The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
ASEE
Paper ID #44335

Shifting Views in Changing Times: Towards a Mixed Methods Study Examining Faculty and Student Perceptions on Engineering Ethics

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Introduction

It is well accepted by both engineering education practitioners and researchers that developing ethical engineers is critical for preparing engineering students to meet the obligations of professional practice upon entering the workforce. Yet despite changing society contexts, and in an era where active changes are being seen in post-secondary engineering students (e.g., Sottile et al., 2021; Sottile, Cruz, & McLain, 2022) engineering ethics education largely looks the same as it did a generation ago. This paper re-examines the question of engineering ethics education with an eye towards evaluating how students and faculty respond to relatively modern engineering ethical situations.

Literature Review

A Case for Case Studies

As Martin, Conlon, and Bowe (2021) point out, "[c]ase studies are considered to be the most popular method to teach engineering ethics" (p. 47). Case studies are so ubiquitous in engineering ethics education practice that some engineering faculty cannot articulate why they have chosen to adopt the pedagogical approach in their own classrooms. As case studies are conceptualized for this purpose by the profession, students inductively (Merry, 1954) consider situations or scenarios intended to simulate things they may see in professional practice (Herreid, 1994). Despite their popularity, utilizing case studies is not entirely without concern. While case studies sync well with problem-based learning currently in vogue in engineering education, case selection and design has traditionally been unprincipled (Dolmans et al., 1997). The depth and richness of cases is another point of contention. Reid (2012) examined that question in the context of first-year engineering students and found the situation mixed – while richer cases appeared to stimulate more student discussion, pre- and post-instruction survey data Reid collected could hardly point to differences in student outcomes.

Situational Ethics

In his seminal article, Joseph Herkert (2005) pitched considering individual, professional, and social reference frames for engineering ethics. Accepting that premise, then, two broad categories of ethical situations arise, specifically microethical situations (e.g., individuals or the internal affairs of a given engineering profession) and macroethical situations (e.g., an engineering profession's social responsibility considered collectively) (Herkert, 2005). This exists against a backdrop of increased attention on companies' efforts on corporate social responsibility (CRS), given that "companies perform their CSR duty to fulfill their social obligations not only to extend their market reach but also as a strategy to fulfill the social obligation[s] placed on firms by society" (Lin, Banik, & Yi, 2016, p. 108). Looking at these side-by-side, it is almost unsurprising that some researchers such as Smith et al. (2021) would call for the need for grounding engineering ethics education around CRS efforts to enhance students' role ethics.

Codes of ethics arise frequently in engineering ethics education (Herkert, 1999) which is unsurprisingly given their role in engineering practice. Codes of ethics proliferate across the engineering profession, for example, from the National Society of Professional Engineers (2019), the American Institute of Aeronautics and Astronautics (2023a, 2023b), the American Society of Civil Engineers (2020), and the Institute of Electrical and Electronics Engineers (2020). As an example, Xu et al. (2020) dovetailed the use of case studies, a code of ethics, and social media in a civil engineering education context. That said, the use of codes is not without controversy, particularly since they often fail to consider the increasingly globalized practice of engineering (Kline, 2001).

Academic Integrity

Many engineering educators conceptually link engineering ethics with academic integrity, with the general thinking in the profession being that by practicing academic integrity in one's educational years they would be practicing ethical decision-making needed for effective professional practice. As alluded to by Bertram Gallant and Rettinger (2022), this is perhaps not entirely unwarranted given prior findings that academic integrity violations by students should be conceptualized not as misconduct but instead as a developmental issue (Kibler, 1993a, 1993b). This developmental issue is long-running – extant literature (e.g., Hossain, 2022) suggests that students' academic integrity literacy skills are poor coming out of high school. Seider, Novick, and Gomez (2013) found that ethical philosophy training was effective for adolescent students, but by the time students reach post-secondary engineering education that ship has largely already sailed. Meanwhile, academic integrity practice is taking place under new circumstances as well; Lesage et al. (2024) recently looked at generative artificial intelligence for both laboratory report prose and for computer code in the mechanical engineering education context and found that while it had the potential to reduce barriers for students, it also posed questions about the longer-term integrity of academic assignments.

Measuring the Measurement Problem

Yet, while academic integrity incidents can be readily assessed (many institutions, including the author's, keep statistics), assessing ethical development is more challenging. Goldin, Pinkus, and Ashley (2015) go so far as to assess ethics education as an ill-defined problem. One significant complication is the need for indirect measurement of ethical development (Fife-Schaw, 2012). Despite the challenges, some researchers have experienced some success. For example, LaPatin et al. (2023) successfully measured ethical differences in engineering students between institutions and between educational years, and Esparragoza et al. (2019) successfully applied the Model of Domain Learning to measure engineering students' ethical learning.

Methods

Given the utility of survey-research (e.g., Sapsford, 2007), this study utilizes a scenario-based survey for College of Engineering (COE) faculty, graduate students, and undergraduate students at The Pennsylvania State University (Penn State). Penn State is a large, public, research-intensive institution located in the northeast United States. The survey featured a combination of Likert scale responses and open-ended responses; however, the instant article presents solely the quantitative results. This study was submitted for review by Penn State's institutional review board and was determined to be exempt.

For the Likert scale items, summary statistics were calculated, including sample sizes, means, medians, skew, kurtosis, and standard deviations. While sample sizes, means, medians, and standard deviations are likely familiar to the reader, skew and kurtosis merit comment. "The literal meaning of 'skew' is a bias, dragging, or distortion towards some particular value, group, subject, or direction" (Shanmugam & Chattamvelli, 2015, p. 89). If a sample is skewed to the left, the responses cluster on the higher side, with the median higher than the mean; if a sample is skewed to the right, the responses cluster on the lower side, with the median lower than the mean (Ott & Longnecker, 2010). Skew values of zero indicate symmetric distributions, positive skew values indicate distribution tails that point to the right, and negative skew values indicate distribution tails that point to the left (Minitab, 2023). On the other hand, "kurtosis measures the relative concentration or amassment of probability mass toward the center (peak) of the distribution" (Shanmugam & Chattamvelli, 2015, p. 92). Kurtosis values of zero indicate distribution peakedness consistent with a normal distribution, positive kurtosis values indicate greater peakedness relative to a normal distribution, and negative kurtosis values indicate lower peakedness relative to a normal distribution (Minitab, 2023). While interpretation of means is challenging with ordinal data, such data will be presented largely with the goal of facilitating meaning-making.

Hypothesis testing of between group differences and of within group differences occurred. The null hypothesis for all hypothesis tests focused on the measures of central tendency being equal, with the alternative hypothesis being that the measures of central tendency not being equal. Given that the proposed hypothesis is examining the question of equality, the statistics will be calculated via a two-tailed statistical test (Ott & Longnecker, 2010). Outside of certain specialty areas, engineers are generally more familiar with parametric statistics than they are with non-parametric statistics. However, the parametric t-test requires several assumptions: the absence of outliers, continuous data (i.e., interval or ratio data), independent measurements, random samples, normally distributed data, and that the variances for the two groups are the same (Verma & Abdel-Salam, 2019). While most of these assumptions are agreeable for this work, Likert scales immediately raise concerns with the continuity assumption given their reliance on ordinal data.

Much ink has been spilled debating whether the continuity assumption even really matters (compare, for example, Jamieson, 2004, with Norman, 2010). That said, "[s]cience, at its best, is a social activity" (Regehr, 2021, p. 78) – indeed, without a social component, normal science and paradigm shifts would not be possible (Kuhn, 1962). The current social paradigm in educational research is to favor non-parametric methods for Likert items, so this work will present non-parametric Mann-Whitney test for differences in median, which, as Ott and Longnecker (2010) point out, has been deemed equivalent to the Wilcoxon rank sum test (Conover, 1998). A key advantage of the Mann-Whitney test for our purpose is that it can handle ordinal data sets (Rosenstein, 2019) and can be used on skewed data sets so long as the distributions have (approximately) the same shape, even if shifted horizontally (Hogg, Tanis, & Zimmerman, 2020), though at the cost of usually being somewhat more conservative than parametric approaches.

Survey Instrument

I have previously set out the rationale for the development of the survey instrument in Sottile (2023), which this section of the paper summarizes. As an initial matter, and consistent with the review of the literature, "ethics surveys often involve scenario-based questions so that researchers can make post hoc judgements regarding subjects' apparent ethical knowledge" (Sottile, 2023, p. 3), which, of course, aligns with typical pedagogical approaches engineering faculty often use to teach engineering education (i.e., the case study). Two validated instruments have found special favor in engineering fields, namely, the Defining Issues Test 2 (DIT-2) (Rest et al., 1999) and the Engineering and Science Issues Test (ESIT) (Borenstein et al., 2010). Two main issues presented that counseled pursuing another approach – first, the DIT-2 and the ESIT are not publicly available, but more fundamentally neither instrument directly addresses some issues of current note in engineering ethics, so a new instrument was developed. Three scenarios were generated in Sottile (2023); see that reference for an explanation for the motivation behind each of the scenarios.

Scenario 1: Concealing Errors

Having been edited since the original draft publication (Sottile, 2023), the first ethics scenario presented respondents with a scenario featuring the issue of concealment of errors. The quantitative portion of the first scenario prompt was:

Please consider the following scenario when answering questions on this screen:

Imagine that you are a junior engineer working under the direction of a senior licensed professional engineer (P.E.) with many years of experience in bridge design. During a late-stage design review, significant concerns were expressed about the team's design possibly leading to an unacceptable level of vibration.

The P.E. overrules the concerns without discussion and prepares the bridge design for delivery to the project sponsor. When a member of your team asks about the resolution to the design concerns, the P.E. tells your colleague that if they raise the concern again the P.E. will have them fired.

[Question 1. Likert scale, responses choices: very unethical, somewhat unethical, neither ethical or unethical, somewhat ethical, very ethical]

Please select the response that best describes how you interpret the ethics of this scenario.

- [Q01.1] How ethical do you think it is for the P.E. to act this way?
- [Q01.2] How ethical would your peers think it is for the P.E. to act this way?
- [Q01.3] How ethical would current engineering professionals think it is for the P.E. to act this way?

Scenario 2: Code Sharing

Having been edited since the original draft publication (Sottile, 2023), the second ethics scenario presented respondents with a scenario featuring the issue of code sharing. The quantitative portion of the second scenario prompt was:

> Please consider the following scenario when answering questions on this screen:
>
> Imagine that you work for a contractor producing aerospace software for the U.S. Federal Government. A major deliverable deadline is rapidly approaching, but due to unexpected challenges in the software design phase the project is running well behind schedule.
>
> You notice a colleague scrolling on an internet code sharing website, Github. Your colleague notices you are glancing at their screen, so your colleague tells you that they found some code online that they can splice into the project to save significant time developing one of the software's features.
>
> [Question 04. Likert scale, responses choices: very unethical, somewhat unethical, neither ethical or unethical, somewhat ethical, very ethical]
>
> Please select the response that best describes how you interpret the ethics of this scenario.
>
> - [Q04.1] How ethical do you think it is for your colleague to use Github in this way?
> - [Q04.2] How ethical would your peers think it is to use Github in this way?
> - [Q04.3] How ethical would current engineering professionals think it is to use Github in this way?

Scenario 3: Artificial Intelligence Text and Image Generators

Having been edited since the original draft publication (Sottile, 2023), the third ethics scenario presented respondents with a scenario featuring the issue of utilizing artificial intelligence. The quantitative portion of the third scenario prompt was:

> Please consider the following scenario when answering questions on this screen:
>
> A major writing assignment is coming up for an engineering student's capstone design course during a very busy part of the semester. There are a few major sections of the paper that require mostly formulaic responses. A student in the course decides to use ChatGPT, an artificial intelligence chatbot, to write those sections of the paper for them.
>
> [Question 06. Likert scale, responses choices: very unethical, somewhat unethical, neither ethical or unethical, somewhat ethical, very ethical]
>
> Please select the response that best describes how you interpret the ethics of this scenario.
>
> - [Q06.1] How ethical do you think it is for the student to use ChatGPT in this way?

- [Q06.2] How ethical would your peers think it is to use ChatGPT in this way?
- [Q06.3] How ethical would current engineering professionals think it is to use ChatGPT in this way?

Survey Validation Activities

As I have noted elsewhere (Sottile, 2023, p. 5), "[f]ace validity is a significant concern with new survey instruments." For a survey instrument to be face valid, it must "appear[] to be measuring what it claims to measure" (Kline, 2000, p. 18). Towards that end, the survey was initially drafted in consultation with a survey research specialist. A draft of the survey was then presented (Sottile, 2023), underwent peer review, and was presented orally at the Spring 2023 ASEE Zone 1 Conference. Peer reviewers and conference session participants had positive feedback about the survey draft. A draft of the survey was then utilized as a series of in-class case studies by three faculty teaching ME 322 Engineering Design VI at Stevens Institute of Technology during April 2023, resulting in additional, helpful feedback from those faculty and students. Finally, the revised survey was presented to senior academic administrators in the COE of the host institution who reviewed the survey and provided a final round of feedback.

Results

The survey was deployed over a 4-week period between Monday, 02 October 2023 and Sunday, 29 October 2023 via Penn State's Qualtrics license. Subjects were recruited from the COE at Penn State at both its University Park location (for faculty, graduate students, and undergraduate students) and its World Campus location (for graduate students only) via opportunity sampling (Miles & Huberman, 1994). While the Penn State COE partially funded this project, the host was not in a position to assist in survey deployment. At the recommendation of the host the survey was distributed by various contacts the researcher had within each of the respective COE academic programs. Given this highly diffused recruitment strategy, response rates cannot be estimated as not all contacts confirmed that the survey was distributed to their respective populations and because student enrollment numbers fluctuate daily.

Prior to any analysis being done, in view of current best practices (e.g., Osborne, 2013) the survey data was cleaned. There were 14 substantive questions asked (Q01-Q07, with subparts for the Likert items, and including the qualitative portion of the survey omitted from the present article), so if a respondent omitted more than four of those responses, their survey response was sorted out of the data set intended to be used for data analysis. By doing so, the resulting data set available for analysis contained responses for respondents who completed at least two-thirds of the substantive portion of the survey. While the two-thirds cut-off was necessarily arbitrary, it was intended to balance the resulting sample size against having useful survey responses.

Typical undergraduate student respondents were traditionally aged Caucasian men of varying engineering majors. The undergraduate population had a weak representation of first-year students, but otherwise had a reasonably balanced representation of sophomores, juniors, and seniors. Typical graduate student respondents were fairly young (nearly 75% of the graduate student sample reported between 18 and 34 years old). Nearly half of the graduate student sample were men and roughly half identified as Caucasian, with graduate majors and degree types varying. Typical faculty respondents were middle aged (80% reported being between 35- and 64-years age) Caucasian men of varying engineering academic units. Most respondents reported being from North America and not being (students) or having been (faculty) a first-generation college student.

A key for the Likert coding scheme can be found in Table 1, with unethical views coded with lower integer scores than ethical views. As noted in the Methods section, an initial consideration was to see if the distributions between comparison pairs were broadly similar. By visual inspection, it appears that the response distributions were roughly comparable for all three scenarios (in some cases, perhaps with some shifting), so no indications were present to suggest that the Mann-Whitney test would not be usable. Test statistics (W-scores) are presented instead of z-scores in view of the collective interplay between sample sizes and the extant non-normality in the underlying response distributions. Summary statistics are reported in Table 2, between group hypothesis test results are reported in Table 3, and within group hypothesis test results are reported in Table 4.

Table 1. Coding Scheme for the Likert Items

Respondent Choice	Coding
Very Unethical	1
Somewhat Unethical	2
Neither Ethical or Unethical	3
Somewhat Ethical	4
Very Ethical	5

Summary Results

Significant skewing was present for most of the Scenario 1 (Q01, concealing errors) sub-items and significant kurtosis was also present. The interpretation of those findings is that in general the responses were largely tightly clustered towards respondents viewing the scenario as being relatively unethical. By comparison, relatively little skewing or kurtosis was present for most of the Scenario 2 (Q04, code sharing) sub-items. The interpretation of those findings is that in general the responses trended more towards a normal distribution, with respondents generally viewing this scenario with greater moral ambiguity. In contrast to the results for the first two scenarios, skew and kurtosis varied by respondent group for the Scenario 3 (Q06, artificial intelligence text and image generators) sub-items in inconsistent ways. Generalizing these summary results presents a perplexing challenge, as no consistent rationale pattern immediately presents itself, though a general observation can be offered that the Scenario 3 response distributions tended to be intermediate between the distributions for Scenarios 1 and 2.

Scenario 1: Concealing Errors

No between group comparisons achieved statistically significant differences for Q01. Looking within groups, faculty had a statistically significant different response ($p = 0.041$) between Q01.1 and Q01.2, and a statistically significant different response ($p = 0.032$) between Q01.1 and Q01.3, which together suggest that faculty thought their own perspectives differed from both their peers and from current engineering professionals. No other within group comparisons achieved statistically significant differences for Q01.

Table 2. Summary Statistics

Item	Population	N	M	Med	Skew	Kurtosis	SD
Q01.1	Faculty	31	1.065	1	3.73	12.72	0.250
	Graduate Students	48	1.500	1	2.43	4.79	1.167
	Undergraduate Students	73	1.178	1	4.45	23.00	0.609
Q01.2	Faculty	31	1.258	1	1.16	-0.70	0.445
	Graduate Students	47	1.596	1	2.08	3.53	1.136
	Undergraduate Students	73	1.315	1	3.06	12.73	0.664
Q01.3	Faculty	30	1.333	1	1.69	1.96	0.606
	Graduate Students	47	1.638	1	2.04	3.80	1.092
	Undergraduate Students	73	1.301	1	3.16	13.38	0.660
Q04.1	Faculty	30	3.067	3	0.01	-0.33	1.143
	Graduate Students	48	2.938	3	0.27	0.28	0.976
	Undergraduate Students	72	2.903	3	0.07	-0.61	1.115
Q04.2	Faculty	30	3.367	3	-0.02	0.82	0.890
	Graduate Students	48	3.125	3	-0.25	0.42	0.866
	Undergraduate Students	72	3.069	3	0.01	-0.68	1.053
Q04.3	Faculty	29	3.345	3	-0.10	-0.16	1.010
	Graduate Students	48	2.979	3	0.04	-0.14	0.911
	Undergraduate Students	72	2.458	2	0.61	-0.43	1.138
Q06.1	Faculty	30	1.867	1	1.11	0.27	1.167
	Graduate Students	47	2.234	2	0.81	0.07	1.165
	Undergraduate Students	70	1.914	2	1.38	2.21	0.989
Q06.2	Faculty	30	1.967	2	0.62	-0.44	0.928
	Graduate Students	47	2.404	2	0.59	-0.39	1.116
	Undergraduate Students	70	2.457	2	0.39	-0.39	1.086
Q06.3	Faculty	29	2.172	2	0.80	0.31	1.167
	Graduate Students	47	1.830	2	1.42	2.06	0.963
	Undergraduate Students	70	1.614	1	1.55	3.63	0.786

Scenario 2: Code Sharing

Looking between groups, undergraduate students had a statistically significant different response with both faculty ($p < 0.001$) and with graduate students ($p = 0.004$) for Q04.3, suggesting that undergraduate students perceived the views of current engineering professionals differently than both faculty and graduate students did. No other between group comparisons achieved statistically significant differences for Scenario 2.

Table 3. Between Group Mann-Whitney Test Results

Item	Comparison	Diff.	W	p
Q01.1	Faculty & Graduate Students	0	1,127.0	0.070
	Graduate & Undergraduate Students	0	3,113.0	0.114
	Faculty & Undergraduate Students	0	1,573.5	0.457
Q01.2	Faculty & Graduate Students	0	1,167.5	0.465
	Graduate & Undergraduate Students	0	2,975.5	0.361
	Faculty & Undergraduate Students	0	1,628.5	0.996
Q01.3	Faculty & Graduate Students	0	1,089.0	0.309
	Graduate & Undergraduate Students	0	3,099.5	0.082
	Faculty & Undergraduate Students	0	1,601.0	0.694
Q04.1	Faculty & Graduate Students	0	1,239.0	0.558
	Graduate & Undergraduate Students	0	2,926.0	0.904
	Faculty & Undergraduate Students	0	1,631.0	0.514
Q04.2	Faculty & Graduate Students	0	1,288.5	0.251
	Graduate & Undergraduate Students	0	2,968.5	0.719
	Faculty & Undergraduate Students	0	1,722.5	0.174
Q04.3	Faculty & Graduate Students	0	1,274.0	0.114
	Graduate & Undergraduate Students	1	3,426.0	0.004**
	Faculty & Undergraduate Students	1	1,944.0	<0.001**
Q06.1	Faculty & Graduate Students	0	1,026.0	0.115
	Graduate & Undergraduate Students	0	3,029.0	0.133
	Faculty & Undergraduate Students	0	1,428.0	0.487
Q06.2	Faculty & Graduate Students	0	1,018.5	0.099
	Graduate & Undergraduate Students	0	2,707.0	0.705
	Faculty & Undergraduate Students	0	1,247.5	0.037*
Q06.3	Faculty & Graduate Students	0	1,233.0	0.188
	Graduate & Undergraduate Students	0	2,961.0	0.252
	Faculty & Undergraduate Students	0	1,729.5	0.020*

$*p < 0.05$; $**p < 0.01$

Note. Differences between medians. p-values adjusted for ties.

Looking within groups, undergraduate students had a statistically significant different response (p= 0.001) between Q04.2 and Q04.3, and they had a statistically significant different response ($p = 0.012$) between Q04.1 and Q04.3, which collectively suggest that students thought their own perception would differ from both their peers and from current engineering professionals. No other within group comparisons achieved statistically significant differences for Scenario 2.

Table 4. Within Group Mann-Whitney Test Results

Group	Comparison	Diff.	W	p
Faculty	Q01.1 & Q01.2	0	883.5	0.041*
	Q01.2 & Q01.3	0	949.0	0.829
	Q01.1 & Q01.3	0	865.0	0.032*
Graduate Students	Q01.1 & Q01.2	0	2,214.0	0.382
	Q01.2 & Q01.3	0	2,174.5	0.601
	Q01.1 & Q01.3	0	2,152.0	0.155
Undergraduate Students	Q01.1 & Q01.2	0	5,015.5	0.040*
	Q01.2 & Q01.3	0	5,400.5	0.856
	Q01.1 & Q01.3	0	5,050.5	0.060
Faculty	Q04.1 & Q04.2	0	839.5	0.238
	Q04.2 & Q04.3	0	906.5	0.923
	Q04.1 & Q04.3	0	837.5	0.324
Graduate Students	Q04.1 & Q04.2	0	2,168.5	0.209
	Q04.2 & Q04.3	0	2,442.5	0.371
	Q04.1 & Q04.3	0	2,286.0	0.745
Undergraduate Students	Q04.1 & Q04.2	0	5,003.5	0.371
	Q04.2 & Q04.3	1	6,038.5	0.001**
	Q04.1 & Q04.3	1	5,826.0	0.012*
Faculty	Q06.1 & Q06.2	0	862.5	0.411
	Q06.2 & Q06.3	0	865.5	0.588
	Q06.1 & Q06.3	0	828.5	0.248
Graduate Students	Q06.1 & Q06.2	0	2,126.5	0.406
	Q06.2 & Q06.3	1	2,576.0	0.006**
	Q06.1 & Q06.3	0	2,457.5	0.072
Undergraduate Students	Q06.1 & Q06.2	-1	4,190.0	0.001**
	Q06.2 & Q06.3	1	6,053.0	<0.001**
	Q06.1 & Q06.3	0	5,352.5	0.059

$*p < 0.05$; $**p < 0.01$

Note. Differences between medians. p-values adjusted for ties.

Scenario 3: Artificial Intelligence Text and Image Generators

Looking between groups, faculty and undergraduate students had a statistically significant different response ($p = 0.037$) for Q06.2. Faculty and undergraduate students also had a statistically significant different response ($p = 0.020$) for Q06.3. Collectively, this suggests that the groups perceived the views of their peers and of current engineering professionals differently. No other between group comparisons achieved statistically significant differences for Scenario 3.

Looking within groups, graduate students had a statistically significant different response ($p = 0.006$) between Q06.2 and Q06.3, suggesting that graduate students thought the perceptions of their peers differed from those of current engineering professionals. Undergraduate students had a statistically significant different response between both Q06.1 and Q06.2 ($p = 0.001$) and between Q06.2 and Q06.3 ($p < 0.001$), suggesting that undergraduate students thought that that their perceptions different from their peers and they thought that their peers' views would differ from current engineering professionals. No other within group comparisons achieved statistically significant differences for Scenario 3.

Limitations

There are several limitations inherent to this work. Given the diffuse subject recruitment strategy, it is possible that ethically minded individuals are overrepresented in the sample (i.e., that ethically minded individuals would be more likely to respond to a voluntary survey on engineering ethics). Further, this survey examined individuals at one Research 1 institution in the United States and the results may to a degree reflect that (e.g., individual's views on code sharing may be influenced by institutional academic integrity culture and rules). Subjects were asked about their perceptions of the views of industry, but contemporaneous surveying of individuals from industry was not an available avenue at the time of this study.

Discussion

The fact that the quantitative results were relatively unremarkable for Scenario 1 (concealing errors) is itself perhaps unremarkable, insofar as concealing errors is a classic problem in engineering ethics that has been thought about at length. More intriguing were the results for Scenario 2 (code sharing) and Scenario 3 (artificial text and image generators), which were more "modern" challenges. For example, undergraduate students generally held statistically significantly different views relative to their perceived views of their peers and of industry on the ethics of code sharing, which is consistent with the author's personal observations of students at the host institution. The positionality of generative artificial intelligence is, perhaps unsurprisingly, unsettled in engineering ethics education, as it is across much else in the organizational field and across society more broadly. Yet generative artificial intelligence is not a problem likely to go away; accordingly, more attention is likely warranted towards adapting instruction to better align with addressing these more "modern" issues.

The perception gaps noted herein are consistent with contemporaneous findings in other engineering education contexts such as first-year engagement (Sottile et al., 2024). Prior findings that students' relationship with time itself have been changing (Sottile et al., 2021; Sottile, Cruz, & McLain, 2022) have relevance here: if students have reconceptualized their views of time and time management so that they "optimize to the constraint" in new ways, we can hardly be surprised by their tendencies to view some more modern engineering ethical situations differently than their faculty under similar reasoning. Engineering students are emerging engineers, ascending into a sociotechnical landscape much different than what existed when most of their faculty were themselves emerging into the profession. In an organizational field (especially in the Research 1 institutional context) where faculty attention is driven relentlessly towards research at the expense of teaching (Sottile, 2024b), one perceives that engineering educators might require special support from the engineering education research community and from faculty development professionals in adapting to such changing circumstances. On that basis, one may perceive a rich area for future work.

Directions for Future Research

Future work for this project will focus on fully analyzing the qualitative portion of the survey, and then using both the quantitative and qualitative strands to perform a wholistic mixed methods analysis. Future work may also fruitfully explore the possibilities for perception gaps with respect to other professional skills relevant to engineering education, and on useful supports for assisting engineering educators in transforming their teaching to meet challenges arising in present-day engineering ethics education.

Acknowledgement

The author gratefully acknowledges funding support from Penn State's College of Engineering. Any opinions, findings, conclusions, or recommendations presented in this paper are those of the author and do not necessarily reflect the views of Penn State or its College of Engineering.

Endnote

This work was adapted from Sottile (2024a) with permission from the Educational Research and Methods Division program chair for the 2024 ASEE Annual Conference and Exposition.

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