Using Role-Plays to Improve Ethical Understanding of Algorithms Among Computing Students

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***Abstract*—We present a Research-to-Practice paper where we used role-play case studies to improve student understanding of the ethics of algorithms. As the use of algorithmic decision-making continues to grow across areas of society, there is a need to prepare future technology workforce for ethical thinking related. Our work was informed by the situated learning paradigm, and our goal was to improve perspectival thinking among students. Recognizing an issue from multiple perspectives and taking on different perspectives to examine it leads to increased understanding. Drawing on this work, we created and implemented a role-play case study in an undergraduate computing data mining course. The role-play case study focused on the use of algorithms for facial recognition. Data were collected from pre-and post- discussion assignments, and a student survey. Thirty-one students enrolled in the course and completed the ethics module. The data collected in the assignments focused on student's recognition of ethical dilemmas, the change in student's perspective on the case due to creating a collaborative consensus and understanding the complexity of algorithmic decision making. To formally analyze the data, we created a coding schema drawing on the literature and preliminary qualitative analysis of our data. The data were independently coded by multiple coders. The findings indicate that through their participation in collaborative role-play scenarios, students were able to recognize a wide range of issues and offer potential solutions. We discuss the implications of the work. Curriculum material created as part of this work is available as an open education resource.**

Keywords—computing ethics, role-plays, case study, algorithms, perspectival thinking

I. Introduction

In recent years, ethics of computing, especially in relation to algorithms, machine learning (ML), and artificial intelligence (AI), are at the forefront of issues that computing faculty are engaged with. Some of the requirements to teach ethics comes from professional societies and accreditation agencies, but there is also an increased awareness that ethical issues are important for students to learn, given the proliferation of computing across all aspects of lives. Fake news, filter bubbles, data privacy violations, user tracking, breach of user data, and cyberbullying are just a small list of the number of issues related to computing ethics that affect users [1].

Algorithms now drive decision-making across a range of domains, from how we work to the fabric of democracy through the message that reaches voters [2-3]. Automation and day-to-day services rely on computing and technology professionals – who work as data scientists, programmers, or artificial intelligence (AI) experts – and these professionals, in turn, depend on their knowledge of algorithms to meet their intended goals [4]. Their decisions shape the choices available to society, such as which products we buy, what music we listen to, what news stories we see, what social connections we make, or, as in the recent case of Boeing, prohibit a pilot from making a decision that could potentially save hundreds of lives. Consequently, the ability to control how a person acts or is prohibited from taking action is a serious responsibility borne by a computing professional, and there have been a renewed focus on improving ethics education [5-7].

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. Consequently, many scholars have recently developed ways to teach ethics to provide stronger contextual training to students [8-11].

In this research-to-practice paper, we leverage the situated learning paradigm to create, implement, and test role-playing scenarios (RPS) to teach undergraduate students the ethical aspects of algorithmic thinking from a situated learning lens. We focus on algorithmic thinking as it is an underlying element of a diverse range of courses and topics within artificial intelligence, data science, computer science, and information science. The educational research component of this work consists of assessing how RPSs shape perspectival understanding of ethical algorithmic thinking. The practice part focuses on how to implement role-play case studies in courses to achieve desired learning goals.

II. Background and Prior Work

A. Ethics of Algorithms

On its face, an algorithm is a set of instructions for how a computer should accomplish a particular task. Although often conflated with programming, it is well recognized within computing that algorithms are more fundamental and complex than that. Combining calculation, processing, and reasoning, algorithms can be exceptionally complex, encoding for thousands of variables across millions of data points. This ability of algorithms to manipulate data has become a more critical

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element of algorithmic thinking than a mere 'set of instructions' approach. The mere perception of what algorithms do or are capable of often provides a misleading sense of how by merely following instructions, they automatically lead to unbiased outcomes or decisions. This misconception persists because the input to the algorithm, the data, are themselves seen as objective entities, and therefore the combination of data with algorithms automatically must lead to standard, unbiased outcomes. Yet, as researchers have pointed out, this is not the case [4, 12-13]. The input is subjective, with the processing, and, therefore, with the outcomes as well. In other words, algorithms are anything but neutral.

In recent years, following the increased role of computing in society, the neutrality of decision-making that relies on algorithms is being debated. There is an increased understanding that given the specific data that are used to create different models, neutrality is an ideal but not a realistic outcome. The mathematician Cathy O'Neil has described an algorithm as an "opinion embedded in mathematics," and has argued that, like opinions, all algorithms are different [2]. Furthermore, she contends that human decision-making is being deferred to software systems across domains despite evidence that the system is making decisions that are incorrect and even unjust or harmful.

Another problem with algorithmic decision-making at a societal level is that increasingly the most important algorithms shaping society are what Frank Pasquale, a law professor at the University of Maryland, calls "black boxed" [3]. This means that there are no auditing mechanisms to know what algorithms are actually doing. There are no consumer or civil rights protections that guide the use of data and algorithms even in society's most critical functions such as healthcare, education, hiring, banking, or housing. Therefore, there is a need to create and enforce standards that ensure that decision-making is fair, transparency and accountability exist, and there is responsibility for harm when algorithmic decision-making results in discriminatory and inequitable outcomes [14]. For ethical decision-making, students need to be able to interpret the models used and be able to come up with actionable items based on that.

B. Situated Learning and Perspectival Understanding

For a nuanced and context-based understanding of how algorithms work in real-world applications, one of the theories of learning that allows us to design and assess that goal is "situated learning" [15-20]. 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. Greeno and van de Sande advance a perspectival view within the situated learning tradition which argues that a person's or group's knowing 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)" [21-23]. They define perspectival understanding as a cognitive arrangement of entities, their properties, and their relationships. The critical aspect here is that the learner brings a point of view to the situation. This process of developing a perspectival understanding is a continuous process as long as the learner is engaged with the situation. The learner can be closely embedded and enmeshed in a perspective or view from the outside, but as long as there is coherence, learning can occur. Greeno and van de Sande's notion of a perspective is similar to how we view scenarios. They state that although perspectives function at many levels, they conceive of them as "information perspectives" [21]. The focus of their view is on the situation that is being dealt with and how informational resources associated with it shape participant's understanding.

C. Role-Play for Teaching Ethics

When trying to improve contextual understanding, a common approach to ethics teaching is the use of role-play scenarios (RPS), often also simply called role-plays [24]. Many scholars have developed and used RPS as a way to teach ethics with the belief that because RPS requires the active engagement of students, students who experience or participate in RPSs can learn to identify ethical issues by understanding multiple perspectives [25]. One of the most common applications for RPS has been the ethics of doing research, including authoring and publishing. Role-playing provides an even closer approximation to actual 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 [26].

In a role-play, students are provided with facts about a situation or scenario into which they are then inserted or given a role for a brief interaction. The scenarios given to students can be fictional or often are based on an actual incident. RPSs are a type of collaborative learning pedagogical approach that we are using for perspectival understanding and are effective because collaboration triggers cognitive processes associated with learning [27]. The collaborative activity allows learners to strengthen their understanding of the material they have already learned but also allows them to repair mental models that may be fragmented or incomplete [28]. By linking new information to information they already have, they change their thinking and thus their perspectives. RPS is a cognitive-elaboration approach within collaborative learning, it requires actively processing information, and aims to elaborate basic information-processing activities such as encoding, activation of schemas, rehearsal, metacognition, perspective, and retrieval [27]. 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.

III. RESEARCH STUDY

In this section, we describe the research site, role-play implementation, data collection, and analysis used in our study to examine the effect of role-play discussions in improving perspectival contextual understanding of ethics.

A. Facial Recognition Role-Play Design and Implementation

The role-play scenario we designed follows a fictional situation involving the stakeholder's decision on the use of 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 [29]. 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 [14]. 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 Software and Services	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 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. Research Site

This study was conducted at a large public university in the United States with undergraduate students in the engineering school who were majoring in computing-related areas. The course used for this data collection was a data mining course. Both theory and practical curriculum covered topics related to principles and methods for data analysis and knowledge discovery. The course serves as a core class for students. 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. A pre-discussion assignment was completed by all participants which focused on understanding student's individual perspective 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 participants of the role-play. 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.

C. Data Collection

Data were collected in Fall 2020 across the semester from the data mining class. Thirty-one students took part in the "Facial Recognition" role-play discussion spread across six groups of 4-7 members. Due to COVID-19 restrictions, this course was offered online in a synchronous format. Students submitted their pre-discussion assignments, participated in the synchronous class meeting for the role-play activity, and in the following week, submitted the post-discussion assignment. Twenty-five of the thirty-one students also participated in an optional survey, which was completed immediately after concluding the role-play activity.

D. Analysis

A coding schema was created to analyze and score the participant's responses to the pre-and post-discussion assignments. The schema was created inductively and iteratively by three coders. The coders initially conducted an open-coded reading of the responses to understand the type and granularity of answers provided by the students. Next, a set of criteria were identified and refined over a process of 3 iterations. The final coding schema for the scenario included the questions 1) student's recommendation is based on their role, and 2) ethical dilemmas are recognized (issues of privacy, bias, and inclusion) (See Table II).

TABLE II. FACIAL RECOGNITION SCENARIO-CODING SCHEMA

Criteria	Code
1. Student expresses a recommendation based on their role:	A. No, the recommendation is not based on the assigned role.
	B. Yes, the recommendation is based on assigned role.
2. Ethical dilemmas are recognized based on the role	A. Issues of privacy are recognized.
	B. Issues of bias are recognized.
	C. Issues of inclusion are recognized.

An example of a pre-discussion submission that discussed at least three ethical dilemmas is the following:

> "There are three concerns in this story. 1. Student privacy 2. Bias for people of color 3. Access to technology. For the student privacy issue, we can add a clause to our agreement with the software company to not share any student data and identification with any other entity...For the bias on people of color, we can ensure the software has a respectable error rate for people of color, or we can have a secondary check by a human being before applying any kind of enforcements...With respect to access to technology, I do not think that there are many students without capable devices and connectivity in this day and age. For the connectivity issue, they can use the Wi-Fi provided by the campus, and if for any reason a student does not have access to a device, there could be manual checks done by campus security."

An example of a post-discussion response that identifies three dilemmas is the following:

> "I am good with my role. Most of the people would recommend the adoption of the technology. Rest of the people recommend the technology with more regulation, caution, and testing. The main criteria considered were the safety, cost, feasibility, and impact of the technology on inclusion, equity, and privacy among the student body. We did agree adopting the technology once the checks are put in place. The technology is still considered faulty due to the bias in training data. The misclassification will be a severe problem that excludes certain students from accessing the community and on campus resources. I personally agree with the recommendation. The technology can be beneficial if it is used correctly. At this point of time, it may seem pre-mature so more testing and regulation should be done. From a different perspective to protect the inclusion and equity, the campus needs to be reopened and students need to engage with the community. So, the adoption of the technology would actually help achieve that goal."

Once a final coding schema was defined for the role-play scenario, raters coded the pre-and post-discussion assignments. The authors analyzed and coded the data and worked together to reach consistency in the findings. The inter-rater reliability was calculated for each assignment and can be seen in Table II.

TABLE III. FACIAL RECOGNITION SCENARIO-INTER RATER RELIABILITY

Assignment	% of matched coding
Pre-discussion	95%
Post-discussion	94%

IV. FINDINGS

First, we present the survey results that were administered to the participants in the class after their role-play activity. Participation in the survey was voluntary. Twenty-five students responded to the survey, and the results are presented in Table IV and V.

There were four questions on the survey:

A) *My perspective on the scenario changed because of my role*,

B) *I found the role-play challenging*,

C) *I learned something because of participating in the role-play discussion,* and,

D) *Participating in the role-play discussion has made me more aware of ethical issues related to the use of algorithms*.

TABLE IV. SURVEY (QUESTIONS A-C) RESPONSES

Question	Definitely not	Probably not	Might/ Might not	Probably yes	Definitely yes
A	3	4	5	10	3
B	0	8	0	11	6
C	0	0	1	3	21

TABLE V. SURVEY (QUESTION D) RESPONSES

Question	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
D	1	0	0	5	19

As shown in Table IV, the majority of students reported that their perspective had changed through their participation in the role-play. They also reported that they found the role-play challenging and that they learned from their participation. Finally, almost all students agree or strongly agreed with the statement that they had become more aware of ethical issues after participating in the role-play discussions. This can be seen further from the results of Question C on Table IV. 21 of the 25 respondents acknowledged learning something from the RPS. Students found the activity challenging, and this could be partly attributed to the newness factor of the activity for many students. We also note that 18 of the 25 respondents acknowledged that their own perspective of the scenario changed due to the requirements of the RPS to take on a positionality of a role.

Next, we present the results from the Facial Recognition Scenario's pre- and post-discussion assignments in Table VI and Figure 1. Students completed the assignment before and after participating in the role-play activity. The authors used the coding schema to identify the number of ethical dilemmas identified by students individually in the pre-assignment and collaboratively in the post-assignment. The number of ethical dilemmas recognized by a student in the pre-discussion is displayed vertically on Table VI, and the number from the post-discussion is displayed horizontally. Students could identify between 0 and 3 ethical dilemmas in total.

Table VI shows the change in perspectival understanding. Out of the thirty-one students that completed the assignments, thirty students were able to identify between 1 and 3 ethical dilemmas in the pre-discussion assignment based on their specific role. Twenty-seven students identified between 1 and 2 dilemmas in the pre-discussion assignment. This was an expected outcome, as all the roles outlined two ethical dilemmas directly and implied others through the context of the information provided. Additionally, students were encouraged to address all the stakeholder's concerns through their responses and could potentially identify all three dilemmas from the scenario instructions. Several students went beyond their specific role in addressing their role's perspective, anticipating the dilemmas that other roles would face during the activity. Three students identified all three ethical dilemmas and addressed them in their pre-discussion response.

TABLE VI. CHANGES IN STUDENT RECOGNITION OF ETHICAL DILEMMAS, PRE- AND POST-DISUCSSION ASSIGNMENT

		Post-Discussion				
	Score	*0*	*1*	*2*	*3*	*Pre-Total*
Pre-Discussion	0	0	1	0	0	**1**
	1		2	8	1	**11**
	2			13	3	**16**
	3				3	**3**
	Post-Total	**0**	**3**	**21**	**7**	

In the post-discussion assignment, many students were able to identify a wider breadth of ethical dilemmas—all 31 students who completed a post-discussion assignment identified between 1 and 3 ethical dilemmas from the case. Additionally, the students who were able to identify between 2 and 3 rose from 19 in the pre-discussion to 28 in the post discussion. Participating in the role-play discussion allowed students to interact with perspectives that were perhaps different from their role and, in some cases, different from how the students felt. The number of students that correctly identified all three ethical dilemmas in their response rose from 3 to 7 in the post-discussion assignment.

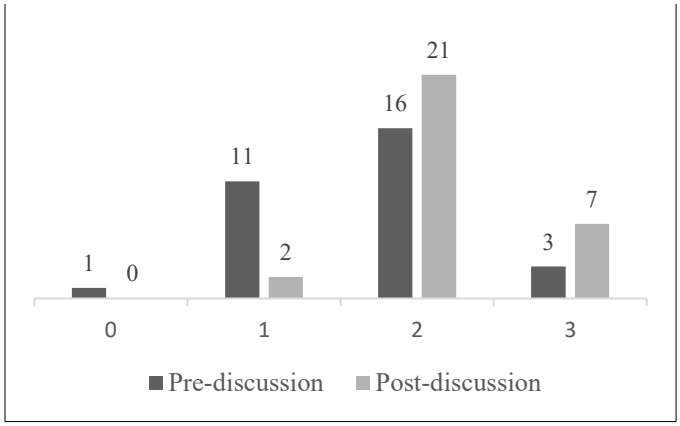

Fig. 1. Change in student's recognition of ethical issues from pre-discussion to post-discussion assignment.

Finally, the survey also provides some context for students' perspective of the role-play activity (Table VII). Overall, students identified the role-play activity as a positive learning environment. In addition, many students mentioned that this was the first time they have participated in a role-play activity and that they enjoyed learning through this style of activity.

TABLE VII: COMMENTS IN SURVEY

The discussion was useful for uncovering at least one or two viewpoints of the topic that I had not myself considered... the assignment was both interesting and valuable in terms of expanding my own perspective as well as articulating my thoughts and opinions to others.
These discussions are very helpful. We are students in tech industry. It opens our eyes to some possible consequences of tech, especially when its early and the society isn't ready for it.
I think it's a very fun experience and it should continue to be conducted in future classes.
I think it would be helpful to set aside at least some time for participants to discuss the scenario from their own point of view, not their role's. It was a little tricky for myself and I think others in my group to think of how our role would view the situation since it was different from how we see it ourselves.
I thought it was a very interactive and thought-provoking way to learn about the ethical issues in the algorithms used in the AIs. It enabled me to think and understand the need for reducing bias from different interesting and valid perspectives which I wouldn't have been able to otherwise. Overall it was a very new experience which I enjoyed and most importantly learned from.
It was a very good activity and should be encouraged in future so that everyone would be aware about these type of scenarios or incidents that would demand ethical and morally right decisions to overcome limitations. Also as a student, I was able to understand various other perspectives and thought process of my counterparts which I would not think about in general.
I think this discussion is a very important assignment we had this semester. It not only enhanced our moral personality but also helps us merge our ethics with technology.
I think this was a wonderful exercise. From all the breakout discussions that we had throughout the semester, this was the most engaging and most informative. It required me to change my perspective and think differently.
The discussion was useful for uncovering at least one or two viewpoints of the topic that I had not myself considered. Consequently I felt that the assignment was both interesting and valuable in terms of expanding my own perspective as well as articulating my thoughts and opinions to others.

V. Discussion and Conclusion

The goal of the study we present here was to teach students how to think about the implementation of algorithms in a contextual manner and to be able to take on different perspectives around an issue to develop ethical understanding related to algorithms. To impart this learning to students, we designed and implemented a role-play case study with collaborative discussion. Our results show that students were able to better identify ethical dilemmas through the situated learning experience of participating in the role-play activity. By engaging their own perspectival understanding of the scenario and discussing that of other stakeholders, students could identify a wider breadth of issues than they did on their own. Through their participation in the module, students were better able to recognize and respond to issues of bias, inclusion, and privacy. They depicted an understanding of how facial recognition algorithms can affect user data and how those possible errors can be reduced and avoided. Our study also shed light on the importance of using role-plays for teaching about these issues. By creating a concrete situation and specific roles, many of which students could identify with, we provided students an easy way to adopt a perspective. It also forced them out of their own personal viewpoints related to the issue, and as they had to discuss the case from their adopted perspective and thus they were more cognitively engaged with the topic. There are some limitations to this work as we only look at a single role-play, and we have not measured long-term cognitive gain, if any. Future work will implement more role-play discussions and measure effects across scenarios as well. There were also suggestions from students about providing more time for discussion and reflection, from their perspective, and this is another aspect that can be easily implemented in the future.

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