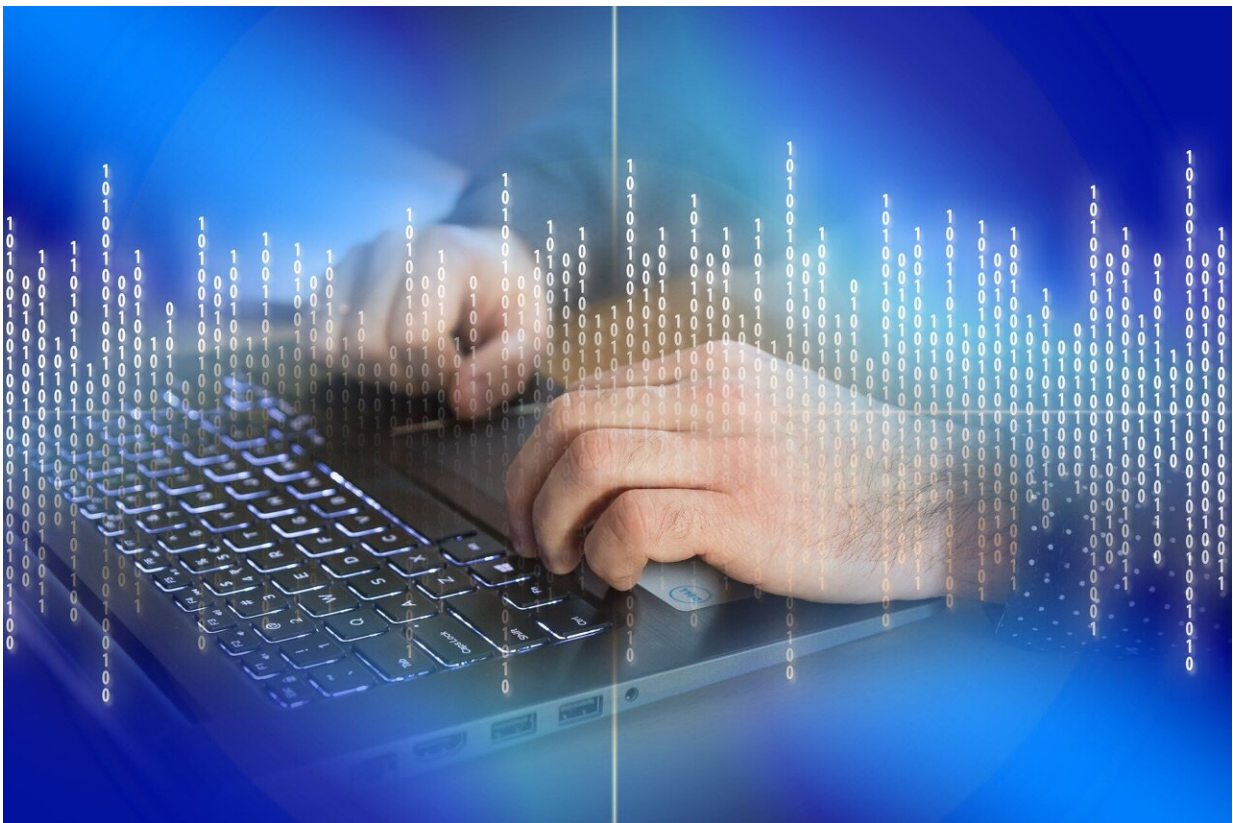


Initiative encourages computer science students to incorporate ethics into their work

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Computer science students at the University of Toronto are learning how to incorporate ethical considerations into the design and development of new technologies such as artificial intelligence with the help of a unique

undergraduate initiative.

The [Embedded Ethics Education Initiative](#) (E3I) aims to provide students with the ability to critically assess the societal impacts of the technologies they will be designing and developing throughout their careers. That includes grappling with issues such as AI safety, data privacy and misinformation.

Program co-creator Sheila McIlraith, a professor in the department of [computer science](#) in the Faculty of Arts & Science and an associate director at the Schwartz Reisman Institute for Technology and Society (SRI), says E3I aims to help students "recognize the broader ramifications of the technology they're developing on diverse stakeholders, and to avoid or mitigate any negative impact."

First launched in 2020 as a two-year pilot program, the initiative is a collaborative venture between the department of computer science and SRI in association with the department of philosophy. It integrates ethics modules into select undergraduate computer science courses—and has reached thousands of U of T students in this [academic year](#) alone.

Malaikah Hussain is one of the many U of T students who has benefited from the initiative. As a first-year student enrolled in CSC111: Foundations of Computer Science II, she participated in an E3I module that explored how a data structure she learned about in class laid the foundation of a contact tracing system and raised [ethical issues](#) concerning data collection.

"The modules underlined how the software design choices we make extend beyond computing efficiency concerns to grave ethical concerns such as privacy," says Hussain, who is now a third-year computer science specialist.

Hussain adds that the modules propelled her interest in ethics and computing, leading her to pursue upper year courses on the topic. During a subsequent internship, she organized an event about the ethics surrounding e-waste disposal and the company's technology life cycle.

"The E3I modules have been crucial in shaping my approach to my studies and work, emphasizing the importance of ethics in every aspect of computing," she says.

The program, which initially reached 400 students, has seen significant growth over the last four years. This academic year alone, total enrollment in computer science courses with E3I programming has exceeded 8,000 students. Another 1,500 students participated in E3I programming in courses outside computer science.

In recognition of the program's impact on the undergraduate student learning experience, McIlraith and her colleagues—Diane Horton and David Liu, a professor and associate professor, teaching stream, respectively, in the department of computer science, and Steven Coyne, an assistant professor in the department of philosophy with a cross appointment to computer science—were recently recognized with the 2024 Northrop Frye Award (Team), one of the U of T Alumni Association Awards of Excellence.

Horton, who leads the initiative's assessment efforts, points to the team's paper showing that after participating in modules in only one or two courses, students are inspired to learn more about ethics and are benefiting in the workplace. The paper is [published](#) in the *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*.

"We have evidence that they are better able to identify ethical issues arising in their work, and that the modules help them navigate those issues," she says.

Horton adds that the findings build on [earlier assessment work](#) showing that after experiencing modules in only one course, students became more interested in ethics and tech, and more confident in their ability to deal with ethical issues they might encounter.

The team says the initiative's interdisciplinary nature is key to delivering both a curriculum and experience with an authentic voice, giving instructors and students the vocabulary and depth of knowledge to engage on issues such as privacy, well-being and harm.

"As a philosopher and ethicist, I love teaching in a computer science department," says Coyne. "My colleagues teach me about interesting ethical problems that they've found in their class material, and I get to reciprocate by finding distinctions and ideas that illuminate those problems. And we learn a lot from each other—intellectually and pedagogically—when we design a module for that class together."

E3I is founded upon three key principles: teach students how—not what—to think; encourage ethics-informed design choices as a design principle; and make discussions safe, not personal.

"Engaging with students and making them feel safe, not proselytizing, inviting the students to participate is especially important," says Liu.

The modules support this type of learning environment by using stakeholders with fictional character profiles that include names, pictures and a backstory.

"Fictional stakeholders help add a layer of distance so students can think through the issues without having to say, "This is what I think,"" Horton says. "Stakeholders also increase their awareness of the different kinds of people who might be impacted."

McIlraith adds that having students advocate for an opinion that is not necessarily their own encourages empathy, while Liu notes that many have a "real hunger" to learn about the ethical considerations of their work.

"An increasing number of students are thinking, 'I want to be trained as a computer scientist and I want to use my skills after graduation,' but also 'I want to do something that I think will make a positive impact on the world,'" he says.

Together, the E3I team works with course instructors to develop educational modules that tightly pair ethical concepts with course-specific technical material. In an applied software design course, for example, students learn about accessible software and disability theory; in a theoretical algorithms course, they learn about algorithmic fairness and distributive justice; and in a game design course, they learn about addiction and consent.

Steve Engels, a computer science professor, teaching stream, says integrating an ethics module about addiction into his fourth-year capstone course on video game design felt like a natural extension of his lecture topic on ludology—in particular, the psychological techniques used to make games compelling—instead of something that felt artificially inserted into the course.

"Project-based courses can sometimes compel students to focus primarily on the final product of the course, but this [module](#) provided an opportunity to pause and reflect on what they were doing and why," Engels says. "It forced them to confront their role in the important and current issue of gaming addiction, so they would be more aware of the ethical implications of their future work and thus be better equipped to handle it."

By next year, each undergraduate computer science student will encounter E3I modules in at least one or two courses every year throughout their program. The team is also exploring the adoption of the E3I model in other STEM disciplines, from ecology to statistics. Beyond U of T, the team plans to share their expertise with other Canadian universities that are interested in developing a similar program.

"This initiative is having a huge impact," McIlraith says. "You see it in the number of [students](#) we're reaching and in our assessment results. But it's more than that—we're instigating a culture change."

More information: Diane Horton et al, Do Embedded Ethics Modules Have Impact Beyond the Classroom?, *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1* (2024). [DOI: 10.1145/3626252.3630834](#)

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