PRIME Ethics: Purdue's Reflective & Interactive Modules for Engineering Ethics

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Description

This activity is considered an NAE Exemplar in Engineering Ethics Education and was included in a 2016 report with other exemplary activities. The activity describes the development of a pedagogical and ethical framework to better allow students to practice their ethical reasoning skills.

Body

Exemplary features: Pedagogical design that is transferable and reproducible; progressive learning design and approach to teaching ethical reasoning

Why it’s exemplary: Our multidisciplinary team of engineering, communication, and ethics educators has developed an innovative, interactive learning system for enhancing students’ ethical reasoning skills as well as their satisfaction and engagement with engineering ethics education. We first addressed the need for enhancing ethical reasoning by developing a pedagogical framework of Scaffolded, Interactive, and Reflective Analysis (SIRA) that extends beyond case-based analyses. Second, we created a coherent framework for ethical reasoning applicable to engineering by articulating a principle-based approach, Reflexive Principlism. Third, to better engage students in ethics education we developed four learning modules, each deliverable in a hybrid format for stand-alone course or embedded curricular application. Additionally, we developed an Ethics Transfer Case tool to assess students’ transfer of ethical reasoning. To disseminate this work, we have published several articles based on our research findings and have begun sharing these modules and learning system with ethics educators for testing in their institutions.

Program description: For an engineer to design, practice, or lead ethically, individually or in a team, she must have competence in ethical reasoning skills, especially in light of increasingly complex social and ethical issues facing engineering. Our interdisciplinary team has developed and assessed an innovative approach and a series of interactive learning modules for enhancing the ethical reasoning skills of engineering students. We have refined and tested this pedagogical and theoretical approach to ethical decision making through multiple iterations (2012–2015) with over 60 students (senior undergraduate and graduate students, and practicing engineers) from various backgrounds. Our system of five interactive, multimedia learning modules is designed to both enhance students’ satisfaction and engagement with ethics and develop effective ethical reasoning skills. The student learning objectives framing this learning system are (1) Identify and describe ethical issues in the context of historical and developing technology and engineering practice; (2) Follow a structured, interactive, iterative reasoning process to reach a supported decision in response to complex ethical deliberations; and (3) Reflect on their ethical reasoning process over multiple case studies to reevaluate the coherence between the principles, codes, and theories involved in any given case.

The educational research goals of the project center around two core questions: (1) What is the impact of this learning system on the development of students’ ethical reasoning, and their satisfaction and engagement with engineering ethics education? (2) What components of this learning system contribute to change in students' ethical reasoning ability and to their satisfaction and engagement? Each of the five modules in the learning system challenges students to move through six stages of reflective analysis. Collectively, the varied cases we have developed expose students to diverse stakeholder perspectives, conflicting value claims, and contemporary ethical problems. The first module teaches the foundational Reflexive Principlism approach to ethical decision making that students apply to all subsequent cases. The next four case-based modules include a historical disaster (Kansas City Skywalk), two cases evaluating emergent medical technologies (pediatric heart valve distribution and diagnostic device development), and a novel approach to the 2010 Deepwater Horizon oil spill. Together the cases explore a range of ethical questions focusing on the specification and balancing of the principles of respect for autonomy, nonmaleficence, beneficence, and justice. The diverse range of ethical, epistemic, social, and systemic issues encountered throughout these cases has proven particularly impactful for enhancing engineering students' ethical reasoning skills.

We designed, delivered, and tested this learning system in several teaching modes, from residential courses to hybrid in-class/online to a primarily asynchronous online format. In all modes self-paced individual learning offered in a multimedia context is complemented with highly interactive small-group discussions. For the multimedia context we partnered with an innovative educational media company to build an interactive system of integrated resources embedded in actual student deliberations. Students continue deliberations in small groups of 4–5 to attempt to resolve a complex ethical issue.

The staged process of this pedagogical approach is as follows: (1) Establishing Knowledge: Exposure to the case context, scenario, and facts. (2) Perspective-Taking: Individually investigating multiple stakeholders' perspectives. (3) Compare & Contrast: Juxtaposition of student and stakeholder perspectives. (4) Inducing Conflict: Evaluation of expert (technical and ethical) opinions. (5) Justification & Decision Making: Consensus building in a small group case report determining and justifying the most ethical course of action. (6) Reflection and Reflectivity: Reflection on the balancing and application of principles. The epistemic and ethical complexity of cases increases as students work through each stage in each module. The six-stage structure is scaffolded, with higher levels of supportive materials in the earlier stages to assist students in gaining knowledge and confidence in their responses and ethical reasoning ability. The direct role of the instructor shifts from content expert to facilitating coach as the module progresses to discussion and analysis of more complex ethical issues. The final stage of meta-reflection challenges students to reflect on what they have learned and how their ethical reasoning process developed throughout the case. The final stages of the module challenge the student to higher levels of ethical reasoning consistent with those measured by validated ethical reasoning assessment instruments.

As the foundation to the SIRA pedagogical system, we formulated Reflexive Principlism, an ethical reasoning approach that is particularly applicable in engineering. It leads the decision maker to internalize a reflective and iterative process of specification, balancing, and justification of four core ethical principles—beneficence, nonmaleficence, justice, and respect for autonomy—in the context of specific case constraints, much like an engineering design process. Reflexive Principlism also addresses a pressing need in engineering ethics for a coherent ethical reasoning approach that is applicable to complex cases in an engineering context. This approach provides structure to ethical reasoning while allowing the flexibility for adaptation to varying contexts through specification and balancing of the principles. As an example, in the context of the Deepwater Horizon case study, when considering the ethicality of deeper and riskier drilling in the Gulf of Mexico, Reflexive Principlism challenges students to integrate stakeholder perspectives (e.g., of BP executives, local business owners, marine life) in their decision-making process; this adds richer specification to the principles in the case context.

Last, we developed and validated an Ethics Transfer Case tool, an innovative rubric-based assessment that evaluates students' transfer of the Reflexive Principlism approach to ethical issues beyond the course. The tool evaluates ethical reasoning along four core components of Reflexive Principlism: (1) identification and implications of the four ethical principles, (2) specification of where, when, how, by what means, and to whom the principles apply, (3) justification, or coherence between the ethical decision, the principles, and codes, and (4) reflectivity, the conscious deliberation on the process of reasoning and decision outcomes.

The PRIME Ethics learning system develops ethical reasoning skill using complex, realistic ethical cases that address both micro- and macroethical issues relevant to engineering practice and professional leadership.

Assessment information: We have continually refined and evaluated our PRIME Ethics learning system using a strategy of both quantitative and qualitative instruments to assess students' ethical reasoning skills and their satisfaction and engagement with engineering ethics education. To assess impact on students' ethical reasoning development we triangulated results among three quantitative assessment measures: (a) the well-established and regularly applied Defining Issues Test-2 (DIT2), (b) the newly developed, engineering-specific, moral development assessment tool, the Engineering Ethical Reasoning Instrument (EERI), and (c) our novel Ethics Transfer Case method. The DIT2 and EERI assessment tools measure developmental stages of ethical reasoning (based on Kohlberg's schemas) in a general and engineering context, respectively. Higher scores indicate a greater tendency toward postconventional thinking. Analyzing changes in the pre- and postcourse measures with the EERI taken by more than 60 students indicated significant increases in their ethical reasoning levels. Similar but less significantly positive changes were observed with the pre- and postmeasures with the DIT2. To provide a more granular assessment of the specific elements of ethical reasoning changes in students, we used our Ethics Transfer Case tool for the three most recent semesters. Initial evaluation of differences between pre- and postcourse scores indicated a significant increase in students' ethical reasoning using Reflexive Principlism, specifically along the components of identification, specification, and justification; however, reflectivity indicated a slight, albeit nonsignificant, increase. To assess the impact on students' satisfaction and engagement with engineering ethics education, we used a mixed methods approach with quantitative and qualitative measures: (a) a subset of items extracted from the Student Engineering Ethical Development survey to assess satisfaction and engagement; (b) a new survey instrument to assess the efficacy of our SIRA pedagogical approach; (c) a quantitative assessment of components perceived to be most effective by students along dimensions of engagement, providing new information, understanding ethics, developing critical thinking, and guiding decision making; and (d) a semistructured interview with students at the end of the course. Preliminary findings indicate that students' satisfaction with their ethics education increased in all measures after completing the learning system. Two components were repeatedly ranked most effective: (1) multimedia case videos were highly effective for engaging students and providing new information, and (2) videos of interactive student deliberations were most important to understanding ethics, developing critical thinking, and guiding decision making.

These findings provide empirical support for the efficacy of Reflexive Principlism combined with a SIRA pedagogical framework as an innovative approach to successfully engage engineering students in ethics education and enhance their ethical reasoning skills. The PRIME Ethics learning system contains highly interactive media and deliberations that encourage active engagement with learning, uses complex ethical cases that connect directly to engineering practice addressing both micro- and macroethical issues, provides an innovative theoretical approach and structure to enhance the level of ethical reasoning, and can be delivered in a hybrid online and in-class format as a stand-alone course or embedded in a curriculum.

Additional resources:

1. PRIME Ethics: https://engineering.purdue.edu/BME/PRIMEEthics

Rights

Resource Type

Educational Activity Description

Parent Collection

NAE Exemplars in Engineering Ethics Education

Topics

Evaluation and Assessment
Pedagogical Approaches
Case Study Method

Discipline(s)

Engineering
Teaching Ethics in STEM