# AC 2011-1585: WE CAN'T GET NO SATISFACTION!: THE RELATIONSHIP BETWEEN STUDENTS' ETHICAL REASONING AND THEIR SATISFACTION WITH ENGINEERING ETHICS EDUCATION

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# *We can't get no satisfaction!*: The relationship between students' ethical reasoning and their satisfaction with engineering ethics education


## Abstract

Student satisfaction is a common metric for evaluating classes and other educational programs, and sometimes that satisfaction is seen as a proxy for effectiveness of those programs. For this paper, we examine student satisfaction within the context of engineering ethics education, examining the relationship between student satisfaction and ethical reasoning ability. As part of a national study of ethics education, we draw on survey data from 3,914 undergraduate engineering students, and results suggest that higher levels of ethical reasoning actually predict lower levels of satisfaction with ethics education. Further, the amount of ethics education and the methods through which it is taught also affect students' levels of satisfaction.


## Introduction

In a time of constrained budgets and growing demands from students, student satisfaction is often a factor in deciding which educational programs continue to be supported and funded. Program and course evaluations often rely on student satisfaction reports rather than more sophisticated assessments of effectiveness. In addition, published engineering education research uses student satisfaction as an outcome in evaluating education interventions and course offerings. Satisfaction has also been linked to student motivation and retention.

However, little research, has been conducted to analyze which student characteristics and experiences predict satisfaction with any type of higher education program, and this question is absent in the published research on professional engineering ethics education. In this paper, we consider how satisfaction with engineering ethics education relates to a student's ethical development and examine what factors can lead to greater student satisfaction with these programs.

## Literature Review

Despite its use as an evaluation tool and a proxy for program effectiveness and success, little research has been done on student satisfaction, particularly as it relates to engineering education. Even in published research on engineering education programs, some authors use satisfaction as evidence for program success[1,2,3], but little is known about how satisfaction relates to desired outcomes or the factors that contribute to satisfaction.

Although satisfaction in and of itself is not an ultimate goal of education programs, Astin[4] positioned satisfaction as an intermediate outcome for students, one that makes possible other more important outcomes. Kuh, Kinzie, Buckley, Bridges, and Hayek[5] included satisfaction as one of their eight components of college student success. Consequently, researchers have found that student satisfaction with their college experience consistently predicts many desirable student outcomes, including GPA[6,7,8], persistence[9], intellectual growth[8], and academic competence[10]. These studies, however, have approached satisfaction by looking at disciplines

across academia, and often at the college experience as a whole, rather than at satisfaction with individual programs or experiences.

In one of the few studies of student satisfaction specific to engineering education, Grimberg and colleagues[2] examined attitudes of students who participated in an undergraduate research program. They found that students who believed they had been successful in meeting the stated outcomes of the program were more likely to be satisfied with the program overall. This corresponds with earlier research[11] finding that satisfaction and performance are related. In this previous study, Bean and Bradley found that the influence of satisfaction on performance is bigger than the influence of performance on satisfaction suggesting that satisfaction can actually improve student's success; the empirical design employed by Grimberg and colleagues[2] makes possible this causal order. Further, Grimberg and colleagues also found that students showed higher levels of satisfaction when a program had been tweaked to relate more to students' demonstrated interests in environmental sustainability, suggesting that satisfaction derived, at least in part, from a personal interest in and connection with the material being presented.

Responding to a dearth of research at the time, in 1993, Lamport[12] urged researchers to devote more attention to issues of satisfaction; however, since then the issue has remained relatively under-researched, particularly in the area of engineering education and in relation to specific programs and education experiences. In this study, we hope to fill some of that gap, particularly as it relates to engineering education. Therefore, we examine the following research questions: *What is the relationship between students' ethical reasoning and their satisfaction with their engineering ethics education? How do characteristics of students and their ethics education experiences predict satisfaction with those experiences?*

**Conceptual Framework**

This model of students' engineering ethical development arises from the tradition of Astin's Inputs-Environments-Outputs (I-E-O)[4] model. Astin's model, which has long served as the dominant framework for studying college student outcomes, conceives of these outcomes as arising students' precollege characteristics and experiences their experiences within their institution's specific environment. Terenzini and Reason[13] expanded upon that to provide more detail on the ways that environments act upon students, including aspects of organizational context and curricular and co-curricular experiences. We have adapted the model to apply to engineering students across their entire college experience as a framework for analyzing data collected and drawing conclusions from the larger investigation of engineering ethics education.

Our conceptual model of ethical development conceives of five distinct, yet interconnected, domains affecting students' engineering ethical development: student characteristics, institutional culture, individual student experiences, formal curricular experiences, and co-curricular experiences. Student characteristics refer to a student's pre-college characteristics and experiences, including demographic characteristics and high-school behaviors. Institutional culture refers to the organizational, faculty, and peer environment at the institutional and departmental level, including faculty and student body composition. This institutional culture comprises formal and informal educational practices; academic policies and priorities, like the presence of an honor code; peer effects, like the prevalence of cheating; and a variety of other

characteristics. In addition to the institutional culture, the model also includes individual student experiences, acknowledging that despite a shared institutional culture, the individual experiences of students within that culture can vary widely. Included in those individual experiences are students' individual curricular (including both the classes taken and the type of instruction in those classes) and co-curricular experience (for example, student organization participation and internships).

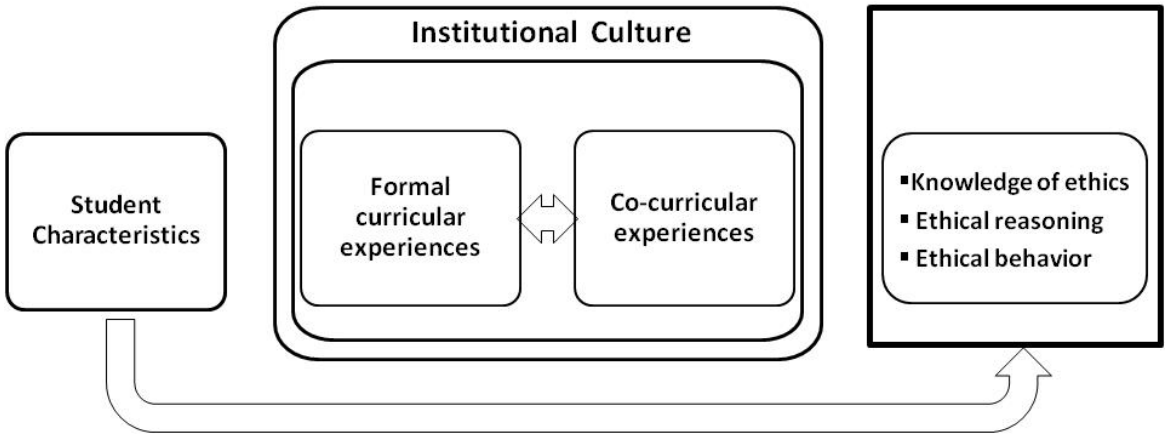


Figure 1. Conceptual model of engineering students' ethical development

The model conceives of students' engineering ethical development comprising three distinct constructs: knowledge of ethics, ethical reasoning, and ethical behavior. Knowledge of ethics refers to a student's understanding of professional engineering codes of ethics and other rules governing ethical behavior; ethical reasoning refers to a students' ability to apply reason when identifying ethical options to professional engineering ethical dilemmas, and ethical behavior refers to the ability of the student to engage in behaviors consistent with his or her reasoned ethical decision.

**Methods and Data**

We conducted these analyses using survey data collected as part of a larger, NSF-funded investigation of ethics education in undergraduate engineering programs. In the larger study, we collected qualitative and quantitative data from 19 partner institutions chosen to represent the wide range of institutions that provide engineering education. We selected partner institutions based on large enrollment in traditional engineering disciplines, diversity of student population, geographic location, and to represent a wide range of Carnegie Foundation classifications[14]. At 18 of these institutions (one institution is only a member of the quantitative sample), we conducted focus groups with engineering students ($n$=123) and faculty ($n$=111) and individual interviews with senior-level academic and student affairs administrators ($n$=36), asking participants about elements of the institutional culture that they saw as affecting students' ethical development, the ways in which ethics was incorporated into the students' experiences, and the ways in which students identified and approached ethical dilemmas. More information about survey construction is available in earlier papers by the authors[15,16].

Using the data from these focus groups and interviews, we created the Survey of Engineering Ethical Development. In this survey, students were asked questions related to measures of three types of ethical development: knowledge of ethics, ethical reasoning, and ethical behavior. In addition, they provided demographic information, details about their ethics education, and reported their satisfaction with their professional engineering ethics education to date.

**Sample**

The sample for this paper is composed of 3,914 engineering undergraduate students at 18 of these partner institutions (one of the 19 was removed from the quantitative sample due to technical problems in electronic survey recruitment). Students were recruited using a stratified random sampling process designed to balance responses by institution, institution type, and student class year. We recruited 17,344 students, for a total response rate of 22.6%. Freshmen are 32.6 % of the sample, sophomores 24.0%, juniors 22.8%, and seniors 20.9%. The student sample is 22.1% female, 11.6% under-represented minority (defined in this sample as students who are Black, Latino/a, Native American, or Pacific Islander), and 8% international students. Additional student characteristics can be seen in Table 1.

**Data**

Our data analysis focused on two variables of interest: satisfaction and ethical reasoning. The dependent variable for this study is a student's satisfaction with his or her college engineering ethics education. Respondents selected from among four response choices: very satisfied, satisfied, unsatisfied, or very unsatisfied. Descriptive data for this variable can be found in Table 1.

The primary independent variable is a student's level of ethical reasoning, defined in this study as his/her performance on the Defining Issues Test 2 (DIT2)[17]. The DIT2, based on Kohlberg's Theory of Moral Development[18] and Rest's Four Component Model of Moral Development[17,19], is an assessment of the moral judgment that respondents use to determine which possible responses to a dilemma are moral and which ones are not. Students with more highly developed moral judgment employ a more cognitively complex type of moral reasoning scheme that gives primacy to moral criteria (such as human rights or equality) rather than social conventions (existing laws and rules). Students with more highly developed moral judgment are more likely to take into account nuance and gray areas in more complex considerations of moral issues. For this study, we use the N2 Score, a continuous measure which estimates the degree to which respondents prioritize moral criteria and devalue adhering to social conventions in their moral judgment. Higher N2 Scores correspond to more highly developed students and more cognitively complex reasoning.

**Analysis**

We conducted the analysis in two phases. In the first phase, we employed analysis of variance (ANOVA) to determine whether there are statistically significant differences in students' ethical reasoning (measured by DIT2 N2 Score) based on their level of satisfaction with their ethics

education. A series of post hoc Tukey range tests was then performed to identify which group differences were significant.

In the second phase, we conducted an ordered logistic regression to determine which factors, including ethical reasoning, predict a student's level of satisfaction with his or her engineering ethics education. An ordered logistic regression model is a latent-variable model that assumes that ordered categorical outcomes represent a continuous variable and specific cutpoints) or thresholds) in the value of that variable correspond to the different categories in the observed ordinal variable. A student's observed value of the ordinal variable changes when his or her unobserved value on the latent variable passes one of the cutpoints[20,21]. For example, in this study, satisfaction in ethics education would be assumed to be a continuous variable, and each of the ordered categories – very unsatisfied, unsatisfied, satisfied, and very satisfied – can be thought of as representing a range of values for that underlying variable.

In addition to moral development (represented by the N2 score used in the ANOVA), other independent variables were included in the model; these variables included gender (with male as the reference group), class year (with freshman as the reference group), and cumulative college GPA (with an A average as the reference group). We also included dummy variables indicating whether a student identified as an under-represented minority (Black, Latino/a, Native American, or Pacific Islander), an international student, or a transfer student. We also included a measure of how important students believed learning about ethics was to their overall education. As the majority indicated ethics instruction was either "very important" or "important," we recoded this measure into a binary variable comparing those who responded "very important" to all other responses. Additionally, we also added institutional fixed effects for each institution in the sample (with the institution with the largest number of students serving as the reference group) in order to account for institutional-level variance in the outcome.

The model also included variables describing aspects of the students' ethics education. We presented students with a matrix of 54 specific types of ethics educations and asked them to indicate all they had experienced. We used these data to create a continuous measurement of the number of times they had experienced an episode of ethics education. We also asked students to indicate which one ethics education experience that they were most likely to consider when faced with an ethical dilemma. Subsequent questions measured the types of cognitive task they were asked to perform during that experience. These levels of cognitive task correspond to Bloom's Taxonomy of learning objectives – in order of complexity, knowledge, comprehension, application, analysis, synthesis, and evaluation. By including these variables, we are able to include measures of the magnitude of a student's ethics education, the applicability of that education, and the cognitive depth of that education. The lowest level on Bloom's Taxonomy (knowledge) was used as the reference group. Descriptive data for all variables can be found in Table 1.

Table 1. Descriptive analysis of dependent and independent variables (n=3914).

| | **Total Sample**[+] | **Very Unsatisfied** | **Unsatisfied** | **Satisfied** | **Very Satisfied** |
|---|---|---|---|---|---|
| Ethical reasoning N2 Score mean | 32.217 | 34.896 | 34.441 | 32.132 | 30.870 |
| Population | 3914 | 1.8% | 12.5% | 64.0% | 21.7% |
| Freshman | 1271 | 0.09% | 8.9% | 65.7% | 24.4% |
| Sophomore | 936 | 1.4% | 13.6% | 64.8% | 20.2% |
| Junior | 876 | 2.2% | 16.5% | 61.4% | 19.9% |
| Senior | 816 | 3.2% | 12.7% | 62.9% | 21.3% |
| Female | 857 | 1.6% | 15.9% | 61.2% | 21.2% |
| Male | 3015 | 1.8% | 15.4% | 61.9% | 20.9% |
| Under-represented minority | 453 | 3.3% | 10.6% | 59.2% | 26.8% |
| International student | 346 | 1.6% | 11.8% | 60.5% | 26.1% |
| Transfer student | 508 | 3.4% | 12.8% | 60.9% | 23.0% |
| Believe ethics education is "very important" | 1445 | 1.9% | 11.9% | 51.9% | 34.2% |
| Number of ethics education experiences | 6.59 | 5.75 | 5.85 | 7.00 | 8.40 |
| Cumulative College GPA of A | 1483 | 2.3% | 13.1% | 63.4% | 21.2% |
| GPA of B | 1788 | 1.2% | 12.0% | 65.3% | 21.5% |
| GPA of C | 517 | 1.9% | 11.5% | 64.1% | 22.5% |
| GPA of D or F | 45 | 0.0% | 15.9% | 52.3% | 31.8% |
| *Bloom's Taxonomy of Most Significant Ethics Education Experience* | | | | | |
| Justify decision you would make if confronted with same situation | 1707 | 1.2% | 9.7% | 62.4% | 26.7% |
| Evaluate ethical decisions of other engineers | 598 | 1.2% | 11.4% | 67.4% | 20.1% |
| Identify relevant information to make ethical decision | 350 | 1.1% | 13.5% | 69.9% | 15.5% |
| Apply information to new ethical situations | 215 | 0.5% | 9.4% | 63.2% | 26.9% |
| Recognize ethical concerns of professional engineers | 320 | 2.5% | 16.6% | 64.7% | 16.3% |
| Remember facts presented during activity | 141 | 4.3% | 12.8% | 66.7% | 16.3% |
| None | 313 | 3.2% | 18.9% | 60.9% | 17.0% |

Note. Group means for each level of student satisfaction are presented for continuous variables (N2 score and number of ethics education experiences). Percentages are presented for each continuous variable. [+]Due to missing data, not all groups of variables add up to the sample total.

## Results

Descriptive analysis of the data indicates students' N2 Scores were lower at each progressively lower level of reported satisfaction with engineering ethics education; Figure 2 shows that both the means and the entire distributions shift downward as students are more satisfied. ANOVA

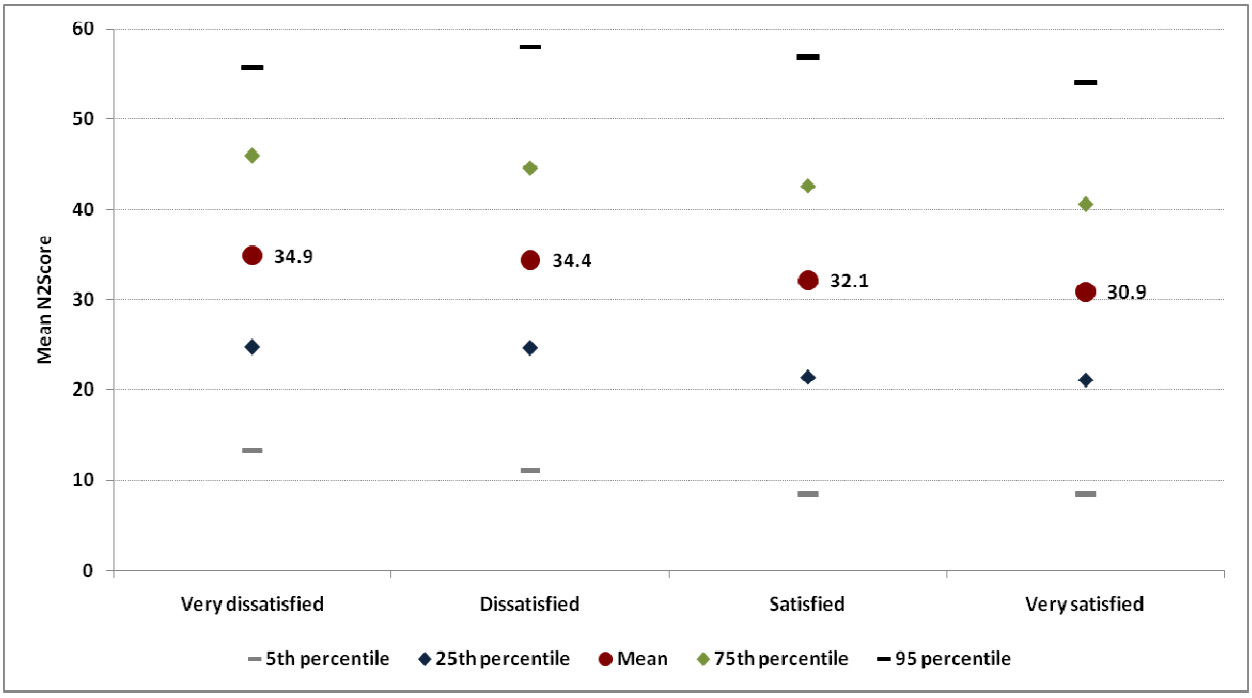


Figure 2. Difference in N2 Score means based on levels of satisfaction with engineering ethics education.

results indicate there are significant differences in students' levels of ethical reasoning based on their levels of satisfaction in their engineering ethics education ($f$=6.179; $p$<.001). A series of post hoc Tukey tests reveal that students who are *unsatisfied* with their ethics education have

Table 2. Significant differences in mean N2Score between levels of satisfaction with engineering ethics education.

| | Very Unsatisfied | Unsatisfied | Satisfied | Very satisfied |
|---|---|---|---|---|
| Very Unsatisfied | -- | -- | -- | -- |
| Unsatisfied | -- | -- | -- | -- |
| Satisfied | -- | 2.309** | -- | -- |
| Very satisfied | -- | 3.571*** | -- | -- |

Note. * $p$<.05; **$p$<.01; ***$p$<.001.

significant N2 Scores that are 2.309 higher than students who are *satisfied* (p<.01) and 3.571 than those who are *very satisfied* (p<.001); see Table 2 for significant differences in means

between satisfaction levels. The results suggest that the higher a student's level of moral reasoning, the less satisfied he or she is with ethics instruction.

With the relationship between satisfaction and N2 Score established in the first set of analyses, we conducted an ordered logistic regression to determine whether that relationship would persist while controlling for other factors and the level of impact of those other factors on satisfaction.

Results from the regression model suggest that this relationship does persist even when taking those other factors into account. In an ordered logistic regression, the odds ratio coefficients can be interpreted as the increase or decrease in odds of a student moving beyond one of the cutpoints in the latent variable into the next higher category with an independent variable increase of one-point (or one standard deviation for standardized results). The change in the odds ratio coefficient can be interpreted as a representation of movement along the linear latent variable assumed to be underlying the observed ordinal variable (in this case, level of satisfaction). A linear effect of each independent variable in the model would move the predicted value of that linear variable up or down, moving it closer to the cutpoint that leads to either the next higher or next lower level of satisfaction. Because that latent variable is unobserved, the ordered logistic regression model estimates the odds that the effect on that latent variable would be enough to move it past that cutpoint to the next category, for example, from "satisfied" to very satisfied."

In the model presented in Table 2, the standardized odds ratio indicates that a one standard deviation increase in N2 Score decreases the expected odds of moving to the next higher level of satisfaction by 10.1% ($p<.001$). Even when taking into account the other variables on the model, higher levels of ethical reasoning predict lower levels of satisfaction with ethics education.

In addition to measured ethical reasoning, other student characteristics also predicted satisfaction with engineering ethics education; these results help educators to understand what is likely to influence assessments of satisfaction. The variables predicting the largest percent change in odds are class year. Specifically, for sophomore, junior, and senior students, the odds of increasing their levels of satisfaction were lowered by 27.7% ($p<.01$), 47.9% ($p<.001$), and 49.2% ($p<.001$), respectively, compared to freshman students. Female students were also less likely to have higher levels of satisfaction relative to male students. Additionally, rating ethics education as "very important" compared to any other importance level predicted in increase in the odds of 39.1% ($p<.001$). Two of the 17 fixed effects were also significant predictors of changes in odds; however, to protect the identities of the institutions involved in the study and the students who attend them, we do not present those results in detail.

All independent variables relating to the students' engineering ethics education were also significant predictors of students' satisfaction. Increasing the number of ethics education experiences students reported predicted a 7.80% increase in odds of changing level of satisfaction; the standardized percent change was 44.3%. The likelihood that students were to consider their ethics education when encountering an ethical dilemma was measured on a five-point Lickert-type scale, and an increase of one point on that scale predicted a 40.5% increase in odds. Finally, although not all higher Bloom's Taxonomy levels compared to the lowest levels were significantly associated with students' levels of satisfaction, two of the five higher levels

(evaluating and applying ideas) increased the odds of having higher levels of satisfaction 26.3% ($p<.01$) and 19.4% ($p<.05$), respectively.

Table 2. Ordered logistic regression of students' level of satisfaction with their engineering ethics education

| | Odds Ratio Coefficient | Percent Change | Standardized Percent Change |
|---|---|---|---|
| Ethical reasoning N2 Score | .993** | -0.70** | -10.1** |
| Sophomore | .723** | -27.7** | -- |
| Junior | .521*** | -47.9*** | -- |
| Senior | .508*** | -49.2*** | -- |
| Female | .776*** | -22.4*** | -- |
| Minority | .985 | -1.5 | -- |
| International student | 1.263 | 26.3 | -- |
| Transfer student | 1.032 | 3.2 | -- |
| Believe ethics education is "very important" | 1.391*** | 39.1*** | -- |
| Number of ethics education experiences | 1.078*** | 7.8*** | 44.3*** |
| Likely to use most significant ethics education experience | 1.404*** | 40.5*** | -- |
| GPA of B | 1.000 | -.00 | -- |
| GPA of C | .992 | -0.8 | -- |
| GPA of D or F | 1.104 | 10.4 | -- |
| *Bloom's Taxonomy of Most Significant Ethics Education Experience* | | | |
| None | .864 | -13.6 | -- |
| Justify decision you would make if confronted with same situation | 1.101 | 10.0 | -- |
| Evaluate ethical decisions of other engineers | 1.263** | 26.3** | -- |
| Identify relevant information to make ethical decision | 1.075 | 7.5 | -- |
| Apply information to new ethical situations | 1.194* | 19.4* | -- |
| Recognize ethical concerns of professional engineers | .919 | -8.1 | -- |

Note. Institutional fixed effects were included in the model, but are not presented in table. Standardized percent change is presented for continuous variables only. *$p<.05$; **$p<.01$; ***$p<.001$.

## Conclusions and Implications

Results of this study provide insight into both the value of *satisfaction* as a proxy for *effectiveness* of engineering ethics education programs as well as characteristics of students and ethics education practices that predict higher levels of student satisfaction. In regards to the main relationship considered in this study – that between ethical reasoning and satisfaction with ethics education – the results suggest an inverse relationship between reasoning and satisfaction. That is, students who have higher levels of ethical reasoning ability tend to be less satisfied with their ethics instruction than students with lower levels of ethical reasoning ability. Because of the

cross-sectional nature and other limitations of this study, it is impossible to understand why this relationship exists, but we suggest several reasons why this might be the case.

First, the nature of advanced ethical reasoning may contradict common approaches to engineering ethics education. A higher N2 score on the Defining Issues Test 2 is indicative of a complex approach to moral and ethical dilemmas. While students who score lower are more likely to defer to external laws and regulations to guide their evaluation of moral dilemmas. Those who score higher are more likely to consider individual circumstances and gray area and arrive at a conclusion that privileges a sense of justice rather than laws and rules. Despite this understanding of advanced ethical reasoning, previous research has found that most ethics education in undergraduate engineering programs focuses on professional codes of ethical conduct[22,23] and other black-and-white solutions to ethical dilemmas, rather than helping students learn to recognize and reason through the complex factors that influence ethical decision-making and behavior. It seems plausible that students who are developed enough to prioritize more complex ethical reasoning would be unsatisfied with ethics education that does not address those complexities, but rather focuses on concrete codes and rules.

As students develop more complex ethical reasoning, they may reflect on their previous ethics education as less satisfactory, regardless of their opinion of it at the time. Our results indicate that satisfaction with ethics education decreases consistently after the freshman year. A significant amount of ethics education happens during the first year of engineering programs, often in an introductory general or discipline-specific engineering course[22,23] meaning the longer the time between those experiences and the students' evaluation of them, the less satisfying they are. As older students develop higher levels of ethical reasoning, they may reconsider their earlier experiences with ethics education through the new lens that their subsequent education and development has provided them. Despite initial satisfaction, those early educational experiences may not hold up upon later review. The effects of ethical reasoning and class year persisted even when controlling for the other factors, so this cannot be explained only by age or development. Further research is necessary to understand precisely how these two factors work together to influence satisfaction.

Beyond these student characteristics, the characteristics of their actual ethics education experiences were also significant predictors of satisfaction with ethics education. Students with higher numbers of ethics education experiences and those who believed in the usefulness of those experiences were more likely to be satisfied; also, those who were asked to complete cognitively complex tasks as compared to cognitively simple tasks were also more likely to be satisfied. These findings suggest that ethics education has an emphasis on a greater number of experiences, the applicability of those experiences to real dilemmas students may encounter, and more cognitively advanced tasks may all lead to greater satisfaction among students. Considering these factors when planning both experiences in individual classes and the distribution of ethics education across the curriculum could lead to students feeling more satisfied with their engineering ethics education in general.

Too often in higher education satisfaction is used as a proxy for effectiveness when evaluating courses and programs. Satisfaction is simpler and less time-consuming and resource-intensive to measure than effectiveness. However, these results suggest that for engineering ethics education,

determining that students are satisfied with the educational experience does not mean the experience has increased their ethical reasoning abilities. Using student satisfaction to assess ethics education programs may not provide results that allow educators to draw valid conclusions about the effectiveness of those programs in developing students' ethical reasoning.

While satisfaction alone should never be the ultimate goal of educational activities, it does have a place alongside effectiveness. As discussed earlier in this paper, satisfaction with education can improve students' motivation to achieve in specific areas. Additionally, in times of shrinking budgets and more demands of "customer satisfaction" from students and their families, student satisfaction – and a lack of satisfaction – can have an impact on which programs and initiatives receive funding and are prioritized by administrators. Understanding what predicts students' satisfaction will help educators and administrators both understand what those satisfaction ratings are telling them and which types of programs and approaches may lead to higher levels of satisfaction. Further research should address ways that ethics education programs can be designed to improve both effectiveness and satisfaction.

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