Piloting an Adaptive Ethical Decision-Making Tool for Engineering Students

Dr. Vignesh Subbian, University of Arizona

Vignesh Subbian is an Assistant Professor of Biomedical Engineering, Systems and Industrial Engineering, member of the BIO5 Institute, and a Distinguished Fellow of the Center for University Education Scholarship at the University of Arizona. His professional areas of interest include medical informatics, healthcare systems engineering, and broadening participation in engineering and computing. Subbian's educational research is focused on ethical decision-making and formation of identities in engineering.

Dr. Linda R Shaw, University of Arizona

Linda R. Shaw, PhD, LPC, CRC is the Director of the Doctoral Program in Counselor Education and Supervision and a Professor in the Master's program in Counseling at the University of Arizona, where she teaches classes in both group counseling and ethics. She served as a member of the American Counseling Association (ACA) Ethics Revision Task Force for the 2014 ACA Code of Ethics revision and as the Chair of the CRCC Code of Ethics Revision Task Force for the 2017 revision to the Professional Code of Ethics for Rehabilitation Counselors. Dr. Shaw also served as Vice-Chair of the Commission on Rehabilitation Counselor Certification (CRCC) and as chair of the Ethics Committee for CRCC. Dr. Shaw's research focuses on disability human rights, ethics in counseling and healthcare, professional issues in rehabilitation counseling and group counseling. She has published and presented widely on issues related to ethical behavior, professional practice and professional issues in rehabilitation counseling.

Work-in-Progress: Piloting an Adaptive Ethical Decision-Making Tool for Engineering Students

Introduction

Ethical and social issues in engineering practice are becoming highly prevalent and multifaceted because of the growing complexity of technology, the nature of public policies, and digital disruption in our society. This necessitates that students have a stronger understanding of ethical and societal implications of their work, and are equipped to make well-reasoned decisions that are consistent with their personal and professional values. In this work, we present a pedagogical tool to enhance ethics education and better prepare engineering students in dealing with ethical issues related to their practice as well as emerging technologies. The prototypical ethical decision-making tool builds upon an existing framework, which parallels the engineering design process and provides students with series of steps for identifying pertinent ethical and sociotechnical issues, applying a range of ethical theories, and arriving at well-informed decision.

Background

There exists a number of ethical decision-making models that borrow from multiple fields and theoretical perspectives and seek to equip engineering students with a methodology for addressing even very complex ethical dilemmas [1]–[3]. These models are important additions to the ethics curriculum as they allow for movement beyond deontological approaches and incorporate ideas drawn from consequentialist ethical approaches (consideration of the consequences of various actions) and virtue ethics (focus on reflecting whether one's actions are consistent with the type of virtuous person one might wish to be). Most of the decision-making models developed for the field of engineering education to date are logically sequenced steps designed to reduce stress and to guide the student through a series of logical actions that usually include gathering pertinent data, generating potential courses of action, evaluating the possible courses of action using a number of different criteria, and arriving at a decision that is presumed to be the best possible outcome.

Limitation of Current Models: While the development and use of these models in ethics education is a promising step forward, their efficacy in engineering education may be less than optimal due to insufficient focus on internal and external context in engineering-specific models. Several authors have noted the limitations of applying a model that stresses highly cognitive, rational approaches to a process that is undoubtedly influenced by non-rational factors [4]–[7]. A limitation of engineering ethical decision-making models proposed to date is that they often do not include steps that acknowledge that choices are also likely to be heavily influenced by the personal and professional experiences and value systems of the decision-maker, and do not include a process by which they are asked to subject these underlying biases to a logical and rational analysis. Additionally, as Nair and Bulleit propose, it is necessary to create an educational experience that allows for ethical considerations "to be brought up naturally" [8]. Thus, there is a need for a pedagogical tool that will allow students to develop skills within the areas of micro ethics, pertaining to individual responsibility, and macro ethics, to ensure the integrity of the collective ethics of engineering practice.

Methods

The development of the ethical decision-making tool was informed by the conceptual framework for engineering student's ethical development, which is built upon the Inputs-Environment-Output model [6]. Here, the *inputs* include students' personal and professional characteristics, the *environment* is the overarching college experience that comprises of institutional culture (e.g., campus climate, peer environment) and individual student experiences (formal curricular and co-curricular experiences), and the *output* is the overall ethical development that includes ethics knowledge, ethical reasoning, and ethical behavior. In addition to this conceptual framework, the tool adapts and extends work by Bero and Kuhlman [3] to (1) include deontological, consequentialist, and virtue ethics concepts, (2) addresses unconscious biases and contextual influences on decision-making, (3) emphasizes values of the professional practice of engineering, in addition to drawing parallels to the engineering design process. The tool development process was also augmented by cross-disciplinary review of best-practices, input from ethics experts, engineering faculty, students, and practitioners. The ethical decision-making tool was piloted in a dual-level (undergraduate and graduate) engineering course at the University of Arizona.

Results

A prototypical version of the ethical decision-making tool is shown in Table 1. The tool is organized into five steps: (i) identifying an ethical problem, (ii) gathering facts and context, (iii) exploring different decision-making options, (iv) making a decision, and (v) testing and monitoring the consequences of the decision. Each of these steps include guiding questions to help students approach the problem with an engineering mindset as well as apply ethical concepts. For example, the tool intentionally requires students to explore various decision options using different ethical approaches (deontological, consequentialist, and virtue ethics). The guiding questions also probe personal values and relevant past experiences that will potentially help reveal some unconscious biases to the student.

As a part of one of the required course activities, 42 students (39 from engineering and 3 from non-engineering disciplines) used the tool to explore ethical implications of technology in healthcare and biomedicine. We plan to use the Ethical Competency Assessment Framework proposed by Zhu and Jesiek [7] as a basis for student assessment across three areas – ethics knowledge, contextual knowledge, and attitudes. Each guiding question in the tool can be mapped one or more of these three areas and then assessed on a scale of 1 to 5 with 5 being effective and 1 being not effective. Such an assessment is a part of our ongoing work.

Conclusion

This work-in-progress paper includes a pragmatic, prototypical ethical decision-making model for use in engineering education. The proposed model has the potential to promote intuitive decision-making among students when used in different contexts and different stages in their educational experience. With repeated (rather than single) and intentional exposure to the tool across the curriculum, students will develop an intuition to readily identify and tackle ethical issues in their engineering profession. Further development of the model and evaluation of its success and limitations in enabling ethical reasoning and improved decision-making skills are warranted. Future work will investigate the utility of using the model in promoting adaptive,

ethical decision-making as well as increasing awareness of equity and social justice among engineering students.

Table 1. *Prototypical Worksheet for Ethical Decision-making*

Step I: Identify a problem 	***What is the ethical dilemma?*** *Note: Be as descriptive as possible*
Step II: Gathering facts and Context 	***Where is this dilemma taking place? In other words, in what context is this problem taking place?*** ***Who are the stakeholders involved?*** ***What are the relevant facts of the dilemma?*** ***What facts are not known? In other words, is there any information you wish you had?*** ***Describe factors (ex: your personal values, past experiences) that may affect your decision?*** ***Describe any policies and regulations related to the dilemma?***

	What are relevant ethical codes related to the dilemma?
Step III: Explore and Brainstorm options. 	***What are the various decision choices available for the dilemma?*** *Which option complies with your duties and obligations?* *Which option will produce the most good and do the least harm?*

	Which option best respects the rights of all who have a stake? *Which option treats people equally or proportionately?* *Which option leads you to act as the sort of person I want to be?* ***What are the consequences of each choice?***
Step IV: Make a decision. 	***Based on all of the above approaches, which option would you eventually pick and why?***
Step V: Test and monitor the decision 	***How can your decision be implemented with the greatest care and attention to the concerns of all stakeholders?*** In other words, how will you control for the negative consequences of this choice? ***How will you monitor your decision?***

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References

[1] M. Davis, "Teaching Ethics across the Engineering Curriculum," in *International Conference on Ethics in Engineering and Computer Science*, 1999.

[2] L. Fan, “Decision-making models for handling ethical dilemmas,” *Proc. Inst. Civ. Eng.*, vol. 156, no. 4, pp. 229–234, 2003.
[3] B. Bero and A. Kuhlman, “Teaching ethics to engineers: Ethical decision making parallels the engineering design process,” *Sci. Eng. Ethics*, vol. 17, no. 3, pp. 597–605, 2011.
[4] M. Rogerson, M. Gottlieb, and M. Handelsman, “Nonrational processes in ethical decision making.,” *Am. Psychol.*, vol. 66, no. 7, pp. 614–623, 2011.
[5] A. Tjeltveit and M. Gottlieb, “Avoiding the road to ethical disaster: Overcoming vulnerabilities and developing resilience.,” *Psychother. Theory, Res. Pract. Train.*, vol. 47, no. 1, p. 98, 2010.
[6] C. Finelli, M. Holsapple, and E. Ra, “An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development,” *J. Eng. Educ.*, vol. 101, no. 3, pp. 469–494, 2012.
[7] Q. Zhu and B. Jesiek, “A Pragmatic Approach to Ethical Decision-Making in Engineering Practice: Characteristics, Evaluation Criteria, and Implications for Instruction and Assessment,” *Sci. Eng. Ethics*, pp. 1–17, 2016.
[8] I. Nair and W. M. Bulleit, “Framing Engineering Ethics Education with Pragmatism and Care: A Proposal,” in *American Society for Engineering Education Annual Conference & Exposition*, 2018.