Embedded Ethics in CS: Experiences with Integrating Ethics Assignments in Sophomore, Junior, and Senior level Courses

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Abstract

Technical and ethical aspects of Computer Science (CS) are interdependent. Many CS departments teach ethical and social implications of technology in separate standalone courses. However, prior research shows that ethical issues are better taught in tandem with their related technical content as an integral required skill in CS curricula. In this experience report, we share our experience with embedding ethics assignments in 3 CS courses at different levels: a CS2 course in software design and data structures, a CS3 course in data structures and algorithms, and a Software Engineering capstone course, all taught at Virginia Tech (a large public R1 institution) in Spring 2024. Students from the 3 courses were surveyed at the beginning and end of Spring 2024. By comparing results from the pre and post surveys, we found that the embedded assignments for the CS2 and CS3 courses improved students' confidence in their knowledge about how ethical issues may come into play in their career, their confidence in their ability to address ethical issues arising from applying technology in real contexts, and their confidence in communicating and defending their positions on how to address these issues. For all 3 courses, students gave positive feedback on how the assignments were engaging and relevant to the course, and how it improved their ability in raising, and reasoning about, ethical implications of technology. We believe that the practices and results of our experience will be helpful to other CS instructors thinking of injecting ethical content into their technical courses.

CCS Concepts

• **Social and professional topics → Model curricula**.

Keywords

CS Ethics, Social aspects of CS, Undergraduate, CS2, CS3, Capstone

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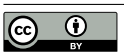

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1 Introduction

The Tech industry experienced a concerning number of ethical violations during the last decade. Examples of these violations include: Google's race-biased photo classification system [1], the Cambridge Analytica and Facebook's data breaching scandal [2], and Amazon's gender-biased data driven hiring system [3]. This indicates that CS students need some kind of training in ethical and social implications of the technology they build. This pushed CS departments to include computer ethics into the curriculum [13]. Currently, many CS departments include ethics as separate standalone courses at both the undergraduate and the graduate levels. In these courses students learn about ethical and social concerns that arise from using technology and how to address it in the tools they develop. Furthermore, students learn to formulate, reason, and communicate positions in ethical situations related to computing technology. However, previous research shows that learning the technical skill separately from its ethical implications makes it easy for students to have the false impression that ethics is not an integral part of their work as CS practitioners [12, 17]. Accordingly, students might perceive ethics as an afterthought, burden, or just a box to tick at the end of their program [16]. Miller [20] stated that technical skills and their ethical implications are best taught in conjunction with one another. By learning ethical and related technical topics concurrently, students perceive ethics as an integral skill that they should learn out of the course, as they should not only focus on how to build technology, but also on the ethical considerations that will restrict their design.

Geotze [16] defined three models of integrating ethics into computer science curricula: multidisciplinary, interdisciplinary, and transdisciplinary. In multidisciplinary integration, the technical aspects and skills are taught separately from their related ethical and social aspects. In interdisciplinary integration, both ethical aspects and technical aspects are taught in tandem, in which ethics is presented as one of the skills that students should learn out of a technical course. In transdisciplinary integration, a new discipline is formed with its new courses, approaches, and methods combining both technical and ethical aspects of CS.

The CS department at Virginia Tech is currently implementing a multidisciplinary approach of teaching ethics by offering two standalone ethics courses, one at the undergraduate level, and the other at the graduate level. The undergraduate course is required for CS majors, and it focuses on the responsibilities of computer professionals in directing emerging technologies and understanding its impacts on the society. Most of students take this course in their junior year. The graduate course focuses on raising ethical concerns and social implications of technology, and how computer

professionals should address them in the tools they develop. In addition, the graduate course has a research component designed to teach students research conduct and the rights of human subjects.

In this paper, we share our experiences with implementing an interdisciplinary approach of teaching ethics in 3 different courses. We also examine students' self-efficacy relating to ethics topics and their opinions about the appropriateness of covering ethics content in the curriculum. We embedded ethical assignments into a software design and data structures course taught at the sophomore level (CS2), a data structures and algorithms course taught at the junior level (CS3), and a Software Engineering (SE) capstone course taught at the senior level. The CS2 course includes an introductory ethics module, and requires students to apply ethical reasoning to scenarios related to course programming assignments. In the CS3 course, students were assigned case study readings related to an ethical issue that arises from applying a data structure or an algorithm they learned about in a real-life scenario. After that, students were required to submit a writing assignment describing their responsibility as computer professionals in addressing the identified ethical issue, and proposing ways to mitigate it. In the SE capstone course, senior students (who have already taken the standalone undergraduate ethics course) were required to develop a fully functional system to get hands-on experience before they graduate. Ethical considerations were integrated as a design principle focusing on ethically-informed choices for design and deployment. Students were required to raise ethical concerns and identify ethical implications of what they build.

This paper is organized as follows. Section 2 presents prior work of integrating ethics into different CS courses. Section 3 describes the embedded ethics assignments for the CS2, CS3, and SE capstone courses. Section 4 describes the evaluation methodology of the embedded assignments in terms of improving students' ethical reasoning and their confidence in raising and responding to ethical issues arising from using technology. In addition, this section presents our results from pre and post surveys administered for the 3 courses at the beginning and end of the Spring 2024 semester. Section 5 presents our comments on the results and lessons learned from this experience. Finally, Section 6 concludes the paper and defines directions for future work.

2 Related Work

The idea of integrating ethical content into CS courses through an interdisciplinary approach is not new. In page 9 of the 1978 ACM curriculum [7], a new CS9 course related to the social aspects of computing was recommended as a standalone elective. However, an argument was presented that this material is crucial to CS students, and it should be provided throughout the curriculum in different courses. In 1988, Miller [20] stated that technical issues are best understood in their social context, and the social aspects of computing are best understood in their underlying technical detail. In this seminal paper, Miller presented case study examples and accompanying questions showing how ethical and social aspects could be integrated into all courses of the CS curriculum (CS1 through CS8) as defined in the 1978 ACM recommendations. In 2018, Harvard initiated the Embedded EthiCS program [17] by developing short ethical modules and embedding them into 14 different CS courses. After the positive results of Harvard's program, several universities followed Harvard's path and started developing similar initiatives [4, 11, 19].

Prior attempts of integrating ethics via an interdisciplinary approach could be classified as shallow or deep integration according to the level at which the ethical material is injected within the technical content [9]. Shallow integration could be defined as injecting isolated ethical modules (e.g., reading and writing assignments) related to the technical content without modifying the technical content itself. In other words, we can think of the embedded ethics modules as an extra but important material that students need to cover as part of the course requirements. On the other hand, deep integration could be defined as the modification of the technical assignments (e.g., programming labs and projects) to contextualize them within an ethical dilemma.

An example of shallow integration is the work mentioned earlier done at Harvard by Grosz et al. [17]. Another example is the work done by Horton et al. at the university of Toronto [18]. Two ethical modules were embedded in a CS2 course including readings and quizzes before class, in-class activities, and after class write-ups. The modules were about Covid-19 contact traces raising the issue of the tradeoff between privacy and public health. These modules directly relate to graph data structures and algorithms. Klassen and Fiesler [19] introduced a new assignment based on speculative science fiction named the "Black Mirror writers room". In this assignment, students were asked to use the theme of "Black Mirror" episodes and speculate about future harms and implications of using technology. One more example is the work done by Cote and Albu from the University of Victoria [10]. Ethical writing assignments were embedded in a senior year course about computer vision offered as an elective in the computer and electric engineering program. The assignments required students to comment on privacy and security issues of computer vision technologies.

There are multiple examples as well for the deep integration approach. Fiesler et al. [12] replaced some of the old programming assignments in 3 different introductory programming courses at the University of Colorado Boulder with 2 new assignments that teach the basics of programming in the context of real-world ethical dilemmas. The first assignment covered boolean expressions and conditionals in the context of personalized ads. The second assignment covered lists and file I/O in the context of data-driven college admission algorithms. Skirpan et al. [21] integrated ethical thinking in an upper-level Human-centered Computing course at the University of Colorado Boulder. Students were required to work on a semester-long group project applying ethical reasoning in their design and take several dimensions of social impacts into consideration. Brown et al. [8] re-contextualized a technical assignment in an AI course by adding a human context to graph shortest path algorithms. Students were asked to modify existing algorithms to find the safest path instead of the shortest path. Cohen et al. [9] started an initiative at Brown university to integrate content about socially-responsible practices through ethics assignments added to 14 courses across the curriculum. For example, in a CS1 course, multiple programming assignments were related to personalized ads. In a CS2 course, all major projects were redesigned to include a social context (e.g, algorithmic hiring bias).

3 Integrated Ethics Material

Our integrated ethical assignments were based on the shallow and deep approaches described in Section 2. We adopted a shallow integration approach for the CS2 and CS3 courses, and a somewhat deep approach for the SE capstone course. More details about the integrated assignments are provided below. All assignments and their grading rubrics are publicly available online for other instructors to use[1].

3.1 Software Design and Data Structures

The CS2 course offered at our program is required for CS majors and minors, and several other majors on campus. The course is taught in Java, and it provides an introduction to data structure implementation through bags, stacks, queues, lists, and trees. The course emphasizes software design with a focus on object-oriented programming. The course is programming-intensive with small coding practice, weekly labs, and 5 projects. Students are also required to complete exercises in a custom on-line e-book and additional learning activities such as multiple choice questions, design activities, and ethics prompts. The course has 4 in-class quizzes and a final exam.

The course's website has a content page covering an introduction to ethics. This content page includes some videos, written descriptions, references, and multiple choice questions. Following that lesson, students are assigned a discussion prompt in the form of a Canvas Discussion. The course of about 600 students is broken into 18 discussion groups of about 30 students. Students are instructed to either argue a position or make a counterargument in response to a classmate's position. Posts are expected to be 150 - 300 words and reference a theory or guideline provided in the ACM ethical guidelines [14] or The Eight Key Questions Handbook [22].

In Spring 2024, 3 ethics discussions were required worth 1.5% of the total course grade. The introductory discussion prompt addresses ethical solutions for preventing denial of service attacks. The other two discussions are related to the final two programming projects. The fourth programming project is a program that queues data about songs and allows users to place songs into playlists according to music genres. The corresponding ethics prompt asks students to consider ownership of music built with Generative Artificial Intelligence. The ethics prompt for the fifth programming project encourages students to reflect on the ethics of developing an app designed to reinforce user engagement while working on a team project that builds graphs of social media views and likes.

Ethics discussions were graded by graduate teaching assistants based on five aspects: summarizing the ethical situation, defining a clear position about how to address the ethical situation, defining clear and coherent arguments, referencing any ethical theory or guideline, and the proper use of language.

3.2 Data Structures and Algorithms

The CS3 course offered at our program is required for CS majors, but a number of non-majors also enroll in the course. The course is taught in Java, and it focuses on advanced structures like priority queues, balanced trees, hash tables, indexes, and graphs. The course is programming-intensive with 4 large projects worth 50% of the course grade. Students are also required to complete eTextbook MCQ/TF and programming exercises offered through the OpenDSA infrastructure [15] worth 10%, in-class MCQ quizzes worth 5%, and one midterm and one final exam each worth 15% of the course grade. In addition to that, starting in Spring 2024, students were required to complete 4 writing assignments directly related to ethical and social implications of the data structures and algorithms they learned about in the course. Each ethics assignment was released after completing the related technical content. Ethics assignments were worth 5% of the total course grade.

In the first ethics assignment, students were required to read three articles about the environmental impact of algorithms before submitting their writings. This is related to the topic of asymptotic algorithm analysis. The goal here was to give students the sense that using inefficient algorithms (e.g., bubble sort) will have a negative impact on the environment, because its execution will release more carbon dioxide (CO_2) to the atmosphere than an efficient algorithm (e.g., quicksort) solving the same problem. To further engage students in this assignment, they were given the formulas on how to calculate the carbon footprint of any algorithm given its running-time function. After that, students were required to submit a 1 page report on how advancements in algorithm design can contribute to more sustainable computing practices, and to reflect on the ethical responsibilities of algorithm designers in making choices that consider environmental sustainability.

The second ethics assignment was related to priority queues and how it can promote discrimination if not used properly. Students were required to read two articles before submitting their writings. The first was about discriminatory algorithms to prioritize candidates in organ donation queues, and the second was about cases where people who pay more in services receive higher priority. After that, students were required to submit a report proposing a set of ethical guidelines to address and mitigate bias and discrimination in the context of priority queues.

The third ethics assignment was about data ownership and privacy. This is related to the topic of file structures. Students were required to complete five readings before submitting their writings. The first three readings were about three real data breaching cases to help them conceive the seriousness of the problem. The remaining two readings were about the California Consumer Privacy Act (CCPA) [5], and the General Data Protection Regulation (GDPR) [6]. After that, students were required to submit a report exploring the ethical considerations and best practices in ensuring customer data privacy and security within computer science systems, and to critically analyze the challenges, propose solutions, and consider the ethical responsibilities of developers in protecting and handling customer data.

The fourth ethics assignment was about the formation of echo chambers in social media networks and how to mitigate it. This is related to graphs and graph traversal algorithms. Students were required to complete four readings before submitting their writings. The readings were about how giant social media platforms like X and Facebook could push users into echo chambers or bubbles in which only similar voices are heard, and how this could promote polarization and hate speech. After that, students were required to submit a report exploring the potential of the graph-based algorithms they learned about in class (e.g., breadth-first and

[1] https://tinyurl.com/yskcfa9v

depth-first search) to mitigate the formation of echo chambers and confirmation bias in digital platforms.

All four assignments were graded by the course's instructor based on three aspects: students' understanding of the ethical issue and how it relates to the technical content, students' ability to develop positions on how these issues could be addressed, and how students could defend their positions.

3.3 Software Engineering Capstone

The SE capstone is one of several capstone courses offered at our department, with each capstone course covering one major CS area. The focus of SE capstone is very wide by design, since its core element is usually the process of developing software solutions, which is implemented in almost any type of software product. Every year, however, this capstone course has a certain theme, so that the scope is a bit narrower. For Spring 2024, the theme was "Incorporating LLM solutions in daily life activities". Students spend the first 2 weeks in team-building and ideation activities, until they all choose their groups (with 4-5 students per group) and settle on one project idea. This happens after they do research, submit two written assignments, and meet with the instructor. Because students need to come up with their own project ideas, and then will be required to develop and deliver the solution they proposed, they have a lot to think about and consider since week 1 of the semester. In addition to the several research and technical assignments, they were asked to consider ethical concerns in all stages of solution development. The topic of "Ethical issues" was covered in the second week, providing four articles on ethical issues for them to read. Students were then explicitly tasked with answering ethics-related questions in their assignments, which usually include 6-10 questions to answer. Examples of these questions are presented below along with the time they were assigned during the Spring 2024 semester.

- Preliminary project research (week 3): Identify and list at least three potential ethical implications associated with your software project. Consider issues such as privacy, security, bias, accessibility, and environmental impact.
- Project research & Business model canvas (week 4): What are your initial thoughts on how to consider the potential ethical implications of your product/system?
- Final project presentation & Demo (week 13): How did you tackle the ethical challenges you've mentioned in your original proposal? (briefly for the presentation)
- Final project submission & Write-up, (week 14): How did you tackle the ethical challenges you've mentioned in your original proposal? (in detail for the write-up)

Additionally, since the class follows an agile development approach, students deliver two intermediate demos (after each 3-week iteration), before the final presentation at the end of the semester. In each presentation, students were required to show their progress not only towards a working product, but also towards mitigating and tackling ethical concerns relating to their projects. Students also had to discuss ethical concerns in every team meeting with the class instructor.

4 Evaluation

4.1 Surveys

To understand how the embedded ethics assignments affected students' ability to raise and respond to ethical issues arising from technology, students from the three courses responded to a pre and post survey during Spring 2024. The pre survey was administered before covering any of the ethics material (during week 5 for the CS2 course, and during week 2 for the CS3 and SE capstone courses). The post survey was administered one week before the end of the semester after covering all of the ethics material for all courses. Both surveys were administered online using our institutional copy of QuestionPro[2]. For the CS2 course, responding students received 5 points bonus for each survey towards their interactive e-book assignment completion. This is worth about 0.13% of their course's grade. For the CS3 course, responding students received 10 points bonus for each survey towards their in-class participation score. This is worth about 0.2% of their course's grade. For the SE capstone course, students received 1 point for each survey as part of their bonus "service" assignments, which is 0.5% of the total course grade. To see the improvement in students' ethical awareness and reasoning, we only included results from those students who completed both the pre and post survey. Incomplete survey responses were ignored. All three courses used the same pre survey. For the post survey, there were some slight differences for each course to reflect the different embedded ethics assignments.

The pre survey consisted of six rating questions on a Likert scale from 1 to 5, where 1 means Strongly Disagree, and 5 means Strongly Agree. Details about these questions are given in Table 1 (Q1 - Q6). The first six questions of the post survey were identical to the pre survey. Additional questions were included in the post survey asking specifically about students' perspectives regarding the embedded ethics assignments and whether they were interesting, related to the technical content, and helpful in improving students' ability to raise and respond to ethical issues arising from technology. Details about these additional post survey questions for each course are given in Section 4.2. 444 students out of 570 (77.9%), 121 out of 146 (82.8%), and 38 out of 39 (97.5%) from the CS2, CS3, and SE capstone responded to both the pre and post survey.

4.2 Results

First, we were interested in seeing the difference in students' responses before and after the integrated ethics material was incorporated. To do that, we matched the ratings of each student for the first 6 questions (Q1 - Q6 in Table 1) from the pre and post survey, and calculated the difference between their ratings (a within-group comparison). After that, a Wilcoxon signed-rank test [23] was conducted to see whether there was any significant difference between students' ratings in the pre and post survey. Results from this analysis are presented in Table 1. For the CS2 course, the ratings from the post survey were significantly higher than the ratings from the pre survey for questions Q3 to Q6. Similar results were found for the CS3 course, except for Q4 in which we didn't find a significant difference between pre and post ratings, despite the average

[2]https://www.questionpro.com/us/

Table 1: Results from comparing students' responses from the pre and post survey. The * after a p-value indicates a significant difference at $\alpha = 0.05$.

Survey Question	CS2 (N = 444)			CS3 (N = 121)			SE Capstone (N = 38)		
	Mean Pre	Mean Post	P-value	Mean Pre	Mean Post	P-value	Mean Pre	Mean Post	P-value
Q1: I am interested in learning more about ethical issues arising from applying technology in real contexts	3.86	3.73	0.99	3.77	3.78	0.38	3.93	3.93	0.40
Q2: For CS courses like this one, I believe that learning about the ethical implications of technology and its impact on society is as important as learning about the technical content	3.75	3.81	0.06	3.62	3.84	0.01*	3.93	3.93	0.42
Q3: I feel confident in my knowledge about how ethical issues and social impacts arising from technology may come into play in my career	3.79	4.00	<0.0001*	3.79	4.01	0.001*	3.69	4.11	0.003*
Q4: I feel confident in my ability to identify and raise ethical issues arising from applying technology in real contexts	3.85	4.05	<0.0001*	3.86	3.96	0.07	3.90	4.00	0.22
Q5: I feel confident in my ability to investigate and reason about different approaches to address the ethical implications of technology in real contexts	3.80	4.06	<0.0001*	3.75	4.06	<0.0001*	3.79	3.95	0.22
Q6: I feel confident in my ability to communicate and defend my positions on addressing identified ethical implications of applying technology in real contexts	3.80	4.05	<0.0001*	3.68	4.13	<0.0001*	4.00	4.03	0.33

post rating was higher, which indicates that there was some improvement. Furthermore, for the CS3 course, the post ratings were significantly higher for Q2. For the CS2 course, the post average rating for this question was higher than the pre rating, but the p-value was slightly higher than 0.05. For the SE capstone course, the only significant difference was for Q3.

Second, we were interested in collecting students' perspectives on the embedded ethics assignments for the 3 courses in terms of whether the ethical content was relevant to the technical content, whether students were interested in solving the ethical assignments, and whether students would like to see more of this kind of assignments in other CS courses. In addition, students were also asked to rate each of the embedded ethics assignments covered throughout the course based on its impact on improving their ethical reasoning. Figures 1, 2, and 3 show the rating results for these post survey questions for the CS2, CS3, and SE capstone course.

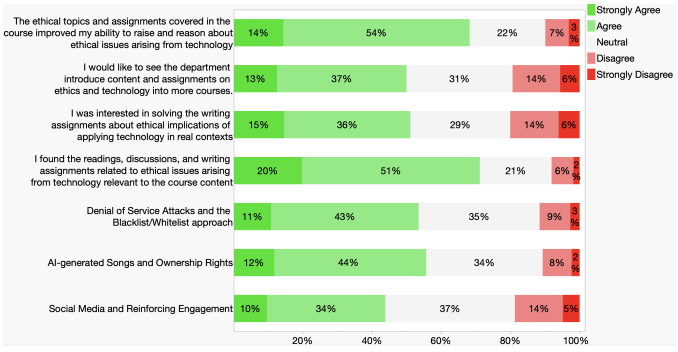

Figure 1: CS2 ratings for the post test questions regarding students' perspectives about the embedded assignments, and the impact of each assignment on their ethical reasoning.

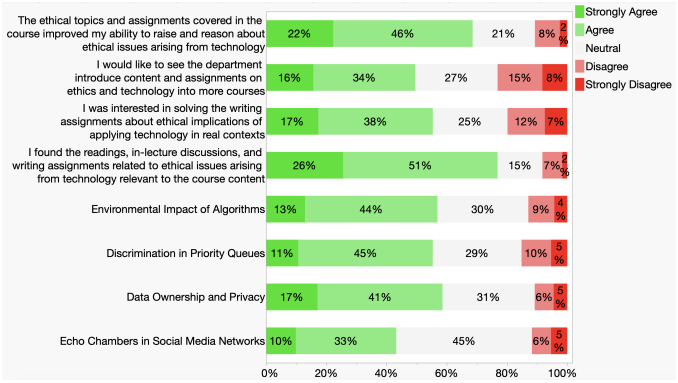

Figure 2: CS3 ratings for the post test questions regarding students' perspectives about the embedded assignments, and the impact of each assignment on their ethical reasoning.

5 Discussion

It is clear from the results shown in Table 1 that the embedded ethics assignments for the CS2 course improved students' confidence regarding their knowledge about how ethical and social issues come into play in their career, their ability in raising ethical issues arising from the use of technology in real contexts, their ability to reason about addressing those ethical issues, and their ability to communicate and defend their positions in addressing those issues. The same improvement was found for CS3 students except for Q4 regarding their ability to identify and raise ethical issues arising from applying technology in real contexts. Furthermore, for Q3 the embedded ethics material for the CS3 course strengthens students' belief that learning about ethical implications of technology is as important as learning about the technical content. Based on these results, we can say that the effect of the embedded ethics

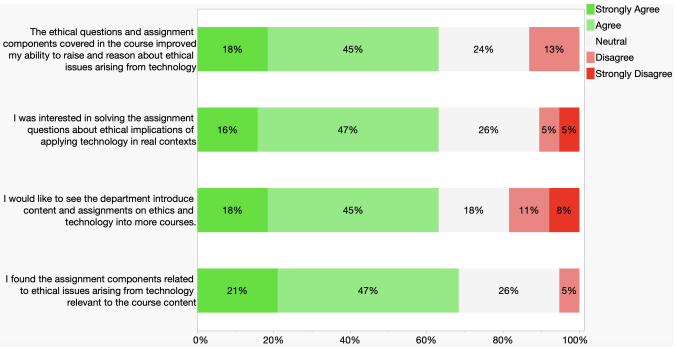

Figure 3: SE capstone ratings for the post test questions regarding students' perspectives about the effectiveness of the embedded ethics questions.

assignments for the CS2 and CS3 courses is similar to a high extent. We can attribute this similarity in results to the similarity in course content, and the similarity in the embedded ethics assignments. Both courses are programming-intensive teaching data structures. Furthermore, the embedded ethics assignments in both courses consisted of two parts: a reading part providing real examples of the ethical issue or concern, and a writing part encouraging students to think and reason about approaches to mitigate these ethical issues. In addition, students were required to communicate and defend their proposed approaches in their writing part.

For the SE capstone course, the only significant improvement we found was in students' confidence in their knowledge about how ethical issues arising from technology may come into their career (Q3). However, as we see from Table 1, the average post survey ratings for Q4, Q5, and Q6 are better than that of the pre survey. It is probable that there was no statistical significant difference because of the smaller sample size in comparison to the CS2 and CS3 courses. In addition to that, as described in Section 3, this course is different from the CS2 and CS3 courses in the sense that students were not required to do ethical readings or writings, but they were only required to include ethical reasoning in their project design, and to clearly indicate how they addressed ethical issues in their design in their final project write up. Furthermore, students take this course in their senior year just before graduation. In their junior year, students were required to take a standalone course about professionalism in CS in which they learn about their responsibilities towards the society as computer professionals. Accordingly, students from the SE capstone course were previously exposed to ethics, and this might explain why the results were different for this course when compared to the results from the CS2 and CS3 courses. This might also indicate that a standalone course in ethical and social implications of technology has an impact on students' ethical awareness and their confidence in their ethical reasoning ability.

Results from Figures 1 and 2 indicate positive students' feedback regarding the ethics assignments for the CS2 and CS3 courses. The majority (more than 50% gave ratings of strongly agree or agree) of students reported that the embedded ethics content improved their ability to raise and reason about ethical issues arising from technology, and that the ethical readings, writings, and discussions were relevant to the technical content covered in the course. In addition, the majority of the students reported that they were interested in solving the ethical writing assignments. Surprisingly, the same exact proportion (50%) of students in both courses gave positive ratings about their willingness to see similar assignments in other CS courses. Perhaps one of the explanations for this is the extra time and effort required for students to solve these ethics assignments, and that their focus in programming courses is more on the technical assignments. It is also worth noting that 44% of CS2 students and 43% of CS3 students (both are less than 50% and approximately the same proportion) gave positive feedback about the last ethics assignment in terms of its impact on improving their ethical reasoning. This might be due to the fact that students in both courses have limited time at the end of the semester wrapping up their final programming project, and preparing for the finals. Probably students did not focus that much on this last ethics assignment as their deadline was towards the end of the semester. Results from Figure 3 indicate positive students' feedback regarding the embedded ethics components for the SE capstone course. The majority of the students found the assignment components related to the course content, and they were interested in solving them. Furthermore, the majority of students reported that the ethics questions improved their ability to raise and reason about ethical issues of technology, and that they would like the department to introduce assignments like this in other courses as well.

6 Conclusions and Future Work

This paper shares approaches to embed ethics into 3 different undergraduate CS courses. Students in programming-intensive CS2 and CS3 courses who read and write about ethics can improve their CS ethics self-efficacy. These students reported increased confidence in their knowledge about how ethics come into play in their career, their ability to investigate and reason about the different approaches of addressing ethical concerns of technology, and their ability to define and defend their positions of how these ethical issues are addressed. Furthermore, if the assignments are relevant to the covered technical content, students will be interested in solving them even if they might appear as an extra load, and that these assignments will improve students' ability to raise and reason about ethical issues arising from technology. Students in senior level capstone courses might not get similar improvements, especially if they are required to take a standalone ethics course in their junior level.

In the future, we would be interested in trying a deep approach of embedding ethics assignments in CS2 and CS3 courses, and seeing whether we will get similar results as we got here from the shallow approach. For the deep approach, programming projects in both courses will be redesigned to put them in an ethical context.

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