Control and Automation: Science and Engineering. • (Article) Lyon, D. (2008). Surveillance Society. Talk for Festival del Diritto. • (Video) Crockford, K. (2020) What you need to know about face surveillance. Ted.com.
		Algorithmic Lending Risk Decisions	
3	A loan manager wants to explore algorithmic decision-making for credit and loan decision-making and whether data on demographic and socio-economic profiles should be included.	• Data Analyst • Underwriting Specialist • Chief Credit Innovation Officer • Financial Research Analyst • Loan Process Regulatory Officer • AI Ethics Adv. Group Director	• (Framework) Ongena, S. and Popov, A. (2015). Working Paper Series - Gender bias and credit access. European Central Bank. • (Article) Courtland, R. (2018). Bias detectives: the researchers striving to make algorithms fair. Nature, Vol. 558, No. 7710, pp. 357. • O'Neil, C. (2017). The era of blind faith in big data must end. Ted.com.
		Building Trust after the Volkswagen (VW) Emissions Scandal	
4	A rental company's fleet manager is interested in VW vehicles. They want to know if the company can be trusted and what responsibility organizations have to correct the problems they cause.	• Consumer Adv. Group Chair • Env. Engineering Professor • Env. Advisory Group Director • Software Developer • Automotive Industry Expert • Compliance Director	• (Framework) ACM Code of Ethics. • (Article) Mansouri, N. (2016). A Case Study of Volkswagen Unethical Practice in Diesel Emission Test. International Journal of Science and Engineering Applications. • (Video) Thiruvengadam, A. (2016). The Cheat: Volkswagen and Emissions Testing. MSU Video on PBS.org.
		E-scooters on Campus - Sustainability and Responsibility	
5	A student reporter is interested in cross-community dialogue on the responsibility of e-scooters from the institution, companies providing the services, and users on campus.	• E-Scooter Lending App. Founder • Transport Eng. Professor • Local Transport Director • Sustainability Director • Student Mobility Org. Rep. • Accessibility Services Head	• (Framework) Hilty, L. M. (2009). ICT and Sustainability - Issues beyond Climate Change. Informatik 2009. • (Article) Pyzyk, K. (2019). Reduce, reuse, rescoot? A look at e-scooters' long-term sustainability. Smart Cities Dive. • (Video) Penalosa, E. (2013) Why buses represent democracy in action. Ted.com.
		Conversations and Community with AI Ethics for Agriculture	
6	A local reporter is interested in hearing from community members of an agriculture-dependent region on the impact and implications of AI technology on people, regulations, and livelihoods.	• AI Farming Start-up CTO • Org. Extension Coordinator • Civic Engagement Director • Tech-savvy Local Farmer • Tech Evangelist • Tech Critical Farmer • Non-Profit Farmer Rep.	• (Framework) Jobin et al. (2019). The global landscape of AI ethics guidelines. Nature Machine Intelligence. • (Video) Foley, J. (2012). The Other Inconvenient Truth. Ted.com. • (Video) Chandra, R. (2019). Data-driven farming could transform agriculture. Ted.com.

Table 1. The six case studies used with the role-play activties (descriptions, roles, and resources).

final grades were assigned. All data was anonymized by a third party not involved with grading. Only data from students who consented to the study were analyzed.

Table 2 shows the activities used to assess student interactions with the case studies and role-plays.

4. Findings

In this section, we discuss findings from our research that speak to the theoretical goals of the project to improve students' 1) perspectival thinking; 2) understanding of micro, meso, and macro level concerns; and 3) ability to recall elements of an ethical framework to build an ethical mindset. We present data from across the cases we designed and implemented and indicate the case and assignment for any student quotations at the end of the quotation.

4.1. Perspectival thinking about ethics

The roles naturally encouraged collaboration and discussion, but since the role-play was focused on getting students to form a recommendation, the discussions allowed each participant to represent their role. The consensus-focused discussion also made them empathize with other roles and appreciate the overall complexity of the case. Different perspectives were expressed throughout the discussion that followed students' preparation for the role-play. Of the data we analyzed, across the course sections, almost 80 percent of the students either agreed or strongly agreed that participating in the role-play activity had changed their perspective. 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. Students reported that although they held a certain viewpoint beforehand, they could understand others after participating in the role-play discussion.

For instance, when discussing the Boeing case, Student 1 expressed that:

My role opened my eyes more to the situation. At first, I thought the 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; Boeing Case; Role-play Transcript]

Student 2 highlighted how their perspective on who was to blame for the disaster shifted after the discussion:

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 was essentially lied to. I agree there should have been more oversight, but the FAA trusted Boeing. And, you know, that was wrong, but at the same time, it just made me a little bit more sympathetic toward someone in that position. - [Student 2; Boeing Case; Role-play Transcript]

In the case that focused on using e-scooters and sustainability of information technology-based products, students' understanding of sustainability widened as they co-constructed knowledge with their peers.

For instance, Student 3 commented that:

During the discussion, while I was listening to other group members, my perspective did change because I was able to create more ideas in my mind and was able to understand the idea of sustainability based on what others were saying." - [Student 3; E-Scooter Case]

For Student 4, the role-play allowed an improved understanding of an infrastructural decision of allowing or banning e-scooters on campus and they were able to evaluate the long-term impact of this decision:

Yes, my perspective has changed because an e-scooter is not as environmentally friendly as I had initially expected. Although individual e-scooters are not very harmful to the environment, the biggest impact on greenhouse gas emissions comes from the resources used every day to locate all the scooters, recharge, and return them." - [Student 4; E-Scooter Case; Post-Case Assignment;]

4.2. Linking micro-meso-macro ethical concerns

The next finding we focus on is the ability of role-play cases to teach students the skills to reflect on and link micro, meso, and macro-level issues related to a case or scenario (Johri and Hingle, 2022).

For instance, in the facial recognition case, students developed a situated understanding of the micro (the technology and algorithmic aspects of facial recognition), meso (their university as the context for the implementation of the software), and macro (use of facial recognition algorithms across services and its effect on privacy) level ethical concerns. Furthermore,

Activity	Example Prompt	Artifacts and Data
Pre- and Post-Role-play Assignments – An open-book exercise to prepare and debrief students' learning.	• (Pre) Why is your suggested approach best? • (Pre) What are the main barriers to this approach? • (Post) What recommendation did your group reach following the discussion and what criteria were considered?	• Open Response (Text) • Multiple Choice Responses (Text) • Fill in the Blank (Text)
Role-play Activity – A 30-45 minute role-play activity based on the case study.	• From the perspective of your role, why the disaster happened, and how could it have been prevented? • From the perspective of your role, how can we ensure future safety, and transparency, and rebuild trust?	• Participation Transcripts (Text)
Role-play Debrief – A 10-minute debrief held immediately after the activity.	• Is there a role you would have preferred playing and why? • Did you agree or disagree with the perspective of your role?	• Participation Transcripts (Text)
Individual and Group Concept Maps – A pre (individual) and post (individual or group) concept map for each case.	• What is your response to why this happened and how it could have been prevented? • Why do you think your approach is best? • What do you think are the main barriers to this approach?	• Concept Maps (Diagram)
Final Course Activity – An end-of-semester survey serving as a culminating reflection exercise.	• What role does ethics play in the development of technology? • What did the Boeing role-play case study and your discussion participation, teach you about ethics?	• Open Response (Text) • Multiple Choice Responses (Text) • Fill in the Blank (Text)
Course Evaluations – Students completed the 30-45 minute long role-play activity.	• Please provide any feedback or recommendations for the role-play activities and the cases discussed in this course.	• Open Response (Text) • Multiple Choice Responses (Text) • Fill in the Blank (Text)

Table 2. Activities, assignments, and assessments given to participants in the course.

they were able to discuss these in a related manner, such as linking the use of facial recognition for surveillance in society and its impact on student privacy.

As Student 5 expressed, there are several layers of ethical dilemmas in play in the case:

So there are several issues with this technology, such as diverse faces, and we're trying to apply it to a university campus, which is a very diverse demographic. Obviously, the safety of the students would benefit from this tech. We know who is coming in and leaving campus, so we can monitor the overall health of our students. But there are privacy concerns, and this would take several iterations to implement, and we just don't have that time. I think there are other things that we can implement quickly. They may not be as effective, but we can keep everybody safe. - [Student 5; Facial Recognition Case; Role-play Transcript]

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).

In the same case, there is a layer of complexity in that any application to monitor for COVID symptoms would need to be implemented at a systems level — the campus infrastructure would have to be modified to make the application work. As this relationship becomes clearer, many students suggested that physical testing and physical surveillance would also be viable options and that the technology may be overcomplicating COVID tracking solutions. By looking into why facial recognition was being considered 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 nuanced understanding of the issue.

Student 6 discussed the nuances of the technology and the issues, particularly for COVID detection:

> I am not advocating for the implementation of facial recognition. I could be convinced that it is beneficial for tracking COVID. However, it takes time for the algorithms to mature and give sustainable results. So my primary concern is, it can be done, but at what cost will it be a sustainable system? Also, COVID is airborne and transmitted through breathing near an infected member, but the problem with facial recognition is you're instructing users to remove their masks or PPE so that you can scan their faces. [Student 6; Facial Recognition Case; Role-play Transcript]

4.3. Knowledge of ethical elements

Each case addressed specific ethical themes and frameworks, which were also given to students as a resource. These themes were given to students in an applied nature, rather than providing readings on ethical theory.

The ethical principles we expected students to engage with, question, and reflect on were represented in the resources, videos, and articles students were required to read along with the case before participating in the role-play activity. Frameworks were especially useful in providing students with an actionable ethical mindset. For example, with regard to the E-scooter case, the overall ethical themes were related to sustainability, transparency, responsibility, and accountability. Student 7 highlights sustainability through their discussion:

> Sustainability was the theme for the e-scooter case. E-vehicles have some merit, but we do not have long-term data for if they do enough to affect the planet positively. It is much easier to see the cons of their production and end of lifespan negatively add to CO2 emissions." - [Student 7; E-Scooter Case; Final Course Assignment]

Student 8, on the other hand, describes a similar viewpoint, but through the lens of transparency. This does indicate the complexity of technology and how interwoven these ethical themes often are:

> The main theme of the e-scooter case was transparency. Companies need to be open about their products, the risk, and dangers that can affect students. This would help students become aware and minimize injuries and accidents. It is important to enforce transparency through safety regulations and policies." - [Student 8; E-Scooter Case; Final Course Assignment]

5. Practical Implications and Lessons Learned

In addition to theoretical findings, there are also practical implications and lessons learned in terms of applying role-plays for algorithmic-focused discussion.

5.1. Discussion-based collaborative learning

The primary advantage of using role-play cases comes from their affordances for a discussion based on different perspectives. The ability to converse, express opinions and perspectives, and modify how one thinks is central to their use. In practical terms, students do not just read and prepare, but they bring conversation that navigates both their role's perspective and that of their own. As Student 9 describes, if each student brings these dual perspectives to the table, there are many different ideas to talk about:

> I like that we're playing a role, and we have to listen from that perspective. So we have to think differently about the situation. I think it is a better way to learn, rather than just writing essays. [Student 9; Facial Recognition Case; Role-play Debrief]

Students also highlighted the ability of their peers to gain more from the resources they were all given:

> Rather than writing an essay, when we're in a group, we realize what other people think and what we agree or disagree on. Someone mentioned, "this is what the article said," and I didn't remember it like that, so it helps us challenge each other. We're getting to understand each other's way of thinking because of this. It opens up everyone's mind and viewpoints a little bit more. — [Student 10; Volkswagen Case; Role-play Debrief]

Both Students 9 and 10 described the role-play activity in direct comparison to what would have been a more traditional approach for assessing these topics - writing an essay. In fact, many of the participants talked about interactivity and feedback as important components of their learning with these activities as opposed to simply writing about them.

One of the motives of the moderator role is to help the group work towards a consensus on what decision should be taken collectively. There is an element of explanation and interaction that requires being flexible and compromising in achieving the final outcome - all while being exposed to the complexity of the scenario. Student 11 describes how this exchange between group members can be an interactive and interesting experience requiring problem-solving skills:

> I think the role-plays are a lot more interactive, which is fun because it makes you think about your response and other people's response. It makes you become an active problem-solver. You have to consider that there are many approaches and then it's nice having a conversation or just an activity where people can talk and discuss the approaches. – [Student 11; Volkswagen Case; Role-play Debrief]

Students also find the role-plays to engage innovative and cross-functional thinking similar to that of a debate, especially when assigned a role rather than picking their role. Student 11 continues to describe how engaging in the role-play felt beyond just learning about a topic:

> The role-plays are similar to a debate club, where you are forced to take a side and argue for it. I would continue to do them because they make us actually research and not just copy an opinion. It's not just like brainlessly learning a topic. – [Student 11; Volkswagen Case; Role-play Debrief]

In the debrief, students were asked to reflect on their own perspective on the case rather than that of the role as a way to encourage the near transfer of their learning. Some students described how the cases and the topics discussed affected them directly, and their peers appreciated the links beyond the classroom.

> The collaborative role-plays were cool, because I really appreciate that we had a personal connection to the incident here. That was really interesting. – [Student 12; Boeing Case; Role-play Debrief]

5.2. Interest-based engagement with content

Role-play cases provide an additional mechanism to engage students in issues they are interested in.

Although any case study can achieve this, with role-plays, student interest can be further nurtured by making the case about a context they know and by creating roles that they can easily inhabit or imagine. Student 13 identifies the relation between the fictional case and their own institution and how they have a vested interest in the decision beyond the course.

> Our group concluded that e-scooters had several advantages, like convenience, being a cheaper alternative to cars/ridesharing, helping you travel to and from locations faster than walking, being on time to class, and so on. Particularly in terms of the e-scooters safety and sustainability, I agree with the resolution reached because we have scooters at [my university] as well, and I understand the convenience behind them and see why they are a good fit. However, additional requirements should be implemented for everyone's safety. – [Student 13; E-Scooter Case; Post-Role-play Debrief]

Similarly, Student 14 recounts their own experiences of engaging with e-scooters on their campus. The desired outcome, though arguing for additional requirements in agreement with Student 13, is different:

> As someone who lives on campus, I understand the use of E-scooters since [my university] campus is so huge, but I believe they should not be used as I have almost been hit by the scooters because they were riding on the sidewalks and it does make me quite nervous to walk on sidewalks now. – [Student 14; E-Scooter Case; Post-Role-play Debrief]

5.3. Preparation for future learning

The other advantage of using role-play-based cases is that in addition to preparing for the discussion, by learning about the case, students are encouraged to undertake additional research to prepare for a role (Schwartz and Martin, 2004). Whereas knowledge about the case can be built from many generic resources, preparing for a role motivates and requires students to dig deeper into how someone in their role's position would think about a problem.

> I over-prepared a little for my part. I read through all the articles, and I really tried to understand them, so I Googled certain things. What is the difference in thrust position, or what does that mean? It didn't matter in the end, but it was really interesting for me personally to dive into one aspect of the case. – [Student 15; Boeing Case; Role-play Debrief]

Students also did additional reading beyond what was assigned to them to both support their role's arguments, but also think about how other roles may engage with and respond to their arguments.

I was really interested and started doing my own research. I read that, at first, the FAA was not taking accountability. A House Committee report showed the FAA said they weren't the ones in charge of – according to them – checking the design of new airplane changes in the beginning. They said they shouldn't be held accountable because they sent an unaffiliated unit to represent the FAA who approved the changes. So, really there's a lack of accountability here. – [Student 16; Boeing Case; Role-play Debrief]

6.   Discussion and Conclusion

In this paper, we presented a design-based research study of teaching computing ethics to students. We had two goals for the paper: 1) to link the use of educational theory and learning gains achieved through role-play cases and 2) to present practical guidelines and lessons learned. In our work, we focus on learning about the ethics of algorithms. This topic is broadly applicable across all areas of computing and is a much-needed area of ethical responsibility for computing professionals.

We found that using role-play cases in classes produced learning gains related to the ability to examine issues from multiple perspectives, deconstruct complex situations, and examine micro, meso, and macros level issues separately but also in tandem. Preparing for the discussions and the discussion itself also leads to gains in factual knowledge, especially different elements of ethical frameworks such that students can transfer this knowledge and apply it across cases.

We experimented with different group sizes, discussion leaders, order of cases, the topic of cases, and also, although not reported in the data here, different disciplines and levels of students in terms of the year in college. The findings reported here were consistent across the interventions. Furthermore, different instructors used the cases and reported the same ease with their application and similar learning gains. Overall, there is good evidence that these cases are broadly applicable and can introduce students to topics in adjacent fields that would otherwise not emerge naturally in the course outline.

Additionally, the timeliness of the discussion topics in the course lends to continue these conversations around even newer breakthrough technology. Over the last year, generative artificial intelligence (GAI) has continued to garner attention by releasing platforms such as ChatGPT, Midjourney, and Copilot. Many of our students were naturally interested in these technologies. Often, discussing the social implications of one technology through the cases led them to ask whether the same problems might occur in these newer technologies and engage with how they would attempt to solve them there. The ability to incorporate discussion on extremely new topics through role-plays, assignments, and debriefs was invaluable and demonstrated the practical value of this engagement.

6.1.   Study Limitations

This paper reports on using discussion-focused activities to engage with students about technology ethics. As such, the discussion can be affected by numerous factors, such as the personalities of the participants and their prior knowledge. We also noted participants sometimes fixated on case details not related to the intended talking points. To assist with this, participants can be primed in their discussion through pre-prompts and pre-reading. When describing technical components especially, preparation is critical.

In addition to the course discussed in this paper, we also tested the role-plays in a technical computer science course on data mining. We noted that the discussion of data and algorithms was richer. Students were especially interested in the technical details surrounding bias mitigation, algorithms used, and benchmarking. Similarly, when we used the cases with first-year engineering students, the discussion was shallower and more superficial. For many of these students, the concepts surrounding algorithms were easier to digest when more explainable and direct comparisons to everyday technology were used.

Therefore, while the role-play activities are overall an exciting way to implement discussion about ethics for computing students, adaptations should be made to account for the participant's disciplinary backgrounds and prior knowledge. Gaining access to this information can be a challenge, but one that can be overcome as you engage with the students in the first few weeks of the course/implementation.

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References

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? Educational researcher, 41(1), 16–25.

Borenstein, J., & Howard, A. (2021). Emerging challenges in ai and the need for ai ethics education. AI and Ethics, 1, 61–65.

DeNeve, K. M., & Heppner, M. J. (1997). Role play simulations: The assessment of an active learning technique and comparisons with traditional lectures. Innovative higher education, 21, 231–246.

Greeno, J. G. (1998). The situativity of knowing, learning, and research. American psychologist, 53(1), 5.

Greeno, J. G., Collins, A. M., Resnick, L. B., et al. (1996). Cognition and learning. Handbook of educational psychology, 77, 15–46.

Greeno, J. G., & Van De Sande, C. (2007). Perspectival understanding of conceptions and conceptual growth in interaction. Educational Psychologist, 42(1), 9–23.

Herkert, J. R. (2000). Engineering ethics education in the usa: Content, pedagogy and curriculum. European journal of engineering education, 25(4), 303–313.

Hertel, J. P., & Millis, B. J. (2002). Using simulations to promote learning in higher education: An introduction. Stylus Publishing, LLC.

Hess, J. L., & Fore, G. (2018). A systematic literature review of us engineering ethics interventions. Science and engineering ethics, 24, 551–583.

Hess, J. L., Strobel, J., & Brightman, A. O. (2017). The development of empathic perspective-taking in an engineering ethics course. Journal of Engineering Education, 106(4), 534–563.

Hingle, A., & Johri, A. (2022). Assessing engineering student's representation and identification of ethical dilemmas through concept maps and role-plays [https://peer.asee.org/41162]. 2022 ASEE Annual Conference & Exposition.

Hingle, A., & Johri, A. (2023). Recognizing principles of ai ethics through a role-play case study on agriculture [https://peer.asee.org/44029]. 2023 ASEE Annual Conference & Exposition.

Hingle, A., Johri, A., Rangwala, H., & Monea, A. (2021). Using the boeing max air disaster as a role-play scenario for teaching ethical thinking [https://peer.asee.org/38001]. 2021 ASEE Virtual Annual Conference Content Access.

Johri, A., & Hingle, A. (2022). Learning to link micro, meso, and macro ethical concerns through role-play discussions. 2022 IEEE Frontiers in Education Conference (FIE), 1–8.

Johri, A., Olds, B. M., & O'Connor, K. (2014). Situative frameworks for engineering learning research. In A. Johri & B. Olds (Eds.), Cambridge handbook of engineering education research (pp. 47–66). New York: Cambridge University Press.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge university press.

Loui, M. C., & Miller, K. W. (2008). Ethics and professional responsibility in computing. https://onlineethics.org/.

McCarthy, J. P., & Anderson, L. (2000). Active learning techniques versus traditional teaching styles: Two experiments from history and political science. Innovative higher education, 24, 279–294.

Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016). The ethics of algorithms: Mapping the debate. Big Data & Society, 3(2).

Nestel, D., & Tierney, T. (2007). Role-play for medical students learning about communication: Guidelines for maximising benefits. BMC medical education, 7, 1–9.

Poling, D. A., & Hupp, J. M. (2009). Active learning through role playing: Virtual babies in a child development course. College Teaching, 57(4), 221–228.

Rottmann, C., & Reeve, D. (2020). Equity as rebar: Bridging the micro/macro divide in engineering ethics education. Canadian Journal of Science, Mathematics and Technology Education, 20, 146–165.

Schwartz, D. L., & Martin, T. (2004). Inventing to prepare for future learning: The hidden efficiency of encouraging original student production in statistics instruction. Cognition and instruction, 22(2), 129–184.

Smith, J. J., Payne, B. H., Klassen, S., Doyle, D. T., & Fiesler, C. (2023). Incorporating ethics in computing courses: Barriers, support, and perspectives from educators. Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1, 367–373. https://doi.org/10.1145/3545945.3569855

van de Sande, C., & Greeno, J. G. (2012). Achieving alignment of perspectival framings in problem-solving discourse. Journal of the Learning Sciences, 21(1), 1–44.