Ethics Education in Context: A Case Study of Novel Ethics Activities for the CS Classroom

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ABSTRACT

Our paper offers several novel activities for teaching ethics in the context of a computer science (CS) class. Rather than approaches that teach ethics as an isolated course, we outline and discuss multiple ethics education interventions meant to work in the context of an existing technical course. We piloted these activities in an Human Centered Computing course and found strong engagement and interest from our students in ethics topics without sacrificing core course material. Using a pre/post survey and examples from student assignments, we evaluate the impact of these interventions and discuss their relevance to other CS courses. We further make suggestions for embedding ethics in other CS education contexts.

CCS CONCEPTS

• **Social and professional topics** → **Computer science education**; *Model curricula*; Codes of ethics; • **Security and privacy** → *Human and societal aspects of security and privacy*;

KEYWORDS

Ethics, Pedagogy, Curriculum, Critical Reflection, Active Learning

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1 INTRODUCTION

There is no disputing that computer scientists should be trained in ethical thinking alongside developing their technical skills. The ACM, IEEE, and ABET have all emphasized a need to prepare students to think and act responsibly, while grasping the applicable legal and business challenges related to their practice. We are now seeing the importance of this training, as decisions made by computer scientists increasingly shape our public and private lives.

Examples such as racial bias found in risk assessment systems [15], severe privacy violations occurring internally at Uber [6], the expansion of filter bubbles and propagation of fake news [11], the proven difficulty of robust anonymization [16], and the rapid advancements of predictive inference using Big Data [13] suggest that computer scientists are becoming some of the most powerful moral agents in today's world. However, traditional ethics education for computer scientists may not include practical and timely training on how to weigh the consequences of their decisions. We therefore suggest that it is critical to incorporate ethics education as a continuous and practical thread within CS curricula.

In this paper, we offer our experience adapting an upper-level undergraduate Human-Centered-Computing (HCC) course to stress ethical thinking throughout the process of learning the fundamentals of human-centered design and evaluation. Our goal was to expand the current repertoire of *in situ* learning activities that require ethical judgment and to evaluate students' reactions to an infused ethics and engineering practice course. During the process, we built on prior work that has used project-based learning [14] and current events [5] to motivate realistic ethical problems while further piloting several new activities.

We found that students responded well and were even excited by having to apply what they learned to complex ethical situations. Many of the activities we piloted show promise for being adapted into other courses such as machine learning, data science, software engineering, and algorithms. Here we discuss existing models of ethics education in CS, the structure and components of our course, examples from student assignments, and results of a pre/post-survey. Finally, we unpack these results to make concrete suggestions for how other educators could reuse our material in other CS education contexts.

2 LITERATURE REVIEW

ABET's accreditation standards [2] and ACM's Code of Ethics [4] lay the foundation for ethics education in computer science. In light of these top-down guidelines, many efforts for ethics education in computer science have cited them in their approaches [7, 8, 10, 14,

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19, 22]. There has been further influence from the ACM/IEEE Joint Task Force on Computer Engineering Curricula to adopt courses that build professional experience including dimensions of law and business practice [1].

ABET mandates at least 20 credit hours in professionalism–including ethics along with business, social impacts, teamwork, communication, design, and law [2]. This has given rise to the creation of many one-off ethics courses [10] or project-based courses that integrate concepts of business and law into the material [14]. In the ethics education literature, one can find successful project-based models such as Purewal, et al's course that included a service-learning component addressing e-waste and sustainability [19].

Supporting the creation of a CS ethics course, researchers have argued for classes that incorporate discussion of ethical dilemmas, designing rubrics to aid in the evaluation of such a course [20]. In fact, courses covering social impacts of computing have proven ability to increase interest in CS degrees [10]. Other educators have pointed out the potential for courses that integrate the rich material available in current events, multimedia and film, and short essays that cover topics across philosophy, privacy and civil society, intellectual property, AI, whistle-blowing, security, hacking, piracy, etc [5].

Some schools offload the burden of putting together an ethics course to their philosophy or social science departments. Though, teaching ethics outside of a technical context often leaves students with the impression that the material is irrelevant to them [10, 21]. This problem manifests as a general theme in the literature on CS ethics education—that isolating ethics into a separate or external course makes it appear as a side issue to computing [8].

Our work is an attempt to address this gap between technical material and ethical considerations in the CS curriculum. With a clear desire in the field for improved ethics education [17] and many documented ideas for how to design interesting material, we hope to contribute to this literature by reviewing our own attempt to design a class that integrated core CS content and ethics.

3 COURSE OVERVIEW

The course was an intensive five-week, summer implementation of an undergraduate-level human-centered computing foundations course. The class met 3 times per week for 2.5 hours per session. At its core, the class taught methods for prototyping and evaluating computing systems from a user-centered vantage. Our course further emphasized ways in which the design, development, and deployment of technologies have human consequences. Importantly, the curriculum helped students assess and plan for those consequences and hone the skills necessary to be socially-conscious and responsible engineers. Throughout the course students were assigned weekly reading reflections (10% of total grade), individual assignments (30%), milestones for a course-long group project (50%), in-class workshops (ungraded), and a participation requirement (10%).

3.1 Participants

The course consisted of 31 students (8 female; 23 male) that were primarily computer science majors (23). Beyond CS majors, the class also had one masters student and seven students seeking computer science minors or certificates.

3.2 In-Class Activities

Class time was split up into two parts: lecture and workshop. The lecture was 1-1.5 hours and was given by the primary instructor or an invited guest lecturer. Workshop time consisted of active learning experiences that synthesized lecture content into a practical exercise and discussion. Often, the active learning exercises would allow students time to process dimensions of their group project in relation to course content.

Throughout the course, we brought in a total of five guest lecturers: a researcher focused on co-operative ownership of data and software, a privacy lawyer with practical knowledge of the laws and regulations relevant to computer scientists, an artist specialized in typography and layout, a researcher focused on terms of service agreements and online harassment, and an emeritus professor who detailed his experience watching a 50-year transition of technology. These lectures allowed the class to gain perspective in legal, business, psychological, and historical dimensions of technology—all of which aided in presenting a broad, robust conception of social impacts.

Workshops were primarily done in small groups or within students' project teams. Students were often asked to brainstorm and share ideas with one another with the expectation that disagreement and debate could occur. In order to introduce students to this kind of dialogic atmosphere, the workshop for the first class was a "spectogram" exercise. We had all the students stand in a line and asked them a question formed along two polar extremes. Students then had the opportunity to physically stand anywhere along a spectrum between the poles that best represented how they felt. We then asked a few students from different places on the spectrum why they took this position and then allow students to reorient if a particular point changed someone's mind. We did this exercise with three questions, respectively: 1) Do you believe facebook is good or bad for society?; 2) Do you believe face recognition technology is good or bad for society?; 3) Do you think it is good or bad for Facebook to use face recognition technology to identify the faces of untagged people?

In week 2, we had a workshop that asked students to try and identify the primary stakeholders that would make up the user communities for the systems being developed in their projects. While drawing stakeholder diagrams, students were asked to consider the different "personas" [18] relevant to who may use their app and further identify competing incentives that may align or conflict between these groups.

As the course developed, these workshops became more sophisticated, requiring a deeper understanding of technical and social concepts. Week 3 included a workshop where students were asked to design "capture" systems [3] and come up with metrics for how they would extract insights out of particular data sets. They were first shown an example of the kind of data collected by our university's online courseware platform. Given that dataset, students were asked to come up with a metric that would allow someone to identify good students to recruit for graduate school. Next, they

were asked to design a metric that could be used to analyze Facebook profile data and give a user a "wealth index." Finally, they were asked to design a capture system for a news aggregator that allowed publishers to upload articles and metadata. Their goal was to be able to accurately flag fake news upon upload. At the end of each task we did a talk back where we would identify biases, unfair consequences, or gameable aspects of their designs to help solidify notions of data fairness.

In the classes where a guest lecture was invited, the workshop would attempt to link new ideas from the workshop into core course material already being applied to their projects. For instance, when a privacy lawyer came to lecture about the EU's upcoming General Data Protection Regulation (GDPR) implementation, students were asked to then reconsider their UI designs under the constraints of this regulation. They were given an hour to review at least one of their UIs that contain user data and search for compliance issues and ultimately consider a redesign that would solve these problems. When a terms of service and harassment lecture was given students were asked to consider the social norms that would be important for proper use in their project designs. The workshop then gave them time to consider bullet points for a harassment policy or terms of service and what design decisions these changes may affect in their implementation.

3.3 Individual Assignments

Outside of class students had three types of individual assignments: weekly reading reflections, participation submissions, and an individual applied exercise regarding a topic from the week. Each week had 3-4 required readings and to complete the reflection students had a choice of 3 questions to answer. They could either choose one question and dive deep, writing at least a full single-spaced page, or choose two questions and answer them in a summary form writing at least a half page. The questions were written to force students to recall an aspect of the author's argument or main point and then critically reflect on a dilemma this presents engineers.

Participation submissions were simple responses to fulfill weekly point requirements that could otherwise be attained by speaking in class. Two points per week were required to receive full participation credit and students who did not directly respond to a question or discussion in class could alternatively choose a topic or discussion from class and submit a short write-up. This either detailed their opinions on the topic or offered an example from the media or research that availed deeper complexity.

The solo assignments were meant to give students a chance to apply skills learned in the class outside of the project. One assignment included piloting an observation protocol by watching someone do a common task and interviewing them about how they performed it. Another allowed students to implement a design experiment, applying ideas taught in our lecture on design aesthetics, asking students to play with alternative layouts, colors, and interactive elements that could be incorporated into a website. An ethics exercise we piloted involved students reading a sci-fi piece and discussing the underlying technology, the assumptions about how society was changed by this technology, and ultimately analyzing the likelihood of the story's events happening in real life.

3.4 Team Project

The anchoring component for students was the course-long group project. Milestones involved prototyping the interfaces and functionality for a computing system, evaluating their design, modifying their design based on evaluation, and reflecting on the social impacts of their system if it were to become a commercialized product. Week 1 kicked off with a simple team statement that explained who was working together and how they would submit their assignments (e.g., pencil/paper drawings, digital mockups, CSS/JS code). Week 2 required teams to come up with a problem statement for their project and an initial design concept that included visual mock-ups to describe their initial approach.

The project continued with the students having to apply course content to its development. Week 3 called for a cognitive walkthrough and think aloud study to be performed on their first interfaces. Week 4 asked students to respond to their findings, showing a revised version of all their interfaces. Week 5 finally asked for a report that explained the evolution of their design, a UI showcase that explained their system's workflow, and detailed research into several dimensions of social impacts that should be considered if this project was implemented into a full system.

4 RESULTS

An important premise of our effort is to introduce ethics components *in situ* without sacrificing the core contents. Since our course was not designed as a controlled experiment, it is difficult to draw a definite answer whether we succeeded in meeting this premise. However, judging from the projects student groups had delivered, we did not notice significant difference in quality from previous offerings of the same course. Nor did we notice significant difference in grade distribution compared to previous offerings. In a post-survey, when asked to specify main takeaways from the course, many had mentioned core HCI concepts such as "user testing methods", "considerations for design decisions", and "heuristic evaluation." Taken together, these indicators suggest students were indeed learning the core contents effectively. In the rest of this section, we turn our attention to evidence we uncovered regarding ethics learning.

4.1 Student Responses and Reflection

Looking to individual assignments provided a viewpoint into how the students were processing the course material and ultimately what questions and considerations stuck with them. On a weekly basis our instructional staff read all assignments, pulling out general themes and looking for interesting comments that provided a launchpad for discussion at the beginning of class. In some instances, we would highlight two perspectives that had opposing considerations or solutions to spur discussion around trade-offs and differing assumptions.

Here we offer a summary view into some of the interesting questions and considerations raised by students that signaled a deeper engagement with ethical thinking. Starting with week one, an encouraging result were reflections that portrayed engagement with the "spectogram" exercise, as reflected by a comment "*The topic on the first day of class: facial recognition, was particularly interesting to me. While I thought I had a right stance at the beginning, every*

body's other ideas made me keep think about what I had thought already differently."

A strong sign that ethical and critical thinking is occurring is seeing a student weighing the trade-offs of a particular dilemma. For example, the dilemma of "manipulation vs personalization" was a common topic when we had students read an article by Tristan Harris called, How Technology is Hijacking Your Mind [12] that discusses the cognitive tricks designers can play on users to maximize on-screen time. A student wrote "*Some individuals have more addictive personalities and the cognitive load needed to stop enjoying the constantly refreshed content is much larger. In this way the technology [to manipulate users] seems* ***unfair****...but you can change your settings, you can turn off your phone... I can see the argument for why it is* ***fair****.*"

When reflecting on ProPublica's article, Machine Bias [15], another student exemplified a strong understanding of how the concept of fairness may differ between a user and an engineer. This student wrote "*In a system where the people being evaluated are given no choice and are having their lives changed based on the results, fairness is of the utmost importance...As we have learned in class, someone who knows a system well because they built it is unlikely to be able to replicate using it in the same way someone who doesn't know anything about it would.*"

We also found that students were applying ethical reasoning in their personal life and professional work. For example, a student talked about encompassing skills from class in an internship. The student first commented on their past viewpoint before the class "*[Before] I would only think about the people that actually used the service or product, instead of also including who can also be affected.*" and then reported how the class had changed their viewpoint at work: "*[The class] made me think pretty hard about the user-communities of the start-up that I'm volunteering on, and how thinking of the user-communities for our product will greatly increase the usability and make sure that all the communities (not just the immediate user) are fairly treated.*"

In the same reflection, this student commented on a guest lecture detailing the differences between privacy laws in the United States vs. the upcoming European Commission's GDPRs and how they could affect the start-up for which he is working. Through all these quotes we see a rich engagement with ethical questions as they relate to technical and professional thinking. It should be noted this was only the tip of the iceberg and we had some students go deep into this thought process; one even wrote a 5-page lyrical poem about the ethical dilemmas around search engines.

4.2 Pre/Post Survey Results

We collected pre- and post- class survey responses from 30 students in the class. The surveys contained short-answer, open-ended questions related to the ethical implications of technology and takeaways from the course. The responses to these questions were coded by two research assistants. The responses were given a score of 1 if it contained any mention of ethics, social implications, privacy, or consent. The coders read each of the responses independently and assigned a rating. Differences in the responses were resolved by discussion.

Findings from these survey responses further suggest that embedding ethics into the curriculum increased the amount of students who believe ethics are important to their careers. There was a significant change in the post-survey responses: more students considered ethical implications in their statements. When asked "What questions would you ask to a potential employer if you were being offered a job to design an app that sorts and displays people's photos across all their media platforms?", 30% more students (Pre:10 out of 30; Post:19 out of 30) considered ethics or ethics related concerns in their post survey responses, such as, "*How would you like users to authenticate other devices? What sort algorithm would you like to use? What functions should the program have? What feelings should the user have while using this product? How are photos being stored and who has access to them?*" Additionally, when asked "If you were to make an app where networks of users could share geolocations for house parties—what users might have issues or who may this harm?", 33% more students (Pre:9 out of 30; Post:19 out of 30) mentioned privacy and social impact problems. For example, "*This could harm anyone who does not want their location known, or people who have their house registered as having a party incorrectly, as well as anyone who was having a party, but didn't want it broadcasted.*" The responses showed that our course with ethics interventions throughout had a doubling effect on students considering ethics in technology design.

We included three extra, open-ended questions in the post-class survey. We categorized a response as integrating ethical concepts if the student explicitly mentioned ethics, morals, or privacy, or if they implied ethical decision making through thoughtful contemplation of the social implications of their work, potential harm to others (i.e. empathy, identifying different stakeholders), or caution when approaching and designing a technology solution. It should be noted we did not prompt or otherwise guide students to discuss ethics or social impact for these questions.

When asked, "What will you take away from this course?" 26 out of 30 student responses included ethical considerations, such as, "*I realized that technology can have a much larger impact than I initially thought. I never really took the time to analyze possible future implications or think about privacy. I also never really thought about evaluations and using those to enhance whatever you're working on.*" This shows both a greater perspective of how technology impacts society as well as an appreciation for practical design methods, but other students went further in expressing the need for ethics to be baked into all aspects of technology development. One such student wrote "*There are ethical considerations in almost all aspects of design and implementation, something I hadn't really thought about previously.*"

In the next question, "What's the one thing you've learned in this course that will be most applicable to your career?" 14 out of 30 student responses included ethical considerations. Although this is lower than we had hoped for, we believe responses to this and other questions such as the one before show students' willingness to consider ethical implications in their work, especially when it came to privacy, as answered by one student: "*I'll take more time to consider the implications of privacy policy in my startup ideas.*"

Furthermore, in the final question, "What is one thing you'll do differently following this course?" 25 out of 30 students said that they think about ethics and the social implications of work

differently, including their future work. One student commented "*This course has taught me how to consider my ideas from an all encompassing standpoint, from design, to ethics, to law, etc, and i'll continue to use this frame of mind, especially in my senior project this coming year.*"

Another objective we had with ethics was to explore the tensions that arise in software companies when business goals are introduced. Students were able to articulate such tensions, as one student noted "*That everything needs a way to make money, and often that means sacrificing certain ideals like "free no matter what," privacy, or how you keep people using your software.*"

Finally, we sought to highlight the importance of realizing that humans are naturally bad at predicting what the future holds. This is critical because when developing a technology, such as a classifying algorithm, it is difficult to know how it will be applied in society. And this was expressed in student responses as well, such as "*Predicting the future is next to impossible, so it is important to pay attention to current trends and not get stuck in an obsolete 20 year plan. New laws such as the GDPR mean that as a designer it is important to ensure your business model is not dependent on practices that would be made illegal. Always important to consider values of users and compromise accordingly.*"

5 DISCUSSION

The results of this course were encouraging. The use of current events, real-world problems, and artistic provocations, even when reduced in complexity for pedagogical purposes, amplified student engagement. Many students brought up the fact that this was the most thought-provoking course they had taken and that it opened their eyes to new dimensions of their field. Our course is a foundation course for HCI. We were not forced to sacrifice content nor difficulty by adding these ethical and social elements. In fact, exercises such as designing capture systems and metrics to understand data bias, were almost too technically complex for an undergraduate course. The biggest limitation of our course was over-motivating some of the social issues and being unable to fully address their technical counterparts, such as diving deep into machine learning or cryptography, due to time and content scoping constraints. However, when students later do take topic classes on machine learning or cryptography, it would be ideal for them to receive another dose of ethics training.

Encouraged by the results, we adopt a position on CS ethics education that includes the following principles:

Continuous Ethics education should happen in small doses throughout the curriculum rather than in a one-off course.

In Situ Adding an ethics component to a class assignment relevant to core course content shows that ethics and engineering thinking go hand in hand. This would imply discussing bias and anonymization in a data science or machine learning course, privacy in a computer vision course, etc rather than treating ethics as a set of concepts to learn away from technical material.

Perspectival CS We ought to turn our value equation toward students' abilities to identify multiple perspectives about computing issues (i.e., recognize a dilemma) and translate that dilemma into competing technical choices.

We see many ways these principles could be adopted. A centralized, but simple approach could involve the instructors of a CS department coordinating to add small reflective writing assignments to several CS course in the program (e.g., A Computer Vision Course with a successful reflective component [9]). Though not all courses might lend themselves to as much ethical context as HCC, many technical courses (AI, machine learning, etc.) could integrate ethical components. Ideally, students would be introduced to ethical thinking early in their programs. Making ethics part of an introductory course where themes and dilemmas could later be reintroduced allowing for a continuous ethics intervention through the curriculum while not overburdening any one course.

Through our case study, we believe we have also identified several interesting technical interventions more appropriate to other courses. Some of the exercises we did in our class could be easily adapted. Our exercise in defining a metric on a dataset to discuss bias and trade-offs would be perfect for a data science, algorithms, or machine learning course. A great example would be to use US Census data to analyze correlations between socio-economic status, zip code, and race. Using similar data to design a classifier for predicting voting or employment patterns would allow for teaching on how insensitive data may proxy sensitive features or how subsamples of your data may be misrepresent global properties. In our class we asked students to design a metric for giving everyone's Facebook profile a "wealth index." We did not have the time to test every approach students' designed; however, one could imagine in a more technical data science course, this could be assigned to homework to then give rise to discussion on the different results obtained from different technical choices.

Testing out the enforceability of different harassment policies could be done in a social computing class. An exercise could be as simple as scraping controversial Twitter threads and asking students to tag what should count as harrassment and then reflect on how that would change the discussion. We saw in our course students were intrigued by the difficulty of such a problem and significant time could be added to deepening these ideas.

Evaluating different stakeholder incentives to balance privacy perspectives would be useful in a cybersecurity class. A walkthrough of privacy options offered by Google, Facebook, or another online platform to consider what information is collected, what privacy trade-offs are users facing, and how this may align or misalign for different stakeholders (e.g., journalists vs. photographers) would show the perspectival nature of technical choices. As was shown in our results, students in our course found considering different perspectives to be applicable to their current and future work.

Learning about how one may mislead an audience with data would be perfect for an information visualization class. Telling different stories with the same data set might help instill a sense of responsibility around choices of data presentation. Students left our class with a heightened view of engineer responsibility; though, exercises like these would elucidate exactly where that agency enters and how it relates to ethical business, journalism, science, etc.

6 CONCLUDING REMARKS

Discovering novel and engaging methods for training responsible engineers that do not sacrifice learning technical skills will continue to a central problem for CS curriculum design. As our case study shows, infusing ethical dilemmas and social challenges in the curriculum is by no means a crutch for a course, but can amplify interest. We hope to continue by expanding on the activities we piloted in this case study and encourage other education researchers to do the same. It is our position that until ethics education is threaded throughout a student's development of their computing skills that we will continue to see ethics treated as a side issue rather than a central asset to CS.

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