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Engineering Ethical Curricula: Assessment and Comparison of Two Approaches

In this paper, we assess two approaches for delivery of engineering ethics: a full semester ethics course and an engineering course that includes a discipline-specific ethics module. These represent two common approaches to teaching engineering ethics; each has benefits and drawbacks. As engineering curricula already tend to be crowded, adding an additional course may prove difficult. It is not clear, however, that adding a few ethics-based modules to existing courses will sufficiently develop ethical sensitivity and judgment in the student. On the other hand, a benefit of the module approach is that it is much easier to tailor to the student's discipline.

Our assessment focuses particularly on the effectiveness of each mode in improving moral or ethical judgment. We use the second edition of the Defining Issues Test (DIT), which is a test to measure moral reasoning based on the stages of moral theory progression as identified by Kohlberg. We analyze improvement of moral reasoning ability for each class pre and post ethical instruction and compare the results to a control class with no explicit ethical instruction. We also evaluate moral reasoning development by demographics to identify potential differences.

Students who enrolled in "Ethics and the Technical Professions" (ETP) (N = 129 of final sample) received a full semester on ethical reasoning in the context of professional topics offered by the School of Public Policy and taught by a faculty member with a Ph.D. in Philosophy. A second subset of students (N = 109) took "Modeling in Industrial Engineering" (MIE), which is a general introduction to the types of models (conceptual and computational) and methodologies used in the industrial engineering field. These students received two lectures on ethics, worked through two short ethics cases in class and had an ethics case given as a group lab assignment. The final subset of students (N = 26) served as the control group, with no ethical instruction at all in an industrial engineering class called "Probability with Applications" (PA). The last two courses are taught by faculty in the School of Industrial and Systems Engineering and are generally taken by Sophomores. The total sample who took both the pre- and post-test includes 264 students (197 males, 66 females, and one unspecified respondent).

A primary measure of assessment in our study is the P score, which is a numerical index of moral reasoning developed originally by Kohlberg. The P score indicates the prevalence of post-conventional thinking on the part of each subject given as a percentage from 0 to 95. Rest and

his collaborators also developed a new index to measure moral reasoning in the DIT-2, called the N2 score, which takes into account both the prevalence of postconventional reasoning and the avoidance of preconventional reasoning or personal interest schema. A t-test with equal variance was used to test for differences between groups on measures such as the P score and N2 score.

The effect sizes for the P and N2 scores in the ETP class indicate that the full-term ethics course had a small effect on these measures (since the effect sizes are less than 0.2). Contrariwise, the effect sizes for the MIE class suggest that the integrated ethics modules actually had a small negative impact on the DIT measures. Most importantly, the t-tests comparing the pre- and post-test differences for each of the experimental classes to the control group difference found that neither form of ethical instruction produced an improvement in any of the measures over that seen in the control group. This suggests that any improvement seen from the pre-test to the post-test is primarily due to the students' familiarity and experience with the test and not the result of ethical instruction. We also analyzed the sample by gender, age, academic class, major, and political and religious beliefs.

One important limitation of our study is that the DIT-2 measures only one component of moral conduct; while it is surely important to help students to improve their moral judgment, it is just as important to foster students' ability to recognize situations that call for ethical judgment. There is a further problem that a general measure of moral judgment may not reflect the discipline-specific judgment that may be required in professional settings. In ongoing work, we are developing several assessment tests specific to science and engineering.

Ethics is clearly an important issue in science and engineering, underscored by recent allegations of fraud in the sciences. Our results of the experimental groups compared to the control group suggest that the approaches that many universities use to provide ethical instruction to engineers is not sufficient to improve general ethical reasoning ability as measured by the DIT. In the end, our study serves as an initial comparison with modest implications for curriculum design and implementation, implications that must be developed and tested further in subsequent studies at Georgia Tech and elsewhere. The study also provides evidence of the need to understand and improve our methods for incorporating ethics education in engineering, as well as further develop our assessment methods of our pedagogy.

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