Online Ethics Center
FOR ENGINEERING AND SCIENCE

Normalizing Ethical Reasoning in Mathematics as a Foundation for Ethical STEM

Year

2023

Description

The OEC Project Pages are intended to cultivate a community of practice and allow ethics researchers, educators, and practitioners to more effectively disseminate their work. This Project Page provides a detailed overview and relevant resources for an on-going science or engineering ethics project. Once you've explored this project, visit the "Projects" section under "Resources" to see more ethics projects.

Body

Project Summary

Mathematicians, with some exceptions, have not described what it means to practice and use mathematics ethically. This has contributed to a culture permissive of data-related scandals, questionable professional practices, and decreased public trust in science.. By integrating ethical reasoning (ER) into undergraduate mathematics classes, we can begin to alter the perception that, if mathematics features abstract and theoretical constructs, then the mathematics practitioner has no ethical responsibility. Considering the ‘mathematics practitioner’ to be both the

user of, and the contributor to, mathematics, this proposal seeks to normalize ER as a regular component of mathematical practice. By targeting mathematics courses such as Calculus, Differential Equations, and Linear Algebra, which are foundational for many STEM programs, we take a holistic approach to normalizing ER, a formal stepwise process that can be learned and improved over a career, to foster integrity in STEM research as well as practice.

This project seeks proof of this concept, building on a published developmental model of ER, and a national survey of mathematics practitioners' perceptions of aspects of ethical practice that were derived from mathematics, statistics, and computing. We build on a published developmental model of ethical reasoning, and a national survey of mathematics practitioners' perceptions of aspects of ethical practice that were derived from mathematics, statistics, and computing (the results of which we refer to as the "proto-guidelines") We will invite diverse participants to a catalytic workshop in Year 1, to develop learning outcomes featuring ER in their respective mathematics course contexts, and draft supportive teaching materials. Participants will implement and revise their materials, formally evaluating their effort, and documenting their effects in their respective higher education contexts. Throughout Year 2, participants will share their work with stakeholders, including non-instructor stakeholders through focus groups with business, industry, and government about their perceptions of building ER capabilities in users of, and contributors to, mathematics. This input will be useful in formulating authentic cases and stakeholder analysis problems that instructors can use and refine. In Year 3, participants will attend national and regional hackathons where instructors of other foundational mathematics courses, and at different student levels, can adapt the tested ER instruction materials to promote implementation among a broader set of learners.

This project seeks to foster integrity in both the use of, and contribution to, mathematics. Rather than wait until practitioners have committed to a career in research, we target instructors of, and students in, math courses that are foundational for diverse STEM fields and seek to introduce a learnable, improvable skill set (ethical reasoning). Specifically, we will address the following research questions:

Which ER knowledge, skills, and abilities are most adaptable for use in undergraduate mathematics courses? Do these materials have measurable effects on student attitudes about ethical mathematical practice and/or STEM?

Does the integration of ER, the proto-guidelines for ethical mathematical practice, or workshop participation lead to differences in instructors' attitudes towards mathematical practice? Among participants (instructors, stakeholders, hackathon participants, and students), do they perceive that their mathematics practice is more ethical?

What barriers do participants and stakeholders identify to the integration and normalization of ER, and the idea of "ethical mathematical practice", into higher education mathematics courses? What reproducible and transferable strategies help overcome those barriers?

Intellectual Merit

Mathematics instructors will create and pilot new ER teaching materials authentic to their courses. These materials will be informed by stakeholders and student outcomes, and then shared/hacked for wider use. Proof of the concept will come from uptake (and hacking) of these materials. This in turn will be an indicator of the extent to which integrating ER in mathematics courses can achieve normalization of ethical reasoning in mathematics.

Broader Impact

Teaching ER in mathematics classrooms prepares the future STEM researcher, the future mathematician, and the future user of mathematics. Additionally, teaching ER in mathematics classes for non-majors and non-future researchers increases all learners' understanding of the power and responsibility of mathematics and data. Normalizing ER organically with mathematics problems can efficiently establish a foundation that supports more ethical STEM, both in research and in applications. Developing ER-capable instructors in foundational mathematics courses could serve as a basis for sustaining action, research, and conversations about ethical practice of mathematics, and other STEM fields.

Project Leadership

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